The Land Gap Report

2022

Governments' over-reliance on carbon removals could push ecosystems, land rights and food security to the brink with new land area equivalent to 50 percent of the world's croplands currently being required to meet targets. Climate pledges should focus on protecting and restoring existing ecosystems with carbon benefits.

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Foreword

This report is incredibly timely since a growing number of policy makers around the world are finally focusing on the relationship between land and climate change. The report convincingly outlines how current proposals that focus on land-based carbon removal do not take human rights seriously. Land-based carbon removal proposals ignore the presence of people and their land rights. When policy makers ignore local communities' and Indigenous peoples' land rights, they not only fall short of their human rights obligations, they also make local communities and Indigenous people's less resilient to climate change. If you harm people, you also harm the land.

This report explains how land-based carbon removal requires land-use change. These changes pose a significant risk to people's ability to access, control and steward land. Ensuring that people have access to land and protecting tenure rights provides them with the resources and security they need to adapt to climate change. Strong, secure land rights also allow people to employ changes that require significant work and resources and give them the stability they need to benefit from the gains that accrue in the medium and long term. What is at stake is nothing less than people's fate.

This report further clarifies why and how agroecology provides a way to mitigate and adapt to climate change and fulfill people's human rights. Agroecology is a science and a practice, the primary goal of which is to mimic ecological processes and biological interactions as much as possible in order to design production methods so that food producers' systems can generate their own soil fertility and protection from pests, and increase productivity. As an agricultural practice, agroecology is labour intensive and encompasses a range of production techniques derived from local experience and expertise that draw on immediately available resources. Thus, it also relies heavily on experiential knowledge, more commonly described as traditional knowledge. As a social movement, producer-based agroecology acts as an important driver for strengthening social cohesion through the gradual reduction of social inequalities, the promotion of local governance, sovereignty and the empowerment of local communities.

Studies continue to confirm that agroecological production can meet the global community's dietary needs and can lead to dietary diversity. In fact, recent reports of the Intergovernmental Panel on Climate Change have endorsed agroecology combined with food sovereignty as a viable way to adapt to climate change. Agroecological knowledge and skills, as well as international policy tools and platforms, are all readily available. In 2018, FAO developed a set of agroecological principles known as the 10 elements of agroecology of FAO. In 2019, the High-level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security developed a set of recommendations on the best possible pathways for just and sustainable food system transformations based on 13 agroecological principles. In 2021, the International Fund for Agricultural Development (IFAD) published a stocktaking report on agroecology looking at all 207 agroecology projects supported by IFAD across countries in its five regions, identifying further opportunities to scale up agroecological operations

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Acronyms

ACHPR	African Commission on Human and Peoples' Rights
AFOLU	agriculture, forestry and other land use
AGB	above-ground biomass
BECCS	bioenergy with carbon dioxide capture and storage
BGB	below-ground biomass
CO_2	carbon dioxide
CBD	Convention on Biological Diversity
CDR	carbon dioxide removal
CFM	community forest management
CIFOR	Centre for International Forestry Research
COP	Conference of the Parties
DACS	direct air capture and storage
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FLEGT	Forest Law Enforcement, Governance and Trade
FRA	Global Forest Resources Assessment
GAFF	Global Alliance for the Future of Food
GDP	gross domestic product
GHG	greenhouse gas
Gt	gigatonne
ha	hectare
HFLD	high forest, low deforestation
HLPE	High Level Panel of Experts on Food Security and Nutrition
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
IP	indigenous peoples
IPs and LCs	indigenous peoples and local communities
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change

IPES-Food	International Panel of Experts on Sustainable Food Systems
IUCN	International Union for Conservation of Nature
LMICs	low- and middle-income countries
NDC	Nationally Determined Contribution
NGO	non-governmental organization
NYDF	New York Declaration on Forests
OECD	Organisation for Economic Co-operation and Development
PA	protected area
PBL Netherlands	Netherlands Environmental Assessment Agency
RCP	representative concentration pathway
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RRI	Rights and Resources Initiative
SDG	Sustainable Development Goal
SEEA_EA	System of Environmental Accounting – Ecosystem Accounting
SRCCL	Special report on climate change and land
SSP	shared socioeconomic pathway
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNDROP	United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

The Land Gap Report

The total area of land needed to meet projected biological carbon removal in national climate pledges is almost 1.2 billion hectares – equivalent to current global cropland. Countries' climate pledges rely on unrealistic amounts of land-based carbon removal.

More than half of the total land area pledged for carbon removal – 633 million hectares – involves reforestation, putting potential pressure on ecosystems, food security and indigenous peoples' rights. Restoring degraded lands and ecosystems account for 551 million hectares pledged.

Current 'net accounting' methods assume that planting new trees offsets fossil fuel emissions or the destruction of primary forest, but this ignores scientific and ecological principles.

Evidence shows that indigenous peoples and local communities with secure land rights vastly outperform both governments and private landholders in preventing deforestation, conserving biodiversity, and producing food sustainably.

Agroecology promotes socioecological resilience by restoring ecosystem functions and services through biologically diverse agricultural and food systems, also a key approach to the realization of human rights in the context of climate change.

This report examines the area of land required to meet projected biological carbon removal in national climate pledges and commitments. We find that almost 1.2 billion hectares (ha) of land – close to the extent of current global cropland – are required to meet these pledges.

This finding shows that countries' climate pledges rely on unrealistic amounts of land-based carbon removal, which cannot be achieved without significant negative impacts on livelihoods, land rights, food production and ecosystems. For example, over half of this area (633 million ha) requires a land-use change to achieve the projected carbon removal, with the potential to displace food production including sustainable livelihoods for many smallholder farmers. Slightly less than half (551 million ha) would restore degraded ecosystems.

These findings suggest that countries need to reduce their reliance on land-based carbon removal in favour of stepping up emissions reductions from all sectors and prioritizing ecosystem-based approaches to restoration. We recommend that countries address four interlinked issues related to the use of land in their national climate pledges: (i) greater clarity over assumptions made about the extent, use and ownership of land in national climate pledges; (ii) prioritizing the protection of primary ecosystems over tree planting efforts, since the latter's mitigation benefits are negligible in the current critical response decade; (iii) ensuring that land-based climate mitigation measures build on and strengthen the rights of indigenous peoples, other human rights, livelihoods, and food sovereignty, and (iv) promote multifunctional strategies, such as agroecology, that contribute to socioecological resilience while supporting the realization of various human rights.

The land gap

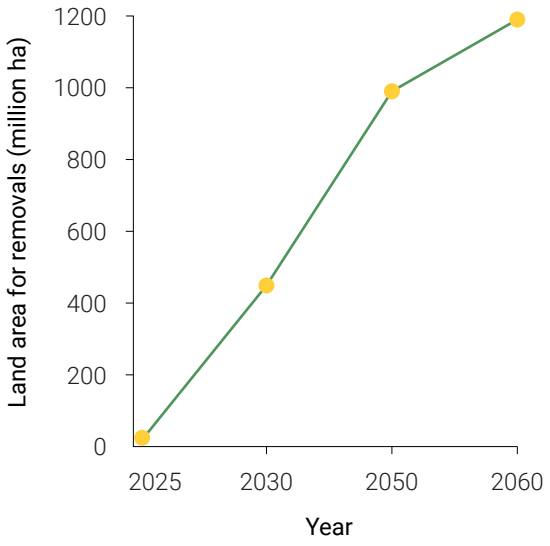
The growing momentum for climate mitigation has given rise to a new urgency around safeguarding the sustainability of ecosystems, land use and social justice. Net zero pledges by country Parties to the United Nations Framework Convention on Climate Change (UNFCCC) already cover 83 percent of global greenhouse gas (GHG) emissions, and additional pledges are coming from non-state actors, including the private sector. This climate mitigation momentum is crucial to keep global warming within the temperature goal of the Paris Agreement.

However, these pledges, collectively geared towards net zero, often rely on land-based carbon dioxide removals (CDR), which are then used to offset a theoretically equivalent amount of fossil fuel emissions in national greenhouse gas inventories. The much-needed momentum on climate action also raises serious concerns if the mitigation burden is shifted away from reducing fossil fuel emissions and onto land, local communities and ecosystems.

While other 'Gap' reports describe a gap between mitigation ambition and the emissions reductions needed to meet Paris

Carbon dioxide removal in national climate pledges

Countries' climate pledges rely on 451 million ha of land for carbon removals by 2030, another 533 million hectares by 2050, and another 200 million ha is pledged from one country for 2060. This reliance on land can be expected to increase as more countries make longer-term pledges.



Agreement goals, this report demonstrates the gap between governments' over-reliance on land for carbon mitigation purposes and the more limited role that land can play to meet competing needs, including CDR.

The Land Gap Report shows how countries' climate pledges, if implemented, will increase these competing demands made on land. The report quantifies the aggregate demand for land-based mitigation in the climate pledges submitted by Parties to the UNFCCC. A key finding is that countries' climate pledges would require almost 1.2 billion hectares of land to be prioritized for carbon dioxide removal. This land area is larger than the United States of America (983 million ha), and almost four times the area of India (329 million ha). Even more concerning is that over half of the land needed to fulfill climate mitigation pledges – 633 million ha – requires a land-use change through plantations and establishing new areas devoted exclusively to forests, which will compromise the rights of indigenous peoples, other human rights, livelihoods and food sovereignty (including the ability of local communities and smallholder farmers to feed themselves). Furthermore, the carbon removals achieved through plantations, afforestation and reforestation, will take a long time and hence not be sufficient in the next critical decade to contribute very much to limit peak global warming.

The other half of the 1.2 billion ha for carbon removal – 551 million ha – includes activities to restore degraded lands, including agroforestry, reduced harvest and regenerating degraded forests. This approach of seeking to maintain and augment carbon stocks in existing ecosystems holds more promise for climate and biodiversity and poses fewer threats to other dimensions of sustainability. However, the potential area available for expanding forest cover is uncertain and depends on restoration approaches which respect human rights and focus on the restoration of ecosystem function. Improved governance and stewardship of land and territories focused on these goals is sorely needed to achieve multiple inter-related objectives.

These findings have implications for governments' approach to land-based climate mitigation objectives, including carbon accounting, biodiversity conservation, and the rights and livelihoods of indigenous peoples and local communities (IPs and LCs).

Conserving primary ecosystems while respecting rights

Conserving all carbon-dense primary ecosystems, and in particular all remaining primary forest – boreal, temperate, and tropical – is critical to climate mitigation efforts, as they store far more carbon compared with harvested forests or plantations. Primary forests provide the reference condition for assessing change in ecosystem function in the past, as well as potential gains in the future. Patterns of biodiversity that evolve naturally or under indigenous stewardship comprise the most stable and resilient ecosystems and, within system limits, provide resistance to threats that are increasing with climate change such as pests, disease, drought, floods and fire. Thus, the carbon stored in ecosystems with higher levels of integrity is more stable and resilient.

A better understanding of the essential role of primary forests in regulating the global climate is needed. So too is better quantification of the size of the mitigation opportunity associated with ecosystem-based removals. Both factors could help accelerate transformative change. So too would an understanding of the importance of the stability, resilience and adaptive capacity of ecosystems for their persistence in a warming climate. Protecting the remaining primary forests and engaging in large-scale ecological restoration of degraded forests is essential to solving the overlapping biodiversity, climate change, social justice, and zoonotic disease crises.

Key factors to achieve transformation include: reforming the rules for carbon accounting; prioritizing forest mitigation actions; identifying and appropriately recognizing multiple ecosys-

tem functions and services; reducing the risk of loss of carbon stocks due to disturbance events by improving the integrity of forest ecosystems; and reforming policies and practices of governments, businesses and communities to promote synergistic and holistic solutions that foster socioecological resilience.

Secure land rights

Evidence to date shows that IPs and LCs with secure land rights vastly outperform both governments and private landholders with respect to the multiple goals of preventing deforestation, conserving and restoring biodiversity, and producing food sustainably. Moreover, there is impressive overlap between primary ecosystems and the collective landholdings of IPs and LCs. However, recognition of rights to land, resources and/or territory has been partial, limited and fraught, while subject to opposition, violence and elite capture. Despite this, IPs and LCs have proven to be effective stewards of the world's biodiversity and natural resources, reflecting essential contributions that have thus far been inadequately recognized by states, and poorly supported by the broader international community. We draw attention to the ways in which addressing current gaps in capacity and funding lead to important gains in forest conservation and sustainable use with positive benefits for livelihoods.

We argue that the most effective and just way forward for using land-based carbon removals is to ensure that IPs and LCs have legitimate and effective ownership and control of their land and adequate opportunities to represent their own interests and engage on equal terms – ultimately exercising self-determination – in the pursuit of actions that directly or indirectly affect their lands, territories, livelihoods and collective rights.

Food system transformation towards agroecology

The world's industrial food system represents more than a third of global anthropogenic GHG emissions, by far the largest sector contributor. Industrial cropping, ranching, and land-use changes contribute a quarter of those food-sector emissions. Cropland managed unsustainably is the main anthropogenic source of nitrous oxide, with synthetic nitrogen fertilizers accounting for most of the global increases in emissions of this potent GHG. Likewise, large-scale conventional agriculture (mainly livestock and rice production) contributes 36 percent of global anthropogenic methane emissions. Land conversion for industrial agriculture and agricultural intensification are the two prime causes of global biodiversity loss through land use change.

The GHG intensity of industrial food production needs to be cut drastically and negative impacts on biodiversity and climate reduced. We argue for agroecological approaches, which restore and conserve ecosystem functions and services based on biologically diverse systems, while strengthening local livelihoods, respecting cultural values and local knowledge systems and promoting site-specific technical and social innovations. Agroecological management that replaces monocrops with crop diversification (such as intercropping, crop rotation, cover crops, prairie strips, and others) has positive effects on reducing GHG emissions and other pollutants. It also has positive effects on productivity, decreasing the so-called 'yield gap' compared to conventional agriculture. Agroecological approaches that build organic matter in soils contribute to carbon sequestration and greater resilience to extreme climate events. The contributions of agroecology to equity, justice, inclusion, and dignifying working and living conditions – expressed in improved social well-being, sustainable livelihoods, food sovereignty, and health – make agroecology relevant to the promotion and implementation of a myriad of human rights.

Mitigation and carbon accounting

Current approaches to carbon accounting fail to recognize how the risk of carbon stock loss varies widely depending on ecosystem integrity. They instead consider carbon fungible, and all carbon stocks are in effect assumed to have the same stability, longevity and resilience.

Most problematic, particularly given the use of 'net accounting' to justify achieving 'net zero emissions', is the presumed fungibility of fossil fuel carbon and ecosystem carbon. This assumption has mistakenly allowed removals from forest re-growth to offset an equivalent amount of the emissions from fossil fuel use, industrial agriculture and forest harvesting in national GHG inventories. Similarly, current carbon accounting practices fail to recognize that carbon lost from primary forests is not offset by planting trees. With lower ecosystem integrity in monoculture systems, susceptibility to extreme events, and the risk of carbon loss, are higher. Harvesting mature trees with the expectation of re-growth creates a decades-long carbon debt by permanently reducing the carbon stored in the landscape and increasing the stock in the atmosphere. Similarly, the role of wood products for mitigation has been misrepresented, creating the false impression that carbon stored in products has a greater benefit than in forest and other ecosystems.

These deficiencies would be addressed if governments were to adopt a more comprehensive approach to carbon accounting based on stocks and flows that allows the true change in the carbon stock of the atmosphere to be defined and the mitigation benefits of forests and other ecosystems to be recognized. The rules for carbon accounting need to make provision for reporting information about the carbon stocks and flows in all biologic carbon pools, which is related to the condition of the ecosys-

tem and the impacts of human activities on each pool. This comprehensive carbon accounting system is incorporated in the UN System of Environmental Economic Accounting Ecosystem Accounting (SEEA_EA). The SEEA_EA system provides an important opportunity to bridge the silos of the Rio Conventions (UNFCCC, UNCCD and CBD) and inform the Sustainable Development Goals by revealing synergies among these international commitments and demonstrating the benefits from integrating climate and biodiversity actions.

Conclusion

Governments' reliance on land-based carbon removal in current climate pledges is unrealistic in terms of available land and unfeasible in terms of the human rights tensions that devoting land primarily to carbon removal implies. Land-based carbon removals make an important contribution to mitigation efforts only if they are accompanied by rapid and deep cuts in fossil fuel emissions from all sources. Land-based carbon removals must complement and not offset fossil fuel and other emission reductions. Carbon accounting practices need to provide clearer and more accurate information on the true impacts of different mitigation actions. Information is needed that shows the mitigation benefits of protecting primary forests while restoring ecosystems for more integral, stable and resilient carbon removals. Restoration improves ecosystem functions and services that are relevant for broader ecological and social benefits. Food system transformation based on agroecological principles is critical for achieving socioecological resilience to climate change, as well as the promotion and realization of human rights, and in particular the right to food.

Key messages for decision makers

- **The 'net' in net zero must not distract from emissions reductions now.** Framing climate targets as 'net zero' risks undermining mitigation action by allowing a trade-off between emissions reductions and removals. Targets based on net accounting obscure the extent to which countries are relying on land removals for meeting climate mitigation commitments.
- **Ecosystem restoration as a removal could help get us closer to 1.5 °C if emissions reductions in all sectors happen now.** The scale of CDR that can be achieved sustainably via ecosystem restoration is sufficient to be compatible with a 1.5 °C temperature limit only when coupled with the most ambitious reductions in emissions from all sectors – such as fossil fuel use, industrial agriculture, deforestation and forest degradation related activities.
- **We don't have the land availability for unrealistic removals claims.** Countries current pledges implicate a land area equal to the total global food growing base; changes in land use proposed in those pledges are equivalent to half of global crop land. This reliance on land use change is deeply unrealistic and if implemented will exacerbate existing social and ecological challenges caused by demand for land. There is no available land for expanding energy crop or monoculture plantations.
- **Focusing on tree planting deflects attention from the urgency, immediate and multiple benefits of protecting and restoring forest ecosystems.** Keeping existing forest ecosystems healthy and functional is the most important contribution of land towards meeting a 1.5 °C temperature limit by avoiding emissions and maintaining stable carbon stocks.
- **Agroecology contributes to socioecological resilience and requires higher institutional support.** Agroecological principles contribute to climate change adaptation and mitigation by restoring and enhancing ecosystem functions and services, while respecting and strengthening livelihoods (particularly of IPs and LCs), providing enough healthy and diverse food, and fostering human rights promotion and realization.

CHAPTER 1

Introduction

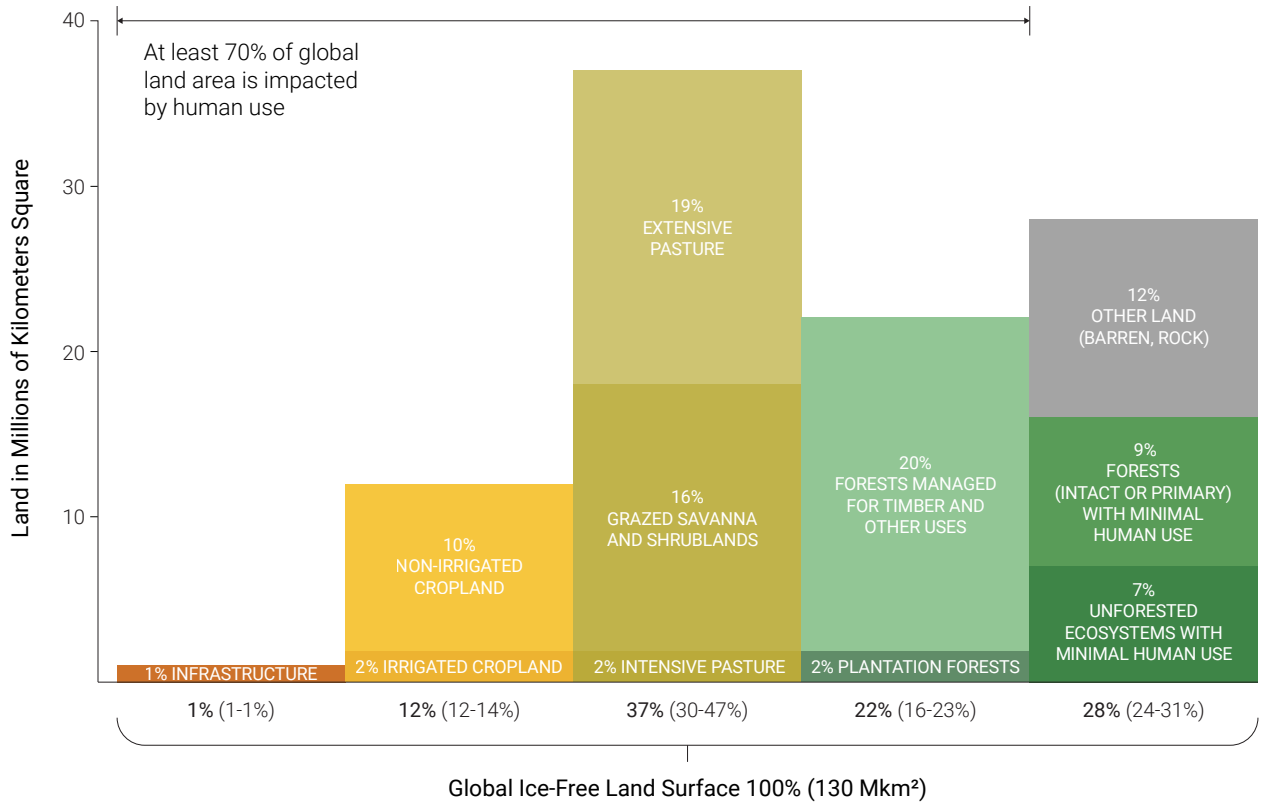
Land is critical to human well-being, biodiversity, planetary regulation and the provision of other ecosystem functions. Land is also central to addressing the accelerating and entwined crises of climate, biodiversity, food and social vulnerability and inequality. All these issues imply an urgent need for rights-based and equitable approaches to protect and restore degraded land and ecosystems and safeguard biodiversity.

The many and often competing demands made on land reflect an overall increasing pressure. Today, more than 70 percent of terrestrial land surface is used by humans (IPCC, 2019a). Land-use change is a leading driver of biodiversity loss, as well as a contributor to climate change. At the same time, many climate mitigation approaches that rely on land, such as large-scale afforestation efforts, threaten to exacerbate, rather than help to solve the biodiversity crisis, as well as threatening the livelihoods of indigenous peoples and other vulnerable and land-dependent communities (IPBES 2019; Allan *et al*., 2022; Meyfroidt *et al*., 2022).

The question of land has gained renewed importance as parties to the United Nations Framework Convention on Climate Change and its Paris Agreement, and non-state actors including major corporations, are offering pledges to achieve 'net zero' emissions (Hale *et al*., 2022). Underpinning these pledges are assumptions about the scale of emissions reductions that actors will undertake directly, the scale of mitigation achieved through the mechanisms of carbon markets and offsetting, and the scale of carbon dioxide removal that can be achieved, whether through land or technological options. Achieving net zero carbon dioxide (CO_2) emissions is necessary to halt global warming on multidecadal timescales (Allen *et al*., 2022). Yet the proliferation of pledges, from state and non-state actors alike, is leading to growing uncertainties about the potential aggregate demand for land and land-use change to address climate mitigation, as well as other social and ecological objectives. Mitigation scenarios to limit warming to 1.5 °C require net-negative emissions in the second half of the century, meaning that the pressure on land is only likely to increase beyond 2050.

This report examines the aggregate demand for land and land-use change to address climate mitigation. It does so by examining the climate pledges submitted by countries to the UNFCCC.

Figure 1.1 **Global Land Use Area**



Source: IPCC 2019a

While other 'Gap' reports describe a gap between mitigation ambition and the emissions reductions needed to meet the goals of the Paris Agreement, this report demonstrates the gap between governments' reliance on land for mitigation purposes and the role that land can realistically play.

The findings reflect a fundamental flaw in an understanding of the contribution of land-based mitigation relative to the role of reductions in fossil fuel use to limit warming to 1.5 °C, as well as a failure to understand the role of land to achieve sustainability more broadly. The report will show that land can only play a relatively limited role in climate change mitigation, but that rights-based and regenerative land management practices hold strong potential to meet multiple sustainability objectives. It will also demonstrate that we must prioritize land uses that meet multiple objectives, rather than those that solely address climate mitigation.

This introductory chapter gives a broad overview of the mitigation challenge, the contribution that land and forests already make to lowering global temperatures, and the expectations for land-based removals in global mitigation strategies. **Chapter 2** presents the results of the 'Land Gap Calculator' – the area of land explicitly included or implicitly required to achieve the climate pledges set forward by national governments. **Chapter 3** outlines the importance of maintaining existing forests for climate (and planetary) stability. **Chapter 4** shows how the most effective and just way to include land in climate mitigation responses is to ensure that indigenous peoples and local communities (IPs and LCs) have effective and legitimate ownership and control of their land, exercising self-determination in the sustainable use of their lands and territories. Chapter 5 shows that business-as-usual in agriculture and food systems is not an option, and that alternatives based on biologically diverse systems, such as agroecology, can contribute to both climate adaptation and mitigation.

1.1 The mitigation challenge

The need for urgent and rapid responses to climate change is now foremost in international science and policy debates. The urgency is compounded by mounting evidence that many impacts are irreversible and that tipping points in the earth system could soon be crossed, accelerating warming and impacts (Lenton *et al*., 2019). The political response can be seen in the growing commitment to net zero targets. As of June 2022, countries' net zero pledges covered 83 percent of global greenhouse gas emissions (Hans *et al*., 2022).

Despite the current momentum for mitigation, a mismatch remains between the proliferation of net zero targets and progress towards achieving the goals of the Paris Agreement. Anthropogenic warming has now reached 1.25 °C above pre-industrial levels and countries' pledges for future climate action remain insufficient to stay within the well-below 2 °C – let alone 1.5 °C – temperature thresholds of the Paris Agreement (Matthews and Wynes, 2022). To stabilize temperatures at 1.5 °C, the Sixth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) concluded that we must reach global net zero CO_2 emissions by 2050 (IPCC, 2021). However, our current global emissions trajectory suggests that we will exceed 1.5 °C in less than 10 years and that even implementation of the mid-century net zero goals will be insufficient to limit global warming to 1.5 °C above pre-industrial temperatures (Matthews and Wynes, 2022).

It is important to note that the IPCC defines net zero emissions as a planetary and collective goal. Therefore, companies and even countries cannot achieve net zero emissions *per se*, but must contribute to the pathway towards that collective global goal. This means that wealthy industrialized countries will need to reach net zero earlier and provide support to other countries for low emissions development, in accordance with the principle of common but differentiated responsibilities and respective capacities, as reflected in the UNFCCC (1992) and the Paris Agreement (2015).

All scenarios that reach net zero CO_2 emissions by around 2050 rely on some degree of anthropogenic carbon dioxide removal to reach 1.5 °C towards the end of the century. If we were to avoid relying on CDR, CO_2 emissions would need to reach zero by 2040 to stay below a 1.5 °C temperature target (Matthews and Wynes, 2022). This throws into sharp relief the challenge of achieving the 1.5 °C temperature limit without any reliance on CDR.

Anthropogenic CDR involves removing CO_2 from the atmosphere and storing it in the biosphere (land and forests), or permanent storage in geological reservoirs. Such removals are proposed *in addition* to the (non-anthropogenic) carbon removal that land and ocean sinks perform as part of the carbon cycle. Modelled pathways for limiting warming to 2 °C first included CDR on a large scale in the IPCC's Fifth Assessment Report (IPCC, 2014a). The 1.5 °C scenarios included in the IPCC's Sixth Assessment Report also assume substantial CDR volumes and increase deployment and substantially increase deployment in the second half of the century (IPCC, 2021).

In most of these scenarios, the 1.5 °C target is first exceeded, before then being returned to at the end of the century through large-scale CDR. The scientific literature typically refers to this as a situation of overshoot – building on the theoretical ability of CDR to lower global temperatures. There are, however, significant risks with this option. Even a temporary overshoot results in significant climate impacts, such as increasing sea level rise, loss of ice sheets and the release of permafrost carbon, which

may continue for millennia (IPCC, 2021). Such impacts on people and ecosystems may be irreversible (IPCC, 2022a). Similarly, the scenarios are unable to fully account for the potential effects and risks associated with climatic tipping points. Recent research provides an ever stronger evidence base that climatic tipping points are interconnected, and that several of them are already showing signs of being activated (Armstrong McKay *et al*., 2022). Crossing tipping points holds severe risks for accelerating both warming and the associated impacts on people and ecosystems, and constitutes an argument against relying on upscaling CDR to counter a temperature overshoot.

Scenarios for 1.5 °C that limit overshoot require between 30 and 1,090 gigatonnes (Gt) CO_2 in cumulative removals from technology-based CDR between 2020 and 2100 (IPCC, 2022b).[1] The land-use sector (agriculture and forestry) is expected to contribute another 20–400 Gt CO_2 of additional removals (IPCC, 2022b). At the upper end of the range, this is a huge scale of removals that would require a new industrial revolution in terms of infrastructure deployment and land use on a scale of existing global agricultural needs. At the lower end of the scale, removals could be delivered through nature restoration options that bring co-benefits.

Several risks of relying on large-scale CDR to reach 1.5 °C have been explored in the literature. First, increasing reliance on CDR can have potentially wide-ranging effects on biogeochemical cycles and climate. It can also influence water availability and quality, food production and biodiversity, depending on the form of revegetation (IPCC, 2022b). Second, the promise of future large-scale CDR can become an excuse to further delay mitigation efforts in the present (the so-called mitigation deterrence effect) (McLaren *et al*., 2021). Third, CDR may simply fail to work as intended, thereby increasing the mitigation and adaptation challenges (Dooley and Kartha, 2018). The deployment of new technologies also poses risks to human rights, including those of indigenous peoples, not just because these technologies are allowing the climate crisis to deteriorate, but also because use of the technologies themselves may threaten human rights.

These concerns highlight the need to minimize reliance on removals as far as possible. This means, above all, a focus on rapid reductions in emissions from fossil fuels and from deforestation and degradation. Indeed, pathways that meet the 1.5 °C temperature limit through rapid reductions in fossil fuel emissions and by protecting existing forests, with little reliance on CDR, do exist (Grubler *et al*., 2018; van Vuuren *et al*., 2018; Johansson *et al*., 2020; Keyßer and Lenzen, 2021). They illustrate vividly that any form of CDR should only be used to complement rapid phase-out of GHG emissions and not to compensate for them, or to allow business-as-usual approaches to energy production, land management and food systems to continue.

Additional carbon removals via ecosystem restoration do not in any way compensate for further delays in fossil fuel emission reductions and cannot be used to offset ongoing emissions to achieve net zero in a 1.5 °C-compatible scenario.

1.2 The role of land and forests in climate mitigation

Recent years have seen an increase in attempts to quantify the global mitigation potential associated with land management and ecosystem restoration (Griscom *et al*., 2017; Bastin *et al*., 2019; Roe *et al*., 2021; Walker *et al*., 2022). This has, in turn, led to debates about the magnitude, resilience and potential for climatic benefits, as well as other positive or negative socio-environmental impacts through ecosystem restoration (Dooley and Kartha, 2018; Friedlingstein *et al*., 2019; Lewis *et al*., 2019a).

It is increasingly clear that ecosystem restoration can make a significant contribution to the preservation of biodiversity and a range of other ecosystem, social and cultural services, but that contributions to climate mitigation goals over this century are limited. While various studies estimate a large range in the global potential for terrestrial CDR (110–796 Gt CO_2) (Nolan *et al*., 2021), several papers indicate an approximately 50 percent reduction in potential when relying on ecosystem restoration and minimizing land-use change (Littleton *et al*., 2021; Dooley *et al*., 2022). This more limited potential illustrates that meeting the 1.5 °C threshold remains heavily reliant on rapid and steep reductions in fossil fuel use.

Removals through ecosystem restoration cannot be relied on to reduce global peak temperatures. This is because large-scale CDR through terrestrial ecosystem restoration takes decades to be realized, and cannot therefore reduce a temperature peak expected in the next few decades (Littleton *et al*., 2021). Any climate benefits from ecosystem restoration are dwarfed by the

1 bioenergy with carbon dioxide capture and storage (BECCS) and direct air capture and storage (DACS)

scale of ongoing fossil fuel emissions. For this reason, additional carbon removals via ecosystem restoration do not in any way compensate for further delays in fossil fuel emission reductions and cannot be used to offset ongoing emissions to achieve net zero in a 1.5 °C-compatible scenario (Dooley *et al*., 2022).

In terms of the role that land-based climate mitigation can play in meeting a 1.5 °C temperature limit, keeping existing forest ecosystems intact is the most important contribution (Mackey *et al*., 2020). The natural land and ocean carbon sinks continue to absorb a large share of the CO_2 emitted into the atmosphere, thereby helping to keep warming much lower than it would be in the absence of this natural sink effect (Mackey *et al*., 2020). Maintaining these intact ecosystems and their role in the carbon cycle and climate stabilization is key. Land-based policy measures for climate mitigation should focus primarily on maintaining existing carbon stocks, as opposed to seeking to create carbon removal through tree planting.

CDR that relies on land-use change (such as afforestation and tree planting) should be avoided because it cannot meaningfully contribute to meeting climate goals without having adverse knock-on effects on other dimensions of sustainability. Land scarcity is already a critical issue, with global agricultural use threatening to push several planetary boundaries to their limits, including that for land-system change (Steffen *et al*., 2015; Campbell *et al*., 2017). Land-use change is the leading driver of global biodiversity loss (IPBES 2019). Afforestation and tree planting efforts risk increasing competition over land and having negative repercussions on existing forests, food sovereignty, biodiversity conservation, and vulnerable and land-dependent peoples' tenure and livelihoods. Mitigation responses that compete for land and land-based resources can pose risks, the scale of which largely depends on the type of land management activity undertaken and the context in which it is deployed (such as soil, biome, climate, food system, land ownership) (IPCC, 2022b).

The proportion of emissions absorbed by the natural land and ocean sinks is expected to weaken over time, as the atmospheric concentration of CO2 increases (IPCC, 2021). Immediate emissions reductions are essential to minimize this risk of weakening land and ocean sinks. However, great uncertainty surrounds the future development of the natural land and ocean sinks in response to higher concentration of CO2 and warming, and not all ecosystem responses are fully included in existing climate models. Recent research shows that tropical forests are losing their ability to absorb carbon dioxide due to the combined effects of forest degradation and of warming. The Amazon forest sink is already weakening, and the tropical forests of the Congo basin may not be far behind (Hubau *et al*., 2020). Continued increases in temperatures could see a near halving of land sink strength by as early as 2040 (Duffy *et al*., 2021).

1.3 The land gap

Together, these issues point to the conclusion that climate policy can only rely on land-based CDR to a very limited extent, and not at all to offset continued fossil emissions. Restoring natural ecosystems can result in only a relatively small-scale of CDR, but can make significant contributions to biodiversity and other Sustainable Development Goals (SDGs). However, contributions to reducing peak warming through nature restoration remain limited and land-based mitigation removals cannot compensate for delayed emission reductions in other sectors (IPCC, 2022b).

These conclusions appear to have been largely overlooked in present-day climate policy and practice. Offset markets based on land-based CDR are proliferating (World Bank, 2022). And as this report shows, many countries are planning large-scale land-based CDR, including massive amounts of afforestation and tree planting.

These plans are deeply concerning in two respects. First, because any further delay in rapid reductions of fossil emissions will inevitably lead to an overshoot of the 1.5 °C temperature limit, resulting in devastating and irreversible impacts on ecosystems and vulnerable people. It will likely also further accelerate the weakening of the land and ocean sinks, which will compound the mitigation challenge. Avoiding such overshoot relies almost entirely on steep reductions in fossil emissions in the next decade, and not on carbon dioxide removals from the atmosphere. Second, these plans will push global land use across sustainability thresholds and compromise our ability to ensure food security and avert the biodiversity crisis.

However, this gloomy scenario can still be avoided. The scale of CDR that can be achieved sustainably via ecosystem restoration is sufficient to be compatible with a 1.5 °C temperature limit when coupled with the most ambitious reductions in emissions from fossil fuels (Dooley *et al*., 2022). These steep emissions reductions must be achieved through rapid transformations in our societies, including both supply-side and demand-side measures comprising all aspects of energy production and use (IPCC, 2022b). In terms of land, halting the loss and degradation of primary forests and other intact ecosystems is crucial to climate mitigation strategies – far more so than increasing carbon dioxide removals. Land management strategies that protect existing forests and focus on the restoration of degraded lands, forests and other ecosystems in equitable and just ways are critical to delivering multiple SDGs, beyond any contribution to climate change. The role of land and territories in supporting livelihoods through sustainable food systems, coupled with the land rights of indigenous peoples and traditional communities, is the focus of this report.

CHAPTER 2

The land gap

KEY MESSAGES

- Quantifying the area of land required to achieve carbon removal goals in country climate pledges reveals both an unrealistic expectation for land-use change and an encouraging focus on restoring and regenerating degraded lands.
- Increased reliance on land for carbon dioxide removal increases the risk of overshooting warming thresholds and of dangerous climate impacts. The legitimacy of net zero climate goals is dependent on rapid decarbonization rather than over-relying on removals, particularly from land.
- Increased demand for land as a 'carbon sink' exacerbates land conflicts and food insecurity, escalating climate injustice by framing land for its carbon removal potential, since land has multiple uses.

This chapter provides an assessment of the implied reliance on land for carbon removal in country climate pledges. This report finds that approximately 1.2 billion ha of land are included for CDR in countries' climate pledges. They span activities ranging from large-scale forest plantations to reforestation and restoration of degraded forests, wetlands and rangelands. The pledges envision land-use change (from other land uses to forests) for more than half of this land area (some 633 million ha), equivalent to half of the area of global cropland. These findings point to an unrealistic expectation for land to meet climate mitigation goals. The scale of land-based removals in country climate pledges calls into question the validity of net zero targets as contributions to the 1.5 °C threshold, in contrast with pledges that rely primarily on rapid decarbonization with limited CDR.

2.1 Land area in country climate pledges

Calculation of the land gap relies on two elements. The first is the scale of land-use change assumed in country climate pledges. The second is land available for climate mitigation, which is limited by the multiple demands on land, for food production, ecosystem protection and other needs, limiting the availability of land for climate mitigation.

To assess the reliance on land in country climate pledges, we reviewed all existing net zero and mid-century targets. For countries without long-term pledges, we reviewed near-term climate pledges in countries' Nationally Determined Contributions (NDCs). Our review focused on mitigation pledges. We did not review countries' National Adaptation Plans or land restoration commitments made outside of climate pledges. We identified both land-based CDR (reforestation, restoration and plantations) and technological CDR (BECCS and DACS). We did not assess bioenergy demand separate from CDR pledges, as bioenergy tends to be embedded within the energy sector of climate mitigation pledges. This means that our assessment of land demand for climate mitigation is likely to be conservative.

2.1.1 Methods

Climate pledges were reviewed for all countries.[1] The European Union (EU) was assessed as a bloc, meaning that 166 countries plus the EU were assessed.[2] For countries with long-term strategies (LTS) or net zero pledges, near-term pledges in NDCs were not reviewed. That is, we assessed the longest-term pledge that was available, assuming that any land-based CDR in near-term pledges is encompassed in longer-term pledges. Given that approximately half of our results are based on pledges for 2030, we can therefore expect these results to represent just a portion of the future land demand for climate mitigation, if countries' climate actions follow modelled mitigation scenarios, where reliance on CDR scales up after 2050. Our quantitative assessment could be regarded as reflecting a case where countries without an LTS do not rely on CDR beyond their NDCs (and implement the Paris Agreement goal through emission reductions only).

From this review of 167 mitigation pledges (including the EU as a bloc), It was possible to quantify the land area requirements for 112 pledges that relied on carbon dioxide removal, including land and forest restoration, reforestation, and for a very small number of countries, BECCS (See **Table 2.1** for CDR typology). We reviewed all climate pledges that were submitted until the end of September 2022, including new and updated NDCs.

Country climate strategies and pledges express commitments in a range of different metrics and qualitative ambitions. Therefore, a number of assumptions were made to identify the scale of CDR commitments.[3] The commitments were then combined with data from publicly available datasets on land cover and land use, such as from the Food and Agriculture Organization of the United Nations (FAO), and national GHG emissions profiles such as the Climate Analysis Indicators Tool, to calculate the implied land area when not directly stated.

The various approaches to land management activity types in national climate strategies were categorized into seven activity types, based on their carbon sequestration potential (using IPCC removal factors). **Table 2.1** shows the seven land-use categories we used, in relation to ecosystem condition. 'Primary forests' are intact natural forests with minimal disturbance. 'Old secondary forests' were selected to represent regeneration of degraded natural forests, while 'Young secondary forests' were selected when pledges referred to reforestation or forest expansion. Agricultural landscapes were classified into two broad categories – 'Agroforestry', for pledges that referred to regeneration or integrating trees into agricultural landscapes, and 'Silvopasture', for pledges that referred to restoring degraded rangelands. The activity type 'Mangroves' was used to quantify the removals

1 The list of countries is defined according to UN Member States.

2 The European Union and its 27 member States communicated one joint NDC and one Long-term Climate Strategy, hence we have analysed the climate pledges of the EU as a bloc, rather than individual Member States.

3 The range of land-based actions for carbon removal were presented in climate pledges as emissions reductions required to achieve net zero or interim (2030) targets compared with total emissions (presented in Mt CO_2e or percent of total emissions); references to residual or remaining emissions at the time of net zero; reference to removals/sequestration/CDR (presented in Mt CO_2e or proportion of total emissions); direct references to land area (in hectares, acres or $km^{2)}$ or proportion of land area (of country, or of a land cover type, i.e.: proportion of forest cover to be maintained extended).

potential of restoring or expanding mangroves. The activity type 'Plantations' was used when countries referred to establishing commercial forests or plantations. This categorization represents a simplification of the range of land management activities and practices that countries have referenced in their climate strategies.

Default removal factors from the IPCC were applied based on the activity type and climate domain of the country (or implementation area, if this was identified as being outside the pledging country).[4] For agricultural activities, removal factors were sourced from the IPCC (Table 5.1 IPCC, 2019b). For forestry activities, Harris *et al*. (2021) was used (see Table 2.2 for removal factors). The inclusion of technology-based CDR in national climate pledges was rare, but a handful of countries referred to BECCS and /or DACS. References to BECCS or bioenergy were categorized as plantations. This is not because it is assumed that forest plantations would primarily be used as the feedstock for bioenergy or BECCS, but because the emissions removal factor for plantations is the closest to energy crops, and so approximates the relevant area of land that would be required.

Table 2.2 characterizes the land management categories based on whether the primary intervention involves protection, resto-

4 A more accurate representation of the variety of land management activities would entail considerably more work, but would not greatly change the results, given that the range of emissions removal factors that can be applied is limited

Table 2.1 **Land management activities found in country pledges and IPCC removal factor (RF) categories**

Ecosystem condition	IPCC category	Land management activity
Less disturbed	Primary forest	Protecting existing intact forest
	Mangroves	Mangrove restoration or expansion
	Old secondary forest	Restoring or regenerating existing degraded forest
	Young secondary forest	Mixed plantings, mixed reforestation, reforestation
More disturbed	Silvopasture	Trees in grazing lands, restoring rangelands
	Agroforestry	Trees in croplands (including commercial trees), regenerative agriculture
	Plantation	Commercial planting for harvest, monoculture (no ref. to mixed species)

Table 2.2 **Land activity type categorization**

Approach	Land management	Activity	Removal factor (Mg CO_2 per ha per year)
Non-anthropogenic	Protection	Primary forest	1.55
Anthropogenic	Restoration	Old secondary forest	3.39
		Mangroves	15.40
		Silvopasture	2.62
		Agroforestry	1.49
	Replanting	Young secondary forest	8.50
		Plantation	14.40
Technology options	BECCS	Biomass feedstock identified as plantations	14.40
	DACS	No identified land footprint	

Note: Numbers in the table are shown for global average. Biome averages were used to calculate land area.

ration or replanting. It is important to understand the gains and losses, in terms of both physical and social resources, from each of these land management options. Pledges for avoided emissions and the protection of existing forests were noted, but not quantified in the context of our aim to assess the land area required for carbon dioxide removal in national climate pledges. The critical role that maintaining primary forests intact plays in stabilizing global temperatures, and the way that some climate policies incentivize creating new forests over protecting existing ones, is discussed in **Chapter 3**.

2.1.2 Results

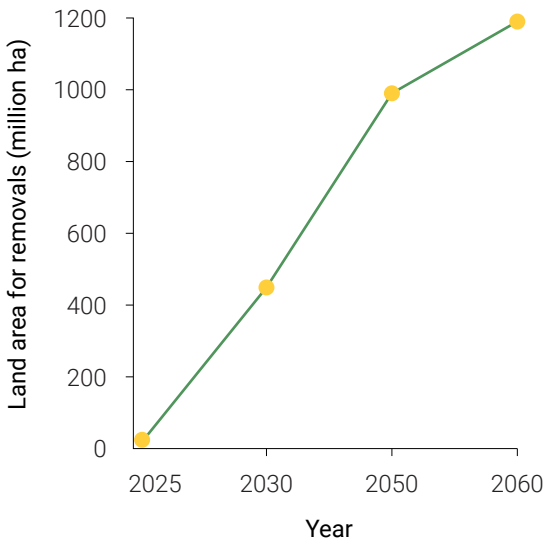
In total, we identified that 1,184 million ha of land would be required to meet the CDR commitments in country climate pledges to 2060 (see **Figure 2.1**). This land area is larger than the United States of America, at 983 million ha, or almost four times the size of India, at 329 million ha. More than half of this pledged land area – 633 million ha – is for planting new forests, requiring a land-use change from existing activities. The rest of the land area is pledged for the restoration of degraded forests, other natural ecosystems, or agricultural lands.

Most of the land area is in 2030 pledges. Fewer countries have submitted 2050 pledges and these are generally less detailed, making it harder to quantify land area. Many of the country pledges for 2030 (mostly in NDCs) focus on extensive land restoration, and climate pledges overlap with land restoration commitments.

Around one third (391 million ha) of the land needed for CDR pledges is based on direct area pledges in country climate commitments, as opposed to pledges expressed in terms of tree planting or emissions reductions through land use. 126 million ha result from indirect area pledges – that is, governments have pledged a proportion of land area, such as a percentage of forest cover increase, meaning that the calculation is based on existing land or existing forest area. Some 667 million ha of the land area in our results are calculated from an emissions pledge, which requires assumptions to be made about the type of activity in order to calculate the removal factor. The reliability of the land area estimates can be discussed by conducting a sensitivity analysis. When all emissions removal factors are based on global average values (meaning that no assumptions are made regarding activity type or biome), the land area in pledges changes the total results by less than 2 percent, showing that results are not strongly driven by our activity or biome assumptions. Another assumption affecting our results is that removals through increasing soil carbon stocks and below-ground biomass are not accounted for. We only use emissions removal factors based on above-ground absorption, even though many countries refer to soil carbon as part of their mitigation strategies. This affects the removals amount and could lead to an overestimation of the land area needed to achieve CDR pledges by approximately 20 percent (IPCC, 2019a) for the 667 million ha where calculations are based on emissions pledges (rather than direct or indirect area pledges).

Figure 2.1 **Carbon dioxide removal in national climate pledges**

Countries' climate pledges rely on 451 million ha of land for carbon removals by 2030, another 533 million hectares by 2050, and another 200 million ha is pledged from one country for 2060. This reliance on land can be expected to increase as more countries make longer-term pledges.



2.1.3 Discussion

Our results speak to the risks created by net zero targets that are over-reliant on land-based CDR, where future removals can undermine near-term emissions reductions. Land-based climate mitigation can also lead to the displacement of other land uses and users, infringing on the rights of indigenous peoples and local communities. Here, we highlight three risks and one hopeful and promising trend coming out of our analysis, as well as how it points to a need for more clarity and transparency across governments' climate and land restoration pledges.

First, a critical risk in framing climate targets as net zero is to undermine mitigation action by allowing an ill-defined trade-off, where land removals are pledged to make up for the lack of direct emissions reductions. The inclusion of almost 1.2 billion ha of land in climate pledges for removals alone (not counting land being relied on for avoided emissions) indicates an extensive reliance on removals, particularly for 2030 targets. Recent re-

search has shown that emissions reductions in the next decade are the only way to limit warming to 1.5 °C, and that scaling up land-based removals cannot reduce peak temperatures (Dooley *et al*., 2022).

The second risk relates to displacing climate action to other countries. Very few countries make explicit commitments to using forest-based offsets to count towards their national mitigation commitments. Currently, the majority of forest-based offset projects are located in the global South. If historical trends persist, this would mean that pressure on land due to land-based CDR will be mainly concentrated in the poorest parts of the world. In other words, land-based CDR and its impacts are likely to be unevenly distributed, raising important climate justice concerns (Carton *et al*., 2020).

The third risk relates to land-based climate mitigation increasing overall demand for land. Land scarcity is already a critical issue, with global agricultural use threatening to push several planetary boundaries to their limits, including that for land-system change (Steffen *et al*., 2015; Campbell *et al*., 2017). Land-use change is the leading driver of biodiversity loss (IPBES 2019). Of the 1.2 billion ha of land that this report identified in climate pledges, over half relied on land-use change. This is particularly significant given that we categorized land into seven activities (see **Table 2.1**), only two of which involved a change in land use. This indicates that governments are over-reliant on plantations or new forests to achieve carbon dioxide removals.

There are also more promising and hopeful trends across governments' pledges. These consist of the approximately 551 million ha included in climate pledges for land restoration, while maintaining existing land uses to a greater or lesser extent. This highlights a growing awareness of and commitment by governments to the land restoration agenda. Many of the countries' climate pledges that we reviewed detail promising approaches to land management. Agroforestry, mangrove restoration and the restoration of degraded rangelands are all activities included in country climate pledges that can improve the contributions of land to multiple sustainability objectives, if implemented with respect to IPs' and LCs' rights to land and self-determination.

Our analysis also highlights the need for greater clarity in governments' pledges. This is important to avoid the risk of making unrealistic and overlapping claims on land to support various sustainability objectives. Current climate pledges from national and subnational governments have been criticized for failing to transparently elucidate their intended use of offset credits and carbon dioxide removal to meet their net zero targets (Hale *et al*., 2022). The same can be said about lack of transparency regarding the extent to which land is included in efforts to meet climate mitigation targets. While many governments include direct land areas in climate pledges, some make obscure assumptions or unquantifiable statements regarding the scale of land-based removals. Therefore, governments' climate pledges must present more clarity about the amount of land and land-use change planned to meet climate objectives. There is also a need for greater clarity about government pledges across United Nations conventions to avoid overlapping claims. Research shows that worldwide, governments (of at least 115 countries) have committed a total of close to 1 billion ha for land restoration (van der Esch *et al*., 2022). This is close to the land area for carbon removals that we found committed in climate pledges, but the restoration pledges in van der Esch *et al*., 2022 are found under a wider range of United Nations conventions (including the United Nations Convention to Combat Desertification (UNCCD) and the Convention on Biological Diversity (CBD) and the Bonn Challenge). It is not clear if these various pledges concern similar, overlapping or different areas of land. Again, more clarity is needed.

2.2 Global demand for land

Humans have already transformed more than 70 percent of the Earth's land area from its natural state, causing unparalleled environmental degradation and contributing significantly to global warming. An estimated 20 percent of global land is degraded to some extent, an area the size of the African continent (UNCCD, 2022). With food production using up half of the Earth's habitable land, and food systems creating one-third of all human-caused emissions, the United Nations is calling for a crisis footing when it comes to conserving, restoring and using the planet's land resources sustainably (UNCCD, 2022).

Avoiding conflict over land resources requires doing things differently. Increased resource extraction and land competition have already been shown to drive sustainability challenges and human rights conflicts. At the same time, strict conservation approaches such as protected areas (PAs) have been shown to dispossess local people. Expecting that land can be used for climate mitigation at the expense of other land demands will only exacerbate existing challenges. The impacts of climate change, competing demands on land, conflicts with food sovereignty and livelihoods, and the complexity of land ownership and management systems are all noted as key trade-offs and barriers to implementing land restoration (IPCC, 2022a).

The international community has pledged to restore 1 billion ha of degraded land by 2030 under the UN Decade of Ecosystem Restoration (UNCCD, 2022). Land restoration is critical for combating both climate change and the biodiversity loss crisis and provides unique entry points to apply human rights-based approaches that improve natural resource use and management. But what is sometimes ignored is the crucial question of how

land restoration is carried out and whose lands are restored. Most importantly, trade-offs between different land uses need to be evaluated, to ensure that carbon sequestration goals do not undermine other uses of land. This section looks at projections of future demand for land across three areas: agriculture, climate mitigation and land restoration, and compares these with our findings – that governments have so far committed almost 1.2 billion ha of land in their climate mitigation pledges.

2.2.1 Demand for land – Projections for climate mitigation

Decarbonization of the energy sector and a transition to widespread renewable energy generation will carry a land footprint, but land availability is not considered a hard technical constraint for 1.5 °C mitigation pathways (Matthews and Wynes, 2022; Teske, 2019). Non-carbon renewable energy sources represent more efficient use of land to produce energy than does bioenergy. For example, solar panels are 100 times more efficient per unit land area than bioenergy for energy production (Searchinger *et al*., 2018). The projected extent of land-use change for climate mitigation, whether for bioenergy or CDR does represent a hard technical constraint to relying on land-based removals as a mitigation option (Dooley *et al*., 2018).

The most commonly included form of CDR in modelled climate scenarios continues to be BECCS and tree planting (referred to as afforestation/reforestation), although more recent research highlights the removal potential of less land-intensive technologies such as direct air capture or ocean-based forms of CDR (Riahi *et al*., 2022). In country climate pledges there is still very little inclusion of BECCS, with a direct reference made by only seven countries, corresponding to a land demand of 80 million ha. Yet widespread expectation for BECCS and bioenergy, as modelled in future climate mitigation pathways, would have substantial implications for land demand and therefore warrants attention in this section.

Estimates for land demand from bioenergy, including BECCS, vary widely across the mitigation scenarios represented in IPCC reports. In the pathways assessed for the *IPCC Special report on global warming of 1.5°C* (2018), land demand for bioenergy will range from 100 to 800 million ha by 2050, with a few outlying scenarios modelling a need for up to 1,500 million ha (Rogelj *et al*., 2018). More recent scenarios give a slightly more modest median land demand of 199 million ha (with a range of 56 to 482 million ha) for 1.5 °C scenarios, with limited or no overshoot (Riahi *et al*., 2022). In contrast, our finding of 80 million ha in land demand for BECCS from only seven countries would imply that this median is likely to be an underestimate, if BECCS to achieve CDR becomes as widespread as in modelled pathways.

Efforts for land-based climate mitigation would be more effective and successful if focused on achieving multiple sustainability objectives, rather than a singular focus on carbon dioxide removal.

Such ambitious expectations for land to meet bioenergy needs for CDR via BECCS raises a number of significant problems. First, modelled mitigation scenarios tend to be unconstrained by concerns for food sovereignty, biodiversity, respect for land rights, or other sustainability thresholds (Heck *et al*., 2018), allowing for substantial trade-offs with any of these. These pathways tend to build on assumptions of 'empty land' which ignore land-use practices that are not easily captured in globally aggregated datasets, such as nomadic lifestyles (Creutzig *et al*., 2021). They frequently rely on the conversion of (tropical) forests to cropland. In addition, they tend to underestimate the emissions from converting land to bioenergy plantations, as well as the potential for carbon storage when land is not used for agricultural production (Harper *et al*., 2018; Searchinger *et al*., 2018). One estimate surmises that taking these factors into account would require land for bioenergy production to be capped at its current level, roughly 50 million ha, in order to prevent undesirable impacts on biodiversity and livelihoods (Creutzig *et al*., 2021). The extreme assumptions being made about BECCS illustrate how easily climate mitigation approaches come into conflict with the finite productive capacity and multiple existing uses of land (Dooley and Kartha, 2018).

The allure of bioenergy (with or without CCS) in mitigation scenarios, and the consequent potential land-use demands for mitigation, is in part a construct of the way that carbon is accounted for in such models. BECCS, for instance, is particularly attractive in low-temperature scenarios that allow for overshoot – first exceeding temperature targets and then using CDR to bring temperatures back down again. A stronger focus on early mitigation action reduces the land demand for BECCS. The idea that bioenergy is carbon neutral across its lifecycle also leads to over-reliance on this approach as a mitigation option. After carbon dioxide is released at the point when biomass is first harvested and combusted, it will take time before the same amount

of CO_2 is sequestered again on that land area (see section **3.2.1**). For dedicated bioenergy crops, this time lag might be a matter of one or two years, but if forest biomass is used, it can easily take multiple decades before the carbon debt is repaid.

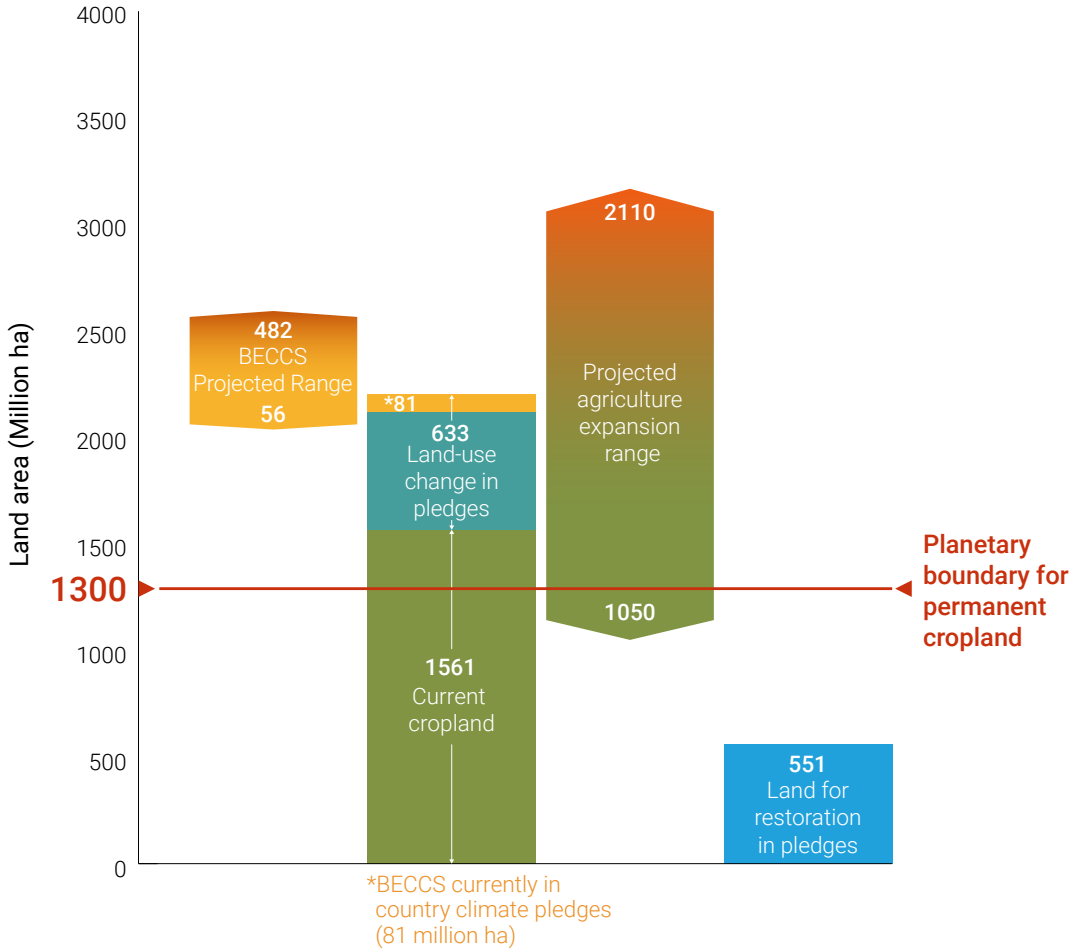
2.2.2 Demand for land – projections for agricultural needs

Modern agriculture has altered the face of the planet more than any other human activity, and now occupies approximately 40 percent of global land. Global food systems are responsible for 80 percent of deforestation and 70 percent of freshwater use, and are the leading driver of terrestrial biodiversity loss (UNCCD, 2022).

Projections of future demand for land for agricultural production vary considerably, based on their underlying assumptions, such as shifts in diets, handling of food waste, population projections and technological innovation to improve yields and/or production processes (Stehfest *et al*., 2019; Willett *et al*., 2019). For example, in the recent report *Food in the Anthropocene*, Willett *et al*. (2019) explores a range of scenarios for food production in 2050, which varies according to three parameters related to production process, food waste and dietary preferences. The resulting scenarios project global cropland area to range between 1,050 million ha and 2,110 million ha in 2050, compared with a baseline of 1,260 million ha in 2010 (see Figure 6 in Willett *et al*. 2019).

Figure 2.2 **Land for mitigation crosses planetary boundary thresholds**

The 633 million ha requiring land-use change found in country climate pledges (including 81million ha for BECCS), adds to demand for land, potentially crossing planetary boundaries if this adds to increased cropland areas. Land for restoration (551 million ha) does not increase demand for land, and can improve biodiversity and socioecological resilience.



Sources for projected ranges and planetary boundary: FAOSTAT 2022, Riahi et al., 2022, Willett et al., 2019.

* BECCS = bioenergy with carbon capture and storage

Projections for future agricultural land use under various shared socioeconomic pathways (SSPs) similarly model different assumptions and policy options, resulting in a range of projections for land use. Cropland change projections from 2010 to 2050 range from a decrease in cropland use of 210 million ha at the lower end to an increase in cropland use of 250 million ha compared with 2010 in the *IPCC Special report on climate change and land (SRCCL)* (IPCC, 2019a). The lower-end scenario features a decrease in pasture of 440 million ha and an increase in bioenergy cropland of 480 million ha, while the higher-end scenario shows an increase in pasture of 240 million ha and an increase in bioenergy cropland of 100 million ha. Other research similarly finds that cropland may either expand or shrink towards 2050, depending on the scenario and assumptions applied, (see, for example, van der Esch *et al*., 2017 and Stehfest *et al*., 2019), with Stehfest *et al*. (2019) projecting the greatest potential expansion to 1,800 million ha of total cropland in 2050.

Increasing land for agricultural use presents problems other than just the risk of increasing competition for land. Willett *et al*. (2019), in *Food in the Anthropocene*, suggest that a threshold for sustainable global cropland use is likely to be around 1,300 million ha (with a range from 1,100 to 1,500 million ha). Springmann *et al*. (2018) suggest a similar level for a sustainable boundary level of global cropland use (1,260 million ha, with a range of between 1,060 and 1,460 million ha). With cropland in 2022 reported by the FAO to be 1 561 million ha (FAOSTAT, 2020), this implies that we cannot expand global cropland further if we wish to stay within a safe boundary for land-use change (Steffen *et al*., 2015; Campbell *et al*., 2017). In **Figure 2.2**, we compare our results against other projected demands for land.

As agricultural land expands, it risks destabilizing vital ecosystems. While the total area of agricultural land has remained stable for some time (and by some projections may continue to remain stable), a shift has taken place over past decades, where less land is cultivated in the global North, as expansion takes place in the global South (Winkler, 2018). This in part reflects increases in export-oriented crop production, indicating that some of the agricultural expansion in the global South is satisfying demand in the global North (Henderson *et al*., 2015; Winkler, 2018). The reduction in agricultural land in the global North has resulted in abandoned, often degraded land, rather than functioning ecosystems and so is not comparable to the loss of ecosystems due to agricultural expansion in the global South in terms of impacts on biodiversity.

Expansion of cropland in the global South poses risks to indigenous peoples and local communities who may face encroachment on their land (especially from large-scale, commercial agriculture or feedlots), as well as biodiversity risks. A business-as-usual scenario for cropland suggests expansion of 89 million ha onto vital biodiversity hotspots towards 2050 (Molotoks *et al*., 2018). Maintaining or increasing terrestrial carbon stocks while meeting growing food demands will require increasing global land-use efficiency in terms of both storing carbon and producing food in a finite global land area (Searchinger *et al*., 2018). How humanity manages the global food system will be decisive to the challenge of feeding a growing global population, while addressing the biodiversity and climate crises in an equitable and just manner. The various projections for the future land footprint of the global food system illustrate that at the lower end there are possibilities for the interrelated nature of food, climate and biodiversity. Importantly, the wide-ranging projections for expansion of agricultural lands also illustrate the possibilities for shifting the global food system towards one that supplies healthy diets for a growing population, in ways that present opportunities for addressing the climate and biodiversity crises. These issues will be the focus of **Chapter 4**.

2.2.3 Land restoration commitments

Many countries have made commitments to restoration under a range of schemes, such as the land degradation neutrality commitments by 122 countries (UNCCD, 2019).[5] Collectively, global commitments to restoration based on national plans for 115 countries under the UNCCD, CBD, UNFCCC and Bonn Challenge total nearly 1 billion ha (van der Esch *et al*., 2022). The commitments include ecological restoration and protection of natural areas and improved land management and rehabilitation of degraded land. The areas include about 20 percent of cropland, 10 percent of forest land and a small proportion of pastures (van der Esch *et al*., 2022).

Little information is available to assess the success of these schemes, as most are based on pledges rather than actions on the ground. For example, of the Aichi Biodiversity Targets, 14 were not met, including targets for the elimination of biodiversity loss and halving the rate of loss of natural habitats. By 2020, less than 3 percent of the estimated potential land area was under active restoration (some 27 million ha) (CDB, 2020). Reporting on progress towards the Bonn Challenge targets is limited and assessment of land areas shows a 54 percent deficit in area committed to meeting country goals (Fagan *et al*., 2020).

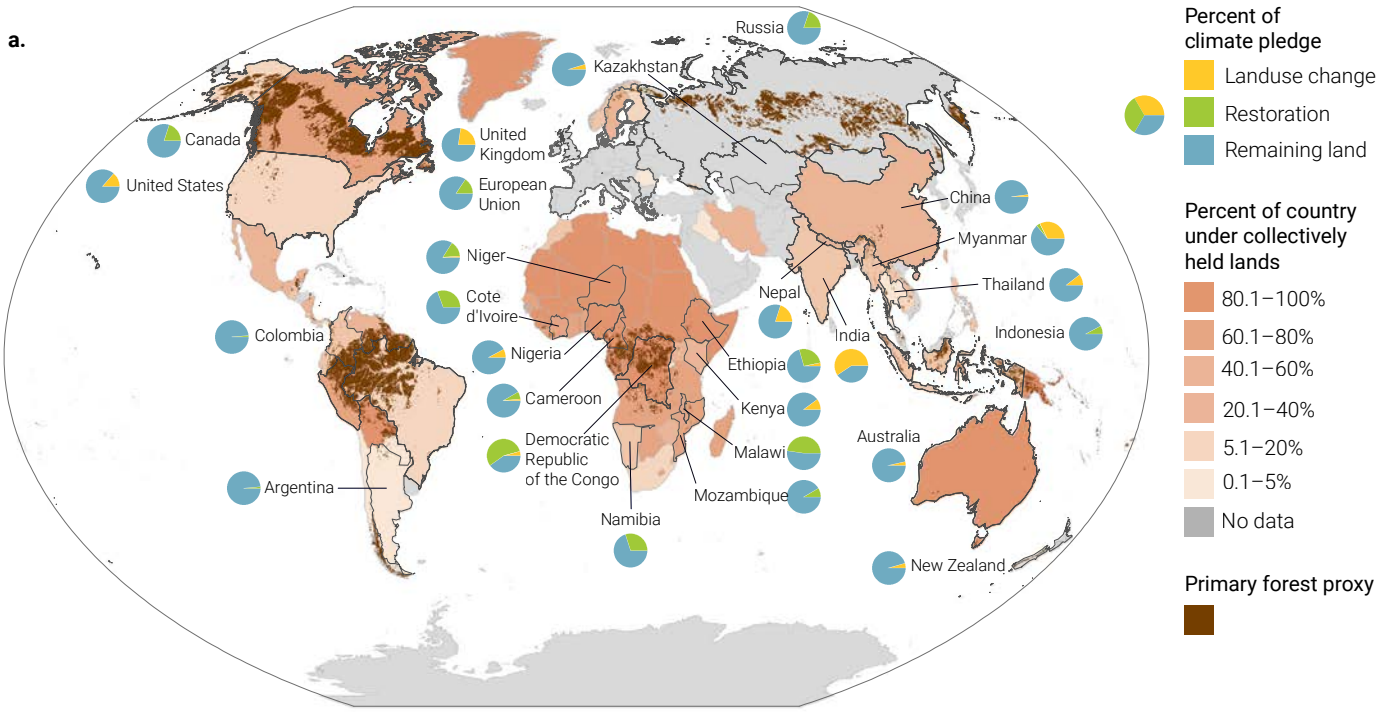
The potential for restoration has been modelled by the Netherlands Environmental Assessment Agency (PBL) (van der Esch

5 Restoration targets include the Latin American Initiative (20 million ha by 2020), African Forest Landscape Restoration Initiative (100 million ha by 2030), Agadir Commitment for the Mediterranean (8 million ha by 2030), ECCA30 including Europe, Caucasus and Central Asia (30 million ha by 2030), Great Green Wall for the Sahara and the Sahel (100 million ha by 2030), the Sustainable Development Goals (SDG) Target 15.3 (land degradation neutrality by 2030), Aichi Target 15 (restore at least 15 percent of degraded ecosystems by 2020), and The Bonn Challenge/New York Declaration on Forests Goal 5 (restore 350 million ha of degraded landscapes and forest lands by 2030).

Figure 2.3 **Intersection of the area of primary forest, collectively held lands, and the proportion of land area pledged for CDR in country climate pledges**

a. Shading for each country represents the proportion of the country area that is under collectively held lands that combines collectively held land. The area of extant primary forest is a proxy using the combined Intact Forest Landscapes and Hinterland Forest (see Figure 3.2). Percent climate pledge is the percent of country land area that is included in climate pledges that involves land use change by replanting or restoration of existing vegetation (see Table 2.2), with the remaining land representing existing dedicated land uses. Selection of countries shown include the top 10 forested countries (see Figure 3.2) plus other countries with large areas dedicated to climate pledges. **b)** Top 10 forested countries (in order of forest area, see Table 3.2) and global total showing primary forest areas in relation to the total country land area, the percent of primary forest that is within protected areas, collectively held lands at a country level, and the percentages of land area in countries' climate pledges that requires land use change (reforestation) or restoration.

a.



b.

Country	Primary forest as a % of country area	% of Primary forest in Protected areas	Community held lands as a % of country area	Reforestation in pledges as a % of country area	Restoration in pledges as a % of country area
Russian Federation	10	16			21
Brazil	28	72	19	Not quantifiable	Not quantifiable
Canada	21	17	62		20
USA	3.4	39	6	14	
China	0.1	22	50	2	
Australia	0.3	87	82	4	
DRC	29	23	86	4	56
Indonesia	19	26	23		8
Peru	36	34	66	Not quantifiable	Not quantifiable
India	0.7	2	21	59	
Global	7.6	37			

Source: Dubertret and Alden Wily 2015. UNEP-WCMC and IUCN (2022).

et al., 2022). Three scenarios to 2050 consist of: (i) baseline or business-as-usual, where land degradation and emissions from land-use change and degradation are projected to continue; (ii) restoration of 5 billion ha (35 percent of global land area) through conservation agriculture, agroforestry, silvopasture, grazing management, plantations and assisted natural regeneration; and (iii) restoration and protection, which combines restoration with protection of natural areas important for specific ecosystem functions, covering approximately half the land surface. Across the range of restoration activities, forest management and passive regeneration have the lowest cost per hectare. A major conclusion is that land restoration has the potential to deliver multiple benefits simultaneously, making it a highly integrated solution for sustainable development that supports the United Nations Conventions on land degradation and desertification, climate change and biodiversity and the SDGs (van der Esch *et al*., 2022).

The work by PBL suggests that the area of 1.2 billion ha of land that we found in climate mitigation pledges falls within the estimated 5 billion ha of restoration potential. However, only 551 million ha of land in mitigation pledges can be categorized as restoration, while 663 million ha requires a land-use change. A study that estimated 1.7–1.8 billion ha of land that could support increase in forest cover based on biophysical potential (Bastin *et al*., 2019) has been criticised for not accounting for existing ecosystems or land tenure rights. Local knowledge is needed to better assess suitable areas for restoration. Further work has been developed by FAO on mapping tree restoration potential to assist countries in identifying areas that are suitable for restoration (FAO and UNEP, 2020) and in developing guidelines to incorporate biodiversity into landscape restoration (Beatty *et al*., 2018). Overall, the area suitable for expanding forest cover is uncertain and depends on principles of ecology and human rights, while the area of global cropland has already reached sustainability thresholds, indicating there is no available land for energy crop or monoculture plantation expansion.

2.3 Conclusions

Our analysis of country climate pledges finds that almost 1.2 billion ha of land are included to achieve carbon dioxide removal for mitigation purposes. The land management activities included in climate pledges range from large-scale forest plantations to reforestation and restoration of degraded forests, wetlands and rangelands. Approximately half of the area pledged for removals (633 million ha) require land-use change in the form of tree planting to establish new forests, reforestation, or plantations. This represents a major risk. It is very likely that governments will be unable to pull off such major land cover change, equivalent to half of the global cropland area. If this happens, countries will fail to make good on their climate pledges and we will see a worsening of global warming. In the unlikely event that governments' actually succeed, they will contribute massively to worsening the crises of food security, biodiversity loss, water scarcity and infringements of IPs and LCs rights, as overall land pressure will increase dramatically. The observed over-reliance on land for climate mitigation in governments' pledges is obscured beneath the banner of net zero climate targets. The balance between reducing emissions and increasing removals must instead focus on rapid decarbonization before 2030 for pathways to 1.5 °C.

Large areas of land are being pledged in NDCs for CDR activities in countries that may conflict with human rights in collectively held lands or protection of primary forests. Areas of remaining primary forest range from very small to moderate but in many countries are poorly protected in formal protected areas and the forests and community held lands may be vulnerable to changes in land use under the NDC pledges (see **Figure 2.3**).

A recent review of net zero targets concluded that the transparency and integrity of existing net zero pledges are "far from sufficient" to ensure a timely transition to global net zero greenhouse gas emissions by mid-century, and observed that an "alarming lack of credibility still pervades the entire landscape" (Hans *et al*., 2022). The authors conclude that the focus needs to be on better targets and identifying where targets are not credible. We would add to this that net zero targets must be transparent about the assumptions made regarding removals, particularly when these rely on land-use change. Countries should avoid using removals to disguise inaction on emissions reductions, and should seriously consider the impact that land-based removals will have on other land uses and users.

Current human use of land and natural ecosystems is already crossing or near to crossing sustainability thresholds. Any further expansion of global cropland would put us beyond a safe threshold for permanent agricultural land, meaning there is no 'spare' land for bioenergy crops, or for conversion of land to tree plantations. Restoration of existing forests and degraded agricultural lands can bring climate benefits, without creating additional demand for land. Hence efforts for land-based climate mitigation would be more effective and successful if focused on achieving multiple sustainability objectives, rather than a singular focus on carbon dioxide removal.

Improved governance and management of land and territories is sorely needed to achieve multiple interrelated objectives, including addressing the climate and biodiversity crises. Current approaches to forest and ecosystem protection, land rights and food systems are exacerbating these crises. The following chapters outline the problems in current approaches and point to transformative changes in each of these areas – changes that are central to land stewardship approaches in line with 1.5 °C mitigation pathways.

CHAPTER 3

Forest ecosystem protection and restoration

KEY MESSAGES

- Primary forest protection and restoration is the most effective climate mitigation action in the land sector, providing co-benefits for adaptation, biodiversity conservation and other critical ecosystem services.
- Primary forests and the ecosystem services they provide are irreplaceable and cannot be offset through new plantings.
- Forest management should be informed by a comprehensive evaluation of all ecosystem services, and through respecting the rights and traditional knowledges of indigenous peoples and local communities.
- Carbon accounting rules need to be modified to recognize the carbon retention value of forest ecosystems and their ecosystem integrity.
- Appropriate decision-making processes, policies and financial incentives are needed to facilitate indigenous peoples and local communities, landowners and governments in maintaining primary forests and improving the conservation management of landscapes, including through buffer zones and reconnecting remnant primary forest areas.

Deforestation and degradation have contributed 35 percent of total historical anthropogenic emissions and 12 percent of emissions this century (IPCC, 2013). One-third of Earth's natural forests are gone, about one-third of forests are degraded by extractive land use, and only one-third remain in a primary state (see **Box 1**). Primary forest is currently being lost at a rate of 3.4 million ha every year. However, forest conservation management and the ecological restoration of forests play a critical role in climate change mitigation. Forests can contribute to a comprehensive mitigation strategy by:

- retaining an accumulated stock of living and dead biomass carbon and soil organic carbon (carbon retention value);
- maintaining the natural terrestrial carbon sink to buffer some of the impact of elevated atmospheric CO_2 concentration from fossil fuel emissions; and
- removing CO_2 from the atmosphere through ongoing growth of primary forests and restoration of secondary natural forests and other degraded forest land.

Retaining carbon stored in forests and preventing its emission to the atmosphere is the prime mitigation opportunity offered by the land sector. Immediate emissions reductions can be achieved by changing current land use and forest management to halt deforestation and forest degradation. Such changes in management must be exercised in a manner that respects human rights, including those of IPs and LCs, and incorporates public participation in decision-making.

Forests remove carbon continuously from the atmosphere and are currently estimated to provide a sink of −7.6 ± 49 Gt CO_2e per year, with 30 percent from tropical and subtropical forests, 47 percent from temperate forests, and 21 percent from boreal forests (Harris *et al*., 2021). However, this sink has been declining due to emissions from forest loss and degradation, interacting with increasing impacts from climate change (Raupach *et al*., 2014; Brienen *et al*., 2015; Steffen *et al*.; 2017, Gatti *et al*.; 2021, Zhu *et al*., 2021; Anderegg *et al*., 2022). It is therefore critical to conserve forest biodiversity and related ecological processes to help maintain their sink capacity.

Forest landscapes have significant potential to remove CO_2, given the extent to which forests have and are being lost and degraded (Mackey *et al*., 2013). Removals though forest restoration and afforestation have been included in assessments of pathways to net zero emissions (IPCC, 2022b) and many pledges made in NDCs could not otherwise be met. However, planted trees take decades or even centuries to accumulate sufficient carbon to replace that lost through deforestation and degradation. Moreover, trees planted for wood supply or biofuel production become sources of emissions, and are not a mitigation solution.

The mitigation and other ecosystem benefits of primary and natural forests will be conserved and enhanced by ensuring the rights of IPs and LCs to their land, culture and sustainable livelihoods. Indigenous peoples have rights to or manage approximately 37 percent of all remaining natural lands (Garnett *et al*., 2018). When these tenure rights to collectively managed land are combined with participatory decision-making, cultural motivation and resources to support planning and governance, protection of forest carbon stocks and biodiversity can be achieved together with sustainable livelihoods (see **Box 3**).

Despite the mitigation potential of conservation management of forests, very little climate funding (~5 percent) is used to support improved practices (Barber *et al*., 2020). International policy and funding mechanisms do not adequately prioritize the protection of primary forests to retain their carbon stocks for mitigation over the restoration of degraded forests or the establishment of plantations, which provide far fewer benefits. Nor do these mechanisms emphasize ecological restoration: almost half of government 'restoration' pledges are in fact for commercial plantations (Fagan *et al*., 2020).

This chapter explains the critical importance of primary forests for climate mitigation, describes the state of the world's forests, and outlines the barriers that are currently hindering effective mitigation and the planned activities for forests under NDCs. It goes on to propose solutions that would improve the integrity of primary and other forest ecosystems and support just and equitable benefit-sharing of ecosystem functions and services for IPs and LCs, as well as for all life on Earth.

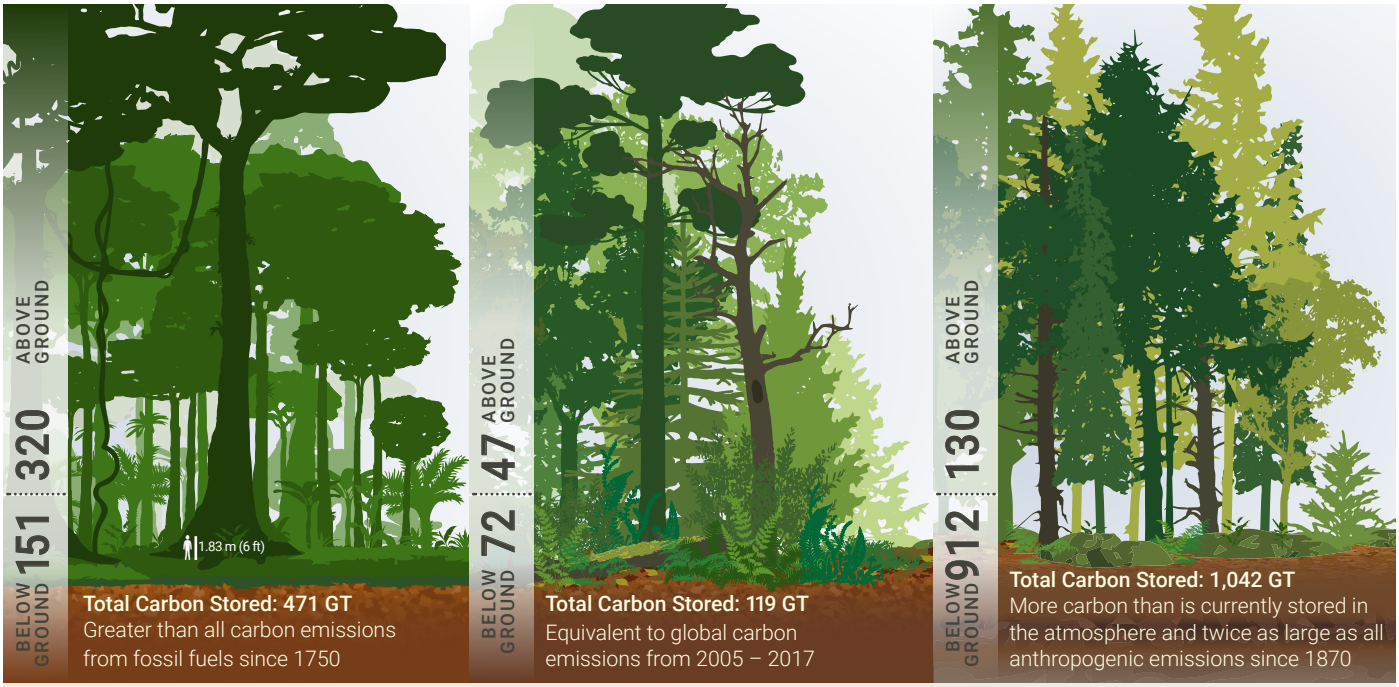
3.1 The importance of primary forests for climate mitigation

Primary forest protection and restoration is the most effective climate mitigation action in the land sector, providing co-benefits for adaptation, biodiversity conservation and other critical ecosystem services.

3.1.1 Description of primary forests

Primary forests are naturally regenerating forests of native species, whose composition, structure and function are dominated by natural ecological and evolutionary processes, including natural disturbance regimes (FAO and UNEP, 2020; IUCN, 2020; Mackey *et al*., 2020). These forests are not subject to modern industrial land use, but most are the customary lands of IPs and LCs (**Box 6**). Primary forests have irreplaceable value for their biodiversity, carbon storage, other ecosystem functions,

Box 1 **Primary forest biomes**



Primary Tropical Forests

Tropical forests store 471 Gt C and roughly half is stored in primary forests.

The attributes below contribute to primary forest stability and resilience to threats from disease, invasive plants, feral animals, drought and fire and enhance ecosystem adapt ive capacity to climate change and other stresses:

- Mammal, bird, reptile and insect seed dispersers and pollinators ensure trees including long lived hardwood species replant themselves and renew the forest.
- Forest fauna and flora drive efficient nutrient and water cycles sustaining healthy forest growth.
- The closed forest canopy creates an interior microclimate sheltering the understorey and maintaining moist, shady and cool conditions.
- Water retained below the canopy stimulates rapid and dense tree and other vegetation growth.
- The canopy transpires water driving convection which in turn can generate regional cloud cover and rainfall.

Primary Temperate Forests

Temperate forests are the most depleted of any forest biome covering roughly one third of their original extent compared to 45% for tropical forests and 65% for boreal forests. Primary temperate forests sequester and store vast amounts of atmospheric carbon in living and dead biomass and soil organic matter, holding onto it for centuries. Their carbon storage value is demonstrated by:

- The highest known biomass (above ground live and dead) of 187kg/m² is in Victorian mountain ash forests.
- Trees can tower to 100+ metres and live for over 1,000yrs.
- Large old trees sequester carbon at 3 times the rate of smaller trees, contribute 76% of the biomass in an old forest but only 43% of tree numbers.
- When old forests are cut down two thirds or more of their stored carbon is released to the atmosphere. Logging emissions are not offset by planting new trees or carbon stored in harvested wood products.

Primary Boreal Forests

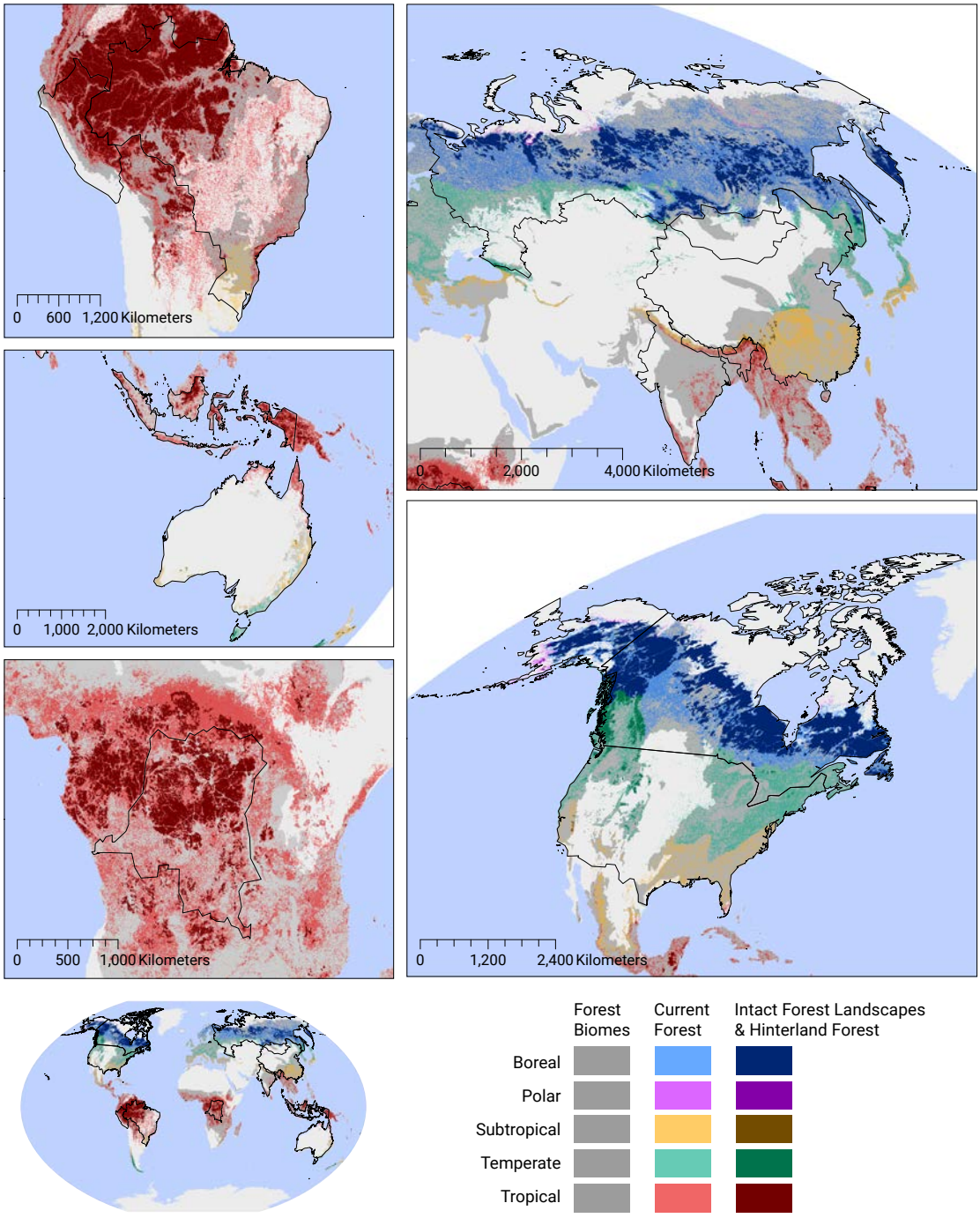
Boreal forests store about 65% of the world's forest ecosystem carbon which is mostly held below ground in peat and mineral soils.

The cold wet environment in boreal forests slows decomposition on the forest floor leading to thick layers of moss and litter and soils that can be metres deep storing as much as 85% of the ecosystem's carbon.

- Carbon stored in the mineral soils of boreal forests has a turnover rate of approximately 50 years, more than twice as long as that in temperate or tropical forests.
- Peat found in fens and bogs of boreal forests store 270 billion tonnes of carbon across the boreal forest landscape.
- Clear cut logging does not mimic naturally occurring fire in boreal landscapes as fires do not combust tree boles and the resulting carbon stored in dead standing trees and woody debris is longer lived than most sawn timber products by at least a factor of two.

Figure 3.1 **Global Forest Extent for Global Ecological Zones**

Extent of forest biomes (pre-agricultural era), current extent of forest area, and primary forests proxy.[1] The top ten forested countries are shown by black outlines (the Russian Federation, Brazil, Canada, the United States of America, China, Australia, the Democratic Republic of the Congo, Indonesia, Peru, India)



Sources: Global Ecological Zones (FAO, 2012); Pre-agricultural era extent (Billington *et al*., 1997; Current extent canopy cover (Hansen *et al*., 2013); Canopy height (Lang *et al*., 2022); Structural classes (Carnahan, 1977; Specht, 1970); Primary forest proxy at global scale using Intact Forest Landscapes in temperate and boreal zones (Potopov *et al*., 2017) and hinterland forest in tropical and subtropical zones (Tyukavina *et al*., 2016) (this does not include small areas of primary forest). Areas of forest lost have been masked out up until 2021 (Hansen et al. 2013).

1 Forest area is defined by FAO in terms of tree cover and land use. It does not include tree cover predominantly under agricultural or urban land use, but does include areas with temporary loss of tree cover through forest management or natural disturbance (FAO and UNEP, 2020).

including cultural and heritage values, and for sustaining the livelihoods and culture of IPs and LCs (FAO and UNEP 2020; IPCC, 2022b) (see **Box 3**).

Primary forests represent the highest level of ecosystem integrity along a continuum of ecosystem condition that reflects the impacts of human activities – from minimal to severe. This highest level is thus the reference condition (or benchmark) for assessing change in ecosystem condition in the past and potential gains in the future. Ecosystem integrity is defined as the system's capacity to maintain composition, structure and function over time within a natural range of variability at landscape scales, and based on ecological and evolutionary processes. Ecosystems with a high level of integrity have the capacity for self-organization, regeneration and adaptation by maintaining a diversity of organisms and their interrelationships (UN *et al*., 2021; IPCC, 2022a).

Ecosystem integrity is underpinned by the functional role of biodiversity in ecological processes that results in a forest having a maximum degree of resilience and adaptive capacity (Thompson *et al*., 2009). Biodiversity refers to the diversity of species, the genetic diversity within species, and the diversity of ecological communities, including interactions across trophic levels. At the ecosystem level, it encompasses the diversity in composition, structure and function, and stabilizing feedbacks such as nutrient cycling. Consequently, if forests are degraded, species are lost and the functioning of the ecosystem is diminished. Naturally evolved patterns of biodiversity comprise the most stable and resilient ecosystems and, within their system limits, provide natural resistance to threats that are increasing with climate change, such as pests, disease, drought and fire. It follows that the carbon stored in ecosystems with higher levels of integrity are more stable and resilient.

The role of primary forests in climate mitigation provides opportunities for transformative change in conservation management of forests, based on recognition of the carbon retention value and the provision of a wide range of other ecosystem services. Protecting the remaining primary forests and engaging in large-scale ecological restoration of degraded forests is essential for solving the biodiversity, climate change, social justice and zoonotic disease crises (Barber *et al*., 2020; Dobson *et al*., 2020).

3.1.2 State of the world's forests

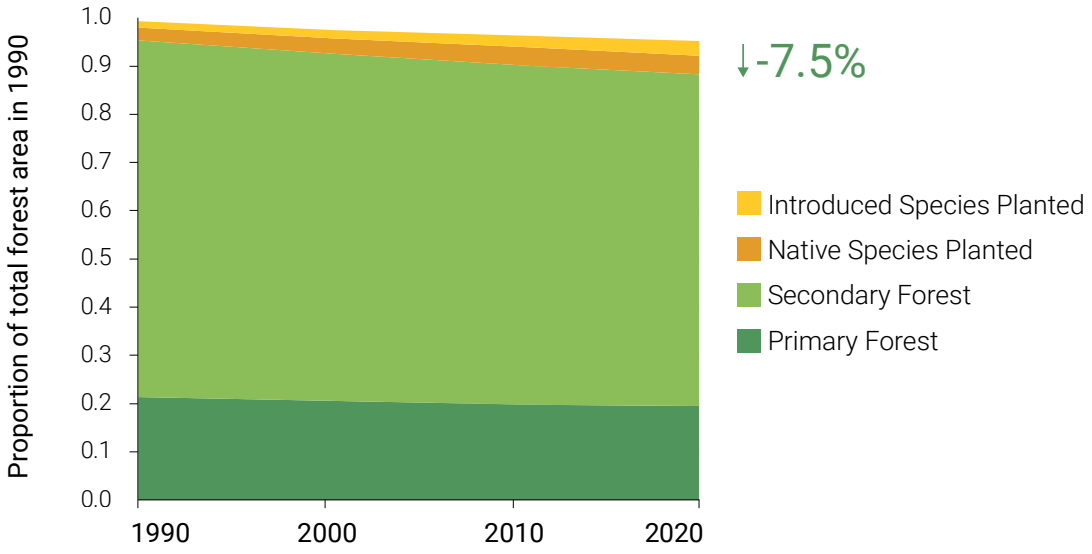
Forests currently cover 4,060 million ha or 30.8 percent of global land area (FAO and UNEP, 2020) and two-thirds of these forests occur in just ten countries (see **Figure 3.1**, **Table 3.2**). The area that is classified as primary forest (1,110 million ha) represents 34 percent of the forest area reported, and 75 percent occurs in the Russian Federation, Brazil, Canada, USA, and the Democratic Republic of the Congo (in order of forest area) (FAO FRA, 2020).

Forest areas in categories of forest type and management type show trends over the last three decades of decreasing area overall, with a decrease in natural forests and an increase in planted forests (see **Figure 3.2**). The total area of forest loss (-420 million ha from 1990 to 2020) is much higher than the net forest area decrease (-178 million ha). But the difference between

Figure 3.2 **Proportion of total forest area in 1990 to 2020**

In naturally regenerated forest subdivided into primary and secondary forests, and in planted forest subdivided into native and introduced species. Total forest area and naturally regenerated forest has decreased over the three decades, but planted forests have increased.

Data source: FAO FRA, 2020



forest areas lost and gained is important: forest loss is from naturally regenerated forests, whereas the area of forest gain is from planted forests and young regeneration, with lower carbon stocks and lower levels of ecosystem integrity. In addition, the reported area of forest loss represents land clearing and does not account for degradation of forests resulting from logging and other human disturbances. Hence, the forest statistics of changes in area underestimate the decrease in carbon stocks and impact on biodiversity and ecosystem integrity. Forest loss occurs particularly in developing countries in tropical forests, but both deforestation and degradation also occur in developed countries with temperate and boreal forests.

The total ecosystem carbon stock in the current extant forest is 680 Gt C (above-ground and below-ground living biomass, soil organic carbon (0 - 30 cm depth) calculated from global maps) shows differences in the total stock and distribution between components by biome (see **Figures 3.3** and **3.4**). This global carbon stock in forests decreased from 668 Gt C in 1990 to 662 Gt C in 2020, due to a net decline in forest area (FAO FRA 2020) (shown in **Figure 3.2**). However, carbon loss due to degradation of existing forest area and changes in forest management type are poorly calibrated in the remotely-sensed data and models, and hence is likely to be underestimated. Estimates of carbon loss from forests indicate that forest degradation may be as significant for carbon losses as deforestation (Baccini *et al*., 2017).

3.2 Barriers to achieving effective mitigation

This section discusses four barriers to achieving effective mitigation through improved conservation management: (i) understanding the role of forests in mitigation; (ii) trade-offs between and synergistic uses of forest ecosystem services; (iii) drivers of carbon stock loss; and (iv) policy failures.

3.2.1 Understanding the role of forests in mitigation

Forest ecosystems play a key role in the global carbon cycle and therefore also in regulating the climate system. Yet forest conservation management and ecological restoration have been largely overlooked in current and proposed actions under NDCs and by non-governmental organization (NGO) and private sector programmes. Instead, there is a misguided focus on tree planting, which ignores the scientific fact that the accumulated stock of carbon and its longevity, not the carbon removal rate, is the principal mitigation value of forests. Furthermore, prioritizing tree planting fails to consider the multiple ecosystem service benefits provided by primary forests, including clean water.

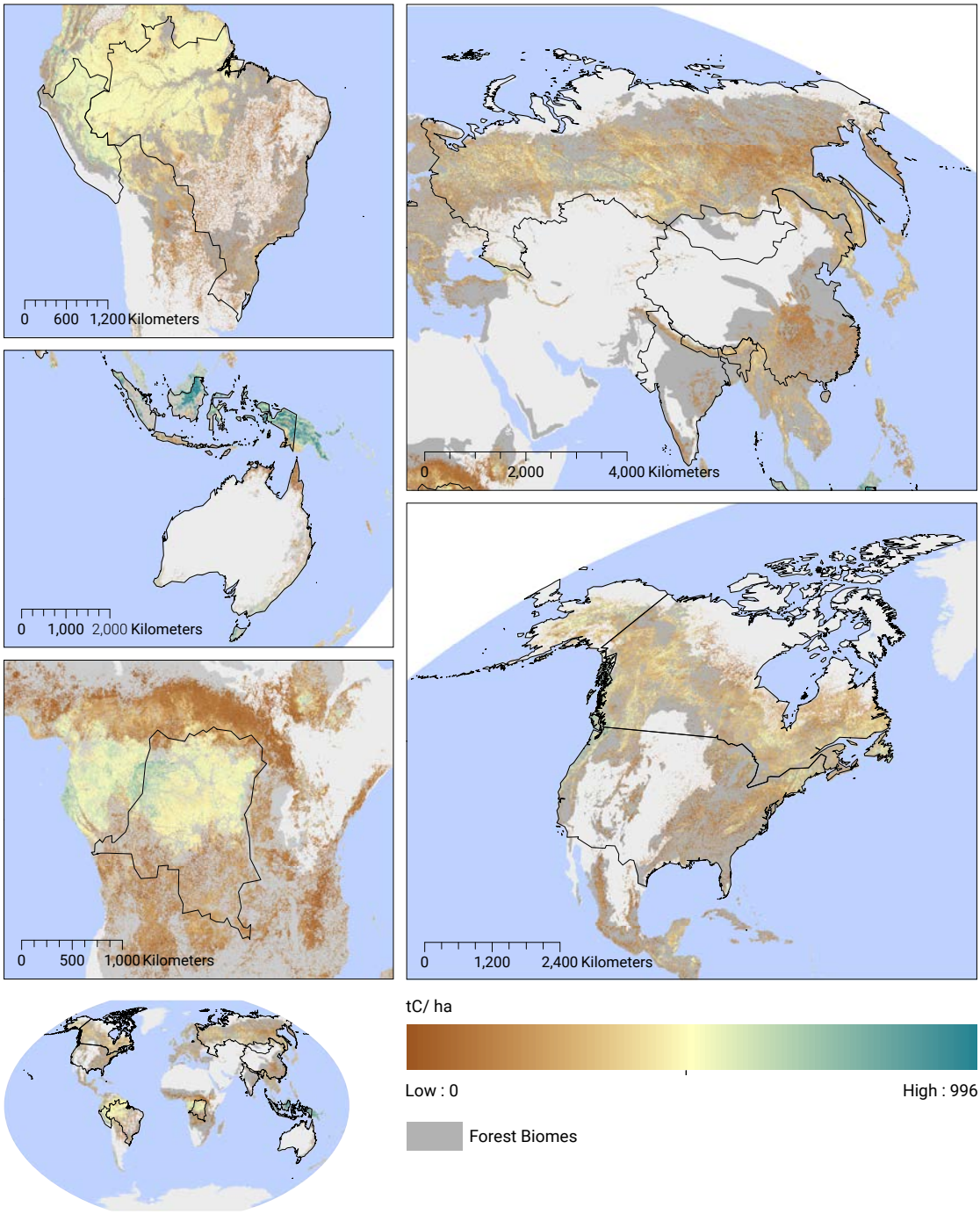
Long-lived, stable and resilient carbon stocks stored in ecosystems with high levels of integrity act as a reservoir in the biosphere, and thus serve to keep carbon out of the atmosphere (Mackey at al., 2008; Barber *et al*., 2020; WEF, 2020). It follows that the feedbacks between climate and biodiversity are two-way, whereby the changing climate can have a negative impact on biodiversity, which in turn reduces the stability and resilience of ecosystems and increases the likelihood of emitting carbon into the atmosphere – creating a mutually reinforcing downward spiral. Conversely, ecologically restoring degraded forests can improve biodiversity, increase forest stability and resilience, and lower the risk of emissions. The ability of forests to adapt to a rapidly changing environment depends on maintaining biodiversity, so as to allow ongoing evolutionary processes and natural selection to enable them to persist or adapt. Maintaining biodiversity and ecosystem integrity is thus an essential foundation for successful climate mitigation and the provision of all ecosystem services on which humanity relies, not merely a co-benefit.

Carbon accounting rules used to report national GHG inventories and develop the current pledges for NDCs (IPCC, 2006, 2019b) assume that only annual flows need to be estimated. This assumption is appropriate for fossil fuel emissions, which are one-way flows. However, this mechanism is inadequate to account for the two-way flows between the land and atmosphere, with emissions and removals (Mackey *et al*., 2013). Reporting net emissions in the land sector, and using this to assess progress towards the goal of 'net zero' emissions (Allen *et al*., 2022), is misconceived because it conflates removals by natural forest growth with emissions from human activities. This net accounting obscures the emissions from logging and masks the mitigation benefits of protecting and restoring forests (Mackey *et al*., 2022a).

The current carbon accounting system also fails to register the risk of carbon stock loss and how this differs with the level of ecosystem integrity. Rather, carbon is considered to be fungible. All carbon stocks are in effect assumed to have the same stability, longevity and resilience (Ajani *et al*., 2013). Carbon lost from primary forest is not offset by planting new trees as the ecosystem integrity is lower, and hence the risk of loss is higher. Assuming it can be offset creates a carbon debt by permanently reducing the carbon stored in the landscape and increasing the stock in the atmosphere. Similarly, fossil fuel carbon and ecosystem carbon are not fungible; they are fundamentally different in terms of the stability of their carbon stocks. The reporting in GHG inventories of net emissions has mistakenly allowed the removals from natural forest growth to offset an equivalent amount of the emissions from fossil fuel use (Mackey *et al*., 2022a). The perverse outcome is that this use of forest removals as an offset mechanism has lessened the incentives and market forces to reduce fossil fuel emissions.

Figure 3.3 **Total ecosystem carbon extant in forest**

Global spatial distribution of total ecosystem carbon density (Mg C ha-1), including above- and below-ground biomass, dead biomass and soil organic carbon (0 - 30cm depth) in the current extant forest. Top ten forested countries are shown with black outlines.



Sources: for above-ground living biomass GlobBiomas (Santoro *et al*., 2018); below-ground living biomass derived from a root: shoot ratio (IPCC, 2019b); dead biomass based on averages from site and inventory data for each biome (Pan *et al*., 2011); soil organic carbon (0–30 cm depth) from GSOC (FAO, 2019); carbon concentration of biomass (IPCC, 2006).

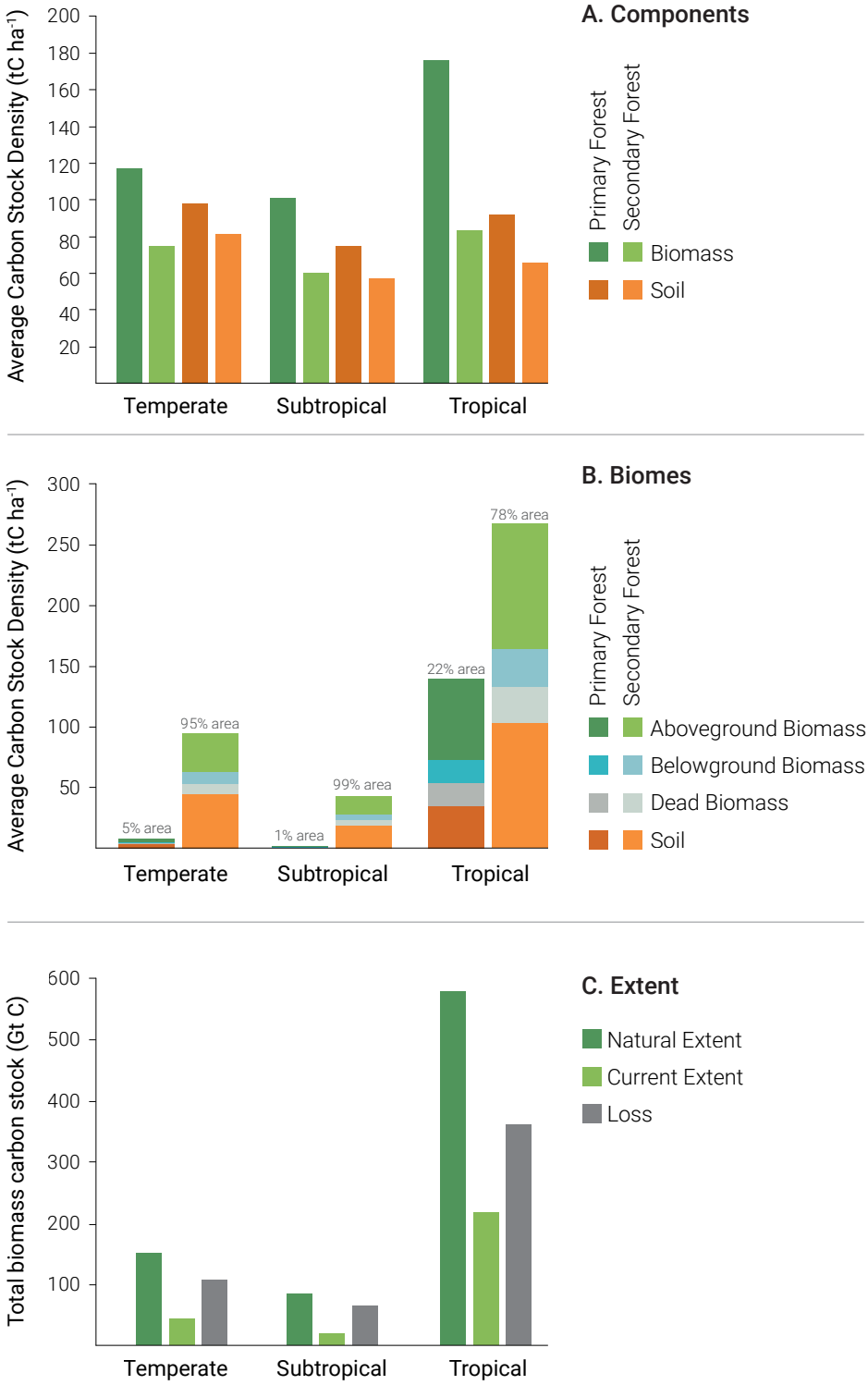
Figure 3.4 **Carbon stock by components, biomes and extent**[10]

(a) Carbon stock density of biomass and soil comparing primary and secondary forests in each biome;

(b) Total ecosystem carbon stock by components in primary and secondary forest, and showing the percent of area occupied by each category; and

(c) Biomass carbon stock in the natural extent of forest, the current extent, and the difference between these extents as the loss in carbon stock.

(Boreal biome not included in comparisons because of uncertainty in defining forest boundaries and high variability in biomass across the large regions.)



Source: Derived from the spatial data in Figures 3.3 and 3.4. Carbon stock estimated in natural extent of forests assuming the carbon stock density of primary forest.

The role of wood products for mitigation has been misrepresented, creating the false impression that carbon stored in products has a greater benefit than that stored in forest ecosystems. The promotion of wood for construction as a mitigation strategy is based on the false assumption that wood provides emissions reduction benefits. Due to changes in how harvested wood products were accounted between the 2006 and 2019 IPCC guidelines, the carbon sink in wood products was halved (Kayo *et al*., 2021). There is little evidence that wood is replacing steel and aluminium in major construction projects, and while the production of such materials is currently emissions-intensive compared with wood, the situation will reverse as soon as these products transition to renewable, non-carbon energy sources. The use of wood for construction will always produce net emissions because the forest carbon stock is maintained at a lower level than an unlogged forest (Keith *et al*., 2014, 2015). Wood products do provide a store of carbon for their lifetime, but this is small and ineffective as a mitigation action, compared with maintaining forests intact (Law *et al*., 2018). Only 30 percent of harvested wood is used for what is classified as long-lived wood products (sawn wood and veneer) (FAO, 2020) and these have an average longevity of 35 years (IPCC, 2014b).

Burning wood for bioenergy is similarly misrepresented. Forest biomass is not clean energy because burning it releases CO_2 emissions which are instantaneous, but their removal from the atmosphere takes a long time, thereby creating a significant time lag (Mackey *et al*., 2022a). This is not a mitigation action for achieving net zero and competes with real clean energy sources, such as solar photovoltaic and wind (Brack, 2017; Booth, 2018, 2022; Law *et al*., 2018; Sterman *et al*., 2018; Keith *et al*., 2022). Again, carbon accounting rules are at fault. Emissions from combustion to produce bioenergy are not counted in the energy sector, nor in the facility or country where it is consumed, and so cannot be compared with other energy sources (Pulles *et al*., 2022). And, as noted in **section 3.3.2**, logging emissions are netted out by ongoing natural growth in the rest of the forest estate.

3.2.2 Trade-offs between and synergistic uses of ecosystem services

Forests provide a multitude of ecosystem services that often go unrecognized and are therefore not included in evaluations of the costs and benefits of extractive activities versus protecting and restoring forest ecosystems. The ongoing provision of the quantity and quality of all ecosystem services, including global

Table 3.1 **Forest management to support mitigation activities also results in gains or losses of other ecosystem services**

Mitigation activity	Gain in ecosystem and cultural values	Loss in ecosystem and cultural values
Protection of primary forests	• Climate regulation • Cultural values • Many other services	• No future wood supply • No industrial-scale activities • Potential for access restrictions affecting indigenous peoples and other resource-dependent groups
Restoration of degraded secondary forest	• Climate regulation • Cultural values • Many other services	• No future wood supply • No industrial-scale activities
Improved silvicultural practices	• Improved ecosystem services • Potential for increased access supporting a pastoral or nomadic livelihood	• Change in wood supply
Reforestation* on abandoned or marginal land	• Improved ecosystem services • Potential wood supply • No change in agricultural production	• Reduced potential for other land uses • Potential for indigenous peoples and other resource-dependent groups who may use the land for grazing, agriculture, cultural heritage
Reforestation* on agricultural land	• Improved ecosystem services • Potential wood supply	• Reduced land area for agricultural production

* Activities include both reforestation and afforestation, as defined by the IPCC (2006), which refers to the establishment of trees on land that had previously been cleared of forest; the distinction depends on the time that the land has been cleared and other land uses.

climate regulation through the retention of carbon stocks, is directly linked to the integrity of forest ecosystems. However, as a finite resource, changes in the way forests are used may create trade-offs between the use of certain services, or enable opportunities for synergies. Hence, evaluations of climate mitigation strategies should include impacts on ecosystem integrity and adaptive capacity, and consequently the provision of all ecosystem services.

Forest land uses that involve trade-offs with climate mitigation include clearing for expansion of agriculture; livestock grazing; mining; and production of wood for timber, pulp and bioenergy. These activities result in deforestation and degradation that reduce ecosystem carbon stocks and cause emissions, exacerbate biodiversity loss, and reduce the quality and quantity of water, aesthetic and cultural values, and non-wood forest products important to local and regional communities.

Table 3.2 **Mitigation actions specified in climate pledges for the top ten forested countries, including developed and developing countries, and classified by criteria for their mitigation benefit**

Low | Moderate | High

Assessment against criteria:

		Criteria for mitigation benefit		
	Mitigation activity	**Trade-off with other land uses/ resources**	**Action in critical time period**	**Providing co-benefits**
Russian Federation	Forest management	Moderate	Low	Moderate
Brazil	Forest planting	Low	Low	Low
	Eliminate illegal deforestation	High	High	High
Canada	Afforestation	Low	Low	Low
	Conserve carbon-rich ecosystems	High	High	High
	Protect 30% of land by 2030	High	High	High
United States of America	Reforestation of 54 million ha	Low	Low	Moderate
	Reduced forest harvest	Moderate	High	High
	Forest restoration	High	Moderate	High
	Forest protection and management	High	High	High
China	Afforestation	Low	Low	Moderate
	Restoration	Moderate	Low	Moderate
	Protection	High	High	High
Australia	Soil carbon on farms	High	Low	High
	Mixed species planting on farms	Moderate	Low	High
	Afforestation	Moderate	Low	High
Democratic Republic of the Congo	Afforestation	Low	Low	Moderate
	Forest protection and management	High	High	High
Indonesia	Moratorium on clearing primary forests	High	High	High
	Reduced impact forest harvesting	Moderate	High	Moderate
	Afforestation for land rehabilitation	Moderate	Low	Low
	Restoration of mangroves	High	Moderate	High
Peru	Restoration through commercial forest plantations	High	Low	Low
India	Afforestation to increase tree cover	Low	Low	Low

Forest protection and restoration support the synergistic provision of many ecosystem services, in addition to carbon retention and climate mitigation. These include local climate regulation; supply of freshwater through water yield and filtration; the provision of clean air; sources of genetic material; the provision of non-wood products, including food and medicinal products for IPs and LCs; habitat maintenance for biodiversity; pollination services; soil quality, erosion control and sediment retention services; flood mitigation; biological control; and aesthetic, recreational, educational and spiritual services. A major barrier is the lack of recognition of many of these ecosystem services and of standardized methods for their monitoring and valuation in relation to different forest management regimes. Nonetheless, it is possible to provide an indicative assessment of the likely gains and losses in ecosystem services resulting from changes in forest management (see **Table 3.1**).

The likely effectiveness of the current NDC forest-based mitigation pledges by countries is hard to determine because descriptions of activities are mostly very general and unquantified. It is therefore difficult to assess the potential land requirements, trade-offs with other ecosystem services, community needs and aspirations, and mitigation benefits. Mitigation activities should be assessed in terms of the area of forest required for carbon dioxide removals, the types of forest management that will produce the greatest removals and carbon storage, and the optimum management to meet multiple objectives and provision, including the protection of biodiversity and the provision of other ecosystem services.

The land area required for dedicated carbon dioxide removals pledged in the NDCs for emissions reduction is 1.2 billion ha globally, and involves a range of mitigation activities for forest land, as well as agricultural and rangelands. However, there will invariably be competing uses for both forested and cleared land. Fundamental criteria for assessing the mitigation benefits of an action include examining: (i) whether there are trade-offs with community needs, biodiversity protection, and other land uses; (ii) if the action produces a change in carbon storage or removals within the critical time period for mitigation (the next one to three decades); or (iii) degradation in the provision of co-benefits (see **Table 3.2**).

Protecting existing forests is the only activity that provides the highest benefits against all criteria. The critical time period for action was the criterion with the lowest scores for many activities. This criterion has not been considered adequately in many NDCs that have focused on a target of net zero emissions by 2050, without calculating the accumulated carbon emissions in the atmosphere that will result from the intervening 28 years of activities producing emissions (Keith *et al*., 2022).

Forest protection and restoration support the synergistic provision of many ecosystem services, in addition to carbon retention and climate mitigation.

The lack of details in NDC-proposed forest-based mitigation activities makes them difficult to implement and attract investment. Australia provides no information about off-farm land sector abatement except to state 'savanna burning' and 'native forest management'. Moreover, the proposed mitigation does not specify avoiding land sector emissions by reducing deforestation or logging, despite the obvious benefits (Mackey *et al*., 2022b). Peru simply states that relying on land use, land-use change and forestry sinks to achieve its climate targets should be avoided as much as possible, given the high chance of carbon loss through deforestation, natural disturbance, or competition for land.

We present case studies in temperate forests in southeastern Australia and the Kayapo Territory of Brazil to illustrate the impact of competing uses of forests on their carbon storage, ecosystem integrity and capacity for mitigation (see **Boxes 2** and **3**).

3.2.3 Drivers of carbon stock loss

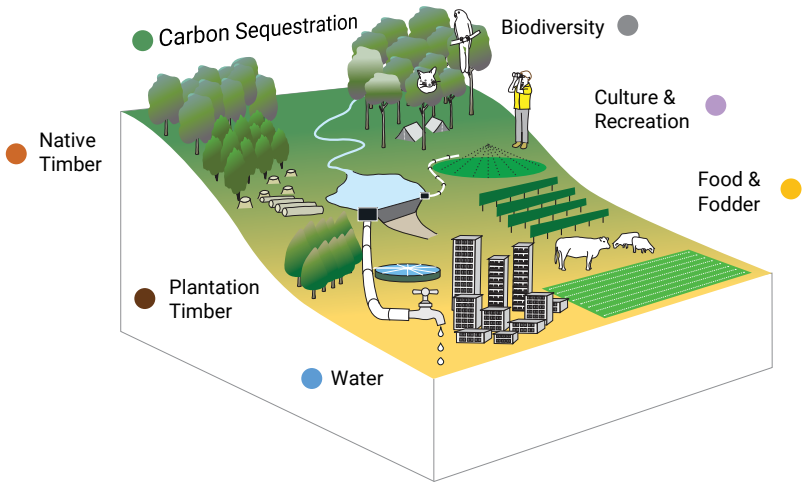
Deforestation and degradation are causing continued loss of forest carbon stocks. The drivers of these activities are demand for food and energy to supply a growing global population and changing patterns of consumption. In particular, marketing in developed countries influences the supply chain and logging practices in developing countries (Davergne and Lister, 2011; Donofrio *et al*., 2017; Sen, 2017; Curtis *et al*., 2018).

Deforestation results from agricultural expansion for crops and pasture (see **section 2.2** and **Chapter 5**), plantations, industrial timber extraction, clearing for mining and infrastructure, urban expansion, fuelwood extraction for commercial bioenergy and local fuel, and fires, which are often associated with roading and logging-site development (Fearnside, 2017; Potopov *et al*., 2017; Curtis *et al*., 2018). These drivers differ among regions and are context- specific, depending on local social, economic and environmental factors. In tropical and subtropical countries, large-

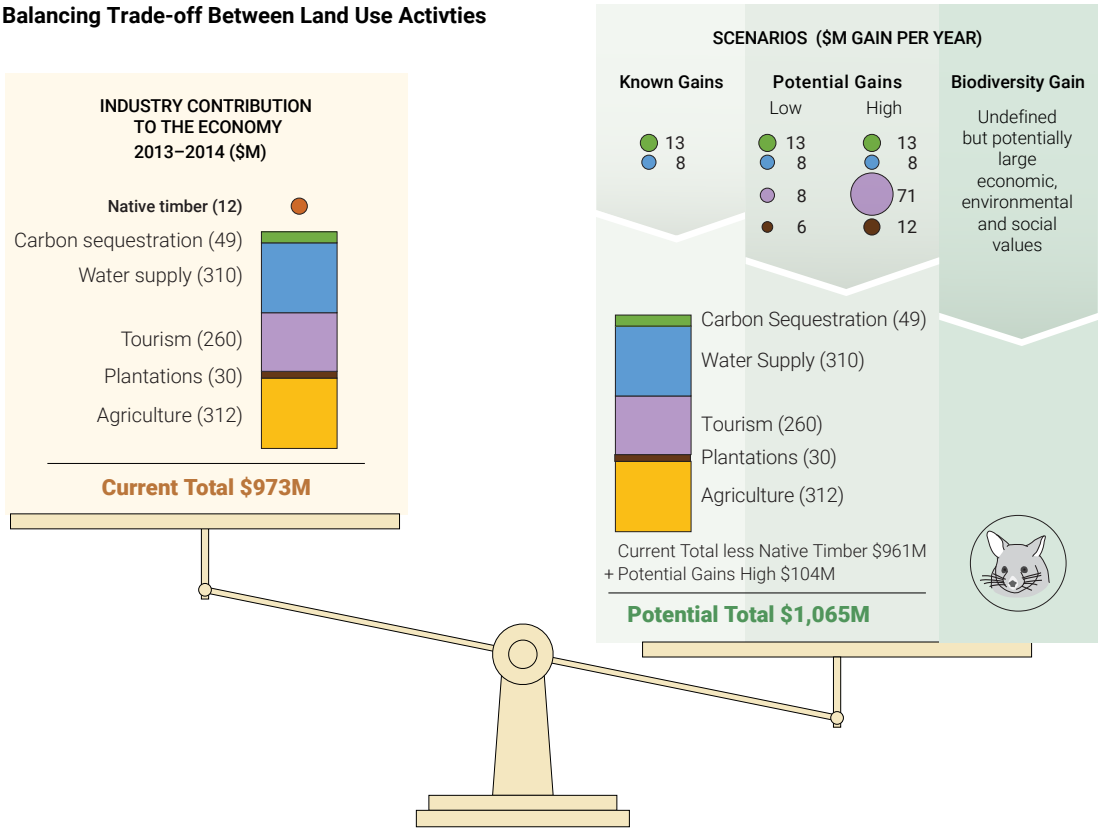
Box 2 **Central Highlands of Victoria case study**

The wet temperate eucalypt forests in the Central Highlands of Victoria, Australia illustrate the usefulness of the UN System of Environmental Economic Accounting Ecosystem Accounting (SEEA_EA) framework (UN *et al*., 2021) for assessing the effects of forest management on carbon stocks and the trade-offs in the provisioning of key ecosystem services: carbon sequestration, water supply, biodiversity conservation, culture and recreation, native timber and plantation timber provisioning, and food and fodder provisioning. Scenarios of known gains and potential gains in provisioning of these ecosystem services showed that their value and contribution to gross domestic product (GDP) (industry, value added) was higher in forests managed for protection where native forest logging was ceased. This demonstration of the trade-offs between forest management for protection or production was used to inform decision-making about contentious land-use issues (Keith *et al*., 2017, 2019).

Ecosystem Services



Balancing Trade-off Between Land Use Activties



Box 3 **Kayapo case study**

In the southeast of the Brazilian Amazon, the Kayapo territory has proven a formidable barrier to forest destruction thanks to de facto protection services – the 9,000+ indigenous inhabitants, who have fiercely defended their lands for generations. Kayapo culture and survival depends on primary forest and riverine ecosystems.

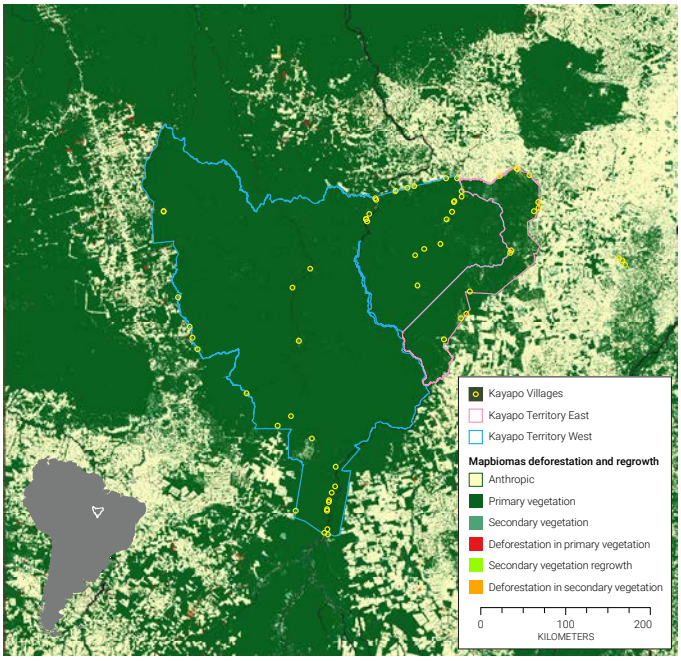
Indigenous territories are protected under the constitution of Brazil, but Kayapo lands are under siege from agricultural frontiers in the region of the Amazon with the highest rate of deforestation. Without adequate surveillance and protection in this lawless region of weak governance, ranchers, loggers, goldminers and commercial fishers invade the territory. Recognizing their need for help to secure their borders and develop sustainable income generation, the Kayapo forged alliances with conservation NGOs more than 20 years ago.

The Kayapo–NGO alliance has implemented conservation and development programmes that continue to grow and empower Kayapo communities, enabling them to protect more than 10 million ha of their forested territory, which stores approximately 1.9 Pg C. This vast area has high conservation significance, being rich in biodiversity and extensive enough to protect large-scale ecological processes. As well as rainforest, the Kayapo territories span portions of the threatened *cerrado* (savannah-woodland) biome and preserve high numbers of endemic fauna and flora species. Evidence for the effectiveness of this approach is provided in the following maps.

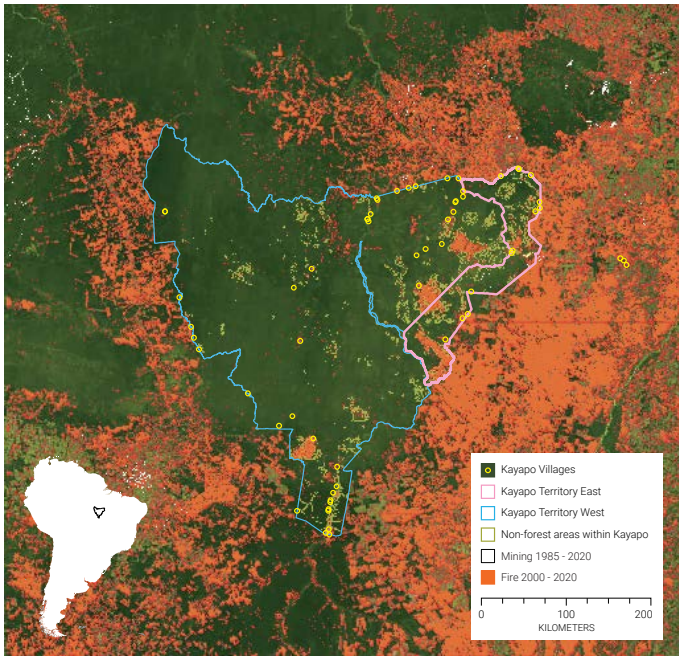
Figure 3.5 **Kayapo territories**

a) The boundary of the Kayapo Territory in relation to the remaining primary forest and deforested land (labelled 'anthropic' land cover); b) The Kayapo Territory in relation to burned and unburned land. Under natural conditions, wet tropical primary forest is resistant to wildfires as the closed canopies create moist microclimates. Non-forest areas, such as cerrado, located within the perimeter of the primary forest are more fire-prone and typically experiences wildfires. In a region lacking effective governance, more than 1.2 million ha of Kayapo territory have been lost to illegal gold mining and logging, largely along the eastern border, and the area has experienced more human-driven wildfires. The well-organized Kayapo Alliance in the western sectors has been more successful in resisting such incursions.

a)



b)



Source: The land-cover and wildfire data were sourced from the MAPBIOMA programme (https://mapbiomas.org/). The mapping of fire scars in Brazil was based on mosaics of images from Landsat satellites, with a spatial resolution of 30 m for the period 1985 to 2020.

scale commercial agriculture for cattle ranching and cultivation of soybean and palm oil are the main drivers of deforestation, but clearing also occurs due to shifting agriculture and small-scale commercial farms (Hosonuma *et al*., 2012; Seymour and Harris, 2019). In temperate and boreal regions, deforestation rates are lower, but still significant in some regions, with Australia having the highest rate of deforestation in the developed world (with a rate of 0.28 percent in the 1990s and 0.26 percent in the 2000s (Pan *et al*., 2011), but decreasing in the past decade).

Degradation is best understood as a reduction in the ecosystem integrity of the forest, attributable to the impacts of human land-use activities, including forest management for commodity production. The composition, structure, function and productivity of the ecosystem is impacted by these land uses, resulting in reduced capacity to deliver the full suite of ecosystem services (CBD, 2006; van Lierop *et al*., 2015; FAO and UNEP, 2020; Prăvălie, 2021; IPBES, 2022; van der Esch *et al*., 2022).

The main drivers of forest degradation are commercial logging, followed by fuelwood collection and charcoal production, uncontrolled fires and livestock grazing in forests (Hosonuma *et al*., 2012; Putz *et al*., 2014; Keith *et al*., 2015, 2017; Erb *et al*., 2018; Taubert *et al*., 2019; Maxwell *et al*.; 2019, Mackey *et al*., 2020). Forests managed for wood commodity production comprise one-third of the world's forests (Puettmann *et al*., 2015). This type of land use invariably results in removing trees, damaging remaining trees and other vegetation, soils and waterways (Mayer *et al*., 2020), and younger even-aged stands dominated by commercially valuable tree species (Puettmann *et al*., 2015; Pearson *et al*., 2017; Mackey *et al*., 2020). Emissions from logging have probably been underestimated and the resulting carbon stock at landscape scale is reduced by 30 to 70 percent (Noormets *et al*., 2015; Arneth *et al*., 2017; Erb *et al*., 2018; Keith *et al*., 2022). Biodiversity is reduced due to removal and damage to vegetation and disturbance of habitats. At landscape scale, degradation from the construction of infrastructure involves fragmentation, resulting in restricted connectivity, diminished ecological processes and greater impact of edge effects (Laurance *et al*., 2006, 2014). The remaining forest has increased vulnerabilities to drought, wildfire, pests, pathogens, weeds and drier microclimates (Briant *et al*., 2010; Lindenmayer *et al*., 2021; Wilson *et al*., 2022). Degradation caused by previous land use can be permanent or irrecoverable. Examples include soil erosion, irreversible change in pedogenic processes, pollution, and the extinction of species This means that the carbon carrying capacity is reduced and can never fully regain its previous stock.

The impacts of degradation are poorly recognized and there is little monitoring of its impacts. Forest degradation is not formally defined in international agreements and a range of definitions and criteria are used by countries, including when reporting to

The lack of an internationally agreed operational definition of degraded forests has hindered reporting against targets that are used to assess progress towards mitigation through land management.

FAO's Forest Research Assessment (FAO FRA, 2020). The lack of an internationally agreed operational definition of degraded forests has hindered reporting against targets that are used to assess progress towards mitigation through land management. These include SDG 15.3.1 'Proportion of land that is degraded over total land area' (UN 2019), Aichi Biodiversity Target 5 'Degradation and fragmentation is significantly reduced' (CBD, 2020), and the UN Strategic Plan for Forests goal 1 'Increase efforts to prevent forest degradation' (UN, 2017). In addition, classification systems for forests do not include characteristics representing ecological condition and the divergence from benchmark levels of ecosystem integrity.

3.2.4 Failures in policy

Primary forests are irreplaceable due to their value in climate mitigation and in conserving biodiversity. Continuing deforestation and degradation demonstrate persistent failures in international and national climate policy and targets to protect forests. Annual forest loss remained at 10 million ha in 2015–2020 (the area of Iceland every year) (FAO and UNEP, 2020). Rates of degradation due to fragmentation appear to be increasing (FAO and UNEP, 2022). *The Sustainable Development Goals Report 2019* (UN, 2019) indicated that 20 percent of the Earth's surface was in a degraded state between 2000 and 2015, with the highest proportion of 36 percent recorded in Oceania. In the five-yearly review of progress towards halving deforestation rates, as per the New York Declaration on Forests, in noting failure to achieve this goal, comments were made about the 'tragic' failure of the initiative to protect primary forests (NYDF, 2019). These statistics illustrate the extent of current policy failure. Climate and forest mitigation strategies have failed to prevent deforestation and have actually fostered degradation in some areas by subsidizing logging, even at low intensities (Hansen *et al*., 2013; Keenan *et al*., 2015; Curtis *et*

al., 2018; NYDF, 2019). For countries with high forest area but low deforestation rates (HFLD), which contain 24 percent of the world's forests, there are few policies and programmes to support improved conservation management of their primary forests (UNDP *et al*., 2019).

There has been no explicit implementation of Article 4.1(d) of the UNFCCC (1992), which calls for the conservation of ecosystem carbon reservoirs (or stocks), nor of the ecosystem provision in Article 5 of the Paris Agreement (UNFCCC, 2015). This means that the assumption of carbon being fungible remains unchallenged and countries continue to report annual flows of carbon that net-out emissions from the fossil fuel sector with removals in the land sector, which are largely through forest growth. Poor policies have led to high-profile initiatives that focus on tree planting, such as the Bonn Challenge, having perverse outcomes. While tackling desertification is a valuable objective, tree planting will only slowly accumulate carbon and benefit mitigation. Many tree planting initiatives have little or no ecological benefit and are at high risk of medium- to long-term failure. Even worse, focusing on tree planting deflects attention from the urgency and immediate benefits of protecting and restoring forest ecosystems. Improving the conservation management of primary and other natural forests provides long-term integrated benefits for climate mitigation and adaptation, biodiversity conservation, and other essential ecosystem services. The mitigation value of preventing emissions now from causing damage to and loss of, primary forests far outweighs the benefits of trying to restore them in the future. There is increasing recognition of the need for holistic solutions in the land sector that integrate management for climate, biodiversity and climate-resilient development. However, achieving these solutions will require transformation in approaches to forest management and an evaluation of the benefits of all ecosystem services (Barber *et al*., 2020; Morgan *et al*., 2022).

3.3 Proposed solutions: prioritizing, incentivizing and financing forest management for mitigation on the basis of ecosystem integrity

The scientific imperative of reducing emissions now and minimizing the risk of future loss necessitates maintaining and restoring the integrity of forest ecosystems. We can scale up ambition by transforming forest management to support multiple objectives and close the land gap. The changes are essential to address the interlinked climate and biodiversity crises that require reducing gross emissions from all sectors, combined with increasing carbon storage in ecosystems and reversing the trajectory of biodiversity loss and ecosystem decline. Improving the conservation management of primary forests and restoration of natural forest ecosystems to support a wide range of ecosystem services can deliver social, environmental and economic benefits. Key factors required to achieve this transformation include: reforming the rules for carbon accounting and priorities for forest mitigation actions; identifying and appropriately valuing all the ecosystem services that provide social, environmental and economic benefits, inclusive of their magnitude, longevity and synergies; reducing the risk of loss of carbon stocks due to disturbance events by improving the integrity of forest ecosystems; and reforming policies and practices of governments, businesses and communities to promote synergistic and holistic solutions that provide optimum benefits. Such a transformation will enable strategies to be implemented that minimize barriers and prioritize effective mitigation. These changes in forest management are needed in all biomes (tropical, boreal and temperate) and forest ecosystem types, and across both developed and developing countries.

3.3.1 Opportunities for addressing the interlinked climate and biodiversity crises

Policy guidance has been slowly evolving in response to increasing recognition of the role of nature in climate mitigation (see **Box 4**). Drivers for this change include recognition that deforestation is a major contributor to GHG accumulation in the atmosphere, as well as IPCC conclusions that it is not feasible to achieve climate goals through reductions in fossil fuel emissions alone (IPCC, 2019a, 2022b). Also important is the expectation by state parties that the deep and rapid cuts now needed in fossil fuel emissions may be lessened by scaling up nature-based solutions (as indicated by their inclusion in NDCs, see **Table 3.2**). This has led to increasing awareness of the nexus between the climate and biodiversity crises, which is slowly shifting the global policy focus towards encouraging synergistic climate and biodiversity actions. The scale of both crises was recognized at the first joint Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)/IPCC workshop, held in 2021 (Pörtner *et al*., 2021), which clearly identified where synergies lie: emphasizing the importance of protecting and restoring carbon and species-rich ecosystems such as forests; and stressing that each crisis amplifies the other and that neither crisis will be solved unless they are solved together. Recent decisions under the Rio Conventions and recommendations by IPBES/IPCC and IPCC (2022b) (see **Box 4**) are important steps forward that may afford some opportunities to address the interlinked climate

and biodiversity crises. However, they are as yet insufficient to ensure that the right priorities are implemented by state parties in their NDCs. The crux of the issue is that forests – and the integrity of their ecosystems – cannot continue to be traded off for other land uses, with the IPCC recognizing that carbon lost from carbon-dense ecosystems such as primary forest is irrecoverable by 2050 (IPCC, 2022b).

3.3.2 Comprehensive carbon accounting to inform policy

Comprehensive carbon accounting of stocks and flows enables the true change in the carbon stock of the atmosphere to be defined and the mitigation benefits of forests and other ecosystems to be recognized and realized. The rules for carbon accounting need to provide information about the carbon

Box 4 Evolution of policies leading to current opportunities from international decisions

Chronology of relevant declarations

- 2007 Conference of the Parties (COP) 14 in Bali: REDD+ adopted for negotiation.
- 2011 COP 17 in Durban: The South African COP President noted: "Forests are central to the world".
- 2014 New York Declaration on Forests: An ambitious programme to "cut natural forest loss in half by 2020 and strive to end it by 2030".
- 2018 COP 24 in Katowice: The COP President made his initiative saving the world's forests for climate and biodiversity.
- 2021 COP 26 in Glasgow: The Global Forest Finance pledge committed USDD 12 billion for 2021–2025 to help protect, restore and sustainably manage forests to meet climate, biodiversity and sustainable development objectives, recognizing the rights and roles of indigenous communities.

Decisions under the Rio Conventions

- Paris Agreement (2015) expectations were raised that Article 5 pertaining to all ecosystems (5.1) and especially forests (5.2) would be informed by paragraphs 12 &13 of the Preamble, which referred to Article 4.1(d) of the UNFCCC and noted the importance of ensuring the integrity of all ecosystems and the protection of biodiversity. Article 4.1(d) "responds to longstanding concerns that biodiversity and ecosystem integrity risks are not sufficiently considered by parties when taking climate action" (Carazo 2017).
- CBD COP 14 (2018) expressed deep concern that "escalating destruction, degradation and fragmentation of ecosystems would reduce the capacity of ecosystems to store carbon and lead to increases in greenhouse gas emissions, reduce the resilience and stability of ecosystems, and make the climate change crisis ever more challenging" (CBD 14/5).
- CBD COP 14 (2018) recognized the exceptional importance of primary forests for biodiversity conservation and the urgent necessity to avoid major fragmentation, damage to and loss of primary forests of the planet (CBD 14/30).
- UNFCCC COP 25 (2019) delivered the first decision since the Paris Agreement on the importance of "integrating action to prevent biodiversity loss and climate change" (i/CP25, para 15).
- UNFCCC COP 26 (2021) – The Glasgow Declaration emphasized "the importance of protecting, conserving and restoring nature and ecosystems, including forests and other terrestrial and marine ecosystems, to achieve the long-term global goal of the Convention" (CMA/3.para 21 and 1.CP/26 para 38).

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- 7.4.1.3 "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" (Goldstein *et al*., 2020).
- 7.42, 28 "Among the mitigation options, the protection, improved management, and restoration of forests and other ecosystems (wetlands, savannas and grasslands) have the largest potential to reduce emissions and/or sequester carbon at 7.3 (3.9–13.1) GtCO2-eq yr-1 (up to USD100 tCO2-eq-1), with measures that 'protect' having the single highest total mitigation and mitigation densities (mitigation per area) in AFOLU (Table 7.3, Figure 7.11".
- 7.5.3 "the protection of high biodiversity ecosystems such as primary forests (SDG15) deliver high synergies with GHG abatement".
- International Union for Conservation of Nature Policy Statement on Primary Forests Including Intact Forest Landscapes (IUCN PF-IFL 2020) policy developed, explaining the importance of primary forests for climate mitigation and biodiversity protection and enabling differentiation of forests based on their integrity.

stocks and flows in all pools and the impact of human activities on each pool, in order to ensure that decisions reflect the true change in carbon stock of the atmosphere. Given that emissions reductions and increased removals are needed in all sectors, mitigation activities can be made transparent and optimized by accounting for fossil fuel emissions and forest (and other ecosystem) emissions and removals with separate reporting, targets and financial mechanisms (Ajani *et al*., 2013). This would prevent the practice of 'offsetting' between and within sectors, and avoid reporting only net emissions (Keith *et al*., 2021, 2022).

Such a comprehensive carbon accounting system is incorporated in the UN System of Environmental Economic Accounting Ecosystem Accounting (SEEA_EA) (UN *et al*., 2021), which follows statistical standards and can thus be integrated with other environmental and economic accounts and provide information to support all international conventions and national policies. Data are reported on the relative integrity of all ecosystems and thus the relative value of, and risks, to the ecosystem services they provide. Metrics describing the state and trends of ecosystem assets, the flow of ecosystem services and benefits to people form accounts for the environment that can be linked to the national accounts of all countries. The ability to reflect the superior value of high integrity ecosystems, such as primary forests, on a country's balance sheet, will enable all countries to see the value for their national economy of maintaining ecosystems in good condition and restoring degraded ecosystems.

The comprehensive carbon accounting system offered by the SEEA_EA provides an important opportunity to bridge the silos of the Rio Conventions and inform the SDGs by revealing synergies among the objectives of conventions and demonstrating the benefits of integrating climate and biodiversity actions to better inform decision-making. Adopting this approach will enable the intent of the COP 25 and COP 26 decisions (see **Box 4**) to be operationalized, so that the mitigation value of ecosystem protection, conservation and restoration are better revealed, and their carbon stocks and stock changes are reported appropriately for the Global Stocktake. Presenting information through the SEEA_EA provides a key tool to incorporate the benefits of forest ecosystems into land-use decision-making and economic planning. This system will be particularly valuable for HFLD countries to demonstrate the value of, and secure funding for, improved conservation management of their primary forests. Comprehensive carbon accounting that follows the SEEA_EA guidelines provides the most prospective pathway for filling the gaps in the current UNFCCC rules in five fundamental components (see **Box 5**).

Such an approach to carbon accounting will help to bridge the divide in the global carbon budget between reported country GHG inventories and what the atmosphere actually sees. Linking carbon accounting to ecosystem condition will enable action on both climate and biodiversity to be integrated into mitigation planning. It is critically important to ensure that climate action achieves robust outcomes for both the fossil fuel sector and the land sector, including forests. By utilizing the SEEA_EA, robust mitigation outcomes in forests can be achieved, as the system reveals the carbon benefits of maintaining existing relatively stable and long-lived primary forest carbon stocks and improving conservation management of forests to increase carbon removals from the atmosphere and accumulation in stable carbon storage.

3.3.3 Prioritizing actions to support mitigation and multiple ecosystem services

Fostering synergistic climate and biodiversity action will maintain and enhance ecosystem integrity and hence the provision of all ecosystem services to society, including indigenous peoples and local communities. Optimizing the benefits for achieving climate goals, as well as goals for maintaining ecosystem integrity, biodiversity conservation and sustainable livelihoods (Mackey 2015, 2020) requires the following actions, in order of priority:

1. **Protect** – prevent carbon stock loss from long-lived stable reservoirs in primary forest ecosystems.
2. **Restore** – increase carbon stocks through restoration, regeneration and connectivity of secondary forests.
3. **Replant** – where ecologically appropriate, increase carbon stocks through community-based replanting with native mixed species on previously cleared land.

The conservation management of forests for carbon storage in combination with multiple ecosystem services can help to close the land gap. This requires a holistic approach to forest management based on retaining ecosystem integrity to achieve climate, biodiversity, social, cultural and economic outcomes. Protecting the services provided by forests with a high level of ecosystem integrity provides many benefits for people, including for communities in the local area and surrounding region. Potential benefits include downstream water supply, resisting fire, protecting non-timber products, food supply and habitat to support pollinators. With effective rights-based and community-driven planning and governance, the conservation management of primary forests is a lower-risk investment compared with new plantings, which are more vulnerable to threatening processes that cause mortality, such as pests, diseases, drought and fire, and are liable to be logged.

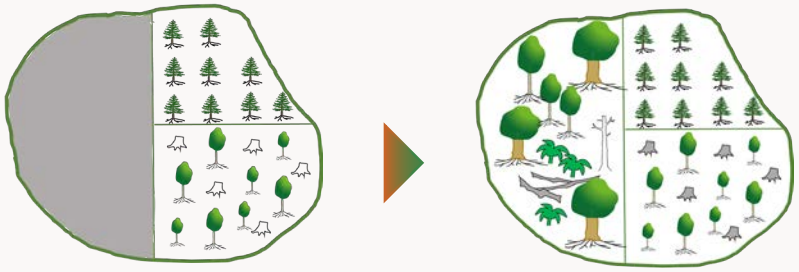
Protecting primary forests is the highest priority because they are critical for providing the ecosystem service of global climate regulation in the form of carbon retention, with the highest mag-

Box 5 **Reforming carbon accounting**

Existing UNFCCC Rules → **Comprehensive Carbon Accounting**

1. Comprehensive Carbon Accounts – all lands, sectors and activities

✗
- Managed lands
- Human activities

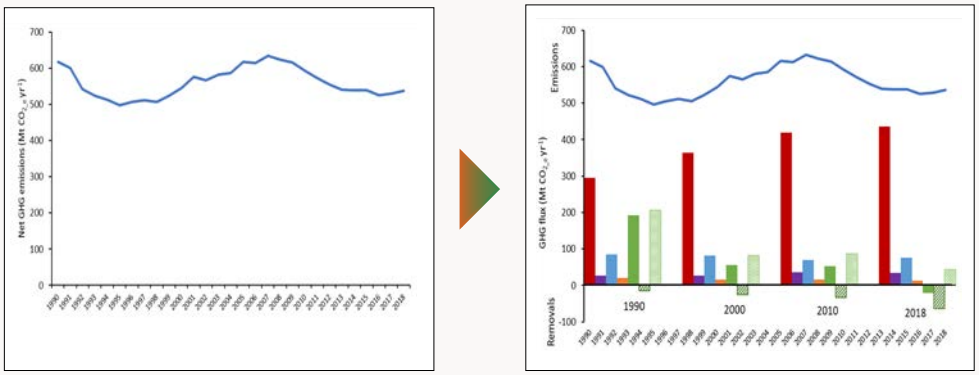


✓
- All lands
- All processes
- Landscape scales

- Carbon accounts need to be comprehensive of all lands, sectors and activities, not limited to those specified as managed by humans.
- Accounting for all stocks and stock changes allows the impacts on the global carbon cycle to be quantified and track stock changes tracked between the biosphere (i.e., natural forests and other ecosystems) and the atmosphere.
- All carbon pools in living and dead biomass and soils are included.
- Assessments are at landscape scales that incorporate different forest ecosystem types and age distributions, and not just comparing individual stands or age classes.

2. All Carbon Stocks and Stock Changes

✗
- Annual net emissions



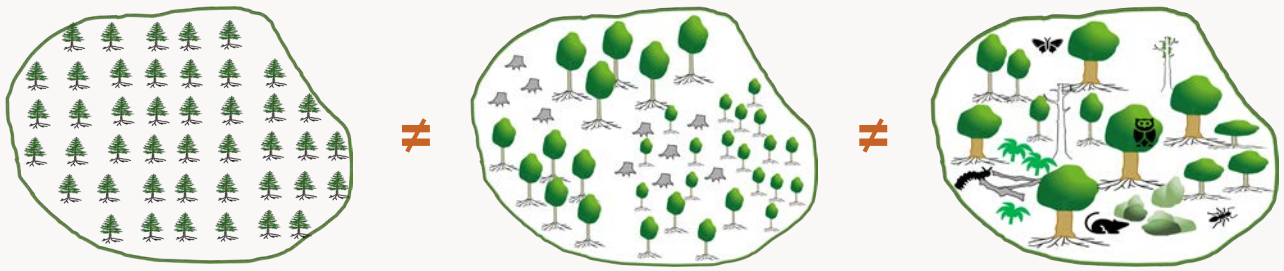
✓
- Gross emissions (losses)
- Gross removals (gains)
- Disaggregated by sector

- All carbon stocks and stock changes need to be reported as gross emissions (losses) and removals (gains), not just present annual net emissions.
- Reporting of carbon stocks allows the value of ecosystems as assets to be included on the balance sheet, as well as the profit and loss that only shows the annual flows.
- Data are disaggregated by sector, not the current "netting out" of emissions from human activities by the removals from plant growth, which makes the land sector appear "carbon positive".
- Policy makers need to see where the emissions are coming from, and removals going to, in each sector in order to identify and assess mitigation strategies.

Sectors Energy Industry Agriculture Waste LULUCF removals emissions

Box 5 **Reforming carbon accounting** (continued)

3. Condition of Carbon Stock Matters



Low Ecosystem Integrity
Transformation to human-modified ecosystems minimises biodiversity and ecological functioning.

Moderate Ecosystem Integrity
Disturbance disrupts biotic trophic interactions and reduces resilience to disturbance.

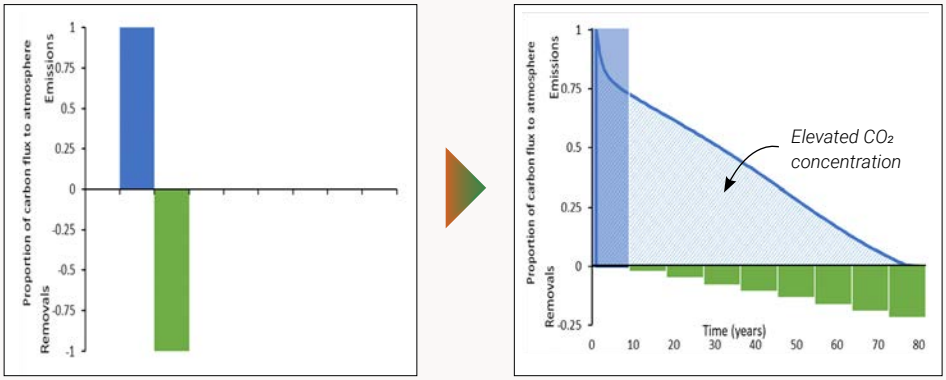
High Ecosystem Integrity
Biodiversity confers resilience and adaptive capacity of ecosystems.

- The condition of carbon stocks in ecosystem reservoirs matters for assessing the capacity for carbon retention, and conversely the risk of loss.
- Ecosystem condition should be classified and included in the accounts. Ecosystems in good condition have a high level of ecosystem integrity resulting in them being more resistant, long-lived and resilient compared to those in poor condition.

4. Time Horizon Critical

✗

- **Instantaneous emissions and removals recorded**



✓

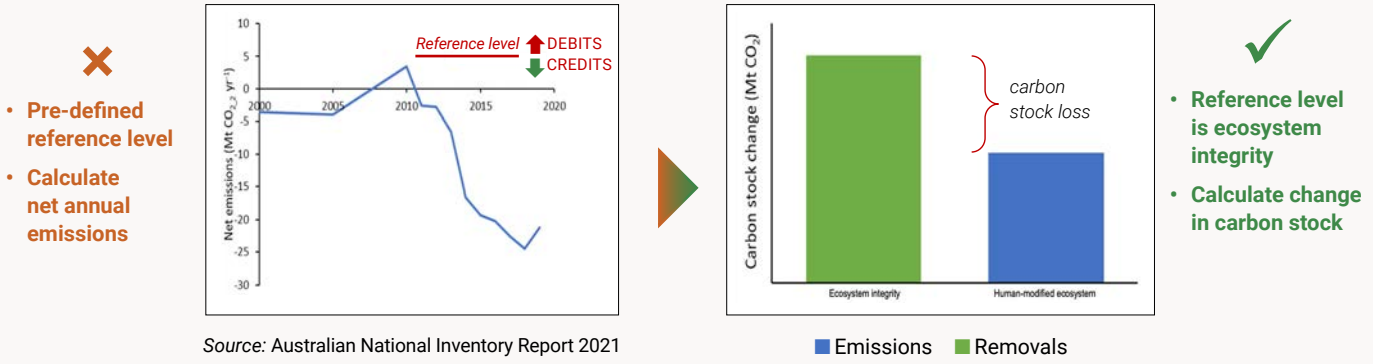
- **Instantaneous Emissions**
- **Long-term removals**
- **Time lag causes carbon debt**

Source: Keith et al. 2022

- The difference in timing between instantaneous emissions from combustion, and the long-term (decades to centuries) of removals by forest growth, means the elevated atmospheric CO2 concentration cannot be compensated forest removals, in the critical decades (2022-2050) that matter for limiting global warming.
- It is the accumulated stock of carbon and its longevity in the atmosphere that are the critical metrics for the climate, not the annual rate of net emissions. Hence, emissions and removals that occur over different time horizons should not be allowed as offsets.
- Activities may be carbon neutral over many decades or centuries, (if the carbon stocks of the reference condition are regained), but they are never climate neutral.

Box 5 **Reforming carbon accounting** (continued)

5. Reference Level for Accounting



Source: Australian National Inventory Report 2021

- Current reference level is based on net annual emissions caused by current human activities and projected into the future.
- The reference level, used as the baseline for calculating change in carbon stocks over time, should represent the carbon stock of the ecosystem with high ecosystem integrity in its natural state, that is the carbon carrying capacity. This is the maximum carbon storage in primary forest ecosystems at the landscape scale under natural disturbance regimes.
- Assessing change from this reference level reveals the true loss of carbon due to human activities, and the potential gain in carbon stocks through restoration.
- Reference levels should incorporate long time horizons that reflect the full extent of carbon dynamics at landscape scales.

nitude, longevity, stability and resilience of any forest carbon stocks. These carbon stocks are irrecoverable on timescales relevant for mitigation (Goldstein *et al*., 2020). Effective protection of primary forests, including intact forest landscapes, requires regulatory and governance change, improved recognition of the rights of and support for IPs and LCs and their roles in planning and governance, and mechanisms that directly address the drivers of continued deforestation and forest degradation, including industrial logging.

Restoration actions for forests should improve the conservation management, foster natural regeneration of previously logged natural forests, and preserve and replenish natural capital – the soil, water and biodiversity (UNCCD, 2022). Restoration can entail a variety of objectives and actions, but should involve the permanent re-establishment of native species. Forms of restoration include rehabilitation (restoration of desired species, structure or process to an existing ecosystem), reconstruction (restoration of native plants on land used for other purposes), reclamation (restoration of severely degraded land devoid of vegetation), and replacement (species or provenances maladapted to a given location and unable to migrate are replaced with new and more climate-resilient vegetation) (Stanturf *et al*., 2014). Restoration action that buffers and reconnects areas of primary and other natural forests will deliver the most resilient, stable and long-term climate and biodiversity outcomes. Overcoming the increasing impact of fragmentation caused by roads for logging and mining and transmission lines is crucial, as core habitats and ecological processes are diminished (Goosem, 2007; Briant *et al*., 2010; Haddad *et al*., 2015; Ibisch *et al*., 2016; Taubert *et al*., 2019).

Restoration priorities should be based on the time needed to restore ecosystem integrity, connectivity between habitats, and the capacity to supply ecosystem services. For example, fostering the recovery of secondary natural forests delivers superior and faster climate mitigation, adaptation, biodiversity and ecosystem service benefits than planting new trees, particularly monoculture plantations. Most forms of ecological restoration will increase the storage and longevity of carbon stocks, but effectiveness will differ depending on the ecosystem condition.

One example of the potential benefits of restoration in Europe is a predicted scenario showing that reducing timber harvesting from the current 77 percent of annual wood increment to 50 percent of the increment would increase the carbon stock in forests – equivalent to double the current annual removals of CO_2 from the atmosphere by forests. This additional removal of CO_2 (242 Mt CO_2 per year) corresponds to over 5 percent of current total annual European Union emissions. The study demonstrated that this reduction in harvesting could be made possible by phasing out wood-based bioenergy (which contributes 87 percent of feedstock for bioenergy) and reducing wood consumption for short-lived products from pulp (Greenpeace, 2020).

Reforestation programmes need to make a clear distinction between planting trees on degraded land that is not currently productive, and land that is currently producing food or fibre or other services. Re/afforestation for carbon plantings should not compete with other important land uses, including food production (commercial, smallholder and/or subsistence) and, where appropriate, plantations for wood supply. Reforestation and afforestation should not be considered a priority activity for mitigation because the benefit of carbon accumulation is slow and so does not address the urgent need for climate action. Even the carbon stocks are not assured, as many tree planting projects have not been monitored and are unable to confirm survival of the trees. Some are harvested within one or a few decades to supply short-lived products or energy. However, in areas of degraded land or abandoned land uses, reforestation that is well planned can provide benefits of sequestering carbon and fostering recovery of biodiversity (Di Sacco *et al*., 2021). Caution should be applied to carbon markets that incentivize monoculture tree crop planting, including for bioenergy, which could jeopardize food production and land rights and have little or no meaningful climate mitigation benefit (Fleischman *et al*., 2020).

Protecting primary forests is the highest priority because they are critical for providing the ecosystem service of global climate regulation in the form of carbon retention, with the highest magnitude, longevity, stability and resilience of any forest carbon stocks. These carbon stocks are irrecoverable on timescales relevant for mitigation.

However, restoration to ameliorate degradation is a critical activity that can help to address many social, environmental and economic problems, while contributing to climate mitigation. The important role of restoration is manifest in the UN Decade of Restoration (2021 – 030), which aims to "prevent, halt and reverse the degradation of ecosystems world-wide", including natural, agricultural and urban environments (UN, 2022). There are many forms of restoration initiative, but among the most effective are those that address severe degradation due to soil erosion, desertification and salinization. Landscape-scale restoration projects involving local communities can be powerful solutions for protecting, buffering and reconnecting areas of natural forest and other natural ecosystems and their associated biodiversity. This promotes the ensuing improvement in integrity, resilience and stability of existing, regenerating and planted forests and the carbon sequestered and stored in them. Examples of large landscape scale restoration projects across land tenures that focus on increasing connectivity and buffering existing natural ecosystems include Gondwana Link in south-west Western Australia (Gondwana Link 2022) and the Great Eastern Ranges along the dividing range in eastern Australia (GER 2022).

Restoration success depends not only on the land area, but on the type of restoration chosen and the quality and permanence of restoration or plantings. Natural regeneration of forests – including assisted natural regeneration – should be prioritized (Shono *et al*., 2007; Lewis *et al*., 2019). In contrast, 45 percent of initiatives for restoration under the Bonn Challenge are accounted for by new plantings (Fagan *et al*., 2022). Unless plantation establishment is directly linked to improving agricultural productivity and/or meeting demand for wood – thereby reducing conversion and logging pressure on primary and other natural forests – it will have extremely limited mitigation benefits. Restoration via tree planting will not have a positive climate mitigation benefit if deforestation and forest degradation continue unchecked.

3.3.4 Policy innovation for effective mitigation

Despite recent updates in international policies (see **Box 4**) that demonstrate progress, significant policy innovation is required at international, national and local levels to support urgent action on climate and the conservation of ecosystems. Closing the gap between supply and demand for land and resources requires strategic approaches that recognize, assess and value the multiple ecosystem services provided by forests and their contribution to human well-being and economies.

A landscape level or holistic approach can assist by incorporating ecosystem integrity and providing the capacities and mechanisms for strong governance and effective planning (Chazdon and Brancalion, 2019; Mackey *et al*., 2020; Morgan *et al*., 2020).

Protecting the remaining primary forests and engaging in large-scale ecological restoration of degraded forests is essential for solving the biodiversity, climate change, social justice and zoonotic disease crises

Encouraging synergistic action in NDCs based on the intent of the Paris Agreement will be critical. Article 5.1 encourages all parties from both developed and developing countries to "make use of the full range of ecosystem-based mitigation options to support integrated climate mitigation and adaptation outcomes". Article 5.2 provides guidance on reducing emissions from deforestation and forest degradation in developing countries (REDD+) and encourages non-market approaches to support the multiple functions of forests through a landscape approach" (Carazo, 2017). Providing greater guidance on priorities for achieving synergistic climate and biodiversity outcomes in NDCs is needed, including by promoting relevant IPCC AR6 decisions and the priority actions identified by IPBES/IPCC (Pörtner *et al*., 2021).

Governance and enforcement structures are needed to combat illegal exploitation of forest resources, which occur in many countries and in many forms. For example, estimates of illegal logging include: one-quarter of wood removal from forests in Europe, which is unaccounted for (Camia *et al*., 2021); more than two-thirds of tropical deforestation (Chatham House, 2022); and 50–90 percent of wood sourced from tropical forests, which accounts for an estimated one-tenth of total timber trade worldwide (Greenpeace, 2022). Schemes for certification, traceability, standards and enforcement need to be strengthened, both by producing countries and importing and consumer countries, as supported by the FAO Forest Law Enforcement, Governance and Trade Programme (FAO FLEGT, 2022).

Improved monitoring and assessment of targets such as the New York Declaration on Forests set a goal of 150 million ha restoration by 2020 and received pledges of 170 million ha. However, only an estimated 18 percent has been realized in terms of increased tree cover through restoration, reforestation and afforestation (NYDF, 2019).

Regulation by governments can create rapid change and incentivize transformation through markets and investment. For example, the Biden administration introduced regulatory measures to protect mature (including old growth and primary) forest on public land in the United States of America. Regulatory measures could also be used to reduce the demand for wood for bioenergy by disallowing combustion of wood to count as zero emissions and as a renewable energy source (Mackey *et al*., 2022b).

Financing mechanisms and incentives are needed to harness the full value of ecosystem services through conservation management of forests to support incomes for the development of local communities, based on just benefit-sharing and without the need for income from exploitation (Morgan *et al*., 2022). Such mechanisms form part of integrated financial solutions being pursued to address national priorities and commitments related to climate change through the drivers of deforestation and degradation, as well as disaster risk reduction and land restoration (UNCCD, 2022). Strong government environmental regulations can be effective in incentivizing private finance for conservation (Davergne and Lister, 2011). Effective financing mechanisms can also be developed by shifting subsidies away from destructive and highly emissive industries to low carbon, protective and restorative activities (IPBES, 2019; White House, 2022).

The socioeconomic and business case for action on ecosystem protection has been made by the Organisation for Economic Co-operation and Development (OECD) to the G7 Environment Ministers (OECD, 2019b). Despite these high-level agreements, financing to incentivize climate action by protecting ecosystems remains very small, accounting for approximately 8.5 percent of the subsides given to fossil fuels or 6.3 percent of global GDP (CBD, 2012; OECD, 2019a; Coady *et al*., 2019). Possible sources of financing for forest conservation management include international environmental funds, REDD+, aid, national budgets, private sources, carbon markets, and payment for ecosystem services, such as results-based payments for reduced carbon emissions from deforestation and degradation (FAO and UNEP, 2020). Each of these sources raises different issues for governance, human rights and conservation. For example, REDD+ projects have been initiated in 50 countries, but only 9 countries have as yet reported emissions reductions. Moreover, the effectiveness for conservation management of primary forests is mixed; some positive lessons are being gained about land-use policy reforms linked to sustainable supply chains and the importance of land tenure, but have been criticised by IPs and LCs (Duchelle *et al*., 2019; FAO and UNEP, 2020). The economic case for securing land rights for indigenous peoples has been demonstrated, representing a low-cost, high-benefit investment; for example, the cost of securing forest tenure can be just 1 per-

cent of the total net benefit of the ecosystem services (Ding *et al*., 2016; Garnett *et al*., 2018). Non-market mechanisms should also be considered as playing a crucial role and there are opportunities for harnessing these through Article 6.8 of the Paris Agreement (UNFCCC, 2015).

Supply and demand of wood products require a transformational change based on re-evaluation in terms of: (i) the efficiency of supply of wood from different forest types; (ii) the loss and damage to key ecosystem services caused by timber harvesting; and (iii) markets and patterns of consumption that dictate the balance between supply and demand. Supply of wood products is increasing in response to market forces driving growing demand, particularly by large chain retailers and for bioenergy (see **Figure 3.6**). This relationship between supply and demand needs to be corrected, so that supply pays the full price of the environmental impacts, and demand is reallocated by increasing the use of recycling, substitution and longer product lifetimes.

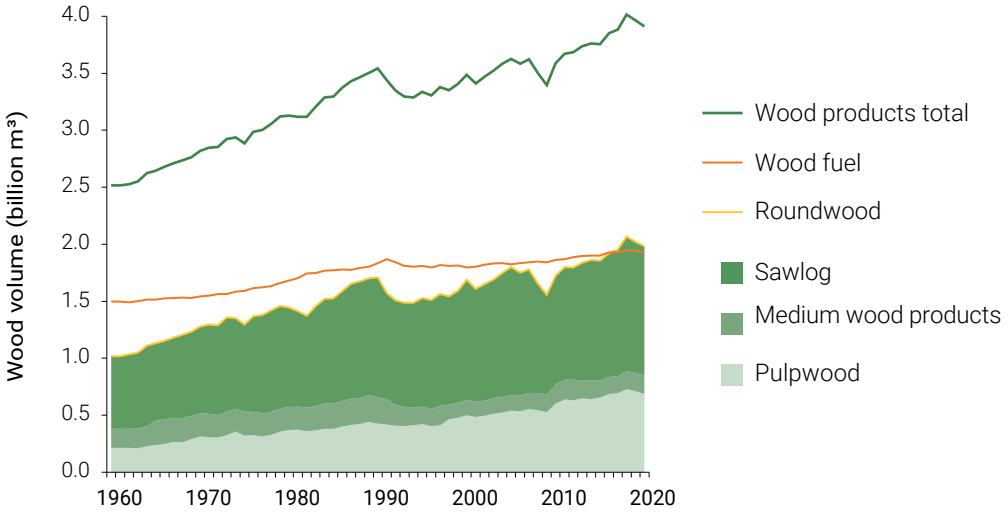
More than half the global supply of wood products is derived from natural forests, even though these are far less cost-effective or efficient in terms of producing and extracting timber, and have greater ecological impacts over a far greater land area than wood production from plantations. Plantations represent 3 percent of all forest area (FAO and UNEP, 2020), but produce 46 percent of global industrial roundwood, although the relative proportions of production vary across biomes (see **Figure 3.7**). (Payn *et al*., 2015; Jurgensen *et al*., 2014). Production from planted forests is predicted to be capable of meeting increased demand to 2030, based on scenarios of increases in planted area plus increases in productivity (Carle and Holmgren 2008; Payn *et al*., 2015). However, any increase in plantation area must follow the key principles that they: (i) are not established by clearing natural forests or other natural ecosystems; (ii) do not violate the rights of landowners or custodians; and (iii) do not exploit, pollute or deplete resources such as water, soil or biodiversity (Turner *et al*., 2006). Increased productive capacity of plantations on existing land needs to incorporate strategies for climate adaptation that focus on forest health, so as to reduce the risks from extreme climatic events, pests and diseases (Payn *et al*., 2015).

Damage to other ecosystem services caused by logging needs to be included in the price of wood, such that prices are not based solely on the costs of production. Such an evaluation would greatly increase the cost of harvesting wood from natural forests, further incentivize sourcing wood from well managed plantations, and discourage use for bioenergy and other low-cost, short-lifetime and high-volume commodities.

Figure 3.6 **Global trends in wood volume production 1960–2020**

Wood production is divided into wood fuel and roundwood, with the roundwood divided into subcategories according to longevity of the products. Highest longevity is sawlogs and veneer logs (half-life 35 years), short longevity is pulpwood (half-life 2 years), and all other products are included in medium longevity, such as wood-based panels and composites, plywood, particle board and fibreboard (half-life of 25 years according to IPCC, 2019a

Source: FAO, 2020.



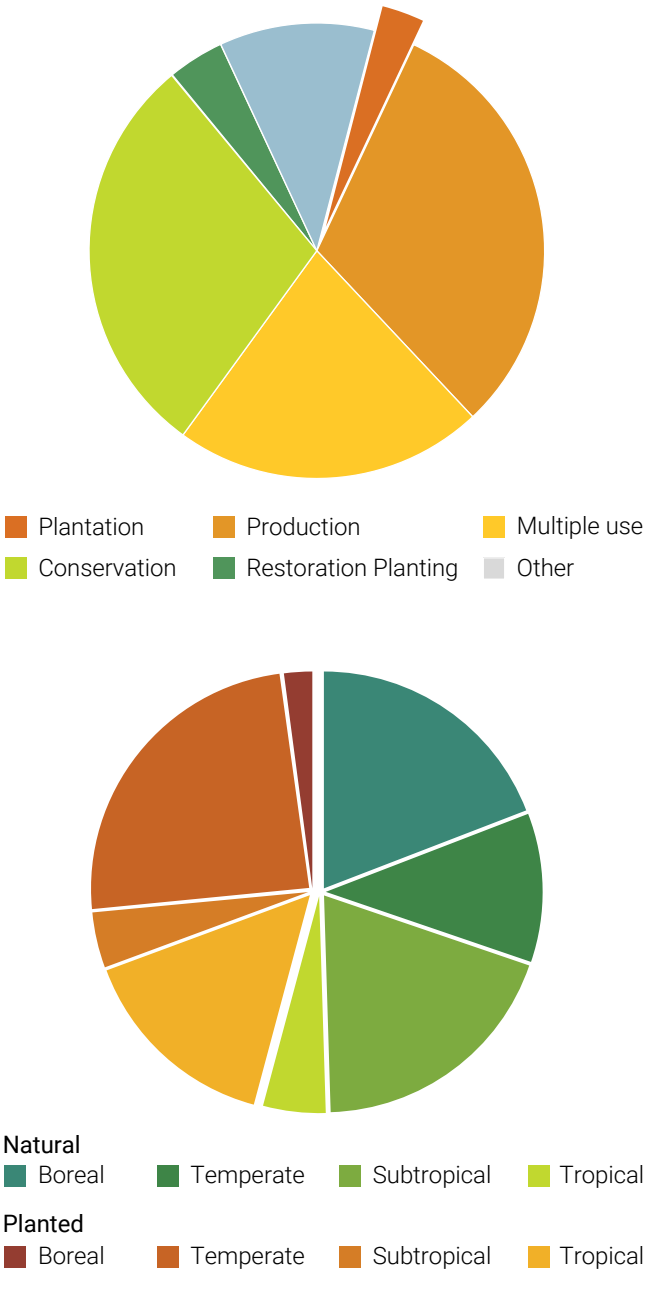
Markets need to be reformed to reduce demand for wood products and shift patterns of consumption. Demand-side measures such as improved regulation and certification could help to counter corporate models of maximizing volume and minimizing costs of wood production, and so reduce reliance on low-cost, high-volume commodities. Responses to changes in wood supply are many and varied, including increasing productivity, increasing efficiency of wood recovery, fostering fuelwood planting to assist local communities, encouraging agroecological farm forestry, and substitution with alternative products derived from clean, renewable and sustainable sources. Reduced consumption is being incentivized by using voluntary and mandatory actions for environmental labelling, sustainability reporting, due diligence, sustainable investment and finance, supply chain transparency, public procurement and corporate social responsibility (EC, 2019).

Community participation is increasing, with growing public awareness of the interlinkages between the climate and biodiversity crises, scrutiny of global supply chains, claims of sustainability and impacts on IPs and LCs. This increased participation in environmental issues has the potential to impact decision-makers in both governments and company boardrooms. A case in point is growing public alarm witnessed in Europe over the impact on forests as a result of demand for bioenergy. Increasingly, misrepresentations, inaccuracies and falsehoods about climate mitigation actions are being challenged in the courts, and coming under increasing scrutiny from scientists, agencies and organizations, including the OECD (PFPI, 2019).

Human rights are a core component of policies for mitigation action. Just, fair and equitable land tenure and social systems enable commitments to be made to the conservation of forests and the ecosystem services that they provide. This is a complex issue that involves far more than simply land ownership and varies in different places and communities, and may, for example, cover customary rights, legal rights, community ownership, cultural values and motivation (Buckwell *et al*., 2022). This is exemplified by the Kayapo – indigenous peoples who have managed to sustain their territory of primary forest based on their land rights, cultural aspiration to defend their territory, and sufficient external support to enable them to do so (see **Box 3**). Local communities in developing or developed countries may have varying degrees of affinity with natural ecosystems and motivation for their conservation to support the common good. Where local communities are dependent on industrial-scale forestry, numerous examples exist in developed countries of how to support change and deliver a just transition to facilitate improved forest conservation-based outcomes.

Figure 3.7 **The proportions of forest management categories in the global forest area**

Consisting of 3% commercial plantations, 7% planted forests and 93% naturally regenerated forests (b) Global wood production (roundwood by volume m3) with 46% sourced from plantations and 54% sourced from naturally regenerating forests, and the proportions by biome within each category.



Data source: (a) FAO and UNEP, 2020; FAO FRA 2020 (b) Jurgensen *et al*., 2014; Payn *et al*., 2015

3.4 Conclusions

Forest ecosystems are a finite resource and the urgent need for climate mitigation necessitates protecting and restoring the carbon stocks in the remaining forests. The healthy functioning of the planet's life support systems depends on protecting primary forests and restoring significant areas of degraded forests. No further loss and damage of forests is warranted, and logging in primary and many other natural forests should therefore cease. The practice of clearing forest for other land uses and consumption of wood products cannot be allowed to continue.

Protection and restoration afford the benefits of multiple ecosystem services, in combination with climate mitigation. In contrast, tree planting for the sole purpose of mitigation appropriates vast areas of currently non-forested lands for carbon sequestration through afforestation or planted trees for bioenergy, which may displace land uses for food production or settlements. Management of forest land is more efficient when it supports the provision of those multiple ecosystem services that are synergistic with maximizing the ecosystem's carbon retention value (Keith *et al*., 2021; Taye *et al*., 2021). The opportunity exists for improved conservation management of primary and other natural forests to meet multiple objectives without industrial-scale planting of new trees. In this regard, Chapter 6 provides a list of **recommended actions**.

Transformation is required for both supply and demand for wood. Forests need to be valued for their full suite of ecosystem services, not just wood supply. The price of products manufactured from harvested wood should reflect the full environmental costs, including the value of other foregone ecosystem services. Growing demand should be met, not by increasing use of natural forests to supply wood, but by increasing supply through improved resilience, productivity, management and design of the plantation estate. Demand for wood can be reduced by using alternative construction materials and energy sources that are truly renewable and non-carbon emitting.

Climate mitigation requires both (1) rapid and deep reductions in emissions from fossil fuels; and (2) maximizing the mitigation benefit from the carbon stored in natural forests by avoiding emissions through improved forest conservation management, and increasing removals through ecologically-based forest restoration. Protecting and restoring forests is therefore an essential climate mitigation strategy and should be used as an additional action to meet climate mitigation goals. However, it must not be used to offset fossil fuel emissions in national GHG accounts, nor to delay the need to decarbonize the energy, manufacturing and transport sectors.

CHAPTER 4

Land rights of indigenous peoples and local communities

KEY MESSAGES

- With few exceptions, the various national climate mitigation pledges have paid little attention to who, in practice, is living on, using and managing the lands involved, much less to existing land rights of indigenous peoples and local communities.
- Without an understanding of history and power relations shaping the rights of indigenous peoples and local communities to land and territories, and thus without a social justice lens, any attempt to fulfil the many land-based climate pledges is likely to perpetuate injustices.
- The most effective and just way forward is to ensure that indigenous peoples and local communities have legitimate and effective ownership and control of their land. They must also have a strong voice to self-represent and engage on equal terms – ultimately exercising self-determination in the search for sustainable pathways for use of their lands and territories.

The vast majority of lands and forests targeted by national and international pledges on climate change mitigation and forest restoration are neither unclaimed nor unused. They constitute the customary lands and territories of indigenous peoples and local communities (see **Box 6**), who for generations have managed, used and effectively stewarded the landscapes and ecosystems that are now being prioritized as greenhouse gas sinks and reservoirs, or important biodiversity areas. While IPs and LCs exercise customary rights to at least half of the world's lands, less than 20 percent of this area is formally recognized as owned by or designated for communities, rendering them and their territories vulnerable to the surging global demand for land.

Evidence to date shows that IPs and LCs with secure land rights vastly outperform both governments and private landholders on issues relating to deforestation, biodiversity conservation, sustainable food production and other land-use priorities. An impressive overlap exists between intact ecosystems and other areas requiring conservation attention and the collective landholdings of IPs and LCs (Allan *et al*., 2022; WWF *et al*., 2021), reflecting essential contributions that have so far been inadequately recognized by states, and poorly supported by the broader international community. Indigenous peoples steward more than 40 million km2 of land across 132 countries and territories (Garnett *et al*., 2018; WWF *et al*., 2021), including 40 percent of terrestrial protected areas. Together with traditional communities, they manage 22 percent of the carbon (217 991 Mt C) found in tropical and subtropical forest countries (Frechette *et al*., 2018), 80 percent of global terrestrial biodiversity (IPBES, 2019), and over one-third of the world's remaining intact forests (Fa *et al*.,

Box 6 **Defining indigenous peoples and local communities**

The separation of the terms IP and LC in this chapter is meant to emphasize their important distinctions.

Indigenous peoples (IPs) constitute diverse, socially and culturally distinct groups whose members, individually and collectively, self-identify as indigenous and as right-holders and custodians of resources, environment and territory. In addition to sharing strong ancestral ties to collectively-held lands, territories and surrounding natural resources, IPs have distinctive traits as peoples and communities with regards to their ancestral environments, spoken languages, knowledge systems, beliefs and livelihood practices, with historical continuity to precolonial or pre-settler periods. Hence, indigenous governance institutions often run parallel and even counter to those of nation states, further contributing to the historical, political and economic marginalization and discrimination of indigenous peoples across much of the world.

As per the United Nations Permanent Forum on Indigenous Issues (UNPFII), a variety of terms may be used to refer to IPs, including tribes, first peoples/nations, aboriginals, ethnic groups, *adivasi*, *janajati*, as well as occupational and geographical terms such as hunter-gatherers, nomads, peasants and hill people. Together, some 370 to 470 million people self-identify as indigenous, speaking more than 4,000 of the world's languages. Although they make up just 6 percent of the global population, they account for about 19 percent of the extreme poor.

The distinct and differentiated rights of indigenous peoples are affirmed by the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) and the International Labour Organization (ILO) Indigenous and Tribal Peoples Convention, 1989 (No.169), and are embedded in a wide range of policies and mechanisms. These include: (a) Expert Mechanism on the Rights of Indigenous Peoples (EMRIP), UNPFII, Outcome Document on the World Conference on IPs (Indian Law Resource Centre, 2014), and stand-alone IP-targeted policies of the various UN agencies; (b) multilateral, intergovernmental and regional bodies' IPs-specific policies, such as the World Bank, European Union, Green Climate Fund, African Union/African Commission on Human and Peoples' Rights (ACHPR); (c) decision-making and coordination arrangement for self-selection and representation, such as the International Indigenous Peoples' Forum on Climate Change (IIPFCC), International Indigenous Forum on Biodiversity; and (d) IP-targeted funding arrangements.

Following precedents set by the CBD, the UNFCCC, and widespread applications in the context of international development (for example, see RRI 2015, endnote 10), the term **local communities** (LCs) is commonly used in reference to groups that traditionally hold and use lands and resources collectively under customary and/or statutory tenure, but do not self-identify as indigenous. Barrow and Murphree (2001) further state that a local community may be defined as a human grouping living in a specified physical area, which is socially bound by a common identity and a shared interest in local resources for cultural, livelihood and economic advancement. LCs draw their legitimacy and rights over resources on the basis of traditional use, territorial affiliation, and shared common-property arrangements, or a negotiated set of rules (Agrawal and Gibson, 2001). Their customary rights largely stem from their *de facto* role as resource managers, and the absence of legitimate state institutions (Ostrom, 1990).

While social movements underpinning local community representation are often regionally-specific and diverse, LC rights are nevertheless affirmed under the United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas (UNDROP). In international law, it is clear that a 'definition' is not a prerequisite for protection.

Box 7 **Customary tenure**

Customary land tenure refers to 'informal' governance institutions used by communities to express and order ownership, possession and access, and to regulate use and transfer of land (Alden Wily, 2011). Such institutions are regarded as living, adaptive and flexible systems, often allowing the inclusion of secondary or seasonal rights to resources, as in the case of pastoral land uses (Knight, 2010; Zartaloudis, 2017).

Access to land within customary tenure systems is derived primarily from membership of the rural social order, be that a village, tribe, clan or other social structure. Customary rights may be held by individuals, households, groups or individuals, or whole communities. Authority is exercised through norms and rules, and enforced through social sanctions. Boundaries are socially and spatially negotiated, with disputes settled through mostly informal adjudication. Although under customary tenure neither men nor women 'own' land, community women tend to face greater discrimination in terms of their inheritance rights and participation in decision-making, among others (RRI, 2017).

2020). For indigenous peoples, local communities, and women within these groups, secure tenure rights can mean the difference between persistent poverty, conflict and overexploitation, and the realization of socially just and sustainable livelihoods.

Despite growing attempts to develop more robust social and environmental safeguards,[1] climate pledges have so far paid little attention to who, in practice, lives on, uses and manages the areas targeted for investment, and even less to their territorial affiliation, cultures, livelihoods and self-determination rights.

Historical precedents are not reassuring. Since at least colonial times, customarily-held lands and territories have been usurped for natural resource exploitation, extraction and strict conservation approaches, leading to the exclusion and forced relocation of IPs and LCs from their ancestral domains (Brockington and Igoe, 2006). The world's reliance on nature-based offsets to meet urgent climate action goals thus comes with high risks. In addition to incentivizing continued fossil fuel emissions, vast tracts of land may be locked up for global climate services, with or without recognition of the rights of IPs and LCs, including their rights to due process and compensation.

This chapter draws on current and emerging research and experience to assess the social-ecological implications of growing demand for nature-based climate action from the perspective of IPs and LCs. It argues that recognition of indigenous and community rights, along with support for their self-determination and just territorial governance, constitute a more effective, equitable and socially just strategy for protecting and restoring ecosystems, while advancing the well-being of the women and men who live in and depend on these areas.

Section 4.1 of this chapter examines the legal and customary ownership of land areas targeted for the realization of pledges discussed in Chapter 2, and their implications for the people who stand to be affected by these investments. Section 4.2 discusses the historical and contemporary evidence of the struggle for collective tenure recognition, and the injustices that continue to be perpetuated as a result. Section 4.3 explores solutions for sustainability and justice, calling for an approach that ensures IP and LC ownership and control over their lands, with an effective voice and self-determination.

4.1 What land?

The land and forest areas required to meet current national climate pledges add up to some 1.2 billion ha. Yet the vast majority of these areas – including lands targeted for biodiversity conservation and forest landscape restoration – are located on the customary lands (see **Box 7**) and territories of indigenous peoples and local communities (Schleicher *et al*., 2019; RRI, 2020b; RRI *et al*., 2021; Allan *et al*., 2022). These IPs and LCs rely on collectively-held lands to meet livelihood needs, and many have developed governance institutions and cultural traditions that are adapted to their biophysical realities and social dynamics. While the customary rights of IPs and LCs are recognized by international law and in many national legal systems, formal recognition and protection of such rights remain weak or inadequate across much of the world, placing them and their lands at the mercy of more powerful interests and priorities.

4.1.1 Customary land rights

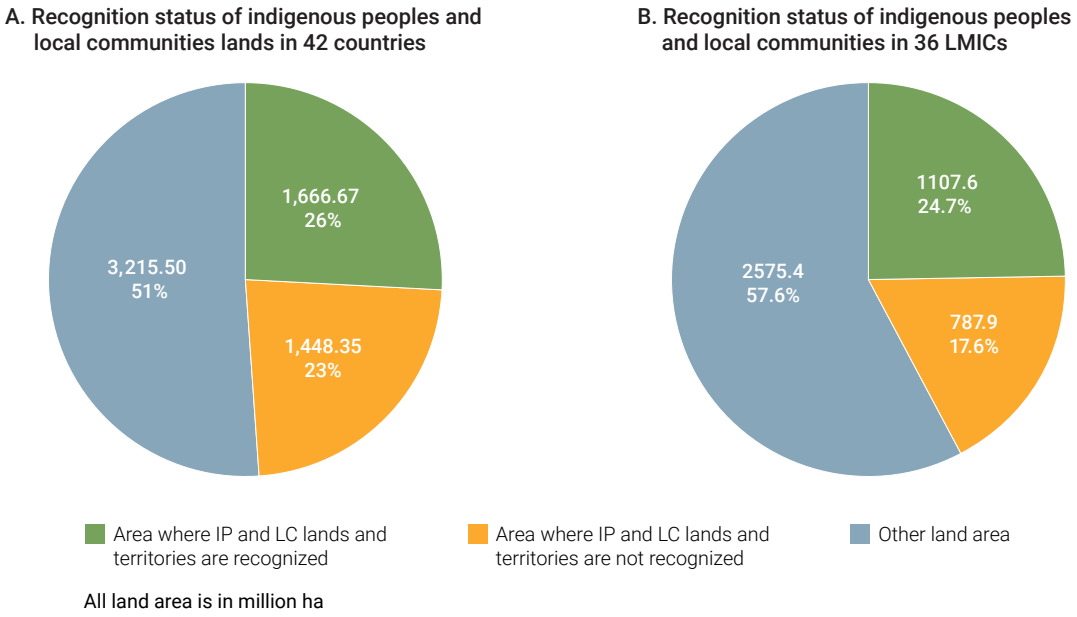
Available data suggests that IPs and LCs hold customary tenure rights to roughly 50 percent of the global land mass (Alden Wily, 2011),[2] but exercise legal ownership over just 10 percent of this area, and designated rights to another 8 percent. As confirmed

1 For example, see ART-TREES (www.artredd.org) and The Core Carbon Principles (www.icvcm.org).

2 The available data demonstrate some variation, in part due to the difficulty of measurement and in part due to what is being measured and where. This includes whether the topic is, for example, lands or forests, and also how IPs and LCs are defined, and which specific countries are included. As a whole, there is similarity, and the estimates are widely considered reliable. Rights and Resources Initiative (RRI) data refer to indigenous peoples, local communities, and Afro-descendant peoples, and the term 'IPs and LCs' should be interpreted as such. Even so, RRI aggregates country-level data on these groups and exact definitions vary between countries. In all cases, however, the defining feature is that lands are collectively held or owned. For simplicity, we use the IPs and LCs abbreviation throughout the chapter. See also Box 5.

Figure 4.1 **Global and regional distribution of land tenure rights**

Status of legally recognized indigenous and community land rights in lower and middle income countries and across a sample of 42 countries, representing 49% of the global land mass (outside Antarctica).



Source: RRI 2020a

by documented evidence[3] and expert input[4] on the customary land rights of communities in 42 countries (comprising half the global land area), IPs and LCs exercise customary rights to at least 49 percent (3,115 million ha of the total area (RRI, 2020a)).[5] Of this, 46 percent (1,488 million ha) remains unrecognized by states, half of which (789 million ha) are located in low- and middle-income countries (LMICs).[6]

These results echo a recent analysis of community-held lands and territories in 24 tropical forest countries (RRI *et al*., 2021), which shows that IPs and LCs exercise customary rights over at least 958 million ha of land, but hold statutory rights to less than half (447 million ha). Given that community-held lands and territories are among the least developed and most intact landscapes on Earth, the likelihood that nature-based climate actions will unfold on customarily-held but legally unrecognized lands or forests is considerable. (see **Figure 4.1**)

4.1.2 Legal recognition of collective lands

The total area formally owned by IPs and LCs, or designated for their use, represents 1.1 billion ha and 855 million ha, respectively (RRI, 2015).[7] By region, Latin America has the greatest extent of land owned by, or designated for IPs and LCs (23.2 percent, or 435 million ha), followed by sub-Saharan Africa (15.4 percent, or 230.9 million ha), and Asia, (3.4 percent, or 69.4 million ha outside of China, which recognizes community rights to 465.7 million ha). Globally however, 5 of the 64 countries assessed

3 Reviews of national land registries, geographical and anthropological surveys, and available community mapping data.

4 Survey of national/regional land and forest tenure experts.

5 Percent of regional land covered by the study: Africa, 47.7 percent; Asia, 38 percent; Latin America, 93.1 percent; and North America, Europe and Oceania 47.9 percent.

6 Of the three regions with a high concentration of LMICs, Africa holds the greatest proportion of legally unrecognized IP and LC lands, where at least 71 percent of customarily-held lands (504 million ha) in the 14 countries analysed (representing 34 percent of the regional land cover) have no legal protection. In Asia, more than 23 percent of customary land claims (146.1 million ha) remain unrecognized by the 11 countries reviewed (accounting for 54 percent of regional land cover). In Latin America, which has the largest share of legally recognized community lands in the world, nearly one-quarter (24.1 percent or 137.5 million ha) of the lands found in the 12 assessed countries lack legal recognition.

7 Following Schlagger and Ostrom (1992) and RRI (2015, 2017), areas 'formally owned' by IPs and LCs means that their rights of access, withdrawal, management, exclusion and due process and compensation are legally recognized by the state for an unlimited duration. Areas 'designated' for IPs and LCs include access and withdrawal rights, as well as the right to participate in management activities and/or exclude outsiders. The right to alienate a claimed area (in part or in whole, through sale, lease or collateral) is not a conditional requirement to either form of tenure arrangement.

(Australia, Brazil, Canada, China and Mexico) contain more than two-thirds (67 percent) of the lands owned by or designed for IPs and LCs, and two of these (Canada and China) account for nearly 44 percent of the total land area attributed to communities. (See **Figure 4.2**) In their absence, the total area owned by, or designated for communities would drop to just 12 percent of the global sum (RRI, 2015).

4.1.3 Legal recognition of collective forests

By contrast, the majority of legally recognized IP and LC forest lands are located in low- and middle-income countries. (See **Figure 4.3**) According to the most recent survey of 58 countries, which accounts for 92 percent of the world's forests (RRI, 2018), communities legally own at least 12.2 percent (447 million ha) of the global forest area, and have designated rights to another 2.2 percent (80 million ha). Although apparently limited – at 14.4 percent – the total forest area under community control has increased by 40 percent since 2002, and the vast majority of this progress (over 98 percent) has occurred in developing countries. Communities now have legal rights to 28 percent of the developing world's forests in Africa, Asia and Latin America (RRI, 2018).

In terms of overall distribution, Latin America has the greatest forest area owned by, or designated for IPs and LCs (respectively, 240.2 million ha and 51.3 million ha). Communities own 43 million ha of Asia's forests and hold designated rights to 10 million ha outside of China (which recognizes community ownership rights over 124.3 million ha of forestlands). In sub-Saharan Africa, IPs and LCs legally own 22.6 million ha and have designated rights to 9.6 million ha. The 8 developed countries in the analysis (including Canada, the Russian Federation and the United States of America) contain 37.1 million ha of recognized community forestlands – a paltry sum, given that these countries host some of the world's largest contiguous forest areas, and that the whole of North America was previously controlled by First Nations.

4.1.4 Legal recognition of indigenous peoples, customary systems and self-determination

The UN Declaration on the Rights of Indigenous Peoples protects the right to self-determination over the governance of internal affairs, as well as "legal recognition and protection" of the "right to own, use, develop and control the lands, territories and resources that they possess by reason of traditional ownership or other traditional occupation or use". Although the declaration is signed by more than 140 states, implementation of indigenous peoples' right to self-governance and human rights varies significantly across regions and countries.

Asia Legal recognition of the customary and self-determination rights of IPs and other traditional communities in Asia is limited, and where statutory provisions exist, legislative gaps and inconsistencies tend to undermine their application (Gilmour, 2016; Basnyat *et al*., 2018; Lee and Wolf, 2018). To date, a number of countries, including Bangladesh, Cambodia, India, Indonesia, Malaysia, Nepal, the Philippines and Timor-Leste, have adopted legal provisions that provide some autonomy through the recognition of customary justice practices or communal land rights (United Nations, 2020). Some provide constitutional protections to specific peoples or geographic regions, such as in India (Nagaland and Mizoram, in the northeast), Malaysia (Sabah and Sarawak), and the Philippines (the Cordilleras and Mindanao). In Bangladesh, the Chittagong Hill Tracts Accord of 1997 creates a special tripartite administrative system that combines elective, civil servant and traditional indigenous authorities. As in the case of the Lao People's Democratic Republic, however, states will often recognize the presence of ethnically diverse groups, but their rights are neither distinct, differentiated nor acknowledged (Baird, 2015).

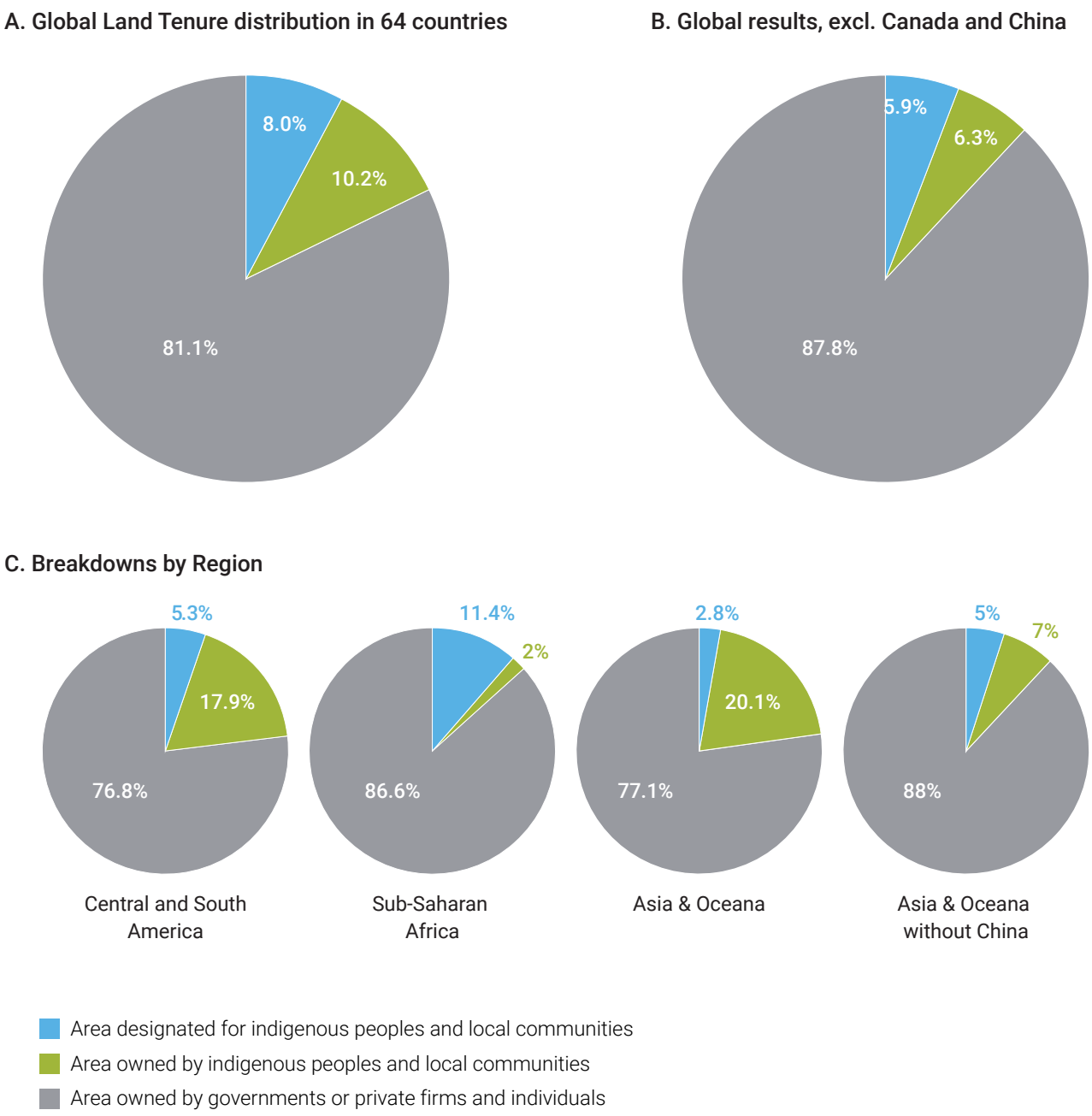
Africa Indigenous peoples and their unique challenges are seldom reflected in state policies or legislation in Africa. Indigeneity is typically associated with transhumant pastoralism (see **Box 8**), hunter-gatherer communities, and dryland horticulturalists or oasis cultures. They include the forest peoples of central and southern Africa, pastoralists of West Africa, including Fulani and Tuareg peoples, forest peoples in East Africa such as the Ogiek, as well as pastoralist groups in East Africa, including Somali, Afars and Maasai, among others.[8] The human rights of IPs in Africa were only recently conceptualized by the Working Group on the Rights of Indigenous Populations/Communities, and adopted by the African Commission on Human and Peoples' Rights (ACHPR) in 2003.[9] To date however, only two countries – the Republic of Congo and South Africa – recognize the distinct collective tenure rights of indigenous peoples and other traditional communities, and only the Central African Republic has ratified ILO Convention 169 on the rights of indigenous and tribal peoples.

Recent estimates suggest that IPs and LCs customarily manage and use 70 to 80 percent of Africa's total land area (RRI, 2020a), and despite colonial antecedents that promoted state control over all lands except for private landholdings, at least 54 percent of the 54 African states now have legislation recognizing

8 Indigenous peoples, poverty, and development (Patrinos and Hall, 2012).

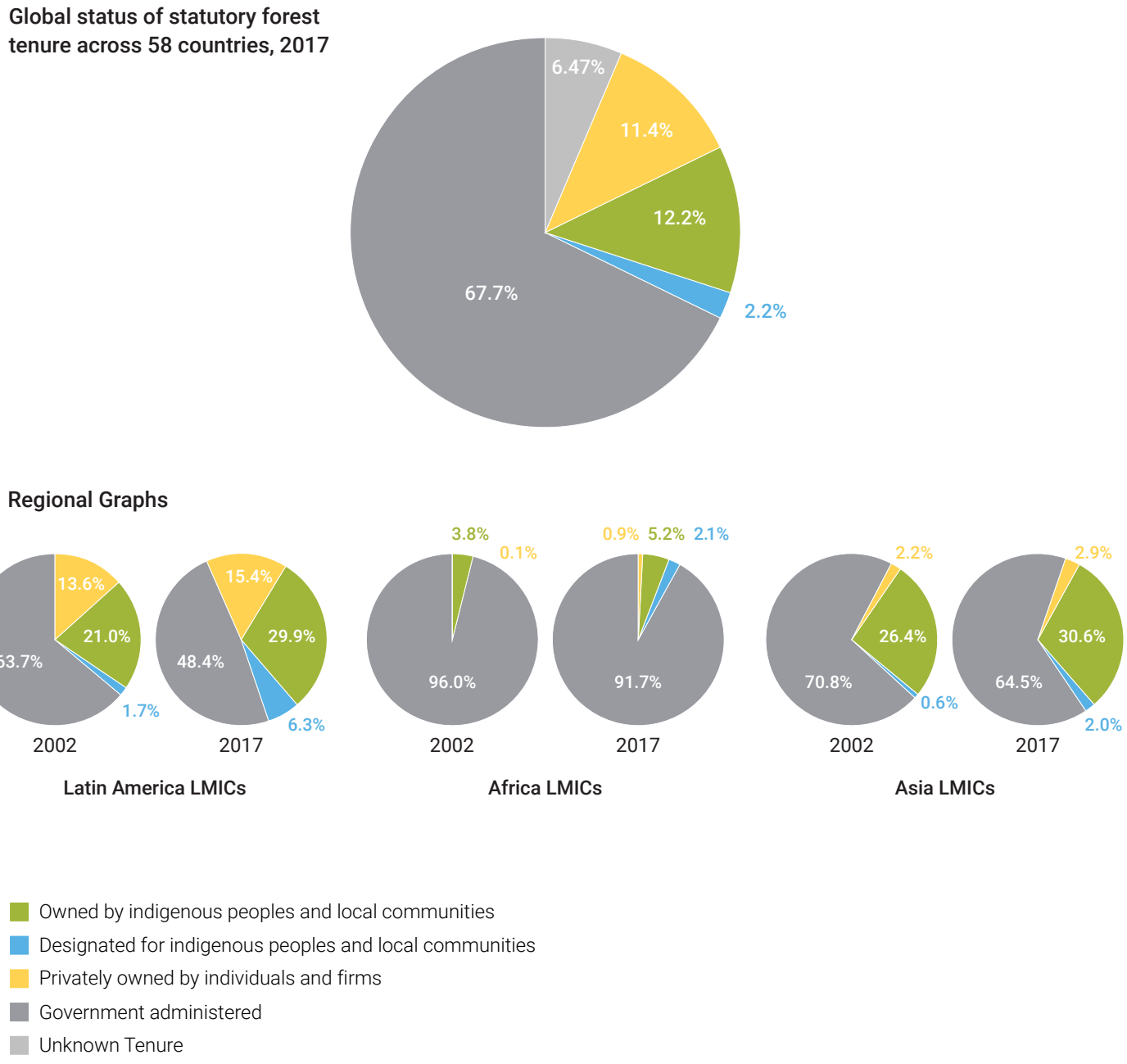
9 ACHPR & International Work Group for Indigenous Affairs, 2005.

Figure 4.2 **Global and regional distribution of land tenure rights**



Source: RRI, 2018

Figure 4.3 **Global and regional distribution of forest tenure rights**



Source: RRI, 2018

collective tenure (Alden Wily, 2018, 2020). Of these, 21 countries have laws that support collective tenure.[10] However, application is variable: some treat community rights as private property;[11] others provide inadequate protection,[12] or fail to respect such rights altogether.[13]

Latin America The Latin American region has gone furthest in recognizing indigenous peoples, often in response to indigenous social movements that have promoted the concept of 'territory' as part of a strategy for self-determination. This led to a "significant change in the idiom of land claims" in the 1970s and 80s (Hvalkof, 2002, p.93). "Territory represents a jurisdiction, protected to some extent by law, in which customary norms, cultural reproduction and self-government can be legally exercised" (Larson *et al*., 2016, p.324). Indigenous organizations used this idea of territory to emphasize control over land and resources as a direct response to racism and exclusion (Bryan, 2012, p.16; Wainwright and Bryan, 2009, p.154), and the model has been widely adopted (although not everywhere, for example in Peru). In addition, all the region's Spanish-speaking countries, with only three exceptions (El Salvador, Panama and Uruguay), have signed ILO Convention 169. Finally, collective models of recognition have also been applied to Afro-descendant communities, such as in Brazil, Colombia and Honduras, and other traditional communities such as rubber-tappers in Brazil or *riberenos* (communities along river shores) in Peru.

4.2 Land and rights: dispossession, recognition and ongoing insecurity

The lands and forests occupied by indigenous peoples and local communities have always been subject to varied and multiple demands, which today are primarily driven by economic pressures and political interests. While growing numbers of countries are adopting laws that recognize IP lands and territories, and/or are signatories to international conventions that support such rights, implementation is often weak, laws are not enforced, and rights are far from secure.

This section explores the experience of, and common obstacles to, recognition and exercising of collective rights to land, territory and resources, including the specific challenges in the case of indigenous and traditional women. We argue that without an

Box 8 Pastoral communities at risk

Although far less data are available on pastoral lands specifically, pastoralism is a significant customary IP and LC livelihood activity. Pastoralism occupies vast land areas in many countries – areas that are particularly vulnerable to global climate and restoration pledges.

Pastoralism is both an economic activity and a form of cultural identity. It is the predominant livelihood support system practised in Africa's arid and semi-arid lands, occupying about 43 percent of the continent's total land mass (African Union, 2010), with at least 50 million people directly dependent on livestock for subsistence (Homewood, 2008).

Pastoralism is key to the maintenance of dryland ecosystem functions and services, including soil fertility, watershed protection, aquifer replenishment, air quality control, protection against storms, erosion and landslides, and carbon sequestration. Grassy biomes store up to a third of the global stock of CO2 in their soils (Parr *et al*., 2014). Pastoral livelihood systems allow traditional communities to cope with this difficult dryland environment (Hesse and Cotula, 2006). Land and associated natural resources are managed through common property regimes where access to pastures, water and mineral resources is negotiated and dependent on flexible and reciprocal arrangements. Pastoralism contributes about 57 percent of agricultural GDP in the Intergovernmental Authority on Development Region* and 30–50 percent in the East African Community.

Despite their demonstrated value, pastoral lands continue to be annexed for uses that are perceived to be more productive, and they are increasingly targeted for land restoration, clean energy production (geothermal, wind and solar) and carbon-trade speculation, among others, leading to an ever-shrinking resource base. These interventions are often promoted and implemented with minimal consideration for social and environmental safeguards. Global pledges reliant on land-based CDR increase this risk. Although pastoralism is increasingly acknowledged as a legitimate and appropriate livelihood and production system, actions to secure the collective tenure rights of pastoral communities are urgently needed.

10 Algeria, Angola, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mali, Morocco, Mozambique, Namibia, Sierra Leone, South Sudan, Tunisia, United Republic of Tanzania, Uganda, Zambia, Zimbabwe.

11 Kenya, South Sudan, United Republic of Tanzania, Mali, Mozambique, Burkina Faso, Uganda, South Africa, Ethiopia, Ghana, Liberia, Angola.

12 Lesotho, Namibia, Zambia, Zimbabwe, Swaziland, Malawi, Sierra Leone, Republic of Congo, Cote d'Ivoire .

13 Angola, Cote d'Ivoire, Ethiopia, Ghana, Lesotho, Liberia, Namibia, Republic of Congo, Sierra Leone, Swaziland, Zambia, Zimbabwe.

understanding of history and power relations, and thus without a social justice lens, attempts to fulfil land-based climate pledges are more likely to perpetuate past and ongoing injustices.

4.2.1 A brief history of dispossession

Throughout history and across the world, indigenous peoples and local communities have consistently faced threats of forced evictions, whether for their land and its resources or to control the people themselves, in order to meet the labour demands of feudal and later, capitalist economies (Sunderlin and Holland, 2022).

According to records dating back to 700 Before Common Era (Dixon and Sherman, 1991), forest estates were usurped by kings and nobles for hunting grounds (Fay and Michon, 2003), and later to secure economic opportunities (Peluso, 1992). Under colonialism, ideas of moral and racial superiority combined with economic interests to drive the occupation and usurpation of rural lands throughout the global South, as well as in North America (Sunderlin and Holland, 2022). More recently, similar ideologies have formed the basis for evicting and displacing local peoples for the establishment of protected areas (Adams and Mulligan, 2003). Throughout, IPs and LCs were a common target, seen as 'backwards' or in need of 'modernization', but most often ignored, marginalized and forcibly displaced from their ancestral homes.

In Latin America, the end of colonialism in the early 1800s brought little relief to indigenous peoples (Larson, 2007). Indigenous policies under independence evolved from enslavement and annihilation to forced removal to reservations, and, finally, to *indigenismo*, or assimilation, which was broadly adopted by 1940 and was still predominant in laws enacted as recently as the 1980s, aiming "to transform Indians into undifferentiated citizens" (Van Cott, 1994, p.260; Stavenhagen, 2002). Those who chose to maintain their indigenous identity thus remained excluded (Eckstein and Wickham-Crowley, 2003). In Peru, until the 1960s, indigenous peoples' constitutional right to vote was restricted to those who had land titles and were literate (Eckstein and Wickham-Crowley, 2003). With regard to land, very few governments recognized rights, except in cases where land access favoured cheap labour and tax collection (Corazao, 2003). Slave labour conditions still continue in some places (Castellanos-Navarrete, *et al* 2021).

For decades, and through much of the twentieth century, Latin American states fostered the colonization of indigenous territories located in the vast tropical forests of the Amazon and Central America. This entailed registering these lands as state property, ignoring historical rights; assigning land and other resource rights (such as mining, logging and fossil fuel extraction) to third parties; promoting infrastructure and other national projects in these regions without consultation or consent of these groups; and criminalizing IPs when they fought back (Smith, 1969; Nelson, 2013). These policies were broadly supported not only by national governments, but also by international financial institutions in the name of development. Colonists were celebrated as ushering in progress by taming the wilderness and "bringing civilization" to the jungle (IDB, 1977; Larson, 2010).

In Asia, the historical trajectory of colonialism and dispossession is highly varied, and includes diverse forms of colonization and the usurpation of customary rights of indigenous and local people from 2,000 different civilizations (Errico, 2017). For example, colonialism in Southeast Asia dates back to the early sixteenth century, involving European colonial powers, followed by the Japanese, and into the twentieth century with the involvement of the United States of America (Yousaf, 2021). In Taiwan, many Chinese settlers drove out indigenous inhabitants from the fertile lowlands after the establishment of the Dutch trading settlements. In India, British administrators imposed the 1865 Indian Forest Act, in response to deforestation caused by colonial timber extraction, which effectively gave state rights to all forest areas previously under customary management systems (Mitra and Gupta, 2009). This centralized British colonial system is so entrenched that even radical attempts to revert community rights (such as the 2006 Forest Rights Act) has had limited success (Lee and Wolf, 2018).

Each colonizer imposed its specific political, economic, social and cultural regime (Tauli-Corpuz, 2008), and land – largely owned by indigenous peoples – was seen as a crucial resource due to its associated wealth and strategic advantages (Murphy, 2009). In Sarawak, Malaysia, the British colonial government saw the *Iban* land tenure system – a longhouse with territories for cultivation, fishing and hunting – as a major obstacle to development. In an effort to 'modernize' society, the 1957 Land Code was introduced; this provided individual land titles, followed by seizure of whatever was left (Perera, 2009). In the Philippines, separate Spanish and American colonizers produced two different cultures and identities among indigenous groups (Tauli-Corpuz, 2008). As in Latin America, some national governments adopted assimilation policies, such as Japan's Former Aborigines Protection Act 1899, aimed at transforming the identity and rights of the Aunu people, and resulting in widespread dispossession (Erni, 2008).

The African continent has a centuries-long history of trade with, and exploitation by, European powers, but a relatively recent period of colonial rule – which has nevertheless left a mark on land and forest tenure. Ivory, slaves, gold and gems were some of the main commodities sought after by European powers prior to colonization. Rapid colonization – also called the scramble for Africa (Jaffe, 1985) – began towards the end of

the nineteenth century. Colonization implied different forms of racialized despotism that resulted in the dispossession of native people (Mamdani, 1996), as well as taxation, forced labour and cropping arrangements, and other ways of appropriating value. Customary authority was instrumentalized by colonial rulers to ensure control by entrenching divisions. In terms of land tenure, across the continent colonial forest and conservation estates excluded native peoples. In Kenya, native peoples were forced into inferior 'native reserves', where 'closed district' policies restricted interaction with neighbouring indigenous communities. Although these efforts were thwarted by resistance and lack of resources, lines drawn on maps continue to have consequences today (Hansen and Lund, 2017; Bluwstein, 2019).

The colonial legacy lives on in many African nations as ongoing, yet incomplete, attempts at establishing state control over land, and as a set of ideas, reproduced in educational institutions and bureaucracies, about the proper use of landscapes. These ideas disfavour the interests of IPs and LCs (Lund, 2015, Sungusia, *et al* 2020a), despite conservation and development programmes that increasingly emphasize participation (Dressler *et al*., 2010), and a proliferation of instruments such as free prior and informed consent and Voluntary Guidelines on Business and Human Rights. In recent decades, conservation has continuously regressed towards recentralization and militarization (Asiyanbi 2019; Mabele 2016).

4.2.2 Two steps forward, one step back

A variety of reform processes, especially in the second half of the twentieth century, marked the beginning of statutory changes in the recognition of IP and LC collective land and forest rights. In Latin America, the Mexican Revolution led to the first significant land law recognizing agrarian and *ejido* communities in 1915 (Agrarian Law, 1915). In Panama, the first indigenous *comarca* (then called San Blas and now known as Guna Yala) was recognized in 1953, leading to formal recognition of indigenous territorial rights in the 1972 Constitution (Roldan, 2004); Peru followed closely with the recognition of collective tenure and titling of indigenous communities in 1974; many other Latin American countries followed in subsequent decades. The most important reforms in the region, however, have been the demarcation and titling of IP and LC lands, with significant progress made especially in Brazil, Colombia, Honduras, Panama, Peru and Nicaragua in the last 30 years. According to RRI (2018), during the 2002–2017 period, Latin America alone accounted for 75 percent of the total increase (86 million ha) in forest area owned by IPs and LCs globally (based on 41 complete case countries). Nevertheless, important challenges remain. In Peru, forest reforms undermined the scope of land rights by reversing indigenous rights for forest land (Notess *et al*., 2020); in Nicaragua, the Government has made little effort to stop the ongoing invasion of indigenous lands by non-indigenous settlers; the case of Brazil under former President Bolsonaro has demonstrated that even apparently secure rights can be undermined (Mantovanelli *et al*., 2021).

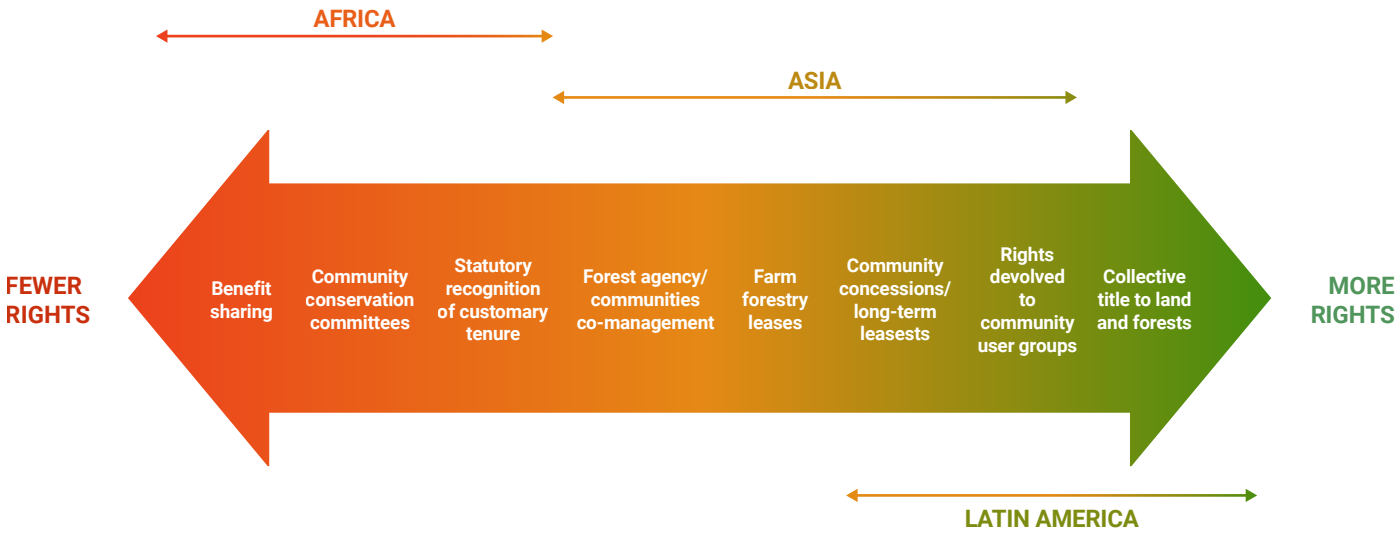
Without an understanding of history and power relations, and thus without a social justice lens, attempts to fulfil land-based climate pledges are more likely to perpetuate past and ongoing injustices.

In Asia, beginning in the late 1970s and early 1980s, a few countries began to grant limited collective tenure rights to communities. Concerns over deforestation led to social movements in South Asia that prompted governments to devolve some aspects of forest rights to communities (Poffenberger, 2000). These included community forestry initiatives (called social forestry) in Nepal (Fisher, 1989; Gilmour, 2003; Gilmour and Fisher, 1991; Malla, 2001) and India, which mainly provided degraded areas for tree planting to take pressure off forests (Saxena, 1997). Although the initial motivation of this devolution was restoring, conserving and sustainably managing forests rather than recognizing rights (Larson and Dahal, 2012), countries like Nepal have now significantly devolved rights through legislative reforms (Kanel, 2008; Ojha *et al*., 2009). In Indonesia, 97 adat communities (almost 50,000 households) have now received titles to 84,000 ha of customary forests since the 2012 Constitutional Court decision (number 35/PUU-X/2012),[14] although the Government prefers to promote its social forestry model (Safitri, 2022).

The majority of African nations have seen new constitutions and land laws since 1990, many of which have supported decentralized and collective land rights (Alden Wily, 2022). These efforts have also shaped the recognition of local communities' rights to use and manage forests and trees. In the United Republic of Tanzania, for instance, villages can declare forest reserves on village land and thereby, in principle, obtain full rights to use and sell products from them, as well as to exclude others. However, in

14 Source: https://forestpeoples.org/sites/default/files/news/2013/05/Constitutional_Court_Ruling_Indonesia_16_May_2013_English.pdf

Figure 4.4 **Common models of forest tenure reform**



Source: Based on Lawry and McLain, 2012.

practice these rights are often curtailed by specific forest regulations and implementation practices (Sungusia *et al*., 2020a; Ece *et al*., 2017). Kenya's new constitution and land act have paved the way for communal land tenure (Alden Wily, 2022), although forests are still based on a co-management model, largely controlled by the forest bureaucracy (Mutune and Lund, 2016).

These changes have emerged for a variety of reasons. They include the acknowledgement that state-led forest management had failed; greater acceptance of the commons (Ostrom, 1990), collective and customary systems; a decline in the value of forests that were already stripped of their timber wealth; decentralization policies around the world that were shifting responsibilities to subnational governments; and the increasing effectiveness of international and national social movements in support of indigenous peoples' rights (Larson and Dahal, 2012; Barry *et al*.; 2010, Sunderlin and Holland, 2022). Social mobilization of IP groups and other traditional communities was key in further advancing the recognition of collective rights to land and resources (see, for example, Larson *et al*., 2015b).

International progress has also influenced national policies. Importantly, in 1989 ILO Convention 169 recognized the social, economic and cultural rights of indigenous and tribal peoples, as well as the right to their traditional lands and territories. The convention was ratified by almost all Latin American countries, but not those in Asia or Africa. The UNDRIP, recognizing the right to self-determination (Article 3), was passed with much broader support in 2007, with 144 countries signing it;[15] however, unlike ILO Convention 169, UNDRIP is non-binding. Nevertheless, in decisions made at Conferences of the Parties, UNDRIP has been recognized. Examples include the Cancun agreements and decisions taken with regard to the Local Communities and Indigenous Peoples platform. In Latin America, a landmark Inter-American Court ruling in Nicaragua recognized indigenous peoples' land rights and established an important precedent for the region, supporting demarcation and titling in accordance with indigenous peoples' "customary laws, values, customs and mores" (Anaya and Grossman, 2002).

Reforms have continued to the present time, with substantial variation in terms of the extent, type, duration and security of rights granted. **Figure 4.4** provides a simplified continuum of forest rights recognition, from fewer and shorter-term to more substantial, long-term rights. The graphic provides a typology of some of the main models for granting collective rights specifically to forests and placing them in a regional context. On the weaker end of the spectrum, the models include revenue sharing,

15 The four countries voting against it in 2007 have since all reversed their positions. See: www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html

community conservation committees and formal recognition of customary tenure regimes, which are common in Africa, as recognized at the constitutional level in the Gambia, Mozambique, Namibia, South Africa and Uganda, but less so elsewhere (Monterroso *et al*., 2021; Alden Wily, 2018). Asian countries are the most diverse, with a strong emphasis on co-management arrangements, and Latin American models provide the most extensive and secure rights – including collective titles in perpetuity. All along the spectrum however, IPs and LCs face numerous challenges (Notess *et al*., 2020; Monterroso *et al*., 2019; Larson and Springer, 2016).

4.2.3 Threats to security for lives and livelihoods

Despite improvements in the extent and depth of rights recognized across regions, communities face increasing risks of violence, criminalization and rollbacks due to rising demand for land and resources, corruption, and a marked political shift towards populist and authoritarian regimes, as well as the closing of civic spaces or opportunities for collective action. As Ostrom (1990) points out, rules in form should not be confused with rules in use. Legally recognized tenure rights do not necessarily ensure tenure security, nor the ability to exercise those rights (Monterroso *et al*., 2019). There are a number of reasons why legal recognition does not guarantee rights. These are set out below, grouped into four main challenges. Failure to address these issues will make the persistence of injustices more likely, even with well-meaning policies.

1. Resource competition and opposition to IP and LC rights

The global thirst for resources is such that even where community rights are clear and robust, efforts to enforce collective land and resource rights are often met with pushback, competing claims, and threats by more powerful actors. Whether in Africa, Asia or Latin America, communities face increasing threats, competing land interests, contrasting worldviews (Larson and Springer, 2016; Monterroso *et al*., 2017), and the subtle tendency to recentralize power in favour of extractive industries, infrastructure and agro-industrial projects. Among other things, this has led to increasing attacks on land and environmental defenders, as reported from the Philippines (Dressler and Smith, 2022), Cambodia (Lambrik, 2019) and numerous other countries (Verweijen *et al*., 2021). Increasingly, these pressures are being driven by green technology proponents and the growing demand for renewable energy.

Competition for resources may sometimes be forged by local elites or private investors, but it is more often led by states, whether for public or private interests. Examples include biodiversity-rich natural forests converted to plantations in India's Western Ghat, leading to the loss of livelihoods of indigenous peoples, their knowledge and their territorial rights (Vijayan *et al*., 2021); oil palm expansion in West Papua, Indonesia, where at least 15 percent of forests have been gazetted for conversion (Runtuboi *et al*., 2021); neoliberal market reforms curtailing IP and LC rights (Hughes, 2008; Leemann, 2021); land and forest concessions excluding people from their land in Bunong villages in Cambodia (Hak *et al*., 2022); and land invasions in Brazil under the Bolsonaro presidency (Mantovanelli *et al*., 2021). Politicians may also see an opportunity to claim land (see, for example, Larson *et al*., 2015a), obtaining advantage during formalization processes.

2. 'Expert'-led conservation and sustainable resource management

Biodiversity conservation, sustainable forest management and climate change interventions are broadly considered 'expert' domains, where traditional knowledge and lived experiences play a peripheral role, and the presence of IPs and LCs are most often regarded as part of the problem rather than the solution. These ideologies are based on professional training and bureaucratic cultures that foster suspicion of local people and undermine the spirit of participatory reforms (Sungusia *et al*., 2020b; Agarwal, 2001).

Throughout the world, IPs and LCs continue to bear the brunt of fortress conservation measures, leading to forced evictions, human rights violations, criminalization and continued threats of violence – often with the complicit support of international conservation (Tauli-Corpuz *et al*., 2020). The Ogiek community in Kenya failed to obtain their land rights in spite of a ruling by the African Court on Human and Peoples Rights that their property rights had been violated (Kibugi, 2021). Attempts to reconcile community interests with protected areas have sometimes met with militarization of biodiversity conservation, as in Nepal (Basnyat *et al*., 2018; Dongol and Neumann, 2021).

Climate mitigation strategies, such as REDD+, have sometimes failed to respect indigenous peoples' rights, as defined by international law and conventions (Milne *et al*., 2019), in part due to a worldview that fails to see local people as allies and equal partners (Sarmiento Barletti and Larson, 2017). There is a rich literature on how existing 'technical' and 'scientific' narratives on climate change demonstrate the inability to engage with other forms of knowledge (such as indigenous, women's) (Nightingale, *et al*., 2020). These value systems have excluded IPs and LCs from recognition as right-holders, knowledge-bearers (Prowse and Snilstveit, 2010; Nikitas *et al*., 2019) and decision-makers, reflecting the power relations that determine whose knowledge and values count.

3. Bureaucratic and logistical obstacles

Communities often face procedural or administrative hurdles in their efforts to secure or exercise their rights. Challenges may be

bureaucratic in origin, or logistical, such as funding and capacity gaps to implement reforms, or the complexity of handling competing and overlapping claims. Concerted efforts by civil society organizations and governments to advance favourable policy reforms may easily be distorted or undermined by such problems.

The formalization of IP and LC rights to land is rarely a simple process. Forest tenure reforms, for instance, generally involve obligations to maintain or restore devolved areas; important state co-ownership, co-management and regulatory authority; the attribution of distinct forest rights to different user groups; and the need to formalize governance structures, user groups or community associations to act on behalf of the community. Demarcation almost always requires strict boundaries, even where these did not formerly exist. Informal common-property arrangements between neighbouring communities may need to be divided, shutting out less powerful groups, such as pastoralist communities, from their traditional territories, grazing areas, or previously held freshwater rights (Flintan, 2011). The anticipation of demarcation and titling can lead to competing claims or land grabs by third parties, including settlers and migrants, or to clearing of land for agriculture as a strategy to pre-empt the restrictions and costs associated with formalization (Sungusia and Lund, 2016). In addition, responsible public agencies seldom have the capacity or experience needed to understand the underlying social complexities and histories of devolved lands and territories. Fragmentation of land and resource rights are common, forcing distinctions between land and forests, trees and tree products, and now carbon, multiplying the number of government institutions involved, and hence their claims of authority over specific arenas. Such fragmentation often leads to even greater challenges for the recognition of collective rights over territories, including the multiplication of procedural steps with distinct agency sign-off authority, which can involve up to 20 formal and 2 to 3 times as many informal permitting requirements for the formalization of a single community title (Notess *et al*., 2020). Difficulties are often compounded by critical inter-agency coordination challenges and transaction costs that can impede support for rights recognition (Myers *et al*., 2022).

4. Elite capture and inequality at local level

Rights to resources, especially in traditional and collective systems, tend to be varied, complex and often overlapping, shaped by histories and underlying power dynamics. In processes of formalization or rights recognition, the failure to understand these dynamics can contribute to elite capture and/or to the reinforcement of inequalities.

Elite capture has emerged as a prominent problem in two overlapping dimensions: (i) between IPs/LCs and others; and (ii) within IP and LC groups. These are overlapping because it refers,

Climate mitigation strategies have sometimes failed to respect indigenous peoples' rights, as defined by international law and conventions, in part due to a worldview that fails to see local people as allies and equal partners.

Box 9 Women's rights in indigenous and local communities

A legal analysis of the extent to which community-based tenure regimes* recognized women's rights to community forests in 30 countries found substantial progress across three overarching indicators at country level, but significant gaps at regime level:** only 3 percent recognized women's voting rights at community level, only 5 percent acknowledged women's leadership, 10 percent recognized inheritance rights, 18 percent defined mechanisms of dispute resolution in conflicts that affected women, and 29 percent recognized women's rights to membership (RRI, 2017). In another five-country socio-legal analysis, barriers in the recognition of women's rights in legal and social norms were linked to: i) legal constraints emerging from implementation gaps, a lack of awareness, and the enforcement of policies and laws at local level; ii) overlaps and contradictions between customary regimes and formal arrangements; and iii) discriminatory social norms and practices at institutional and community levels that limit the recognition and realization of women's legal rights (Monterroso *et al*., 2021).

At the local level, dual layers of exclusion may exist, as women, youth and other marginalized groups may not be considered members of the collective, and existing norms and social practices can limit the ability of women to benefit from and/or exercise their rights, even when protected in statutory law (Meinzen-Dick *et al*., 2021). Further, women's customary rights often depend on those of their male counterparts (father, husband, brother, son), and the security of those rights – such as their ability to inherit land – may be vulnerable, depending on their marital status or their age. It is important to understand the power relations that determine when and how certain women may become vulnerable (Djoudi *et al*., 2013, 2016).

* Community-based tenure regimes were understood as a distinguishable set of national, state issued laws and regulations governing the right to manage resources held at community level.

** Eight indicators assessed by this study included three overarching indicators: 1) constitutional equal protection; 2) affirmation of women's property rights; and 3) inheritance in overarching laws. Five community-based tenure regimes indicators include: 4) membership; 5) inheritance in community-based tenure regime -specific laws; 6) voting (governance); 7) leadership (governance); and 8) dispute resolution.

Box 10 **Only a few countries prioritize land rights in their NDCs**

The Paris Agreement explicitly mentions indigenous peoples in the Preamble and in reference to traditional knowledge,* and COP decisions, both before and after Paris, have recognized IPs and IP rights. While Articles 4-6 call for the integration of land- and forest-based climate mitigation and adaptation strategies within Parties' Nationally Determined Contributions (NDCs), states are neither invited nor encouraged to consider the recognition and inclusion of IP and LC rights and contributions in the realization of those objectives.

RRI's review of NDCs in 2016 and 2019 (see NYDF 2019) revealed that fewer than 25 of 165 submissions referenced non-binding commitments to advance or uphold the rights of indigenous peoples, local communities and women within these groups, and only one (Cambodia) had quantifiable targets for the advancement of IP and LC land rights (RRI 2016, NYDF 2019). Preliminary evidence from the most recent review of commitments made by 31 of the most important tropical forest countries, which contain 70 percent of the world's tropical forests, shows that at least 10 presented non-binding actions to support indigenous and community rights and participation, and one (Nepal) had quantifiable targets. Interestingly, Cambodia appears to have backtracked on its previous commitments, and other countries have either diminished initial commitments (such as Indonesia) or make claims that cannot be achieved in their current context (such as Honduras and Nicaragua).

In contrast to the lack of attention paid to IPs and LCs, however, 78 percent of NDCs revised by 2021 mention gender or women, and they are increasingly referenced as stakeholders and agents of change, rather than just as 'vulnerable' (IUCN, 2021). In Sierra Leone for example, the NDC considers gender and social inclusion issues with a focus on women, youth and elderly persons with disabilities in their national priorities.

* The Center for International Environmental Law and IIPFCC have done 3 compilations on IPs and traditional knowledge in the context of the UNFCCC: www.ciel.org/reports/indigenous-peoples-traditional-knowledge-un-climate-change/; www.ciel.org/reports/indigenous-peoples-traditional-knowledge-unfccc-2019/; and www.ciel.org/reports/indigenous-peoples-and-traditional-knowledge-in-the-context-of-the-un-framework-convention-on-climate-change-2020-update/.

in the first case, not only to other local people claiming lands (as in point (i)), but also to different community governance arrangements that determine who can be considered a member of the collective (Meinzen-Dick *et al*., 2021), and the complex rules for outsiders, newcomers and migrants. Hence rights recognition requires a transparent process for identifying legitimate claims, preventing land grabs and assuring effective representation and the participation of everyone affected.

Within collectives, land is not always owned or accessed equally by all members, so formalization risks increasing the authority of those who are already more powerful (Larson *et al*., 2015) and/or failing to include important land and resources used by collective members. For instance, participatory mapping processes have demonstrated that men and women may use different areas and resources (Larson *et al*., 2019; see also Fortmann, 1985; Gallagher *et al*., 2020); engaging only with 'household heads' marginalizes youth and women (Elmhirst *et al*., 2017), who may not be recognized as full, voting members of the community, putting at risk their ability to access and benefit from land and resources (see **Box 9**).

4.3 Ways forward for sustainability and justice

As made clear in this chapter, climate, conservation and restoration pledges cannot be met without engaging indigenous peoples and local communities (but see **Box 10**). This raises a number of critical questions, namely: *how will IPs and LCs be engaged? With what and whose priorities? And based on what principles or values?* Throughout the world, recognition of IP and LC rights to land, resources and territory has been partial, limited and fraught, marked by competition, opposition, violence, elite capture, and consistent capacity and funding gaps. Despite this, indigenous peoples and local communities have proved to be effective stewards of the world's natural resources (FAO and FILAC, 2021). In short, evidence shows that forest lands that are legally held by communities exhibit lower rates of deforestation, store more carbon, harbour more biodiversity, and benefit more people than lands managed by either public or private entities. Yet the potential is so much greater, should these peoples and communities ever receive support for their stewardship, grounded in genuine participation, secure rights and access, and locally embedded solutions, co-designed to be context-specific, flexible and adaptive.

We argue that the most effective and just way forward is to ensure that IPs and LCs have legitimate and effective ownership and control of their land, and a strong voice to self-represent and engage on equal terms – ultimately exercising self-deter-

mination – in the pursuit of actions that directly or indirectly affect their lands, territories and collective rights. As recognized by the IPCC (2021): "Supporting Indigenous self-determination, recognizing Indigenous Peoples' rights, and supporting Indigenous knowledge-based adaptation is critical to reducing climate change risks and effective adaptation (very high confidence)."

However, as global policy for climate mitigation and landscape restoration gains further impetus, the risk of dispossession and marginalization of IP and LC rights actually increases. These new imperatives are now supported by programmatic interventions that prioritize technical efficiency and short-term gains (easily quantifiable results) over system-level changes (transformations) that prioritize indigenous and local people's perspectives, voices and knowledge (Fleischman *et al*., 2022). Surrendering to the urgency of the climate crisis without due consideration of social-ecological implications "can override, both accidentally and deliberately, the slow and messy processes of participation and democracy, and of assuring the rights and livelihoods of Indigenous, local community and smallholder women and men" (Larson *et al*., 2021).

4.3.1 A call to rethink the approach

The roots of these challenges run deep. To steer away from the risks of the current moment and towards new potential requires fundamental rethinking. The currently dominant approaches to forestry, conservation and land-based mitigation are embedded in institutions and worldviews, in "political economies of expertise", and in "educational practices and institutional socialization" that are exclusive (Lund *et al*., 2019, p.5). Further, these perspectives portray conceptions of "national development and 'progress' as driven by large-scale private investments", and assumptions about communities as drivers of resource degradation (Larson and Springer, 2016, p.13), not to mention racism, sexism, classism and colonial logics (Gutiérrez-Zamora, 2021; Collins *et al*., 2021).

The first step towards moving beyond such logics is to acknowledge their role in shaping thought and practice, particularly among resource and development professionals. This may require questioning and, ultimately, unlearning taken-for-granted ideas and beliefs about ecologies, histories and peoples (Trisos *et al*., 2021). Such a rethink will not be easy, as it is likely to challenge aspects of personal identity, fundamental beliefs, and broad notions of universal forms of expertise that characterize international conservation and development (Li, 2007; Mosse, 2005). It means stepping outside the frameworks we take for granted and questioning our understanding – it means being anti-colonialist. This would require greater engagement with key principles of decolonial thinking (Trisos *et al*., 2021), including:

1. Acknowledging place-based histories. Conservation and development interventions should start by examining and openly acknowledging the specific histories of place, including who resided on these lands previously, for example in pre-colonial periods.
2. Putting place-based knowledge on an equal footing with outside perspectives. The knowledge of people living in a particular place, as well as national actors, must be put on equal footing with that held by international conservation and development 'experts'. This must be done in ways that avoid the trap of nativism, and in recognition that all knowledge is partial and provides different perspectives on a particular reality.
3. Respecting different values associated with land. The values associated with land go beyond the economic and social values that tend to dominate thinking within conservation and development arenas. They may include culture and self-determination, as well as worldviews about place and belonging – a broader concept (especially for IPs and LCs in Latin America) that is better encompassed by the idea of territory.
4. Co-producing solutions. The ideas presented here call for locally adapted and flexible models, co-designed with local people, and based on long-term engagement with IPs and LCs, which permits understanding and trust-building over time. This requires reflexive approaches that embrace humility and openness to learn, and a deep sense of mutual respect and commitment to exchange between different forms of knowledge (Sarmiento Barletti *et al*., 2021).
5. Unpacking the community. The idea of community itself needs to be problematized, and understood from an intersectional perspective that recognizes gender, ethnic, class and other forms of differentiation. Such internal politics within communities may not be immediately visible to well-intentioned outsiders – hence the importance of longer-term engaged co-learning processes.

Embedded biases require positive actions – in support of social justice – to overcome them. This need for change is not only just, but also pragmatic.

4.3.4 From 'rethinking' to action: Engaging the politics of change

Turning words into actions, indigenous peoples and local communities should not simply be 'safeguarded' from the potential harms of climate and restoration pledges, nor should they be viewed as mere 'beneficiaries' of potential 'co-benefits'. Rather,

they should be regarded as rightful allies, partners and decision-makers in the definition of both the problems we face and the solutions we develop. Achieving such ends will require nothing short of a paradigm shift in the way that IPs and LCs have thus far been considered, engaged and involved in decisions and processes that directly or indirectly affect their rights.

Moving from safeguards, to inclusion, rights-based approaches, and eventually self-determination, requires globally-relevant and locally-specific actions that can address political and economic obstacles across scales, sectors and geographies. Global initiatives that count on country and local rollout, even if clearly intended to support indigenous groups, may not have any chance of success without a concurrent effort to proactively 'translate' intentions and win over implementers to new ways of doing business on the ground (Sarmiento Barletti *et al*., 2021). Such initiatives also need to recognize that they are taking place in the context of particular national policies, national and local histories, economies and cultures that have almost always discriminated against IPs and LCs. Without care being taken to actively challenge and rethink cultures and beliefs, and specific attention paid to anti-discrimination, such initiatives are likely to reinforce the status quo.

Securing IP and LC rights is not a straightforward process. Too often the wave of positive change initiatives in public debate and political discussions lose traction or become distorted when they enter the core domains of public choice, thus suggesting the need for a strategy to engage with government machineries for translating policy ideas into action. Sustainable and just solutions require commitment over time, long enough to build trust and mutual understanding. And because rights are never won for good, but must be constantly fought for, they depend on human agency to define, apply, monitor and enforce the norms and institutions that underpin rights-based relationships. Like democracy itself, they require recurrent, progressive and deliberative forms of engagement to be sustained and rendered relevant across time and space (Ostrom, 1997).

4.4 Conclusions

Drawing on the evidence presented in this chapter, it is clear that land-based climate ambitions cannot be realized in the absence of dedicated efforts to advance the legal recognition and protection of the land, resource and territorial rights of indigenous peoples and local communities, including those of mobile peoples and other rural minorities. It is also clear that the global climate agenda cannot be pursued at the expense of community voices, including their rights to free, prior and informed consent, their rights to self-determination, and their right to active, effective, meaningful and informed participation in the planning, implementation and monitoring of all projects, programmes or initiatives that directly or indirectly affect their land, territorial or resource rights.

Safeguards alone will not achieve such ends. Realizing the rights outlined here requires the active and effective involvement of governments, international organizations, companies and investors, and the integration of such rights in the laws, standards and procedures used to guide all landscape-level investments, regardless of their nature, purpose and end use. Moving forward, it is clear that more financing, political support, capacity building and coordination will be required to meet the global challenge of achieving a more just, equitable and sustainable climate-resilient future. The historic pledge of USD 1.7 billion, announced at COP 26 (Ford Foundation, 2021) to secure, strengthen and defend indigenous peoples' and local communities rights to their lands and forests, is an important step in the right direction, but more is needed. RRI estimates that at least USD 10 billion is required to increase the recognition of tenure rights of IPs and LCs to 50 percent of forests owned by or designated for local peoples in low and middle-income countries (up from the current 30 percent – an additional 400 million additional ha of tropical forest). However, the need for investment is far greater, when costs of building and maintaining capacities and supporting the development of robust and sustainable institutions are considered.

To fundamentally change our fossil-dependent global economy, climate solutions need to move away from overly simplified models of nature-based GHG removals and emissions avoidance schemes in the global South. In addition to furthering the injustice and inequality of colonial norms and approaches, reliance on nature-based solutions to achieve carbon neutrality risks accelerating demand for land, while locking in the world on a path of unprecedented global warming – regardless of their purported integrity. The legal recognition and protection of the rights of the world's most vulnerable peoples is nothing less than the litmus test of our global resolve to undertake urgently required societal transformations.

CHAPTER 5

Agroecology for socioecological resilience

KEY MESSAGES

- Business-as-usual in agriculture and food systems is not an option. Transformative change is urgently needed to move away from emissions-intensive industrial agriculture.
- Alternatives based on biologically diverse systems can contribute to both climate adaptation and mitigation. Agroecology provides these and other multifunctional benefits centred on ecological and social resilience that is achieved through the sustainable management of biodiversity.
- Agroecology contributes to the realization of various human rights. Human rights-based approaches help to address climate change challenges and biodiversity loss, while strengthening the agency of right-holders such as indigenous peoples, peasants and women.
- Key policy actions are needed to foster the restoration and sustainable use of agricultural biodiversity by elevating agroecology as a means to practice biologically diverse agriculture, a key holistic approach for climate change adaptation and mitigation.

This chapter refocuses the climate and agriculture debate, not on the potential of agriculture for land-based carbon removals *per se* – since as **Chapters 1** and **2** have demonstrated, there are many associated risks, not least as there is simply not enough land to be devoted exclusively to carbon removals. The perspective explored here is the scope for multifunctional agriculture and food systems, particularly agroecology, to ensure healthy food production and livelihoods, and to contribute to both climate adaptation and mitigation. The chapter starts by examining what is wrong with business-as-usual in the agriculture sector and strict conservation and mitigation initiatives, and why these need to be changed. It then places emphasis on the multifunctional benefits that agroecology can bring and reiterates its importance for implementing a rights-based approach for climate action. The chapter concludes by outlining the key policy elements needed to create climate resilience in agriculture, by supporting agroecology.

5.1 The perils of business-as-usual in agriculture, biodiversity conservation and climate mitigation

Agriculture covers almost 40 percent of the Earth's terrestrial surface (FAOSTAT, 2022). To address the land gap that has been discussed in previous chapters, it is essential to understand the role of unsustainable agriculture and the global industrial food system in generating climate change. However, the climate crisis is not isolated and it cannot be addressed without tackling the underlying causes, including the economic dynamics of industrially-driven food and agriculture systems that result in ecological disruptions (see **Section 5.1.2**). The global food system contributes to multiple planetary stressors (Rockström *et al.*, 2020), which, if addressed from an integral perspective, can enable multiple objectives to be met (Altieri *et al*., 2015; Conijn *et al*., 2018; Gerten *et al*., 2020). Aside from climate change mitigation, these objectives include healthy food production, biodiversity restoration, water conservation, human and ecosystem health, and dignified livelihoods for people, especially those who live in rural areas (IPES-Food, 2016; HLPE, 2019).

Governments around the world have submitted their NDCs as per their commitments under the Paris Agreement. Many governments include the agriculture sector in their NDCs, referring to both mitigation and adaptation. **Chapter 2** presents the results of an analysis of reliance on land for carbon removal in their climate mitigation commitments. In terms of the contribution of the agriculture sector to land-based removals, 272 million ha of land were identified as relating specifically to agroforestry and silvopasture. However, the implications for agricultural lands will be greater than that, given that 633 million ha were pledged that would require a land-use change.

A strong emphasis has been placed in many climate pledges on the restoration of rangelands and other degraded lands, but countries have not provided much detail on what types of agricultural management need to be developed to replace what caused the degradation in the first place. Agroforestry and silvopastoralism are also identified as actions that can help to sequester carbon, but our research found that only about 20 countries mention agroforestry systems in their NDCs and other relevant strategies (see **Table 5.1**). Moreover, very few countries specify area-based targets. An exception is Malawi, which states in its updated NDC: "Agroforestry: Targeted planting of an additional 25 trees/ha on 155,000 ha of crop fields, equivalent to 20% of total arable land, 31,784 ha of village forest areas; and expansion of new fruit area on 27,000 ha to achieve at least a 10% tree cover. Scaled-up potential for all agroforestry types estimated at 700,000 ha." (Republic of Malawi, 2021, p.44). It is important that countries mention specific area targets in their NDCs, since that would enable a more accurate quantification of the pledges and how much total area and what arrangements would be needed to fulfil them, as well as the corresponding monitoring.

Other countries point to sustainable agriculture as an approach that could help to mitigate climate change, but with very little detail on what it actually entails and the outcomes foreseen. A handful of countries and regions have attempted to specify this further. Examples are Bhutan, with its policy of growing 100 percent organic food by 2020; Zambia's intention to have 50 percent of its land under sustainable agricultural practices by 2030 compared with 2015; and the European Union's aim to have at least 25 percent of its agricultural land under organic farming by 2030. Other countries like Colombia, Kenya and Senegal have put forward agroecological measures (GAFF, 2022). Yet these are few and far between and provide little information about what they consider to be organic, sustainable or agroecological. There is also a need for greater clarity in the NDCs to identify which countries are responsible for the bulk of the emissions from unsustainable agriculture, and who should bear the mitigation burden. Moreover, an assessment of 14 selected NDCs found that no country has specified the need to shift subsidies or incentives away from industrial agriculture and redirect them towards agroecological management – measures that would also support small-scale farmers (GAFF, 2022).

The current crises in agriculture, including the contribution of the sector to climate change, is primarily caused by industrial agriculture and its practices that are fossil fuel-dependent, promote land-use change, and are monoculture-focused. Small-scale, traditional and biologically diverse forms of agriculture have

Table 5.1 **Countries' pledges that identify agroforestry as a strategy for land-based carbon removals**

Country	Key elements of agroforestry pledge*
Brazil	Agroforestry identified as one of several mitigation measures.
Belize	Agroforestry practices incorporated into at least 8 000 ha of agricultural landscapes by 2030, with 4 500 ha of this implemented by 2025.
Colombia	Increasing investment for the implementation of agroforestry listed among the main mitigation measures for the agriculture sector.
European Union	Agroforestry identified as needing increasing support due to its potential for, *inter alia*, mitigating climate change.
The Gambia	'Multistrata agroforestry' described as an unconditional target, with potential mitigation of 169 Gg CO_2e in 2030.
Guinea-Bissau	Development of a national reforestation and sustainable management programme for forest and agroforestry ecosystems by 2025.
India	National Agroforestry Policy (NAP) of India aims to encourage and expand tree plantation in complementarity and integrated manner with crops and livestock.
Malawi	Targeted planting of an additional 25 trees/ha on 155 000 ha of crop fields, equivalent to 20% of total arable land, 31 784 ha of village forest areas; and expansion of new fruit area on 27 000 ha to achieve at least 10% tree cover. Scaled-up potential for all agroforestry types estimated at 700 000 ha.
Madagascar	Large-scale adoption of agroforestry planned to reduce emissions.
Mexico	Communal lands identified as opportunity to address environmental and development concerns through agroforestry and sustainable forest management.
Mozambique	Integrated agroforestry systems mentioned as a measure to recover areas degraded by shifting cultivation.
Myanmar	Agriculture described as the second largest sectoral source of greenhouse gas emissions and a new conditional cumulative target of sequestrating 10.4 million tCO_2e over the period 2021–2030 has been set for the sector. Promotion of tree planting and agroforestry to raise the average tree canopy cover across 275 000 ha of agricultural land with <10% tree canopy cover per hectare. The <10% tree cover class per hectare is mentioned as being of primary relevance as it covers the largest area of land nationwide (estimated at 112 068 km2 or 58% of total agriculture land in 2010). The mitigation pillars in the Climate-Smart Agriculture Strategy 2014 where agroforestry can contribute are identified as: 1) watershed and land management; 2) reducing land degradation and soil erosion; and 3) developing new farming systems and techniques.
Namibia	Planting of 10 000 ha of trees per year under agroforestry, which would account for 2% of Agriculture, Forestry and Other Land Use (AFOLU) emissions reduction in 2030. This accounts for potential emissions reduction of 0.358 MtCO_2e in potential mitigation and 1.63% of business-as-usual scenario in 2030.
Nepal	Promotion of, *inter alia*, agroforestry as a conditional target for agriculture.
Senegal	AFOLU targets include rice cultivation and agroforestry to reduce emissions by 0.35% (2020), 0.51% (2025) and 0.63% (2030).
Sierra Leone	Reforestation of 14 000 ha of degraded land and agroforestry.
South Sudan	Promotion of agroforestry for carbon sequestration and other benefits.
Suriname	Promotion of agroforestry.
Tajikistan	Promotion and scaling of, *inter alia*, agroforestry as a source for generating mitigation co-benefits.
Tonga	By 2025, 30% of land targeted for agroforestry or forestry, which will include planting of 1 million trees by 2023. Promotion of integrated agroforestry is planned in areas earmarked for agriculture.
United Kingdom	Support to increased agroforestry (trees and agriculture coexisting on the same land) through environmental land management schemes from the early 2020s.
Zambia	By 2030, 50% of agricultural land will be under sustainable agricultural practices compared with 2015, which will include uptake of agroforestry.

Low **Moderate** **High**

* Usefulness in relation to specificity and quantification

Source: Authors' elaboration based on review of agriculture-related country climate pledges (see **Chapter 2**)

comparatively minimal input to greenhouse gas emissions, but make a valuable contribution to climate mitigation (Verchot *et al*., 2007; Lin *et al*., 2011; Bryan *et al*., 2013; Altieri and Nicholls, 2017; Repin *et al*., 2020; Rakotovao *et al*., 2021). For these types of farming systems and the farmers dedicated to them – particularly those in the global South – there is an urgent need to support their production systems as an effective climate adaptation measure and climate justice action, as although they have done little to cause the climate crisis, they are suffering the most.

The agricultural commitments in the NDCs focus largely on carbon removals and, to some extent, on the need for reductions in synthetic nitrogen fertilizers. This represents a missed opportunity for a climate justice approach that emphasizes the multiple benefits of biodiverse agricultural systems, such as agroecology, including the restoration and conservation of biodiversity and its functions, as well as the realization of human rights (Tomich *et al*., 2011; IPES-Food, 2016).

The focus of this chapter on agroecology is therefore deliberate. Agroecology can certainly play a major part in removing emissions from agricultural production (see Dooley *et al*., 2018; IPCC, 2019a; Sinclair, 2019). However, most importantly, agroecology is a holistic approach with multifunctional benefits, including adaptation to climate change, biodiversity conservation and sustainable use, ecological and social resilience, healthy nutrition and diets, and sustainable livelihoods (IPES-Food, 2016; HLPE, 2019; Sinclair, 2019; Leippert *et al*., 2020) (see **section 5.2**).

Conceptualized in this way, attention moves from a singular focus on carbon as a metric, to measuring the multiple benefits of working respectfully with ecosystems and the people living in them. This means a focus on longer-term benefits for peasants and other smallholders and for society at large, such as ecosystem health, livelihood resilience, genuine healthy food and nutrition, and the economic viability of farms in the face of debt and climate shocks (IPES-Food, 2016). Measures such as nutritional quality, resource efficiency, restoration of biodiversity, provision of ecosystem functions, equity and justice are highly relevant. By these counts, agroecology certainly contributes robustly to climate-resilient and sustainable agricultural and food systems (IPES-Food, 2016).

5.1.2 Industrial agriculture and food systems

The world's industrial food systems are the single most important contributor to GHG emissions (IPCC, 2019a), representing more than one-third of current global anthropogenic emissions (Crippa *et al*., 2021). Industrial agriculture and land-use change contribute one-quarter of those GHG emissions (IPCC, 2019a). Cropland that is managed unsustainably is the primary anthropogenic source of nitrous oxide, with synthetic nitrogen fertilizers accounting for 82 percent of global increases in GHG emissions since the pre-industrial era (1860s) (Tian *et al*., 2019). Likewise, large-scale conventional agriculture (mainly industrial livestock and rice monocrops) contributes 36 percent of global anthropogenic methane emissions (IPCC, 2014b).

Furthermore, land conversion for industrial agriculture and agricultural intensification is the prime cause of global biodiversity loss through land-use change (IPBES, 2019; Benton *et al*., 2021). Biodiversity is declining faster than at any time in human history, and perhaps as fast as during any mass extinction (Ceballos *et al*., 2020). Industrial and conventional agriculture also plays a significant role in water pollution and is responsible for 70 percent of all freshwater use globally (Rockström and Karlberg, 2010; Mateo-Sagasta *et al*., 2018; Mekonnen and Hoestra, 2020). More than 50 percent of synthetic nitrogen fertilizers applied in conventional agriculture are lost, adding excess reactive nitrogen to the surrounding environment through leaching and gaseous losses (Galloway *et al*., 2008; Lassaletta *et al*., 2014). Synthetic nitrogen inputs from river runoffs constitute a significant source of eutrophication in estuaries and coastal waters, and are responsible for the exponential increase in hypoxic zones worldwide since the 1960s (Diaz and Rosenberg, 2008; Sinha *et al*., 2017).

Globally, soils store in their first metre three times more carbon than the above-ground biomass of all forests in the world combined, and double the carbon dioxide content of the atmosphere (Lal, 2004). The alarming rate of soil degradation results in a decrease of this ecosystem function (carbon sequestration), among others. Soil erosion, compaction, salinization, nutrient depletion (due mainly to the decline in organic matter content) and contamination are the major symptoms of soil loss and deterioration, and are all associated with industrial agriculture (Bindraban *et al*., 2012). Moreover, the pesticides used in industrial agriculture and monocrops contaminate soils, water, air and wildlife, and are important factors in acute and chronic human illness and deaths, disproportionally affecting farmers and farmworkers (Rani *et al*., 2021).

The industrial food systems affect health through multiple and interconnected pathways, generating severe human and economic costs. In relation to the food-health nexus, the International Panel of Experts on Sustainable Food Systems (IPES-Food) identifies five key channels through which food systems impact health: occupational hazards, environmental contamination, consumption of contaminated unsafe food, unhealthy dietary patterns, and food insecurity (IPES-Food, 2017). In addition, agricultural intensification and land-use change are major causes of the emergence of infectious diseases (Jones *et al*., 2013). Some 60 percent of these are of zoonotic origin, and 72 percent of these originate in wildlife (Jones *et al*., 2008). The spillover of

these zoonotic diseases to the human population is intricately related to the intensification of agriculture and livestock production through the ecosystem and animal health degradation that they generate (Wallace, 2016).

The global industrial food system also contributes to increasing inequalities (for example in terms of access to land and support services), by favouring large-scale industrial plantations over small- and medium-scale family farming, resulting in the loss of livelihoods for millions of smallholder farmers worldwide (Holt-Giménez and Altieri, 2013; Moseley *et al*., 2015; Kansanga *et al*., 2019; Debela *et al*., 2020). Smallholder farms are defined as less than 2 ha in area and represent about 84 percent of all global farms (Lowder *et al*., 2016). Smallholders' ecological relevance (for example, agrobiodiversity *in situ* conservation) and social relevance (for example, diversified food production) is compromised when their livelihoods are jeopardized. A recent meta-analysis concluded that on average, smallholder farms shelter higher (agro)biodiversity and have higher yields in comparison with larger farms (Ricciardi *et al*., 2021). Depending on the set of countries considered, smallholders and family farmers provide at least 53 percent (Graeub *et al*., 2016) and up to 80 percent of all food consumed globally (FAO, 2014).

This figure is important in the context of land-sparing arguments that advocate for agricultural intensification to increase yields and spare land for conservation and climate change mitigation (Cohn *et al*., 2014; Carter *et al*., 2015; Lamb *et al*., 2016). Although smallholder agriculture represents 84 percent of the total number of farms, it constitutes only 12 percent of all farmland (Ricciardi *et al*., 2021), and 53 percent when including all family farms (Graeub *et al*., 2016). In other words, on 53 percent of the world's farmland, smallholders and family farmers are producing between 53 and 84 percent of the total food consumed globally. This large percentage of food is produced by a sector that receives very little financial and technical aid. Most countries do not prioritize smallholders in their agricultural policies, reducing access to financial resources and leading to the marginalization of smallholders in rural areas (Maas Wolfenson, 2013). Furthermore, the land-sparing argument is based on the assumption that land is indeed spared as a result of agricultural intensification. However, there is very little evidence that this is the case, and when it does occur, it is under very particular circumstances, such as strong forest conservation policies (Rudel *et al*., 2009). For instance, in a study of 10 major crops in 161 countries, Rudel and colleagues (2009) show that as yield increased from 1970 to 2005, the amount of cultivated area increased as well, contrary to the land-sparing expectations. Indeed, empirical evidence suggests that agricultural intensification programmes frequently result in higher levels of deforestation locally (Angelsen and Kaimowitz, 2001; Perfecto and Vandermeer, 2010).

Loss of biodiversity and habitat is predominantly caused by the intensification, colonization and appropriation of land that was and is used by rural people, who manage it in a less intensive way.

All the impacts of the unsustainable global food and land-use systems result in an immense economic cost that is frequently hidden. In 2019, the Food and Land Use Coalition estimated the hidden ecological, health and socioeconomic costs of the global food and land-use systems to be USD 12 trillion. This estimate includes a consideration of some of the effects of climate change, biodiversity loss, undernourishment and poverty. Given the estimated market value of the global food systems of USD 10 trillion, this represents a negative balance of USD 2 trillion annually (FOLU, 2019; see **Figure 5.1**).

This quick review shows that business-as-usual is not an option, and that food system transformation is urgently required (McIntyre *et al*., 2009). This observation was already made by the International Assessment of Agricultural Knowledge, Science and Technology for Development in 2009. In the time since then, there have been a slew of proposals that claim to be able to fix our unsustainable food systems and/or to conserve biodiversity. While promising, these also have to be interrogated closely and we briefly discuss one such proposal below, given its close links with land and forests.

5.1.3 The 30X30 initiative

Many conservationists and climate change advocates are excited about the possibility of expanding protected areas (PAs) to cover 30 percent of the planet by 2030. The so-called 30X30 initiative was launched by the High Ambition Coalition for Nature and People in 2020. The initiative was proposed as one of the targets of the Post-2020 Global Biodiversity Framework to be discussed at the Fifteenth meeting of the Conference of

the Parties (COP 15) to the CBD. By June 2022, more than 100 countries had joined the coalition (High Ambition Coalition for Nature and People Statement, 2022).

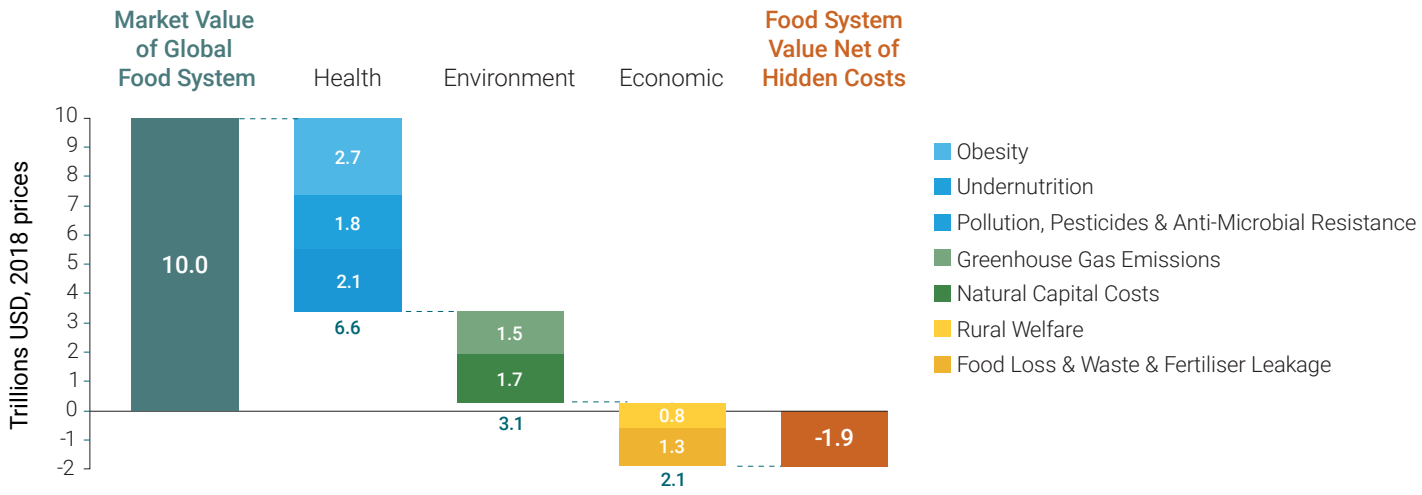
However, not everyone is enthusiastic about the initiative. The PA approach has been reported to frequently violate the rights of rural people, particularly indigenous peoples, peasants, forest dwellers, artisanal fishers and pastoralists (Obura *et al*., 2021; UNEP-WCMC and IUCN, 2021), as detailed in **Chapter 4**. This is particularly true of approaches that embody strict or 'fortress' conservation, which are frequently linked to eviction, restriction of use of traditional lands, and violations of human rights (Boyd and Keene, 2021) to 'protect' ecosystems of value to some other, usually non-local, entity. In addition to criticisms over human rights violations, the PA approach is misguided in several important ways (Aubertin and Weill, 2022).

First, protected areas have a highly variable record regarding their effectiveness in protecting biodiversity and habitats. The establishment of PAs frequently fails to prevent deforestation and habitat degradation (Brun *et al*., 2015; Schulze *et al*., 2017). In tropical regions, conversion from forest to cropland was shown to have increased in PAs even more than in matched unprotected zones (Geldmann *et al*., 2019). There have been some reported cases of exceptions. For example, a study focusing on Southeast Asia found that PAs were more effective at conserving forests than similar landscapes without protection (Graham *et al*., 2021). However, the predominant trends are situations of human rights violations and lack of biodiversity protection in PAs, particularly in the global South (Boyd and Keene, 2021).

Second, a long-term historical perspective indicates that, with rare exceptions, the current loss of biodiversity and forested habitat is not caused by anthropogenic conversion or degradation of pristine ecosystems, which are usually the prime intentions of conservation with PAs. Instead, loss of biodiversity and habitat is predominantly caused by the intensification, colonization and appropriation of land that was and is used by rural people, who manage it in a less intensive way (Ellis *et al*., 2021). Indeed, it has been estimated that 75 to 95 percent of the terrestrial biosphere has been altered by human societies (Kennedy *et al*., 2019; Ellis *et al*., 2000, 2021; Williams *et al*., 2020). Forests under secured land tenure in favour of indigenous peoples are better preserved and the traditional agriculture practised on those lands has been shown to reduce the pressure on other areas, contributing to the conservation of larger areas of forests (Ceddia *et al*., 2019; FAO/FILAC, 2021). This suggests that supporting rural people who are already managing their lands in a sustainable manner may be a more effective way to conserve biodiversity and reduce the carbon footprint than establishing strict conservation in presupposed pristine areas.

Third, and related to the second point, the contribution to carbon storage of agricultural lands devoted to biologically diverse production systems has been greatly underestimated. Approximately one-third of the estimated 3 trillion trees on Earth grow outside

Figure 5.1 **The hidden costs of global food and land use systems sum to *$12 trillion*, compared to a market value of the global food system of *$10 trillion***



Source: Growing Better: Ten Critical Transitions to Transform Food and Land Use, Food and Land Use Coalition, 2019

the 4 billion ha of closed canopy forests (FAO, 2020), mostly in agricultural lands, rangelands and agroforestry-type systems (Zomer *et al*., 2022). It has been estimated that 43 percent of all agricultural land globally has at least 10 percent tree cover, and during the decade between 2000 and 2010, tree cover in agricultural lands increased by 3.7 percent (Zomer *et al*., 2016). Taking these figures into account, the contribution to carbon storage of agricultural lands that include the tree component rises fourfold (Zomer *et al*., 2016; Cardinael *et al*., 2018). This shows the potential and actual contribution to carbon storage of agricultural and livestock systems that integrate trees in their design and management.

Finally, establishing PAs in 30 percent or even 50 percent (which is the target for 2040) of the Earth begs the question, what happens to the other 70 or 50 percent? Proponents of the PA paradigm tend to have a land-sparing approach to conservation, under the assumption that increasing agricultural productivity in some areas will spare land for conservation in others (Phalan, 2018). Therefore, the assumption is that intensifying agricultural production and the production of other resources for human consumption, and concentrating populations in the 50 percent of areas devoted to human activities, would allow the conservation of the remaining 50 percent. This narrative of the separation of ecosystems and people, which follows a linear instead of a systemic approach, has been shown to lead to further ecological degradation and social injustices and inequalities (Agrawal *et al*., 2021; Obura *et al*, 2021; Pascual *et al*., 2021). Furthermore, as previously discussed, the literature reports that in actual terms land-sparing rarely leads to land being allowed to remain fallow after agricultural intensification programmes. Instead, agricultural intensification frequently leads to more deforestation (Angelsen and Kaimowitz, 2001; Perfecto and Vandermeer, 2010). Coupled with the move to apply 'nature-based solutions', there is a risk that the 30X30 initiative will appropriate forests and lands, compromising land rights and threatening to dispossess IPs and LCs, including smallholders, such as peasants, small-scale farmers, gatherers, pastoralists and artisanal fishers.

The four points described above strongly suggest that rather than expanding the failed and unjust model of PAs, policy-makers need to support a complete transformation of agriculture and the global food system. We propose agroecology as a key path for that transformation. **Section 5.2** examines some of the existing evidence in this regard, while **Section 5.4** describes the type of policies that need to be promoted to address the climate crisis and dignify the livelihood of those smallholders who put food on our tables.

5.2 The multifunctional benefits of agroecology

5.2.1 What do we mean by agroecology?

Agroecology is the transdisciplinary and multi-actor approach to designing, managing and transforming agroecosystems and food systems by applying a territorial perspective, in accordance with ecological, social, cultural and political principles. Their implementation takes place considering the local contexts, and with the overall aim of achieving sovereignty, socioecological resilience, justice and integral well-being (for human communities and ecosystems) (Francis *et al.,* 2003; Altieri and Nicholls, 2006; Gliessman, 2015; Rosset and Altieri, 2016; Bezner Kerr *et al.*, 2022). Some examples of those principles are biological diversification of agricultural management and diets, soil health restoration and conservation, protection and use of native varieties and traditional knowledge, a decrease in external dependencies and an increase in self-reliance, democratization of healthy food, strengthening grassroot groups, and enhancing the different dimensions of sovereignty (in terms of food, technology and energy) (Altieri *et al*., 2011; Gliessman, 2015; Giraldo and Rosset, 2021).

Therefore, agroecology is not a technological package or a set of good practices (productive or social) for 'green', 'clean' or 'responsible' agriculture and livestock farming. Instead, it is the adaptive application of principles that go beyond the technical vision of the ecological management of production farms, commonly expressed by input substitution, from synthetic to biological. Neither is agroecology about complying with certain predefined standards to fulfil certification schemes whose implementation and payment increases the price of healthy food. Agroecology is a comprehensive approach to caring for and respecting the diversity of life systems through food production and consumption. To achieve this, a shift in perspective, organization and implementation of agriculture and food systems, as well as of social networks and political structures, is required (Giraldo and Rosset, 2021).

5.2.2 Agroecology and biodiversity

The design and management of biodiverse systems is a key attribute of agroecology, on which the implementation of several ecological, social and political principles is based (Altieri, 1999; IPES-Food, 2016). These include soil health restoration, removal of dependence on external inputs, promotion of diversified diets, and strengthening of food sovereignty. Biodiversity restoration, conservation and sustainable use are therefore essential in agroecology, both as an approach and as an aim. This is due to the role of biodiversity in enhancing and sustaining ecosystem func-

tions relevant to supporting human and non-human life systems (Tilman *et al*., 2014; IPBES, 2019).

Functions such as storing and cycling nutrients and water, biomass production, carbon fixation, habitat provision, pollination, prevention of soil erosion, climate regulation and many others, are directly related to biodiversity (Hooper *et al*., 2005; IPBES, 2016) and, accordingly, to biologically diverse (or biodiverse) agroecosystems (Altieri and Nicholls, 2003, 2006; Nicholls and Altieri, 2013; Guzman *et al.,* 2019). Such functions are the result of positive interactions among species along space and time; meaning that no single species can trigger or foster an ecosystem function by itself, but rather, a variety of species is needed (Zavaleta *et al*., 2010). This highlights the relevance and advantages of biologically complex systems (such as polycultures and agroforestry) in comparison with simplified ones (such as monocultures). The greater the biodiversity, the greater the ecosystem functions and, consequently, the services that are provided (Isbell *et al*., 2011; Gamfeldt *et al*., 2013; Tilman *et al*., 2014).

However, the importance of biodiversity in agroecological production and food systems is not only ecological. Biodiversity also embraces a deep sociocultural, socioeconomic and political relevance. This has its origins in the fact that biodiversity and human communities have interacted historically through adaptive and co-evolutionary processes (Pilgrim and Pretty, 2010). The result has been a biological and cultural amalgam – expressed in biocultural richness – that is clearly recognized in traditional livelihood systems, such as those of indigenous peoples and peasant communities (Altieri, 2004, 2021; Toledo and Barrera-Bassols, 2008). In these, the management of biologically complex and knowledge-intensive systems is a crosscutting feature that supports their longstanding socioecological resilience, although indigenous and peasant production and food systems face increasing pressures and challenges (Altieri *et al.,* 2015; Forest Peoples Programme, 2020; Altieri, 2021; FAO *et al.,* 2021).

A key socioeconomic dimension of biodiversity (wild and domesticated) relates to food and healthy diets, which is extensively documented (Chappell and LaValle, 2011; Sunderland, 2011; Vinceti *et al.,* 2013; Pellegrini and Tasciotti, 2014; Powell *et al*., 2015; FAO/Commission on Genetic Resources for Food and Agriculture, 2020; Campbell *et al.,* 2021). The role of biodiversity in food systems directly derives from the provision of varied sources of nutrients. For example, research shows that there is a clear connection between the diversity of crops cultivated and the diversity of foods consumed, especially in rural households (Pellegrini and Tasciotti, 2014), and hence the nutrient provision, particularly that of micronutrients (Lachat *et al*., 2018).

Moreover, biodiversity influences food production and provision through its ecosystem functions, particularly soil nutrition, pest regulation, water cycling and adaptation to climate change (Frison *et al*., 2011; Lin, 2011). Biodiversity and biodiverse production systems, such as agroecology, are also fundamental to foster and strengthen self-reliance, expressed in higher levels of autonomous production and use of genetic resources (mainly seeds and local animal races), food, energy and knowledge (including locally-adapted innovations and technologies) (Perfecto *et al*., 2009; Altieri *et al*., 2011; Chappell *et al*., 2013). Such a role is a key foundation for food and technological sovereignty, which encompasses the political dimension of biodiverse systems.

The functions of biodiversity described here and others documented in the literature are inherently attributes of agroecology because, as mentioned, its key feature is managing biodiverse systems. This is done by restoring, conserving and sustainably using the biodiversity above and below the ground, and inside and in the surroundings of the agroecosystem, fostering ecosystem functions that include properties such as health, resilience and sustainability (Nicholls and Altieri, 2008; Sánchez de P. *et al.,* 2012; Altieri *et al.,* 2015). From there, agroecology is a crucial strategy to cope with an array of challenges that characterize the Anthropocene, without putting more pressure on land and people. These include the production of sufficient and healthy food, the prevention of agricultural and human health outbreaks, and adaptation and mitigation to climate change.

The following sections provide a brief overview of the evidence on agroecology's contribution to addressing food production and climate change adaptation and mitigation. The purpose of this review is to shed light on the numerous and synergistic benefits of agroecology as a result of its adaptive management, which fosters biologically diverse production systems while also restoring ecosystem functions. It also aims to help visualize the premise that with agroecology it is possible to adapt to and mitigate climate change, while ensuring sufficient and healthy food without depending on technological fixes (such as climate-smart technologies) based on mechanistic approaches, and without isolating people from their surrounding ecosystems (for example, strict conservation).

5.2.3 A quick review of the evidence of agroecology for achieving socioecological resilience

1.Agroecology and food production

There are diverse interlinked factors that explain the productive capacity of agroecology. Those factors are triggered by the management of biodiversity – at genetic, species and (micro) habitat levels – within and surrounding agricultural fields and herds, which prompts functions that are expressed in effective, stable and diverse production systems (Altieri *et al*., 2015). The

biodiversity spatially and temporally nurtured through agroecological management results in the: regulation of pest populations, decreasing their levels of spread and infestation; organic matter accumulation in the soils, contributing to improved and constant nutrients and energy availability, as well as enhanced soil water infiltration and holding capacity; temperature and humidity regulation by the different layers of vegetation in the vertical and horizontal profile of polycultures, creating shade and barriers that reduce water loss by evapotranspiration; and a range of other interrelations and functions (Altieri, 1999; Altieri and Nicholls, 2003; Vandermeer *et al.*, 2010; Lin, 2011; Kremen *et al.,* 2012; Sánchez de P. *et al.,* 2012; Gliessman, 2015). These ecosystem attributes, restored and enhanced by agroecological management, prevent biotic (such as pest) and abiotic (such as nutrient, temperature and water) stresses, with positive impacts on production and yields.

The agroecological practice of replacing monocrops with crop diversification (such as intercropping, crop rotation, cover crops, prairie strips) has positive effects on productivity and other production indicators, even in conventional management. For instance, experimental research with different crop associations, including maize, in comparison with maize production as a monocrop, found a three-year-average increase in grain yields ranging from 27 to 42 percent, together with 25 to 152 percent higher water-use efficiency, 256 percent more energy production, and a decrease in carbon emission of 42 to 52 percent (Chai *et al*., 2014). Two meta-analyses, one on crop associations (Raseduzzaman and Jensen, 2017) and the other on crop rotation (Davis *et al*., 2012), conclude that these result in higher productivity and profitability, the latter benefit resulting from stabilization of yields and reduction of the need for external synthetic inputs over time (Davis *et al*., 2012). Reducing dependence on external inputs also helps to achieve resilience, to an even greater extent than any increases in productivity (Casimiro-Rodríguez *et al*., 2020).

Agroecological management shows that production efficiency depends on biological diversification using functional biodiversity,[1] which results in effective use of space, nutrients, water and energy (Gliessman, 2015), as well as the development of a buffer capacity to biotic and abiotic shocks (Lin, 2011; Altieri *et al*., 2015). This explains the rates of food production in systems with agroecological-based management, such as organic farming. For instance, Badgley *et al*. (2007), based on 293 cases, report an average of organic to non-organic yield ratio of 1.8 in developing countries for 12 basic food categories, concluding that organic systems have the capacity to produce enough food per capita to feed current and future larger populations, without exerting further pressure on agricultural lands.

Research demonstrates that when only yields and no other efficiency indicators that agroecology outperforms on (such as energy use, input-to-yield ratio, contaminant reduction) are considered, the difference between conventional and agroecological farming is small. This is the case of the study carried out by Ponisio *et al*. (2015) which, based on 115 studies, reveals a smaller yield gap between organic farming and conventional agriculture when the former includes polycultures and crop rotations, demonstrating the relevance of biodiversity for increasing yields. This is consistent with experimental research applying a crop rotation with six crops in organic production plots over six years, where no difference in yield was found in comparison with conventional management, and with the organic system showing greater yield stability over time. The greater yield stability was attributed to the increase of soil biota and health and decreasing groundwater pollution (from nitrates) (Schrama *et al*., 2018). The sustainability of agroecology was further demonstrated in a 30-year comparison between associated maize and soybean production and cultivation of each crop separately with conventional agriculture, which showed comparable yields. In those trials, the agroecologically-managed system generated threefold higher profits, as well as soil health improvement (Rodale Institute, 2011).

Furthermore, part of the socioecological resilience provided by agroecology results in economic income to livelihoods in vulnerable ecosystems. Such an impact is reported by Son *et al*. (2020), who found that intercropping increased household income significantly in two communities of Viet Nam's Northern Mountainous Region susceptible to flash flooding and landslides, based on a survey of 384 households. For example, the authors report that banana production intercropped with medicinal plants doubled household income per hectare per year, in comparison with monocrops such as maize. Significant income increases were also observed in maize intercropping with leguminous species, with the secondary crop harvest covering the corresponding initial investment costs.

2. Agroecology and adaptation and mitigation to climate change

The IPCC (2022a, p. 23) states that effective adaptation options such as "agroecological principles and practices, ecosystem-based management in fisheries and aquaculture, and other approaches that work with natural processes support food security, nutrition, health and well-being, livelihoods and biodiversity, sustainability and ecosystem services (*high confidence*). These services include pest control, pollination, buffering of temperature extremes, and carbon sequestration and storage (*high confidence*)." Once again, the biodiversity managed in agroecological systems and its functions that are consequently restored, are the

1 Functional biodiversity refers to biodiversity that exerts regulating roles in the ecosystem's functioning and, therefore, influences directly or indirectly, human well-being (Moonen and Bàrberi, 2008).

bases for such adaptation capacity, leading to improved socio-ecological resilience to weather and climate variability (Altieri *et al*., 2015). The biological complexity thus fostered serves as a climate buffer strategy, due to its ability to regulate water and temperature fluctuations through the density and synergies in biodiversity above and below ground in agroecologically-managed areas (Lin, 2011).

The literature reports the capacity of agroecological systems to endure with greater resilience, and recover more quickly, from extreme climate events. Holt-Giménez (2002) reported that better soil health and deeper topsoil in agroecological plots in hills in Guatemala, Honduras and Nicaragua, contributed to reduced erosion and economic losses during Hurricane Mitch in 1998. Philpott *et al*. (2008) reported that coffee plantations produced under agroforestry systems showed less physical damage (fewer landslides) and loss compared with conventional monocrop coffee plantations in Chiapas, Mexico during Hurricane Stan in 2005. Rosset *et al*. (2011) reported agroecological farms with 50 percent damage, compared with 90 percent and 100 percent loss in conventional production, caused by Hurricane Ike in 2008. More recently, Vázquez-Moreno (2021) reported close to 63 percent harvest recovery in agroecological plots that included trees, compared with only about three percent recovery in conventional monocrops plots in Cuba after Hurricane Irma in 2017.

Healthy soil properties result from agroecological management, such as increased organic matter, improved soil structure – allowing better water infiltration and retention – and the proliferation of beneficial soil microbiota (such as arbuscular mycorrhiza fungi). In combination with related agroecological management, such soil properties have been shown to increase climate resilience. For example, mulching is reported to reduce the effect of wind speed by 99 percent and to decrease evapotranspiration, while cover crops have the capacity to improve soil properties through increased water infiltration and reduced runoff by between twofold and sixfold (Altieri *et al*., 2015). These are two essential characteristics for adapting to heavy rain patterns. The social dimension of climate resilience achieved through healthy soils is manifested in production impacts, among others. Empirical research indicates that the loss of soil organic matter is directly related to reductions in yield. In contrast, the Rodale Institute (2011) reports increases in yields (31 percent) of organic maize in comparison with conventional production in years of drought.

Agroecology also helps with climate change mitigation. A ten-year model for agroecological farming and food in Europe calculated that replacing unsustainable agriculture would make it possible to feed the entire European population, while reducing agricultural GHG emissions by 40 percent (Poux and Aubert, 2018). The model also shows that agroecological practices such as the maintenance of permanent legume grassland have a capacity for soil carbon storage of 0.7 tonnes of carbon per hectare per year and 150–250 kg of atmospheric nitrogen (N) per hectare per year. These findings challenge the notion of land-sparing and agricultural intensification as 'sustainable' approaches to climate change and resilience; indeed, they point to the fact that the solution lies in promoting agroecological management to restore multiple ecosystem functions that sustain climate adaptation, socioecological resilience and, as a co-benefit, climate mitigation.

Another example of effective agroecological management is tree-crop integration, which provides 50–320 kg of N fixation per hectare per year (Sinclair *et al*., 2019). The integration of trees into crop and animal production results in a significant increase in carbon sequestration (Snapp *et al*., 2021). A study in Africa found that agroforestry systems can store more than twice as much carbon as parklands (with a 50-year rotation) and more than four times as much as rotational woodlots (with a rotation of 5 years) (Mbow *et al*., 2014). These figures do not take into account the reduction in GHG emissions from synthetic inputs, which agroecology does not use; thus, the mitigation potential of agroforestry systems is even greater.

Agroecology's potential to adapt to and mitigate climate change is the result of the properties (such as productivity, efficiency, resilience and sustainability) that emerge in agroecosystems and adjacent landscapes as a result of agroecological management, which combines multiple practices consistent with agroecological principles. This was confirmed by Debray *et al*., (2018), who conducted a literature review and identified a number of agroecological practices that have a direct and indirect positive impact on climate change adaptation, while also increasing carbon sequestration. These practices include the use of biodiversity and biological processes to prevent soil degradation, improve soils, enhance water management, prevent and regulate pest populations and implement agricultural management that is climate-adaptive. The authors conclude that it is the combination and synergies of practices – as opposed to isolated practices – that contribute to climate adaptation, while also providing a mitigation co-benefit.

5.3 Agroecology consistent with rights-based approaches

The intertwined and interdependent dynamics of ecological and social processes explain the increased potential for realizing human rights through the agroecological management of production plots, food systems, landscapes and territories. This is

Box 11 Examples of human rights and the corresponding international human rights instruments, whose implementation is supported by agroecological management and action

By being based on biologically diverse systems and thus restoring biodiversity, agroecology, its components (such as land and water), and ecosystem functions (including climate regulation), helps to support livelihoods that rely on it directly. Furthermore, because it is based on participatory and inclusive processes, agroecology strengthens local organizations and agencies, leveraging processes that contribute to socioecological resilience. As a result, agroecology fosters the realization of numerous rights. Some of these are listed below, along with examples of international instruments that address the corresponding human right.

a. **Social, economic, cultural, political and environmental rights** are contained in the Universal Declaration of Human Rights; the Declaration on the Right to Development; the UN Declaration on the Rights of Indigenous Peoples; the International Convention on the Elimination of all Forms of Racial Discrimination; the International Covenant on Civil and Political Rights; the International Covenant on Economic, Social and Cultural Rights; the Convention on the Elimination of All Forms of Discrimination Against Women; the International Labour Organization Indigenous and Tribal Peoples Convention; the Convention on the Rights of the Child; the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas; and the Human Rights Council Resolution 48/13 on the "Human right to a clean, healthy and sustainable environment".

b. **Civil and political rights** such as sovereignty over natural resources are set out in Art.1 of the the Declaration on the Right to Development; Art.2 of the the International Covenant on Civil and Political Rights; and Art.15 of the International Labour Organization Indigenous and Tribal Peoples Convention.

c. **Rights to the conservation and protection of the productive capacity of lands, territories and resources** are enshrined in Art.29 of the UN Declaration on the Rights of Indigenous Peoples; Art.17, Art.19 and Art.24 of the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas; and Art.15 of the International Labour Organization Indigenous and Tribal Peoples Convention.

d. **The right to traditional knowledge and cultural expressions** is described in Art.31 of the UN Declaration on the Rights of Indigenous Peoples; and Art.19 of the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas.

e. **The right to have access to natural resources and to use them in a sustainable manner** is mentioned in Art.5 of the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas.

f. **The right to genetic resources and seeds** is a provision of Art.31 of the UN Declaration on the Rights of Indigenous Peoples; Art.19 of the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas; and Art.9 of the International Treaty on Plant Genetic Resources for Food and Agriculture.

g. **The right to food** is contained in Art.25 of the Universal Declaration on Human Rights; Art.8 of the Declaration on the Right to Development; Art.15 of the UN Declaration on the Rights of Indigenous Peoples; and Art.11 of the International Covenant on Economic, Social and Cultural Rights.

h. **The right to health** is indicated in Art.8 of the Declaration on the Right to Development; Art.5 of the International Covenant on Economic, Social and Cultural Rights; Art.27 of the International Labour Organization Indigenous and Tribal Peoples Convention; Art.25 of the Convention on the Rights of the Child; and UNEP/EA.4/17 p.1e.

i. **The right to a safe environment** is contained in the Human Rights Council Resolution 48/13 on the "Human right to a clean, healthy and sustainable environment".

j. **The right to just and favourable, safe and healthy working conditions** is provided for by Art.23 of the Universal Declaration of Human Rights; Art.14 of the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas; Art.7 of the International Covenant on Economic, Social and Cultural Rights; Art.11 of the Convention on the Elimination of All Forms of Discrimination Against Women; and Art.20 of the International Labour Organization Indigenous and Tribal Peoples Convention.

k. **The right to an adequate standard of living for health and well-being** is described in Art.25 of the Universal Declaration of Human Rights; Art.21 and Art.24 of the UN Declaration on the Rights of Indigenous Peoples; Art.4, Art.16 and Art.24 of the UN Declaration on the Rights of Peasants and Other People Working in Rural Areas; Art.7 and Art.11 of the International Covenant on Economic, Social and Cultural Rights; Art.14 of the Convention on the Elimination of All Forms of Discrimination Against Women; and Art.27 of the Convention on the Rights of the Child.

critical given that the people who emit the least GHGs are the ones who suffer the most from climate change. The process of realizing human rights through agroecological management begins with the improvement of biophysical properties (such as soil health) in biodiverse production systems and of the socioeconomic conditions associated with them (such as food production, income generation, and knowledge sharing) (Altieri *et al*., 2011; Anderson *et al*., 2019; Bezner Kerr *et al*., 2022). These result in the creation of conditions to realize a myriad of social, economic, cultural, political and environmental rights in accordance with international law (see a. in **Box 11**).

For example, the ecosystem functions restored and enhanced by agroecological management sustain self-regulated ecological dynamics and resilient socioeconomic processes that are paramount for the realization of civil and political rights. These may include, for example, sovereignty over natural resources (see b. in **Box 11**), and social, economic and cultural rights, such as the right to the conservation and protection of the productive capacity of lands, territories and resources (see c. in **Box 11**). The knowledge systems involved in the inherent management of biodiversity relate to the right to traditional knowledge and cultural expressions (see d. in **Box 11**).

The literature increasingly reports on the contributions of agroecology to equity, justice inclusion, and to dignifying conditions through improved social well-being, sustainable livelihoods, food sovereignty and health (D'Annolfo *et al*., 2017; Rosset and Altieri, 2017; Anderson *et al.*, 2019; Bezner Kerr *et al.,* 2019, 2022; Frison and Clément, 2020; Giraldo and Rosset, 2021; Petersen *et al.,* n.d.). Such contributions are particularly important for those who are in situations of disadvantage, discrimination or vulnerability. This is the case of rural women who, thanks to agroecological management, may be able to establish self-reliance and production systems, including the use of native species and varieties that support them in carrying out their productive and care roles (Zuluaga Sánchez, 2011; Catacora-Vargas, 2021; Catacora-Vargas *et al*., 2022). As a result, they can exercise the right to have access to natural resources, and to use them in a sustainable manner (see e. in **Box 11**); and the right to genetic resources and seeds (see f. in **Box 11**), in addition to a reduction in socioeconomic and other forms of discrimination.

Diversified and healthy diets resulting from the increase in agrobiodiversity cultivated in agroecological systems (Pellegrini and Tasciotti, 2014) and the reduction in synthetic inputs, together with improved productivity (Altieri *et al*., 2021), are crucial for the realization of the right to food (see g. in **Box 11**); the right to health (see h. in **Box 11**); the right to a safe, healthy and sustainable environment (see i. in **Box 11**); and the right to just and favourable, safe and healthy working conditions (see j. in **Box 11**).

All the above are examples of the broad contribution of agroecology to socioecological resilience, including the right to an adequate standard of living for health and well-being, which are particularly relevant in the context of climate change.

5.4 The relevance of agroecology in climate policy-making

Agroecology's management and practices provide farmers with a means to spread risks during adverse and extreme weather events, adapt to climate change and build socioecological resilience, making agroecology an essential component of the response to climate change.

The preceding analysis demonstrates that, for the agriculture sector, agroecology is best placed to face the challenges of climate change, both in terms of climate adaptation and mitigation. Its management and practices provide farmers with a means to spread risks during adverse and extreme weather events, adapt to climate change and build socioecological resilience, making agroecology an essential component of the response to climate change. At the same time, agroecological practices reduce emissions and increase carbon sequestration. A key point is that due to its multifunctional benefits – such as sustained productivity and yields, as well as increased nutrition through diverse diets and secure farm livelihoods – agroecology helps to reduce the land gap by offering a holistic and effective strategy for managing agricultural land in a way that best meets multiple demands.

Yet in spite of its benefits, agroecology has largely been implemented without much policy or financial support; the scaling

up of agroecology will therefore benefit from an enabling policy environment (HLPE, 2019). In the first place, this should include removing incentives that are propping up monoculture-focused, emissions-intensive industrial agriculture, while promoting agroecology as a climate-resilient agricultural and food system at all levels – from local to global – with an important role for national and subnational governments to coordinate efforts. The inclusion of agroecology in NDCs will be a critical lever to provide overarching policy support for both climate adaptation and mitigation in agriculture (Leippert *et al*., 2020; GAFF, 2022).

Indigenous peoples, peasants and other smallholders, as well as women within these groups – who make up the majority of the world's small-scale producers – play a key role in initiatives for promoting agroecology-based agriculture and food systems. To facilitate their full and active participation, there is a need to strengthen their agency, protect their rights (including tenure rights), and devise tools and approaches to develop and share capacities in accordance with their local context (such as farmer-to-farmer networks) (Mier y Terán Giménez Cacho *et al*., 2018; HLPE, 2019).

The following section briefly outlines the elements that are necessary to create climate resilience in agriculture through agroecology (drawing from Stabinsky and Lim, 2012). These include dismantling perverse incentives, increasing investments in agroecology, managing risks, and protecting the rights of indigenous peoples, smallholders, women and other right-holders severely affected by climate change.

5.4.1 Dismantling perverse incentives and subsidies that promote unsustainable and high-emissions agriculture

Current agricultural policies continue to prop up and lock in industrial agricultural practices that are responsible for the bulk of agricultural GHG emissions (IPES-Food, 2016). Incentives that promote the use of synthetic pesticides and fertilizers, and fossil fuels, or that encourage land degradation, entrench this unsustainable production system (FAO, UNDP and UNEP, 2021).

Agricultural incentives and subsidies therefore need to be redirected away from climate-destructive monocultures and climate-harmful inputs (HLPE, 2019; FAO, UNDP and UNEP, 2021) towards climate-resilient management, such as agroecology (Leippert *et al*., 2020; GAFF, 2022). It has been estimated, for example, that a reduction in the use of synthetic nitrogen fertilizers could already create a net GHG benefit of 0.69 $GtCO_2eq$ per year, while just one agroecological practice, agroforestry, could sequester 1.04 $GtCO_2eq$ per year in above-ground carbon (Dooley *et al*., 2018).

The intellectual property systems that act as drivers of corporate consolidation and corporate dominance of agriculture need to be addressed.

The redirection of subsidies requires action in a just and equitable way, targeting incentives that are provided to multinational corporations and industrial agriculture, while enabling special and differential treatment for developing countries. This should also involve the mitigation of negative impact, especially for the most vulnerable groups, which include smallholders and women small-scale producers (FAO, UNDP and UNEP, 2021). It should also entail redirecting financial savings to support smallholders implementing the sustainable use of (agro)biodiversity and to fund adaptation efforts, as well as providing new and additional financing to enable developed countries to meet their obligations under the UNFCCC (South Centre, 2010) and other relevant multilateral agreements, such as the CBD.

5.4.2 Increasing investment in agroecology

National, regional and international agriculture and climate policy frameworks need to be focused on agricultural adaptation, giving agroecology a central role (Weigelt *et al*., 2019). This is critical, as agriculture is increasingly vulnerable to climate change impacts, with millions of people exposed to food crises (IPCC, 2022a). In particular, increased emphasis on the conservation of agricultural biodiversity through sustainable use, building healthy soils, and developing and sharing water harvesting and other water management techniques is essential (IPCC, 2019a; Sinclair *et al*., 2019; Weigelt *et al*., 2019), particularly in National Adaptation Plans.

Particular attention needs to be paid to the agricultural and food system transformation rooted in agroecology. Some of the leverage points to foster such transformation are capacity building and knowledge generation on agroecological management through participatory processes; strengthening local organizations through horizontal and collective processes; respecting biocultural processes, such as peasant seed systems; securing access to land, water and seeds; and promoting and protecting

equity, justice and other human rights (IPES-Food, 2018; Mier y Terán Giménez Cacho *et al.*, 2018; Anderson *et al.*, 2019; Giraldo and Rosset, 2021).

At the national level, there is a need to identify policy and financial barriers and gaps to an agroecology-based transformation, in order to promote policy coherence (Sinclair *et al*., 2019; Leippert *et al*., 2020). Transitions leading to transformations need to be designed with local actors (such as peasants, smallholder farmers and rural women), in order to be effective and sustainable (IPES-Food, 2018). The initial costs and risks associated with transformation efforts to implement agroecology require support, for instance, through public funding (Herren *et al*., 2011).

Given the multifunctional benefits of agroecology, scaling it up calls for support that is consistent with its ecological, social, economic and political principles. Devoting public budgets, for example from the agriculture sector, could support this endeavour, though this is currently not the case. For instance, in the United States of America, support for agroecology accounts for only a small portion of agricultural public funds (De Longe *et al*., 2016). In sub-Saharan Africa, agricultural investment overwhelmingly reinforces the damaging model of industrial agriculture, sidelining agroecology (Biovision and IPES-Food, 2020).

5.4.3 Implementing an agroecology research and knowledge-sharing agenda for climate-resilient agriculture

Current agricultural research is dominated by the private sector and perpetuates industrial, input-dependent and high-emissions agriculture. In this context, the intellectual property systems that act as drivers of corporate consolidation and corporate dominance of agriculture need to be addressed (Fakhri, 2021).

Agroecology draws on transdisciplinary approaches and integrates these with traditional and local knowledge, cultures and innovations, whose intergenerational transmission and re-creation is fundamental for building resilient food systems, particularly those of indigenous peoples (FAO *et al*., 2021). To overcome the combined challenges of, *inter alia*, climate, biodiversity and food crises, research from the scientific community needs to be complemented by other knowledge systems, such as traditional and local knowledge systems (IPCC, 2019a).

All these observations highlight the need to refocus research and development efforts towards agroecology research and capacity building in the context of climate change, while at the same time strengthening existing traditional knowledge and innovation (Leippert *et al*., 2020). Doing so will require an agenda that is co-constructed, implemented by and monitored with local actors, fostering their organizational strengthening and allowing them to play a central role. At the same time, this implies increased networking, knowledge sharing, and new collaborative research frameworks (HLPE, 2019; Sinclair *et al*., 2019; Weigelt *et al*., 2019; FAO *et al*., 2021). It also involves reorienting the ways in which knowledge is created, documented and shared, moving from top-down, diffusionist and 'expert'-led processes, to research agendas that are rooted in local needs, implemented collaboratively *in situ*, participatory-action-research-oriented, and which apply pedagogic processes that are consistent with the social and political proposals of agroecology (such as farmer-to-farmer knowledge sharing).

5.4.4 Protecting the rights of indigenous peoples and local communities and other right-holders

Agroecology for climate resilient food systems cannot be implemented without a focus on rights, in particular those of indigenous peoples, peasants and other smallholders and people working in rural areas, with particular attention paid to women and youth (HLPE, 2019). This includes protecting rights such as the right to freely use, exchange and sell farm-saved seed (Fakhri, 2021), protecting traditional knowledge systems, promoting secure land tenure (IPCC, 2019a), and recognizing territorial customary self-governance.

Such an approach requires enacting legislation and measures to promote, protect and realize human rights; strong policy commitment to the obligations established in this regard in international law (such as UNDROP and UNDRIP, see **Box 10**); and addressing the power asymmetries and inequities that impede the realization of these rights (Ishii-Eiteman *et al*., 2020; Fakhri, 2021). Corporate and elite control over land, seeds, water and other productive and ecosystem components needs to be replaced with other cooperative and democratic models of ownership and use (Ishii-Eiteman *et al*., 2020).

In relation to indigenous peoples, **Chapter 4** elaborates on ways forward to enable them to exercise self-determination in the sustainable use of their lands and territories, a crucial aspect in order to foster sustainability in agriculture, food systems and climate resilience.

5.4.5 Managing climate risks and reducing vulnerability

It is critical to recognize that agroecology will not be able to solve all structural challenges associated with agriculture, food systems and climate change on its own. In relation to climate change, the financing and transfer of appropriate technologies (such as for climate information, research, infrastructure, communication) by developed countries are needed, in accordance

with the principle of common but differentiated responsibilities and respective capabilities.

A focus on building adaptive capacity and resilience would reduce vulnerability and improve social safety nets to enable smallholders to prevent and cope with climate-related disasters, particularly in rural areas. Special attention and specific support need to be given to women in the different production and care roles that they assume, and to secure their full and effective participation in decision-making. The governance practices of indigenous peoples, including safety nets and solidarity mechanisms based on social organization and customary governance systems, can be particularly important (FAO *et al*., 2021).

5.5 Conclusions

This chapter has highlighted the potential of agroecology for reducing the 'land gap' between governments' reliance on land for mitigation purposes and the role that land can realistically play, in a manner that does not cause further climate change or adverse impacts on biodiversity, while ensuring that farmers are able to adapt to an increasingly heating planet.

It is the multifunctional benefits – based on the establishment and management of biodiverse production and food systems and the creation of socioecological resilience – that confer on agroecology its transformative role. This is enhanced by the human rights-based approach that agroecology represents, which can be scaled up even further by securing access to land and water, respect of traditional livelihoods, and the protection of systems of traditional knowledge, innovations and practices, in favour of indigenous peoples, smallholders and women.

Policy action focused on agriculture's contribution to climate mitigation or land-based removals alone is not enough. Instead, this chapter has provided arguments for a systemic approach that both dismantles the structures that keep emissions-intensive industrial agriculture in place, and increases investments in agroecology to foster climate-resilient agriculture and food systems. Recommendations for building supportive international policy frameworks for agroecology are presented in **Chapter 6**.

CHAPTER 6

Conclusions and recommendations

Current climate pledges assume that massive areas of land across the globe can be managed for generating large amounts of carbon removal in the decades to come. These assumptions warrant closer analysis, given that the increased emphasis on land for climate mitigation holds both promises and risks for the climate, for biodiversity, and for people. This report brings into focus these promises and risks, recognizing that while there are possible benefits with current mitigation strategies, on balance, there are significant risks that need to be addressed.

Consistent with science-based definitions of carbon neutrality and the need to focus individual, national and international efforts to achieve global net zero by 2050 or earlier, companies and governments need to accelerate investments proportional to their footprint into actions that: (i) prioritize the decarbonization of the global economy as a whole; (ii) enhance the protection, restoration and sustainable use of the world's lands and forests – supporting the rights of indigenous peoples and local communities who are best placed to achieve such ends; and (iii) separate targets between emission reductions and removals to maintain the integrity of net zero pledges.

In terms of climate, the major promise of improved land management is to end emissions from land-use due to deforestation and degradation. Land-based approaches to carbon removal, on the other hand, can only yield limited climate benefits in relation to meeting the Paris Agreement temperature targets. Hence, putting a stop to the loss and degradation of primary forests and other ecosystems is far more important to climate mitigation strategies than attempts to increase carbon removals.

Beyond climate, efforts to protect existing forests and restore degraded lands, forests and other ecosystems are critical to delivering multiple SDGs. The role of land and territories in supporting livelihoods through sustainable food systems and land rights of indigenous peoples and local communities has been a primary focus of this report. Also needed are extensive changes to carbon accounting practices related to land and forests, in order to reveal the true gains and losses of carbon and hence show the benefits of prioritizing the protection of existing ecosystems and the livelihoods dependent on their health.

Improved governance and management of land and territories are sorely needed to achieve multiple interrelated objectives. Presently, the processes that drive deforestation and degradation of land and forests also constitute major threats to the livelihoods and human rights, including land rights, of IPs and LCs around the world. Paradoxically, many of the current attempts at conservation and sustainable use of land and forests also infringe on these very same peoples and communities and their rights. This is both morally unjustifiable and counterproductive, as IPs and LCs have been proven to be the best stewards of land and forests, as well as efficient and sustainable producers on the land they manage, and therefore critical actors in addressing the climate crisis.

Similarly, many of the current approaches to responding to the intertwined crises of food, climate and biodiversity, such as agricultural intensification and extensification, tend to aggravate existing problems or produce new ones. For instance, agricultural extensification, to respond to the food crisis and growing demand for bioenergy, results in increased deforestation. Agricultural intensification that seeks to spare land for conservation relies on the use of climate-damaging industrial fertilizer and results in soil degradation and pollution. Both these approaches tend to trample on the land rights of IPs and LCs.

The reasons for the proliferation of these paradoxical and counterproductive strategies are many, and include colonial legacies within development organizations, bureaucracies of governments and educational institutions, and vested interests of industries. These need to be reoriented to pave the way for more sustainable and rights-based approaches. For this, we propose agroecological pathways — based on interrelated ecological, social, economic and political principles — to foster restoration and conservation of ecosystem functions and services which strengthen adaption and mitigation to climate change. The integral approach of agroecology also results in human well-being and sustainability of local livelihoods, strengthened biocultural richness and local knowledge, positive effects on productivity of healthy and diversified foods and many other multiple functions and benefits.

Protecting and restoring forests and other ecosystems

Forest stewardship for climate change mitigation requires ensuring the integrity of ecosystems, maintenance of the terrestrial carbon sink through ongoing growth of forests, and additional removals of CO_2 from the atmosphere through ecological restoration. To achieve this, we recommend:

- Public participation and involvement in planning and governance; ensuring land rights of IPs and LCs; and upholding human rights in the decision-making process for forest management, restoration and protection needs.
- Protect all remaining primary forests from deforestation and forest degradation, including fragmentation from infrastructure corridors and damage from logging, while supporting the rights, governance and livelihoods of Indigenous custodians of these forests.
- Incentivize the restoration of degraded forests and other ecosystems relevant to climate adaptation and mitigation, focussing on establishing ecological connectivity between remaining forest areas.

- Avoid commercial logging of secondary and regrowth forests, but in the limited cases where it may be needed, encourage reduced harvesting that decreases the intensity and area of forest harvest.
- Include the full environmental cost of logging in the price of wood. Encourage an overall reduction in demand for new wood, use of recycled wood, minimal use of short-lived products, and a shift in production and demand towards high-value long-lived products. Source wood from well-managed plantations and agroforestry established on previously cleared land, enforcing safeguards to prevent environmental damage and protect the rights of IPs and LCs.
- Apply effective, community-based planning and governance to forest management decision-making for protection, restoration, resource use, and disaster risk management that is underpinned by the goal of improving ecosystem integrity to promote storage of long-lived, stable carbon stocks.
- Utilize comprehensive carbon accounting of all stocks and flows assessed against a reference condition of ecosystem integrity, following the UN SEEA_EA guidelines, to fill gaps in reporting and reveal the carbon retention and other ecosystem functions of improved forest protection and restoration.
- Develop a global monitoring system to map the remaining primary forests and differentiate categories of forest ecosystem condition, including naturally regenerated but degraded forests and plantations, to better identify the potential for forest restoration.

Respecting and promoting land rights of Indigenous Peoples and local communities

The challenge for policy-makers and practitioners lies in identifying and realizing the paradigm shift that is needed to more consistently, effectively, fairly and equitably engage IPs and LCs in climate action. Such solutions involve multiple strategies and tactics, but also changes to entrenched worldviews. Some specific recommendations include the following:

- Global initiatives that count on country and local rollout that recognize the historical and contemporary drivers of discrimination against IPs and LCs, and actively challenge culturally embedded norms that reinforce the status quo.
- Scholars and Indigenous knowledge-holders engaged in a careful analysis of politics, power and history, to gain understanding of the motivations behind actions and behaviors of those who generate obstacles to IPs and LCs rights. Such analysis can be used to identify priority problems, build data and evidence, and design strategic actions for change, working together with IPs and LCs.
- Fostering changes in education, reorienting curricula and pedagogy for resource professionals from top-down and technocratic approaches to more plural perspectives that include understanding of and respect for local and Indigenous knowledge, participatory research and adaptive learning.
- Reorienting funding towards fostering landscape socio-ecological resilience and securing IPs and LCs rights, particularly to land and traditional livelihoods. Longer-term funding is needed to support ongoing engagement.
- Collaboration fostered by policy-makers across ministries and departments to provide more holistic approaches to problem-solving, and to build capacities for cross-cultural exchanges. Civil society organizations need to align their own activities with these strategies and break ties with those who do not follow them.
- Greater and more sustained forms of financing are required to support these efforts.

Building supportive international policy frameworks for agroecology

A range of international institutions can make positive contributions by supporting and enabling the adoption of agroecology for climate-resilient agriculture and food systems. These institutions can support the efforts undertaken at national and regional levels described in **Chapter 5**, and coordinate efforts to mobilize necessary resources at the international level. Key policy recommendations include:

- Promoting, facilitating and prioritizing the inclusion of agroecology in NDCs. An initiative in support of agroecology for adaptation and resilience in agriculture under the UNFCCC regime, including the Koronivia Joint Work on Agriculture, could help to foster this inclusion.
- Mobilizing public resources for sustainable, predictable and significant public funding for agroecology for climate resilience, rather than speculative and volatile market-derived funding.
- Prioritizing adaptation as the overriding objective for agriculture and development policy. Agricultural adaptation needs to be decoupled from mitigation to prevent diversion of resources from adaptation towards the measurement, reporting and verification of carbon stocks.

- Leveraging research and research partnerships and the funding thereof to focus on agroecology, *in situ* agricultural biodiversity conservation, and strengthening smallholder farmers' livelihoods, particularly in developing countries, with whom the research agenda requires co-creation.
- Ensuring the conservation and sustainable use of agricultural biodiversity and associated traditional knowledge systems to promote climate resilience, including through work on agricultural biodiversity carried out by relevant national and international organizations.
- Prioritizing rights-based approaches in international policy fora to enhance protection of the rights of Indigenous Peoples and local communities and smallholders, in accordance with the United Nations Declaration on the Rights of Indigenous Peoples, the United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas, and other instruments on human rights.

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