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Balancing climate goals and biodiversity protection: legal implications of the 30x30 target for land-based carbon removal

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This article examines the legal conflicts between land-based carbon dioxide removal (CDR) strategies and the establishment of protected areas through the lens of international environmental law. We argue that the 2022 Global Biodiversity Framework's "30x30" target—which aims to protect 30% of global terrestrial and marine areas by 2030—constitutes a "subsequent agreement" under international law and thus clarifies the legal scope and content of the obligation to establish protected areas under Article 8 of the Convention on Biological Diversity (CBD). Since states have pledged 120 million square kilometers for land-based CDR, these commitments potentially conflict with the "30x30" target, especially if global cropland for food production is to be maintained. Consequently, some land-based CDR strategies may directly or indirectly impede the achievement of the "30x30" target, which could be deemed inconsistent with international law. However, as all international environmental law operates in a continuum, this does not imply that land-based CDR should be categorically ruled out. Rather, states should focus on emission reductions and implementing CDR options that provide the most co-benefits to climate mitigation and biodiversity protection efforts.

KEYWORDS

carbon dioxide removal (CDR), land-use, biodiversity protection, international law, protected area, Convention on Biological Diversity (CBD), Paris Agreement

Introduction

The adoption of the Kunming-Montreal Global Biodiversity Framework (GBF) in December 2022 marked a crucial milestone in the global effort to combat and reverse biodiversity loss. At the heart of this framework lies the ambitious "30x30" target, aiming to safeguard 30% of the world's terrestrial and marine areas by 2030 (CBD COP, 2022). Historically, parties to the Convention on Biological Diversity (CBD) have been unable to stop the rapid degradation of ecosystems around the world, as evidenced by the failure of the two previous biodiversity frameworks (CBD COP, 2002, 2010a; CBD Secretariat, 2020; Xu et al., 2021). Nevertheless, *in-situ* conservation measures, such as the establishment and maintenance of protected areas under Article 8 CBD, have remained high on the agenda of many policymakers concerned with biodiversity loss. The pursuit of the "30x30" target, however, gives rise to potential conflicts with land-based carbon dioxide removal (CDR) strategies employed by countries to achieve net-zero emissions.

In recent years, CDR approaches—which are also known as negative emission technologies (NETs)—have garnered much attention, as many countries plan to use them to achieve their declared net-zero goals (Schenuit et al., 2021; Hale et al., 2022; Jacobs et al., 2023; Smith et al., 2023). Yet, the literature has disputed their effectiveness in mitigating climate change, since the mitigation effects of CDR policies such as afforestation are sometimes overestimated (Markusson et al., 2018; McLaren, 2020; Grant et al., 2021a; Stubenrauch et al., 2022; Carton et al., 2023; McLaren et al., 2023). Currently, 99.9% of all carbon removals come from conventional land-based approaches (Powis et al., 2023; Smith et al., 2023). Some land-based CDR policies have the potential to provide multiple benefits, including mitigating climate change, restoring degraded ecosystems, and enhancing biodiversity (Daggash and Mac Dowell, 2019; Hilaire et al., 2019; Moomaw et al., 2019; Realmonte et al., 2019; Yang et al., 2019; Ekardt et al., 2020; Janssens et al., 2022; Stubenrauch et al., 2022). In practice, however, many land-based CDR approaches negatively impact ecosystems through land-use change and monoculture agriculture (Powell and Lenton, 2013; Stoy et al., 2018; Dooley et al., 2020; Tudge et al., 2021; Hanssen et al., 2022; Stubenrauch et al., 2022). Nevertheless, governments have pledged to dedicate 120 million square kilometers (Mkm^2) of land for land-based CDR, which is equivalent to the current extent of global cropland (Dooley et al., 2022). Given the fact that safe and just planetary boundaries on land use have already been exceeded due to the rapid expansion of land used for food production (Steffen et al., 2015, 2018; Rockström et al., 2023), it appears near certain that there are land availability constraints on the competing land-use approaches.

By applying an international legal perspective, this article aims to enhance the scholarly debate on conflicting land-use commitments and legal consequences for both biodiversity and climate law and governance. While there has been considerable research on the natural science and economic phenomenon of land use, land-use change, and land degradation resulting from competing commitments by countries to use land (Powell and Lenton, 2013; Dooley and Kartha, 2018; Dooley et al., 2018, 2020; Stoy et al., 2018; Creutzig et al., 2021), there has been little research on the legal rules relevant to this conflict (for exceptions, see Hennig, 2017; Stubenrauch et al., 2022). Thus, the article fills this research gap by addressing two key questions: First, how are the overlapping and competing commitments to land-based CDR and the establishment of protected areas viewed in light of the relevant rules of international environmental law? Second, can these rules help to reconcile the competing land-use approaches by balancing the related rights and obligations of the states involved?

Methodology and materials

Legal interpretation as methodology

Methodologically, this article employs a two-step approach to examine the conflicts arising from land-based CDR policies and the establishment of protected areas for biodiversity conservation. In the first step, we conduct a review of the relevant literature on land-based CDR strategies and protected areas policies. This review critically assesses the proven effectiveness, or lack thereof, of the land-use approaches in question and highlights the trade-offs associated with each policy. In addition, the scientific literature on current and projected land-use policies will be analyzed to determine whether there are in fact competing land-use claims or whether there is a projected physical shortage of land.

In the second step, we undertake a legal interpretation of the pertinent international environmental law. The analysis centers on the interpretation of international legal treaties and frameworks such as the UNFCCC, the PA, the CBD, and the GBF. It does so by relying on the traditional principles of interpretation as set out in Articles 31 and 32 VCLT (Dörr and Schmalenbach, 2012; Dörr, 2018), which include grammatical, systematic, teleological, and historical interpretation. This legal interpretation involves consideration of the relevant treaty provisions, their interrelationship, their genesis, their underlying purposes, as well as supplementary material (Ekardt et al., 2018b, 2022; Ekardt, 2020; Günther and Ekardt, 2022, 2023), in particular with respect to the issue of adverse environmental effects caused by intensive land use and land-use change. In common law countries, case law is typically used as an additional means of interpretation. However, we will not use this method of interpretation here, as there are no relevant cases or judgments on the specific issues at hand. By applying this methodology, the article aims to provide comprehensive insights into the conflicts between land-based CDR strategies and protected area policies, thereby linking the natural-scientific and legal dimensions of the issue.

Dual crises: climate change and biodiversity loss

Climate change, the Paris Agreement, and mitigation measures

In its recent AR6 Synthesis Report, the IPCC has stated that, given the slow progress in reducing emissions, "there is a rapidly closing window of opportunity to secure a livable and sustainable future for all" (IPCC, 2023, p. 53). It is highly likely that the 1.5°C limit set out in Article 2 para. 1 lit. a PA will be exceeded in the coming decades. Moreover, under a very high emissions scenario (SSP5-8.5), the average temperature may rise to 4.4°C by 2100 (IPCC, 2023). Such an increase in temperatures would endanger the sustained existence of the elementary preconditions of freedom—the basis for all human rights—as well as the likelihood of human civilization persisting as we know it.

Although states adopted the PA in 2015 in order to address the "wicked problem" (Lazarus, 2009; Levin et al., 2012; Incropera, 2016) of ever-accelerating climate change, the last decade has seen a net increase in GHG emissions (IPCC, 2022b). As the climate crisis continues to worsen (Armstrong McKay et al., 2022; Romanello et al., 2022; IPCC, 2023; Thompson et al., 2023), states are seeking complementary solutions (in addition to emission reductions) to achieve the temperature objectives under Article 2 para. 1 lit. a PA. In recent years, CDR approaches have gained popularity among decision-makers and academics as measures to complement emission reductions. There are several closely-linked reasons for this. First, they promise to offset residual emissions in sectors that are difficult to decarbonize, such as cement, steel, and chemicals (Luderer et al., 2018; Buck et al., 2023). Second, their large-scale deployment may help reduce atmospheric CO_2 levels and thus slow global warming (Gasser et al., 2015; Fawzy et al., 2020), although their feasibility in this regard has yet to be proven on a large scale (Anderson and Peters, 2016; Fuss et al., 2018; Hansen and Kharecha, 2018; Heck et al., 2018; Bednar et al., 2019; Grant et al., 2021b). Third, removals are crucial for countries to achieve net-negative emission targets in the long term (Allen et al., 2022; Smith et al., 2023, p. 9). Fourth, and most controversially, these approaches may be particularly attractive to those countries or companies that have relied on fossil fuels and see these technologies as a potential way to postpone their decarbonization efforts (Anderson and Peters, 2016; McLaren, 2020; Sands and Cook, 2021; Carton et al., 2023). However, a distinction must also be drawn here between the various CDR approaches, as some are better suited to advancing the aforementioned mitigation objectives, while others are more likely to lead to mitigation deterrence and carbon lock-in (Asayama, 2021; Strefler et al., 2021).

All CDR approaches (in contrast to solar radiation management) attempt to capture CO_2 or other GHGs from the atmosphere and store them for the long term. The IPCC defines CDR as:

> Anthropogenic activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage, but excludes natural CO_2 uptake not directly caused by human activities (IPCC, 2021 p. 2,221).

In this context, it is important to distinguish CDR from other related approaches, such as carbon capture and utilization (CCU) and carbon capture and storage (CCS), as they share common technical elements but differ in their ability to achieve permanent net removals of CO_2 (Schenuit et al., 2022, 2023; Smith et al., 2023). There are also different ways of distinguishing between CDR methods—for example, between engineered and nature-based removals (Low et al., 2022). For the purposes of this article, we will focus on conventional land-based CDR activities, which include, *inter alia*, the following approaches: afforestation/reforestation, bioenergy with carbon capture and storage (BECCS), peatland management, biochar, carbon farming, and soil carbon sequestration (Lenton, 2010; Brack and King, 2020; Ekardt et al., 2020; Stubenrauch et al., 2022; Smith et al., 2023). Although Direct Air Carbon Capture and Storage (DACCS) may require a significant amount of freshwater (Realmonte et al., 2019), it does not necessitate large areas of land (Madhu et al., 2021; Ozkan et al., 2022). Therefore, we will not categorize it as a land-based approach to CDR.

Conventional land-based CDR approaches are notable in that they currently account for ∼99.9% of all carbon removals (Powis et al., 2023; Smith et al., 2023). The majority of these activities come from afforestation/reforestation and other forestry activities. To date, these CDR activities are responsible for sequestering around 2,000 $MtCO_2$ per year—excluding BECCS and biochar, which account for only 1.82 $MtCO_2$ and 0.5 $MtCO_2$, respectively (Smith et al., 2023). Countries have already committed in their nationally determined contributions (NDCs) to deploy additional CDR activities in the range of 100–650 $MtCO_2$ annually by 2030 (Smith et al., 2023). However, these plans are likely to be insufficient if countries aim to limit global warming to 1.5 or 2°C as required by Article 2 para. 1 lit. a PA.

Current CDR deployment numbers stand in stark contrast to the weight given to CDR as a mitigation policy by integrated assessment models (IAMs). Virtually all scenarios consistent with the PA's net-zero goal rely to some extent on CDR (IPCC, 2022b). Between 2020 and 2100, some IAM scenarios predict that between 450,000 and 1,100,000 $MtCO_2$ will be cumulatively removed through CDR (IPCC, 2022b). Although conventional land-based CDR is expected to account for almost all removals by 2030 (Powis et al., 2023), it should be emphasized that many scenarios prefer BECCS as the most important CDR measure—especially in the second half of the century. According to a scenario in a recent IPCC report, BECCS is projected to be responsible for almost 50% of all CDR activities by 2100, with a cumulative total of 334,000 $MtCO_2$ by 2100 (IPCC, 2022b). Considering a temporary overshoot, this figure increases to 464,000 $MtCO_2$ (IPCC, 2022b). However, all IAM projections should be interpreted cautiously—especially regarding BECCS—since they are skewed toward cost-optimal mitigation solutions and use high discount rates (Gambhir et al., 2019; Köberle, 2019; Butnar et al., 2020; Ekardt et al., 2022). As a result of their susceptibility to various biases and their key set of incomplete assumptions, some academics have begun to question the importance of IAMs in determining countries' mitigation strategies (Low and Schäfer, 2020; Keppo et al., 2021; Hollnaicher, 2022; Rubiano Rivadeneira and Carton, 2022). This is particularly relevant in the case of CDR deployment, as the predicted removal rates of the different approaches would lead to a number of adverse effects, which we will highlight below.

Land-based CDR strategies have been scrutinized because their large-scale deployment would require significant land-use changes (Smith et al., 2016, 2019; Fuss et al., 2018; IPBES, 2019; Dooley et al., 2020; Honegger et al., 2021b). This in turn would result in further biodiversity loss and could exacerbate competition for land used for food crops (IPBES, 2019; Reid et al., 2020; Gvein et al., 2023). For example, a mitigation strategy that relies primarily on BECCS could theoretically be equal to or worse for certain ecosystems and species than the projected impacts of climate change under business-as-usual scenarios (Meller et al., 2015; Williamson, 2016; Hof et al., 2018). Similarly, large-scale forest plantations are also detrimental to biodiversity if they are managed as monocultures, as most afforestation projects currently are (Bonner et al., 2013; Hua et al., 2016; Stubenrauch et al., 2022).

It is important to note, however, that under certain conditions, land-based CDR activities can also be beneficial for biodiversity (Maljean-Dubois and Wemaëre, 2017; Smith et al., 2019; Nunez et al., 2020). Several studies have shown that the rewetting of peatlands, the restoration of degraded ecosystems, and the protection of existing primary forests are essential for the protection of biodiversity and provide substantial carbon sinks (Mackey et al., 2020; Stubenrauch et al., 2022; Gvein et al., 2023). Consequently, ecosystem-based approaches to CDR that focus on the conservation of existing forests and peatlands could overcome the perceived trade-offs between land-use pressures, climate mitigation policies, and biodiversity protection (Mackey et al., 2015; Stubenrauch et al., 2022). Nevertheless, the mitigation potential of ecosystem restoration is also limited by time constraints and by overestimation of its potential, and therefore cannot be utilized to reduce global peak temperatures (Littleton et al., 2021; Dooley et al., 2022). Drastic emission reductions in all sectors, specifically the drawdown of fossil fuels and the minimization of livestock farming, cannot be replaced by any type of CDR policy if countries wish to achieve a scenario consistent with the PA's 1.5°C limit (Ekardt et al., 2018b, 2022; Wieding et al., 2020).

Biodiversity loss, protected areas, and the Global Biodiversity Framework

Global biodiversity loss is occurring at an unprecedented rate. According to the 2019 IPBES's Global Assessment Report on Biodiversity and Ecosystem Services,

> human actions threaten more species with global extinction now than ever before. [...] Globally, local varieties and breeds of domesticated plants and animals are disappearing. This loss of diversity, including genetic diversity, poses a serious risk to global food security by undermining the resilience of many agricultural systems to threats such as pests, pathogens and climate change (IPBES, 2019, p. 10–11).

While several factors have contributed to biodiversity loss, land-use change and related land degradation are the dominant drivers (IPBES, 2019; Dooley et al., 2022). With more than 70% of the Earth's land surface significantly altered, and about 66% of the ocean surface experiencing increasing impacts (IPCC, 2019), the wellbeing of at least 3.2 billion people is already being adversely affected (IPBES, 2018). Of particular concern is the loss of over 85% of all wetlands, along with the disappearance of half of the previously existing forests and coral reefs since the 1870's (IPBES, 2018). All of these effects are strongly linked to agriculture and to a large extent driven by livestock production, as about 75% of the world's agricultural land is used directly or indirectly for livestock production (Ekardt et al., 2023). In addition, factors driven by or related to fossil fuels play an important role. This is the case, for example, with urbanization and expanding infrastructure. Climate change is another driver of global nature change, again fueled by fossil fuels and livestock, and it is increasingly exacerbating other drivers.

Besides addressing the drivers mentioned above, *in-situ* conservation is one of the most important strategies to combat biodiversity loss, as recognized in the CBD's preamble. According to Article 2 para. 13 CBD, *in-situ* conservation

> means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

In short, *in-situ* conservation involves the preservation of biodiversity in the very habitats where organisms reside and interact with their surroundings. One of the primary ways of promoting *in-situ* conservation is through the establishment and maintenance of protected areas—such as national parks or biosphere reserves (Wolfrum, 2004; Jenkins and Joppa, 2009; Watson et al., 2014; Sands and Peel, 2018; Markus, 2022). Accordingly, Article 8 lit. a CBD stipulates that the contracting parties should "establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity." Pursuant to Article 2 para. 14 CBD, a protected area "means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives." The establishment and maintenance of networks of protected areas ensures the conservation of highly valuable ecosystems and representative populations of significant species while also providing refuge from invasive alien species (Thomas and Gillingham, 2015; Gallardo et al., 2017). This also means that these protected areas should not be used for intensive agricultural or industrial purposes that could pose a significant threat to biodiversity.

Since the adoption of the CBD in 1993, there has been a steady increase in protected areas around the globe. As of 2023, protected areas cover ∼16% of the world's terrestrial area and 8% of the world's marine area (Gurney et al., 2023). Although the parties to the CBD adopted the Aichi Targets in 2010, setting themselves the (legally non-binding) goal of establishing protected areas on 17% of terrestrial and 11% of marine areas (CBD COP, 2010b), the literature generally agrees that countries have made substantial progress regarding protected areas – if recent commitments are taken into account (SBSTTA, 2021). However, many recently designated protected areas lack connectivity and are sub-optimally located (CBD Secretariat, 2020). In addition, critical areas for biodiversity conservation face significant protection gaps, with only about 20% being fully protected and around 39% lacking any legal protection (KBA Partnership, 2022). Parties to the CBD are therefore aiming to address this biodiversity deficit through the introduction of Target 3 of the new GBF, which encourages a significant increase in the area of protected areas.

The cornerstone of the GBF is Target 3—also known as the "30x30" target. According to this target, states aim to

> [e]nsure and enable that by 2030 at least 30% of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures.

In the run-up to the adoption of the GBF and thereafter, Target 3 has probably received the most public and scientific attention, as it is seen as the primary tool for halting biodiversity loss (Jetz et al., 2021; Dooley et al., 2022; Dudley et al., 2022a,b; Gurney et al., 2023). This is partly because the significance of Target 3 lies not only in the realm of biodiversity preservation but also in its crucial role in mitigating global warming. Establishing and maintaining protected peatlands, forests, and soils have the additional benefit of generating negative emissions (Matocha et al., 2012; Melillo et al., 2016; Ekardt et al., 2020; Roberts et al., 2020; Stubenrauch et al., 2022). For instance, the total amount of emissions avoided through the establishment of forest protected areas is equivalent to ∼1 year of annual global fossil fuel emissions (Duncanson et al., 2023). Yet, while it has been hailed as a significant achievement, Target 3 may not be ambitious enough, as research suggests that more than 50% of the Earth's land and oceans would need to be protected to stabilize the climate at the 1.5°C limit and effectively halt and reverse biodiversity loss (Dinerstein et al., 2019; IPCC, 2022a).

Other researchers have cautioned against over-reliance on protected areas to address the biodiversity crisis for several reasons. First, the literature is divided on whether a so-called "land-sparing" approach to biodiversity—in which 50% of terrestrial areas are protected, while agricultural and industrial activities can be intensified on the other half of the Earth's surface—is a sound biodiversity conservation strategy (Phalan et al., 2011; Cohn et al., 2014; Fischer et al., 2014; Carter et al., 2015; Kremen, 2015). However, a strict land-sparing approach has been shown to exacerbate biodiversity loss and social inequalities, as increased agricultural intensification would lead to further deforestation (Dooley et al., 2020, 2022; Obura et al., 2021). Second, and related to the first point, the majority of biodiversity loss—from a historical perspective—has not occurred through the conversion and degradation of high-value ecosystems that protected areas are intended to cover. Instead, the main driver of biodiversity loss has been land-use change and associated degradation of rural lands that were previously managed in a more sustainable manner (Ellis et al., 2021). Third, the success of establishing and managing protected areas in order to halt biodiversity loss remains disputed (Watson et al., 2014; Dooley et al., 2022; Meng et al., 2023). States themselves can determine what constitutes a protected area. As a result, many countries have favored a quantity over quality approach to protected areas—so-called "paper parks" (Di Minin and Toivonen, 2015; Relano and Pauly, 2023), which means that endangered species are not adequately covered (Venter et al., 2014). Moreover, studies have shown that the positive effects of protected areas remain limited if they lack connectivity (Loos, 2021). Finally, so-called "fortress" protected area policies have historically violated a range of human rights by displacing indigenous peoples and restricting the use of their traditional lands (Angelstam et al., 2021; Nagrath et al., 2022).

Conflicting land-use targets

In the previous two sections, we have shown that both climate change commitments and biodiversity conservation policies depend on land use. Addressing the climate crisis and biodiversity loss will therefore require coordinating and transforming current and future approaches to land use (Ekardt et al., 2010, 2018a; Stubenrauch et al., 2021). While some climate change mitigation strategies are also beneficial for biodiversity conservation, other land-based mitigation strategies are likely to conflict with the need to establish more protected areas due to the limited amount of land available.

In order to assess the extent to which the "30x30" target of the GBF conflicts with NDCs (on land-based CDR) under Article 4 para. 2 PA, it is first necessary to determine how much land is available in total and how much land would have to be converted. However, there are some caveats that need to be addressed. Data on global land use and related projections of future land use are fragmentary and often of variable quality (Verburg et al., 2011). Moreover, the dynamic nature of land-use practices presents a constant challenge for making precise predictions about future land-use developments (Meyfroidt et al., 2022). As a result, we will not attempt to prove that there is an evident physical shortage of terrestrial land, or that climate change mitigation and *in-situ* biodiversity policies are competing for specific areas of land. While it is difficult to identify a present physical shortage of land due to conflicting land-use policies, the underlying conflicts are already visible today (Dooley et al., 2022). The UNFCCC, the CBD, and human rights law in general have all incorporated some form of the precautionary principle—which requires that action be taken to avoid long-term, cumulative, or uncertain harm (Gardiner, 2006; Sands and Peel, 2018; Ekardt, 2020). The implication is that there need not be a current threat of competing land-use claims that may violate specific rights or obligations under international law. Rather, states must act prudently to avoid such conflicts in the future.

Although the data on global land use and land-use change may be incomplete, numerous studies provide evidence, all of which conclude that the proportion of land untouched by human influence is rapidly shrinking and that the land already in use is deteriorating (IPBES, 2018; IPCC, 2019; UNCCD, 2022). As mentioned earlier, the great majority of human impacts on land are due to the various agricultural and agroforestry practices (IPCC, 2019) that are pushing a number of planetary boundaries beyond their limits (Steffen et al., 2015, 2018; Campbell et al., 2017; Rockström et al., 2023). Of the global ice-free land surface—130 million square kilometers (Mkm^2)—∼50 Mkm^2 are used for agriculture and 30 Mkm^2 for agroforestry (IPCC, 2019, p. 8). As food production has increased by nearly 240% since the 1960's (IPCC, 2019), the relative and absolute share of land used for agriculture has also increased significantly to meet rising food demand. From 2000 to 2019 alone, the annual rate of cropland expansion saw a 58-fold increase, which also adversely impacted existing protected areas (Meng et al., 2023). This agricultural expansion has resulted in one-third of the global land area being affected by land-use change (Winkler et al., 2021), and is responsible for 80% of deforestation (UNCCD, 2022). In this context, it is also notable that 75–80% of global agricultural land is used for livestock production—including grazing land and cropland used to grow animal feed—while only 18% of the total calorie supply comes from meat and dairy products (Poore and Nemecek, 2018; Weishaupt et al., 2020). Studies estimate that the threshold for sustainable global cropland use is ranging between 10 and 15 Mkm^2 (Springmann et al., 2018; Willett et al., 2019). Since current global cropland covers around 12.44 Mkm^2 (Potapov et al., 2022), further expansion will inevitably exceed global sustainability thresholds.

In addition to the prediction that more land will be needed for food production in the future if diets do not change, there is also an expectation that land will be used as a resource to combat climate change and conserve biodiversity. In terms of land-based CDR, parties to the PA have already pledged to use ∼12 million

Mkm² of land for carbon sinks or other NETs by 2060 (Dooley et al., 2022). These pledges would almost amount to four times the total area of India. Over half of this land committed to land-based CDR will be used to plant new forests or plantations, which will require land-use changes with negative impacts on biodiversity (Dooley et al., 2022). Most of these envisaged pledges by countries are to be realized by 2030 (4.5 Mkm²), while there are few (but significant) land-based CDR commitments for 2050 (5.3 Mkm²) and 2060 (2 Mkm²; Dooley et al., 2022). Whether countries would be able to meet these ambitious goals is uncertain (Brack and King, 2020; Quiggin, 2021). Unlike renewables, such as solar and wind, land-based CDR faces a "hard technical constraint" (Dooley et al., 2022, p. 22) in terms of projected land-use requirements. In the future, countries may be tempted to focus more on solar power as a mitigation strategy, which is 100 times more energy efficient than bioenergy per unit of land area (Searchinger et al., 2018).

Commitments to establish protected areas and restore degraded lands to conserve biodiversity also exacerbate the competition for global land use. As of 2023, around 17% of the Earth's terrestrial area is covered by protected areas, equivalent to 12.3 Mkm² (Gurney et al., 2023). Under Target 3 of the GBF, parties to CBD aim to increase this figure to 30%, or 23 Mkm², by 2030. The international community has further pledged to restore nearly 10 Mkm² of degraded land, including around 20% of existing cropland and 10% of forest land (van der Esch et al., 2022). While these targets are ambitious, it is unclear how countries will allocate an additional 20.8 Mkm² of land for protected area establishment and degraded land restoration if they also want to expand food production and land-based CDR (Dooley et al., 2022). In addition, the "30x30" target may not even be sufficient to halt biodiversity loss. As Allan et al. estimate, a minimum of 44% of global land (64 Mkm²) is needed to be covered by protected areas to effectively conserve biodiversity (Allan et al., 2022). However, 1.8 billion people currently live on this land, precluding any strict "fortress" protected area policies.

However, the ostensibly overlapping land-use commitments could be harmonized if the two primary strategies of both climate protection and biodiversity conservation were consistently implemented: a sharp reduction in livestock farming and a phase-out of fossil fuels (Stubenrauch et al., 2021). The latter could slow down urban sprawl and infrastructure construction, the former would free up a large part of agricultural land. Thus, the assumed land conflict between CDR and biodiversity areas could be reduced to a large extent. In addition, there is also the possibility of shaping the remaining agriculture in such a way that it both serves biodiversity and sequesters more carbon, for example through approaches such as crop rotation or legume cultivation (Dooley et al., 2022). Furthermore, as described above, there are also synergy effects between climate and nature conservation for certain non-large-scale CDR approaches such as peatland rewetting (non-monocultural), afforestation, biochar, or low-till farming. All these measures primarily serve the dual purpose of benefiting biodiversity and climate protection, potentially minimizing the conflict between the two treaty regimes to a great extent.

Results: legal analysis of overlapping land-use claims under international law

CDR and the international climate change law

Neither the terms CDR nor NETs are mentioned in any of the relevant international climate law treaties. However, the drafters of UNFCCC did include the concept of "sinks" in the 1993 UNFCCC. According to Article 4 para. 1 lit. d UNFCCC, the contracting parties should, in accordance with their common but differentiated responsibilities,

> [p]romote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems [...].

The Convention further defines sinks as "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere" under Article 1 para. 8 UNFCCC. Consequently, the drafters foresaw the possibility of carbon removals through the conservation and enhancement of sinks. Although the ordinary meaning of the terms "conservation" and "enhancement" of "sinks" does not cover engineered removals, such as BECCS and DACCS, it would be contrary to the Convention's ultimate objective under Article 2 UNFCCC to exclude these approaches, as they are theoretically capable of contributing to the objective of stabilizing greenhouse gas concentrations in the atmosphere (Craik and Burns, 2016; Fuglestvedt et al., 2018; Lin, 2018; Krüger, 2020; Honegger et al., 2021a).

As in the case of the Convention, the PA also lacks provisions that address specific types of CDR. The most important provision concerning CDR deployment can be found in Article 4 para. 1 PA, which mandates that the contracting parties should

> undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.

Moreover, according to Article 5 para. 1 PA, "[p]arties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1 (d), of the Convention, including forests." Although some commentators interpret these provisions as strengthening the role of CDR as a mitigation option (Bodansky, 2016b; Horton et al., 2016; Chen and Xin, 2017; Reynolds, 2018; Mayer, 2021), Article 4 para. 1 PA and Article 5 para. 1 PA cannot be construed as constituting an obligation directly requiring states to implement a particular type of CDR within a specific timeframe, as they lack legal prescriptiveness and precision. Instead, Article 4 para. 1 PA only imposes an obligation on states to "aim" to meet this goal, which cannot be considered an obligation of result (Krüger, 2020). As such, it does not require states to pursue large-scale land-based CDR policies. Similar to the Convention, the Agreement maintains a relatively impartial position regarding the utilization of CDR (Kalis et al., 2021).

Since CDR approaches are considered as removals via "sinks" under both the UNFCCC and the PA, we can likewise conclude that all land-based CDR measures are considered "measures to mitigate climate change" under Article 4 para. 1 lit. b UNFCCC. As a mitigation measure, land-based CDR approaches are therefore placed in the same category as policies that reduce emissions (Honegger et al., 2021a). This does not mean, however, that emission reductions and CDR approaches should be equated from a legal perspective. Rather, the UNFCCC, the PA, and other provisions of international environmental law mandate that emission reductions are the primary course of action, while CDR is seen as a complementary set of measures (Beyerlin and Marauhn, 2011; Lin, 2018; Mayer, 2018; Wieding et al., 2020; Markus et al., 2021; Stoll and Krüger, 2022). This normative hierarchy of mitigation measures can be derived from, *inter alia*, the ultimate objective of the UNFCCC and the legally binding 1.5°C limit under Article 2 para. 1 lit. a PA (Ekardt et al., 2018b, 2022; Ekardt, 2020; Wieding et al., 2020). Although both emissions reductions and sinks are mitigation measures, emission reductions are the most the effective means of achieving the Convention's target of stabilizing GHG emissions (IPCC, 2018, 2023). It follows that due to concerns about the permanence of CDR approaches, they are *prima facie* not as effective in achieving the UNFCCC's ultimate objective (Güssow, 2012; Krüger, 2020; Stoll and Krüger, 2022). Moreover, based on a reading of Article 2 para. lit. a 1 PA, as well as on human rights law, parties must deploy those measures that are most effective, while also causing the least side effects on the relevant interests and rights. Such measures are emission reductions, such as the rapid phase-out of fossil fuels and the minimization of livestock farming (Ekardt et al., 2018b, 2022; Ekardt, 2020; Wieding et al., 2020). A similar conclusion was reached by the German Federal Constitutional Court in its landmark 2021 climate ruling, where the judges underlined the primary role of emission reductions and emphasized the uncertain and limited role of CDR approaches (Kotzé, 2021; Ekardt and Heß, 2023).

The normative hierarchy of mitigation measures under the UNFCCC and the PA remains unaltered by their "nationally determined" nature, as stipulated in Article 3 PA. Contracting parties are, in theory, free to decide which mitigation measures they wish to adopt. However, Article 3 PA explicitly states that parties need to adopt measures in order to comply with the temperature limits specified under Article 2 para. 1 lit. a PA. Consequently, the concept of nationally determined contributions is inherently bounded by the overarching obligation in Article 2 para. 1 lit. a PA, which seeks to limit global warming to 1.5°C (Ekardt et al., 2018b). Given the escalating likelihood of exceeding this critical temperature threshold in the near future (IPCC, 2023), contracting parties must prioritize mitigation measures capable of fulfilling this binding mandate (Ekardt et al., 2018b, 2022). Presently, it seems highly improbable for parties to meet this obligation primarily through the reliance on CDR measures alone, without simultaneously implementing substantial emission reductions. Conversely, reducing emissions across all sectors is imperative for achieving the 1.5°C target in the remaining timeframe (IPCC, 2023). While CDR policies are also necessary, as stipulated in Article 4 para. 1 PA, the legal priority is in favor of the obligation under Article 2 para. 1 lit. a PA, and its indirect mandate to curtail emissions (Ekardt et al., 2018b). In sum, while each contracting party does indeed have discretion when adopting mitigation measures, these measures must be aligned with the legally binding objective under Article 2 para. 1 lit. a PA, essentially necessitating the initial adoption of emission reduction strategies.

Protected areas and international biodiversity law

Article 1 CBD contains a legally binding obligation to halt biodiversity loss (Ekardt et al., 2023). According to the preamble of the CBD,

> the fundamental requirement for the conservation of biological diversity is the *in-situ* conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings [. . .].

Thus, *in-situ* conservation measures—notably protected areas—have normative priority among the Convention's various policies, which is also reflected in the language and context of Articles 8 and 9 CBD (Bowman et al., 2010; Boyle and Redgwell, 2021). This normative priority of *in-situ* measures is due to the fact that they address all five levels of the biodiversity hierarchy—"(1) whole systems such as landscapes or ecosystems, (2) assemblages such as associations or communities, (3) species, (4) populations and (5) genes" (Bowman et al., 2010, p. 599). In contrast, ex-situ measures under Article 9 CBD—i.e., policies outside the original ecosystem, such as maintaining gene banks or zoos—only address biodiversity levels three to five (Wolfrum, 2004; Bowman et al., 2010; Boyle and Redgwell, 2021). Land-based CDR policies are *prima facie* ranked even lower because their direct impacts will be detrimental to all five levels of biodiversity in many scenarios. Ultimately, *in-situ* measures are the more effective measures with fewer side effects on the relevant legally protected interests. We can therefore conclude that, just as emission reductions are preferred in the UNFCCC and its successor treaties, *in-situ* measures are normatively favored by the CBD.

While Article 8 CBD is commonly viewed as the centerpiece of the CBD's substantive obligations (besides the obligation to halt biodiversity loss), its provisions—including the obligation to establish protected areas under Article 8 lit. a CBD—are qualified by the formulation "as far as possible and as appropriate." As a consequence, the contracting parties are said to have considerable discretion when implementing the obligations under Article 8 CBD. Some commentators have even argued that the qualifiers in the CBD effectively allow parties to circumvent to fulfill their obligations (Humphreys, 2005; Lim, 2021). However, the CBD is legally binding as a whole under international law. More relevant, therefore, is the question of the specific legal effect of Article 8

CBD. Whether or not a provision in an international treaty creates a legally binding right or obligation depends on its degree of prescriptiveness and precision.

The concept of prescriptiveness refers, *inter alia*, to the degree of the obligatory nature that is conveyed by the verb that is used in a provision (Oberthür and Bodle, 2016). To illustrate, provisions that use the verb "shall" convey precise and legally binding requirements and are therefore classified as hard obligations (Bodansky, 2016a; Böhringer, 2016). Conversely, flexible obligations often use verbs such as "should" or "encourage," which leave discretion to the parties involved and potentially enable non-enforcement (Bodansky, 2016a; Böhringer, 2016; Rajamani, 2016). In the case of Article 8 CBD, the *chapeau* includes the term "shall," indicating a sufficient level of prescriptiveness.

The precision of a norm hinges on two factors. Firstly, the norm must identify the intended recipient, be it an individual, a group or an institution, thereby establishing specific obligations (Bodansky, 2016a; Oberthür and Bodle, 2016). Secondly, the norm should define the specific requirements or expectations through methods such as setting measurable targets or specifying precise timeframes (Oberthür and Bodle, 2016). However, the precision of the content of a norm may be limited by qualifiers like "as appropriate," as exemplified in the *chapeau* of Article 8 CBD (Rajamani, 2016). Beyond the use of qualifiers, the obligation to establish protected areas under Article 8 lit. a CBD is relatively vague. Although it is clear that the contracting parties are the intended addressees of the norm, the legal content is rather imprecise. Article 8 lit. a CBD does not prescribe any minimum criteria that the area in question must meet before it can be designated by the contracting party as a protected area under its domestic law. As a result, any contracting party could theoretically comply with the obligation under Article 8 lit. a CBD by establishing a protected area on any site—regardless of its ecological status. Due to the aforementioned lack of precision in the wording of Article 8 lit. a CBD, the legal effect of the provision may be questioned.

However, we argue that the "30x30" target of the GBF is a clarification of the legally binding provisions of the CBD—including the obligation to establish protected areas under Article 8 lit. a CBD (Ekardt et al., 2023). While the GBF itself is not a legally binding treaty under Article 2 lit. a VCLT, the GBF can be considered as a "subsequent agreement between the parties regarding the interpretation or the application of its provisions" of the CBD pursuant to Article 31 para. 3 lit. a VCLT. This is because it meets the three conditions necessary to be deemed such a "subsequent agreement." Firstly, unanimous adoption by all contracting parties according to Article 1 para. 1 lit. g VCLT. Secondly, it was adopted by the parties "subsequently" to the adoption of the CBD (Berner, 2017). Thirdly, it is directly relevant for "the interpretation of the treaty or the application of its provisions," as it increases the precision of several obligations of the CBD by clarifying objectives, timeframes, or legal terms. While some authors argue that the parties must additionally be aware of and expressly confirm the legal clarifications in the context of a subsequent agreement (Linderfalk, 2007; ILC, 2018; Minnerop, 2020), we posit that this sole purpose doctrine relies too heavily on subjective factors, which undermines the legal relevance of provision (Berner, 2017). Instead, we suggest that Article 31 para. 3 lit. a VCLT is inapplicable only if the parties explicitly exclude the subsequent agreement from clarifying the interpretation and application of the treaty. In the case of the GBF, the parties have declared that the framework should not "modify the rights and obligations of a Party under the Convention" (CBD COP, 2022, p. 6). As the processes of treaty modification and treaty interpretation are distinct concepts (Moloo, 2012), the GBF can thus be considered as a subsequent agreement pursuant to Article 31 para. 3 lit. a VCLT.

Considering that the GBF clarifies the legally binding provisions of the CBD, we argue that the "30x30" target also clarifies Article 8 lit. a of the CBD. The "30x30" target sets a quantifiable target and specific timeframe: by 2030, at least 30% of terrestrial and marine areas should be effectively conserved and managed through well-connected and equitable protected area systems. It is important to note, however, that the GBF's legal clarifications do not override or modify the existing and ambitious commitment to halt and reverse biodiversity loss under Article 1 CBD. Similarly, the introduction of two new timelines (2030 for targets and 2050 for goals) in the GBF does not change the original obligation under Article 1 CBD, which has required immediate action since the CBD entered into force in 1993.

In addition, the "30x30" target limits the impact of the "as appropriate" qualifier in the *chapeau* of Article 8 CBD. It specifies, in accordance with the relevant findings of the scientific community, the actions that parties must take to mitigate the loss of biodiversity under Article 8 CBD. While the qualifier "as far as possible" still modifies the provision to ensure that certain parties with limited administrative and financial capacity are able to meet the obligations (Krohn, 2002; Marschall et al., 2008), it does not justify the claim that there is no obligation at all. Even if some countries are unable to implement the necessary measures within their territory, they can still assist other countries in achieving the overall target through financial assistance and technological cooperation.

Resolving the conflict between international climate and biodiversity law

Both the deployment of land-based CDR and the establishment and maintenance of protected areas are supported by provisions of international environmental treaty law. On the one hand, the international climate regime generally encourages the utilization of land-based CDR, even if the obligations are vague and there is no legally binding duty or specific timeframe for CDR deployment other than the overarching net zero target under Article 4 para. 1 PA. On the other hand, the CBD obliges its contracting parties to establish protected areas under Article 8 lit. a CBD. Although this obligation also leaves a wide margin of discretion to the contracting parties, the GBF's "30x30" target considerably clarifies the legal content of Article 8 lit. a CBD. As we have shown above, there is only a limited amount of land available either for land-based CDR deployment or for biodiversity conservation purposes if the demand for food production is to be met. Notwithstanding the fact that current land-use practices already exceed safe and equitable planetary boundaries (Steffen et al., 2015; Rockström et al., 2023), it is highly likely that countries will continue to utilize previously unused areas of land or implement land-use changes in order to meet their international obligations under the UNFCCC, PA, or CBD. How can these competing land-use claims, which are also conflicting legal rules, be resolved? From the perspective of international law, the relevant treaty provisions are, *prima facie*, equal and cannot override one or the other (Jacquemont and Caparrós, 2002). However, there are rules and legal balancing mechanisms embedded in the relevant treaties that can be used to reconcile the conflicting legal norms.

One possible argument is that certain land-based CDR approaches could actually benefit biodiversity, particularly in the case of ecosystem restoration and the protection of existing sinks (Ekardt et al., 2020). This means that such policies could contribute to the sub-objective of conserving biodiversity as defined in Article 1 CBD. Consequently, there may be no legal contradiction between implementing some form of land-based CDR techniques and maintaining protected areas, as both could be implemented on the same parcels of land. However, it could also be argued that the threat to biodiversity posed by climate change itself is far greater. If countries continue to emit GHGs under a business-as-usual scenario, there would be severe consequences for all ecosystems and species (Nunez et al., 2019; Habibullah et al., 2022). Tackling climate change is therefore a critical priority for biodiversity conservation (Ohashi et al., 2019). Conversely, both Article 2 and Article 4 para. 1 lit. d UNFCCC explicitly refer to ecosystems as relevant legally protected interests (Jacquemont and Caparrós, 2002). Any effective mitigation measure—including land-based CDR—can also be regarded as benefitting biodiversity in the long term (Williamson et al., 2012), thereby reconciling the ostensible conflict between the two land-use approaches.

Consequently, some authors argue that the sub-objective to conserve biodiversity under Article 1 CBD should not just be interpreted as limiting the deployment of CDR but also as encouraging its use (Honegger et al., 2013; Reynolds, 2014; Du, 2018; Krüger, 2020). This viewpoint holds merit, particularly in the context where land-based CDR strategies can contribute to biodiversity preservation by stabilizing GHG levels. However, this perspective is compelling only insofar as the CDR policies in question are implemented in a sustainable manner that does not pose significant threats to biodiversity. In the case of some large-scale BECCS applications, for example, the impact on certain species and ecosystems may be even worse than in business-as-usual climate scenarios—in which limited emission reductions occur and temperatures continue to rise rapidly (Hof et al., 2018). This does not mean that all BECCS approaches have detrimental effects on biodiversity conservation. The environmental footprint of a specific BECCS plant typically hinges on the sourcing of its fuels, which can involve not only monoculturally-sourced plants but also secondary biomass materials, like municipal waste (Pour et al., 2018). Nevertheless, there are emission reduction measures available that are both more effective at curbing global warming and also would provide large net-benefits for biodiversity conservation—most notably by phasing out fossil fuels and minimizing livestock production (Phelps et al., 2012; Weishaupt et al., 2020; Almaraz et al., 2023). As long as the totality of effects associated with certain large-scale CDR deployment scenarios on biodiversity is uncertain—specifically regarding land-use change—countries should, in the first instance, rely on emission reductions as they are more effective and have multiple benefits for biodiversity (Phelps et al., 2012). There is no doubt that BECCS and other land-based CDR methods have a role to play in the overall mitigation portfolio. However, arguing that these approaches are beneficial to biodiversity does not resolve the legal dispute over conflicting land-use commitments.

A related argument is that land-based CDR policies could theoretically constitute the "sustainable use" of biodiversity, which is the second sub-objective under Article 1 CBD. If that were indeed the case, there would be no contradiction between the UNFCCC and the CBD, since the practice of land-based CDR would also be protected under the CBD. In theory, maintaining peatlands, planting trees, or cultivating bioenergy crops in order to permanently remove CO_2 from the atmosphere could be understood as sustainable use practices or even as beneficial use of biodiversity, provided that the land is not managed monoculturally (Donnison et al., 2020, 2021; Giuntoli et al., 2022). However, according to Article 2 para. 16 CBD, "sustainable use" means

> [t]he use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Thus, a party cannot justify activities that are harmful to biodiversity by invoking that the activity in question may be regarded as "sustainable use" under the second sub-objective of Article 1 CBD (Glowka et al., 1994; Krüger, 2020). In this regard, the Convention has incorporated a specific notion of sustainability, understood as a practice that balances global cross-border and intertemporal interests and rights. Thus, the use of biodiversity cannot be considered sustainable if it would imply a long-term decline in biodiversity. Some land-based CDR policies implemented at the scale foreseen by many IAMs are likely to be detrimental to biodiversity and may likewise infringe upon several human rights of present and future generations (Günther and Ekardt, 2022). Consequently, it is challenging to categorize these large-scale policies as inherently constituting a "sustainable" utilization of biodiversity's components as defined in Article 1 CBD in most scenarios. In contrast, smaller-scale policies that employ sustainable resourcing methods or focus on ecosystem protection and restoration have the potential to align with the concept of "sustainable use" under the Convention. However, this assessment is contingent upon the specific local context and the manner in which the policy is implemented.

Another way to potentially reconcile the conflicting legal norms is through Article 22 para. 1 CBD. The article states that

> [t]he provisions of this Convention shall not affect the rights and obligations of any Contracting Party deriving from any existing international agreement, except where the exercise of those rights and obligations would cause a serious damage or threat to biological diversity.

It follows that a party to the CBD can argue that the obligation under Article 8 lit. a CBD "shall not affect the rights and obligations" of parties under the UNFCCC. Since land-based CDR policies are considered mitigation measures to achieve the ultimate objective under Article 2 UNFCCC (Honegger et al., 2021a), it is arguable that Article 8 lit. a CBD should not affect the use of CDR as encouraged under the UNFCCC. Article 22 para. 1 CBD is applicable in our case because the UNFCCC entered into force before the CBD and is therefore an existing international agreement under Article 22 para. 1 CBD. However, Article 2 UNFCCC does not contain a positive obligation to utilize CDR because it prioritizes emission reductions over other secondary measures (Stoll and Krüger, 2022). More importantly, Article 22 para. 1 CBD does not apply in cases "where the exercise of those rights and obligations would cause a serious damage or threat to biological diversity." Hence, any large-scale land-based policies implying significant damages to biodiversity are not justified under Article 22 para. 1 CBD. Concerning smaller-scale land-based measures that are implemented in a way that does not adversely impact biodiversity, Article 22 para. 1 CBD could only be applicable in cases where a party substantiates the existence of an explicit obligation under the CBD to employ a particular form of land-based CDR.

Finally, the ultimate objective of the UNFCCC underscores the point that mitigation measures must also be consistent with the protection of biodiversity, thereby effectively limiting some forms of large-scale deployment of land-based CDR through further land-use change. The ultimate objective of the UNFCCC, according to Article 2 UNFCCC, specifies that the atmospheric GHG concentrations must be stabilized in order to "prevent dangerous anthropogenic interference with the climate system." Furthermore, mitigation is necessary "to allow ecosystems to adapt naturally to climate change," implying that ecosystems are a legally protected interest under the UNFCCC. It follows that if countries wish to pursue land-based CDR measures—which are permitted but secondary to emission cuts—they should use approaches that are most consistent with biodiversity protection. In practice, this means that parties to the UNFCCC and CBD should prioritize the CDR approaches that are most compatible with *in-situ* conservation, such as ecosystem restoration and the protection of existing sinks (Ekardt et al., 2020; Stubenrauch et al., 2022). Conversely, states should reassess potential large-scale land-based CDR measures if doing so would unduly impede their ability, or the ability of the international community, to effectively achieve the "30x30" target by 2030. If a country nevertheless decides to pursue such a unilateral large-scale land-based CDR policy, this could potentially constitute a breach of "good faith" under Article 1 CBD in conjunction with Article 26 VCLT.

Some may argue that the conflicting legal rules have not really been considered in an entirely balanced manner but are rather tilted in favor of *in-situ* biodiversity conservation to the detriment of land-based CDR policies. Given the present and future damage that will be wrought by climate change, we might reasonably ask whether this conclusion is justified. We argue that it is, because one cannot compare mitigation and conservation measures in isolation but must always consider the alternative courses of action in each specific policy area that are potentially as effective and less intrusive on relevant rights. In our case, the normative hierarchy of mitigation and conservation measures anchored in the different treaty regimes is crucial for interpreting the relevant legal rules. Notably, the UNFCCC and the PA give precedence to strategies focused on emission reductions (Ekardt et al., 2018a; Lin, 2018; Mayer, 2018; Stoll and Krüger, 2022), whereas the CBD favors *in-situ* conservation and protected areas (Bowman et al., 2010; Boyle and Redgwell, 2021). In contrast (land-based), CDR approaches are of secondary importance in the international climate regime (Güssow, 2012; Krüger, 2020; Wieding et al., 2020; Ekardt et al., 2022; Stoll and Krüger, 2022; Ekardt and Heß, 2023), while the CBD may discourage those approaches that are not implemented in a sustainable manner.

This result, however, does not necessarily indicate that the entire array of diverse mitigation approaches falling under the category of land-based CDR policies is fundamentally incompatible with the CBD. Thus, there is no immediate imperative for states to abstain from their implementation. Instead, it is crucial to acknowledge that all principles within international environmental law inherently entail specific limitations and inescapable trade-offs. For example, despite the widespread membership in the CBD, it is noteworthy that the United States (US), has chosen not to become a contracting party. Even though the US issued an executive order recommending the conservation of at least 30% of domestic lands and waters by 2030 (White House, 2021), the order is not grounded in international environmental law. Consequently, it does not intersect with the previously mentioned realm of potentially conflicting land-use commitments governed by international law. In addition, the CBD is characterized by its use of soft language and constructive ambiguity (Harrop and Pritchard, 2011; Boyle and Redgwell, 2021), which serves as a hallmark of flexibility and pragmatism in international environmental law—although there is a legally binding obligation to halt biodiversity loss (Ekardt et al., 2023). The CBD, acknowledging the diverse national interests and priorities of its parties, uses legal language that allows for interpretation and adaptation to varying contexts and circumstances (Fajardo del Castillo, 2021; Lim, 2021). Thus, in situations where there are competing land-use commitments under international climate change and biodiversity law, this ambiguity can offer parties a degree of latitude to navigate norm conflicts without necessarily having to rely on the specific rules and balancing mechanisms mentioned above. For instance, some parties to CBD may deem certain land-based as sustainable mitigation approaches and, therefore, may not consider it imperative to align them with their *in-situ* conservation commitments under the CBD. This again exemplifies the notion that each land-based CDR approach must be evaluated in its specific implementation context. Furthermore, even if a particular land-based CDR policy impacts certain elements of biodiversity, it does not inherently constitute a breach of the responsible party's obligations under the CBD.

Discussion and conclusion

In a 2021 study, Meyfroidt et al. postulated several claims about the sustainability of global land systems (Meyfroidt et al., 2022).

According to the researchers, "humanity lives on a used planet where all land provides benefits to societies." However, "land-use change usually entails trade-offs between different benefits—"win-wins" are thus rare" (Meyfroidt et al., 2022, p. 1). The aim of this paper is to show how these benefits and trade-offs of land-use and land-use change approaches, i.e., conflicting land-use pledges to land-based CDR and protected areas, are translated in terms of international environmental law.

Although safe and just planetary boundaries for land use have already been exceeded due to the expansion of cropland (Steffen et al., 2015, 2018; Rockström et al., 2023)—which is expected to increase in the future—countries have committed themselves to use additional areas of "unused" land or to redesignate existing areas through land-use change. Commitments for land-based CDR and the establishment of protected areas are likely to result in overlapping or conflicting land claims, assuming that cropland used for food production is left untouched (Dooley et al., 2022).

In a legal analysis, we have shown how rules of international environmental law may be used to resolve these competing claims, although there will always be some limitations and trade-offs involved due to the inherent constraints of the pertinent treaty regimes. Under the relevant treaty rules of international environmental law (land-based), CDR policies are normatively subordinate to emission reductions (Krüger, 2020; Wieding et al., 2020; Ekardt et al., 2022; Stoll and Krüger, 2022; Ekardt and Heß, 2023). In contrast, *in-situ* conservation approaches, such as the establishment of protected areas, are the primary measures for achieving the CBD's objective of conserving biodiversity (Bowman et al., 2010; Boyle and Redgwell, 2021). Moreover, the GBF's "30x30" target constitutes a "subsequent agreement" pursuant to Article 31 para. 3 lit. a VCLT, thereby clarifying the legally binding obligation under Article 8 lit. a CBD. It follows that some commitments to large-scale land-based CDR, which would either directly or indirectly undermine the achievement of the "30x30" target, may be inconsistent with the CBD.

What does this mean for countries wishing to pursue these land-use policies? It is essential to clarify that our previous analysis does not inherently deem any of the discussed land-use policies incompatible with international law, nor does it suggest that countries should entirely abandon a particular set of land-use policies. The assessment of legal compatibility remains contingent upon the specific circumstances of each case. Nonetheless, our analysis underscores the fact that there are instances where the international frameworks for climate change and biodiversity preservation do not seamlessly align. Thus, parties need to continuously (re)assess their mitigation strategies in order to fulfill their commitments under both legal regimes. Furthermore, the dual commitment to limiting global warming to 1.5°C and halting biodiversity loss places a fundamental obligation on public authorities to seek synergies between climate and biodiversity protection wherever feasible, as previously mentioned. This approach has the potential to significantly mitigate related land-use conflicts. Given these observations, policymakers should consider the following key considerations:

First, to mitigate climate change, nations must focus on real and significant emission reductions across all sectors. Ambitious climate action—by rapidly phasing out the use of fossil fuels and minimizing livestock production—is the most effective way to limit global warming to 1.5°C, as required by Article 2 para. 1 lit. a PA (Powell and Lenton, 2013; Ekardt et al., 2018b; Weishaupt et al., 2020). By those means, the assumed land conflict between CDR and biodiversity areas could disappear at least to a large extent because this would free up a significant amount of land for both CDR and biodiversity conservation. Furthermore, these kinds of emission reductions would render it unnecessary to make land-use changes that negatively impact both climate and biodiversity, while reducing the risk of food and water scarcity in the long term (Hasegawa et al., 2021).

Second, land-based CDR policies will still be necessary to achieve the 1.5°C limit under Article 2 para. 1 PA (IPCC, 2023; Smith et al., 2023). However, states should focus on those CDR policies that effectively sequester GHG while also providing the most benefits to biodiversity protection (Aguirre-Gutiérrez et al., 2023). It is evident that there is no CDR panacea, meaning that there will always be trade-offs involved when balancing CDR mitigation ambition and biodiversity protection concerns. Nevertheless, CDR should primarily be employed to offset process emissions in hard-to-abate industrial sectors rather than as large-scale mitigation policies (Wieding et al., 2020; Ekardt et al., 2022; Ekardt and Heß, 2023). Moreover, certain CDR options, such as ecosystem restoration and the preservation of existing natural sinks, prove particularly advantageous and thus should take precedence over large-scale monocultural approaches that promote land-use change.

Thirdly, there is a need for reshaping current agricultural practices in a manner that not only benefits biodiversity conservation but also enhances CO_2 sequestration. This can be achieved through methods such as crop rotation, low-till farming, and the cultivation of legumes (Dooley et al., 2022). As restoring natural vegetation is generally more cost-efficient and avoids the negative biodiversity impacts of planting new trees or crops, any land-based CDR policy should focus on protecting or restoring existing ecosystems, for instance with regard to forests and peatland (Ekardt et al., 2020; Weishaupt et al., 2020; Stubenrauch et al., 2021, 2022).

Finally, this ecosystem-based approach would also be most compatible with the establishment and maintenance of protected areas. Protecting key biodiversity areas is critical to halting the accelerating rates of extinction and the spread of invasive alien species (Kullberg et al., 2019). However, countries should not focus solely on establishing new protected areas in order to meet the "30x30" target by 2030, since spending on the management of existing protected areas is often a better investment for biodiversity than establishing new ones (Adams et al., 2019). Furthermore, protected areas must always respect the rights of indigenous peoples in order to achieve sustainable and equitable environmental outcomes.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

PG: Conceptualization, Investigation, Writing – original draft. FE: Conceptualization, Project administration, Supervision, Writing – review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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