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Committed to restoring tropical forests: an overview of Brazil's and Indonesia's restoration targets and policies

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Abstract

The restoration of tropical forests has become a popular nature-based solution for climate change mitigation, protection of biodiversity, and improving the livelihoods of local populations. The Bonn Challenge and the UN Decade on Ecosystem Restoration underscore the international momentum of the restoration movement, with many countries committing to restore millions of hectares of deforested and degraded land in the next decade. Brazil and Indonesia are among the ones with the most ambitious restoration commitments globally. Since both their economies are highly dependent on the export of agricultural commodities, reconciling economic growth with environmental sustainability will be a major policy challenge. In this paper, we (a) identify the main restoration targets and the policies supporting their implementation in both countries, (b) provide a descriptive overview of these restoration-supportive policies, and (c) discuss the main challenges that Brazil and Indonesia face in the implementation of their restoration commitments. We find that Brazil has an explicit and dedicated strategy to achieve its restoration target, but that recent political developments have weakened environmental governance in the country, affecting the implementation of its restoration commitment. In the case of Indonesia, we find that the government has rather focused and progressed on the restoration of peatlands and mangroves, whereas its commitment to restore forestlands has yet to benefit from a dedicated plan that allows to coordinate policies and agencies' efforts towards the achievement of its restoration target.

1. Introduction

The restoration of tropical forests has gained considerable traction as a nature-based solution with the potential to deliver multiple benefits ranging from climate change mitigation, to improvement of ecosystem functions and reduction of biodiversity loss, as well as sustaining the livelihoods of local communities (Chazdon *et al* 2017, Stanturf *et al* 2019). The Bonn Challenge to restore 150 million hectares (Mha) of degraded and deforested landscapes by 2020 and 350 Mha by 2030, and the recently declared United Nations (UN) Decade on Ecosystem Restoration 2021–2030 (UN 2019) underscore the international momentum of the restoration movement. However, despite growing international interest with submitted restoration targets totalling more than 230 Mha globally (Fagan *et al* 2020), the implementation of large-scale restoration initiatives continues to be hindered by deficient forest governance, competition over land for agriculture, and important financial constraints (Stanturf *et al* 2019, Nunes *et al* 2020).

Brazil and Indonesia account for more than a third of the world's tropical forests (FAO and UNEP 2020). They are also the two countries with the highest share of tree cover loss from tropical forests (Curtis *et al* 2019), and are the largest carbon emitters from agriculture, forestry and other land-use (AFOLU) in the world, with nearly 1 billion tonnes of CO_2 equivalent emissions each in 2019 (FAO 2021). The dominant driver of tree cover loss in both countries is commodity-driven deforestation (Busch and Ferretti-Gallon 2017). Since the 1990s, agricultural expansion has cost Brazil 65 Mha of native ecosystems converted to cropland and pasture for cattle in the Amazon states (Stabile *et al* 2020). Today, Brazil is the world's largest producer of sugarcane and coffee and is responsible for over 30% of soybean production and 15% of beef production worldwide, with the agricultural sector representing around 20% of the country's gross domestic product (GDP) and 10% of Brazil's labour share (FAO 2020). The Indonesian economy, on the other hand, is highly dependent on the export of palm oil, for which it is the largest supplier in the world with over 50% of global production (FAO 2020). Since the early 2000s, ∼90% of deforestation and forest degradation occurring in native ecosystems has been the result of palm oil expansion and timber plantations (Curtis *et al* 2019, Tacconi *et al* 2019), with the agriculture and forestry sector currently contributing over 12% to the Indonesian GDP and representing 33% of the labour share (MoEF 2020).

Over the last decade, in an effort to better reconcile agricultural production with forest conservation, both countries have made significant contributions to reducing deforestation rates in their native ecosystems. Starting in 2004, a mix of public policies including the expansion of protected areas (Herrera *et al* 2019) and market restrictions led Brazil to historic reductions of forest loss in the Amazon, with deforestation rates dropping up to ∼80% by 2012, while beef and soy produced on the same land grew ∼14% and 94% respectively (Nepstad *et al* 2014). However, since 2013, weakened environmental governance and disregard for climate change policies have put deforestation rates on an upward trend (Silva Junior *et al* 2021), raising international concerns and pressure on Brazil to re-establish the conditions that made the previous slowdown of deforestation in the Amazon possible. As for Indonesia, following a peak of primary forest loss in 2015 due to massive peatland fires, deforestation has been steadily dropping, with the last few years seeing the lowest rates of deforestation since monitoring started in 1990 (MoEF 2020). But as with the case of Brazil, political developments under current President Joko Widodo's government have also affected climate policy and environmental conservation. Over the last years, his pro-business government has passed legislation encouraging the expansion of large-scale commercial plantations and mining operations in primary forest areas, and continues to prioritize economic growth over environmental sustainability under a 'planned deforestation' model (Dwisatrio *et al* 2021).

In addition to their efforts to curb deforestation, Brazil and Indonesia have also committed to very ambitious and similar international restoration targets. In their Nationally Determined Contributions (NDC) submitted to the UN Framework Convention on Climate Change (UNFCCC), both countries set the target of restoring 12 Mha of degraded forestlands by 2030 (GoB 2016; GoI 2021), with Indonesia including also the rehabilitation of 2 Mha of peatlands, also by the end of the decade (GoI 2021). While closely related and largely supported by the same institutional framework, forest *restoration* is conceptually and operationally different to *avoided deforestation*. Temporally, restoration comes after deforestation/degradation has occurred, and will often require dedicated plans and retargeting policies, in addition to specific implementation mechanisms tailored to the local context (Chazdon *et al* 2016, 2021).

This paper contributes to a growing body of literature (Chazdon *et al* 2016, 2017, 2021, Bustamante *et al* 2019, Stanturf *et al* 2019, Fagan *et al* 2020, Slobodian *et al* 2020) that studies forest restoration policies and their adequacy to meet countries' restoration targets, thus contributing to global restoration goals. When discussing the policy and institutional elements that enable large-scale implementation of restoration initiatives, most of the scientific literature tend to focus on overarching categories, generally applicable across different contexts (Chazdon *et al* 2016, 2021, Mansourian 2016, 2017, Slobodian *et al* 2020). In this article, we focus on the specific contexts of Brazil and Indonesia. To the best of our knowledge, no other study has offered an overview of the policy landscape supporting restoration initiatives in both countries. First, we identify their main restoration commitments. Second, we identify and offer a descriptive analysis of the main policy instruments that support their implementation. Third, we discuss the main challenges that both countries face in the implementation of their restoration commitments, thus hindering progress to the achievement of their restoration targets.

We expect this study to be of use for researchers and policy makers in the field of restoration seeking to have a general understanding of the distinct policy landscapes supporting restoration in both Brazil and Indonesia. Furthermore, we expect this article to lay the foundation for new research, particularly ex-post empirical analysis and evaluation of policy instruments, in order to have a better understanding on what has worked and under what circumstances when attempting to restore large areas of degraded tropical ecosystems.

2. Literature review of restoration targets and policies in Brazil and Indonesia

The analysis offered in this study is based, first, on a review of existing scientific and peer-reviewed literature which was gathered using different databases and search engines, such as ScienceDirect and Google Scholar. The search included the following keywords: 'restoration', 'rehabilitation', 'reforestation', 'recover', 'forest', 'landscape', 'land use', 'tropical', 'degradation', 'deforestation', 'commitment', 'target', 'pledge', 'policies', 'plan', 'strategy', 'implementation' and 'governance', which were combined in iterative rounds with the keywords 'Brazil' and 'Indonesia'. Year of publication (cut-off was set in 2014), number of citations, title, and abstract were the main criteria to determine the selected literature. Second, the study also considered a review of grey literature and institutional reports, such as Brazilian and Indonesian government documentation, their submitted NDCs, legislation, government reports and statistics, publications from NGOs such as the World Resource Institute (WRI) and the International Union for Conservation of Nature (IUCN), and online databases such as Global Forest Watch and Climate Watch, which were selected through snowballing from the peer-reviewed literature and following input provided by local experts on the restoration policy landscape of Brazil and Indonesia. The goal was not to provide an exhaustive and detailed review of all Brazilian and Indonesian restoration-related policies, but to identify which are the main policies supporting the implementation of their restoration targets, review their performance in light of the empirical literature, and to discuss the most salient obstacles that both countries face in the implementation of large-scale restoration, and thus in the achievement of their restoration commitments.

3. Definition and scope of analysis

For the purpose of identifying which policies support the restoration of forests and other types of native vegetation in Brazil and Indonesia, and more specifically, which policies support the implementation of their restoration commitments, this article follows the definition of ecosystem restoration adopted by the UN Decade on Ecosystem Restoration 2021–2030, according to which ecosystem restoration 'is the process of halting and reversing degradation, resulting in improved ecosystem services and recovered biodiversity' (UNEP 2021). The UN specifies that ecosystem restoration includes a continuum of restorative activities, but to qualify as restoration, the activity 'must result in net gain for biodiversity, ecosystem health and integrity, and human well-being, including sustainable production of goods and services' (FAO, IUCN, CEM & SER 2021). Based on this approach to ecosystem restoration, this article focuses on one major category of restorative activity: the ecological restoration of natural forests. This specific type of restorative activity aims to eliminate the drivers of degradation and assist forest ecosystems to recover to the trajectory they would be on if degradation had not taken place (FAO, IUCN, CEM & SER 2021).

Following this approach, there are three main strategies to ecological restoration of natural forests: (a) natural regeneration (or passive restoration), which requires no more than avoiding the drivers of deforestation and degradation, with trees and native vegetation left alone to regrow; (b) assisted regeneration, which involves some human action, but mainly to reduce or eliminate the stressors that disturb natural regeneration, and (c) active restoration, which involves intensive human intervention, such as planting seeds, seedlings and trees, and also removing stressors to accelerate recovery (Siminski *et al* 2021). In general, natural regeneration has been preferred to active restoration in the context of tropical forests and has also been pointed out as the most cost-effective alternative to large-scale restoration (Díaz-García *et al* 2020).

The article also mentions several references related with the Forest Landscape Restoration (FLR) approach, which is the 'ongoing process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes' (Mansourian *et al* 2017b), and serves as the theoretical basis for the Bonn Challenge. The purpose of FLR is very similar to that of ecosystem restoration as defined by the UN Decade on Ecosystem Restoration, and the adoption of one does not exclude the other. Furthermore, the UN Decade on Ecosystem Restoration explicitly mentions FLR as one of its restoration approaches, together with ecological restoration, regenerative agriculture and rewilding (UNEP 2021). However, the UN Decade on Ecosystem Restoration definition offers a broader scope to ecosystem restoration, which conveniently aligns with the heterogeneity of activities understood as restoration under both Brazil's and Indonesia's restoration commitments. In addition, given that only Brazil has submitted a Bonn Challenge restoration commitment, one could expect to find the elements of a FLR approach in its restoration strategy and policies, but not necessarily in the case of Indonesia, which has not submitted a Bonn Challenge commitment. Hence, is based on the concept of ecosystem restoration adopted by the UN Decade on Ecosystem Restoration focused on ecological restoration of natural forests that this article draws its analysis.

4. Brazil

4.1. Restoration targets

Brazil has one important restoration target that underlie its current restoration efforts. In December

2015, the Government of Brazil (GoB) submitted its NDC to the UNFCCC including the explicit commitment *'to restore and reforest 12 Mha of forests by 2030, for multiple purposes'* as a mechanism to reduce emissions from land-use change and forests. Additional land-use mitigation measures included: (a) strengthening and enforcing the implementation of the Forest Code, (b) making efforts to achieve zero illegal deforestation in Brazilian Amazonia by 2030, and (c) enhance sustainable native forest management systems through georeferencing and tracking systems applicable to native forest management, with a view to curbing illegal and unsustainable practices (GoB 2016). The same 12 Mha target was then announced by Brazil in 2017, with a voluntary contribution to the Bonn Challenge: *'to reforest, restore and promote the regeneration of 12 Mha of forested areas by 2030'*. Following the submission of its NDC and the Bonn Challenge commitment, the GoB reiterated its restoration commitment by announcing the restoration of 'at least' 12 Mha by 2030. At this occasion, the restoration target was included in the National Plan for Recovery of Native Vegetation (PLANAVEG).

4.2. Main policies supporting the implementation of the restoration target

4.2.1. Native vegetation protection law (NVPL)

Brazil's main legal instrument regulating the protection and restoration of native vegetation in rural private lands is the Native Vegetation Protection Law (NVPL), also known as the Forest Code. The NVPL provides two basic mechanisms for the protection and restoration of native vegetation: Permanent Preservation Areas (Área de Preservação Permanente, APP) and Legal Forest Reserves (Reserva Legal, RL).

APP are environmentally sensitive areas considered critical for the provision of essential ecosystem services, such as ensuring clean and steady water supply, protection of geological and soil stability, or conserving biodiversity. The NVPL mandates for APP to be left intact by landholders. APP typically include riverbanks, springs, mangroves, hilltops, steep slopes and sandbanks (Chiavari and Leme Lopes 2015).

RL, on the other hand, mandate that every rural landholder must designate a portion of their property, which is restricted from forest clearing, and must be conserved with natural vegetation by their owners. Should vegetation be under the legal percentage, landholders must compensate for the deficit by actively reforesting or restoring the land, or face penalties otherwise.

In establishing the legal percentage that should be left aside as RL, the NVPL distinguishes between rural properties located inside the Legal Amazon[7] (LA) and those located outside of the LA. In addition, for properties located inside the LA, the RL percentage differs according to the type of biome where they are located. Inside the LA, the RL is of 80% in the Amazon biome, 35% in the Cerrado biome, and 20% in grasslands. Within the Amazon biome, the NVPL provides that the RL of 80% can be reduced by state public authorities to 50% in the states that have more than 65% of their territory covered by Protected Areas (i.e. Conservation Units and/or Indigenous Lands). Outside of the LA, the NVPL establishes a RL of 20%, regardless of the type of biome (table 1, figure 1).

Table 1. Legal forest reserve percentages for different biomes in Brazil. Adapted with permission from Machado (2016). © 2016 WWF (panda.org). Some rights reserved.

Land use	Legal Amazon			Rest of Brazil
	Amazon	Cerrado	Grasslands	
Legal Reserve	80% (50%)[a]	35%	20%	20%
Productive Use	20% (50%)[a]	65%	80%	80%

[a] Indicates that inside the Amazon biome, the NVPL provides that the RL of 80% can be reduced by state public authorities to 50% in the states that have more than 65% of their territory covered by protected areas (i.e. conservation units and/or indigenous lands).

The NVPL provides that RL can be: (a) for economic use in a sustainable way; (b) to help conservation and rehabilitation of ecological processes; and (c) to promote biodiversity conservation. In addition, up to 50% of the RL can be restored or reforested using exotic species, as long as they are interspersed with native species. According to recent estimates, the national deficit of APP and RL is around 21 Mha (MMA 2017). So far, the main strategy of the GoB to promote reforestation and restoration of degraded lands has been to increase compliance with APP and RL to curb the 21 Mha deficit (Dave *et al* 2019).

With the expectation to increase compliance by reducing the regulatory burden, the NVPL established an amnesty from fines and from the obligation to restore RL for all landholders who had cleared forests illegally prior to 2008 (Nepstad *et al* 2014). This special regime was devised to provide an affordable way for rural landholders who illegally clear-cut native vegetation for agriculture purposes before 2008 to comply with the RL requirements (Chiavari and Leme Lopes 2015).

[7] The Legal Amazon is an area of 500 million hectares containing all nine states in the Amazon basin (Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Pará, Rondônia, Roraima and Tocantins). Although called Legal Amazon, the region overlaps three different biomes: all of Brazil's Amazon biome, 37% of the Cerrado biome, and 40% of the Pantanal biome. The main characteristic of the region is the abundant and tropical vegetation, including large sections of rainforest.

Figure 1. Map of Brazil with indication of the different biomes and states based on data from the Brazilian Institute of Geography and Statistics available at: https://www.ibge.gov.br/.

4.2.2. National plan for recovery of native vegetation (PLANAVEG)

In 2017, under the framework of the National Policy for the Recovery of Native Vegetation (Política Nacional para Recuperação da Vegetação Nativa, PROVEG) the GoB launched the National Plan for the Recovery of Native Vegetation (Plano Nacional de Recuperação da Vegetação Nativa, PLANAVEG), in order to articulate, integrate and promote policies, programs and actions for the recovery of forests and other forms of native vegetation. The PLANAVEG has also the explicit purpose of implementing the 12 Mha restoration target announced in Brazil's NDC and Bonn Challenge commitment.

PLANAVEG is the key instrument to facilitate large-scale restoration initiatives in the country. While the NVPL sets the legal basis regulating the protection and restoration of native vegetation in private properties, the PLANAVEG's purpose is to enhance coordination and coherence between national and subnational agencies in restoration efforts, together with strengthening policies, financial markets and promoting best agricultural practices. This interdependence is reflected by the fact that the PLANAVEG intends to achieve the restoration of the 12 Mha predominantly by strengthening the implementation and enforcement of the NVPL (MMA 2017).

PLANAVEG proposes three main lines of action to help the recovery process of native vegetation: motivate, facilitate, and implement the restoration of native vegetation. These three lines of action are in turn developed into nine strategic initiatives: (a) awareness; (b) seed and seedlings; (c) markets; (d) institutions; (e) financial mechanisms; (f) rural extension; (g) spatial prioritization and

monitoring; (h) research and development; and (i) human resources (MMA 2017).

The costs of restoration will vary depending on the method used to recover native vegetation. PLANAVEG describes five commonly used methods to promote recovery of native vegetation, with different costs per hectare, ranging from natural regeneration at the lowest cost, to complete plantations at the highest. Brancalion *et al* (2019) conduct a detailed cost assessment of restoration projects in the Amazon, Cerrado and Atlantic Forest biomes in Brazil, and estimate restoration costs associated with implementing the 12 Mha target of PLANAVEG. They estimate a price tag between US$ 700 million and 1.2 billion per year until 2030 to implement Brazil's restoration plan. Benini and Adeodato (2017) estimate that the cost of restoring 12 Mha could reach US$ ∼3.8 billion per year under a scheme of complete assisted plantation, equivalent to 10.8% of the yearly public budget for agriculture (Crouzeilles and Brancalion 2019).

Despite the cost, the expectation is that the implementation of PLANAVEG will generate many socioeconomic and environmental benefits, including (a) reduced cost of compliance with the NVPL; (b) consolidation of the restoration supply chain; (c) increased farmer access to capital and markets; (d) creation of 112 000–191 000 jobs (MMA 2017); (e) diversifying farmer income from new sources of revenue such as timber, non-timber forest products, and payments for environmental services; (f) reduced risk associated with natural disasters; (g) supply of drinking water to urban areas; (h) contribution to biodiversity conservation; and (i) carbon sequestration (World Bank 2017).

4.2.3. Rural environmental registry (CAR)

The NVPL introduced the Rural Environmental Registry (Cadastro Ambiental Rural, CAR) to monitor environmental compliance in rural properties. The CAR is a national electronic public registry, mandatory for all rural properties, with the purpose of integrating rural real estate environmental information. The NVPL requires all landowners to georeference and register their properties using high-resolution satellite images, identifying in a spatially explicit way the property boundaries and the precise areas and limits of the APP and RL, and submit all to the Federal CAR System (SiCAR). The SiCAR integrates and systematises the information provided by rural landowners, facilitating better management and planning of land use in forests, savannas, rural and remote areas. Implementation of the CAR is intended to reduce the costs of monitoring illegal deforestation and facilitate law enforcement and compliance with the NVPL.

Registration to the CAR is incentivized through different mechanisms: (a) strictly enforced fines for non-registration; (b) access to additional lines of credit for farmers; (c) suspension of fines resulting from illegal deforestation; (d) the intervention of public prosecutors enforcing the NVPL on large agricultural companies; and (e) subsidies for furnishing the geo-referenced imagery required for registration.

By the end of 2020, the SiCAR had reached over 7 million farms, corresponding to ∼566.9 Mha (MAPA 2021). The SiCAR system has been explicitly pointed to as a key tool for the implementation of the NVPL, and to fill the 21 Mha deficit of APP and the RL, and thus meeting Brazil's 12 Mha restoration target. The expectation is that following the current stage of registry and validation, the SiCAR will support landowners to develop restoration plans to compensate for illegal deforestation and comply with the NVPL's legal reserve requirement (Dave *et al* 2019).

4.2.4. Environmental reserve quota (CRA)

The NVPL contemplates also the Environmental Reserve Quota (Cota de Reserva Ambiental, CRA) as an alternative mechanism for landowners that are below the RL threshold to compensate or offset their deficits by purchasing surplus from landholders with native vegetation in excess of the minimum RL requirements. This opportunity extends to farmers that over-deforested before 2008. As such, CRA represents another source of income for over-compliant farmers and potentially reduces the cost of environmental compliance for farmers with native vegetation deficits. With the CRA, farmers that over-deforested before 2008 get to choose between continuing their agricultural activity and purchasing CRA in compensation, or restoring deforested areas in their properties.

Admittedly, the CRA is more an offset mechanism than a restoration option. However, its implementation could create a market for forested lands, adding monetary value to native vegetation. Given the relatively high costs of restoration and reforestation in some regions, exchange of CRA could become an effective way to facilitate compliance with the NVPL (Nunes *et al* 2016).

4.2.5. REDD+ initiatives

One additional mechanism to incentivise restoration of forests (or to avoid deforestation and land degradation in the first place) is to directly pay landowners for the conservation of forests in the form of payments for ecosystem services (PES). Perhaps the most classical example of PES in this context is the REDD+ (Reducing emissions from deforestation and forest degradation) mechanism, which has also gained international notoriety since its recognition in Article 5 of the Paris Agreement. The REDD+ mechanism facilitates international cooperation and mobilising financial resources to support developing tropical nations to implement sustainable forest management practices that favour carbon sequestration.

The Brazilian National Strategy for REDD+ (ENREDD+) was launched by the government in 2016. It focuses on actions to prevent and control deforestation and forest degradation and to promote forest recovery and conservation as well as sustainable development (MMA 2016). As of today, the core of the ENREDD+ financial architecture is mostly represented by national funds, such as the Amazon and the Climate Fund (Gallo and Albrecht 2019). The Amazon Fund is the world largest REDD+ programme, funded with over US$ 1 billion donated by Norway and Germany between 2008 and 2017. Related projects have helped farmers with CAR registration and regularisation of their properties, as well as supported environmental planning (Correa *et al* 2020). By the end of 2020, implementation of REDD+ initiatives had involved over US$ 720 million distributed to more than 100 projects through the Amazon Fund (BNDES 2020). The Climate Fund, on the other hand, was created in 2009 as one of the instruments of the National Policy on Climate Change. In its Native Forests sub-programme, the Climate Fund is focused on projects associated with sustainable forest management, restoration with native species, and consumption of forest products of sustainable origin (Gallo and Albrecht 2019). While evidence indicates that some REDD+ initiatives have been relatively effective at reducing deforestation and carbon emissions (Correa *et al* 2019), their impacts on forest restoration are less clear (Bustamante *et al* 2019).

Subnational REDD+ strategies have developed at the state level with promising results. The Bolsa Floresta, for example, is a cash-transfer programme for rural communities that provides payments for environmental protection (Assunção *et al* 2015). Early evidence suggests these programmes have positively contributed to slow deforestation and compensated for the potential impacts on communities' livelihoods as a result of shifting to more sustainable forest management practices (Alves-Pinto *et al* 2018). More recently, following a US$ 96 million payment by the UN Green Climate Fund, the GoB launched FLORESTA+, a programme to promote ecosystem restoration, provision of ecosystem services and strengthening the country's REDD+ strategy (Dave *et al* 2019).

4.2.6. Soy and beef moratoria

While not restoration-specific, market restrictions have nevertheless played a particularly relevant role in the protection of forests in Brazil. In 2006, major grain traders signed the Soy Moratorium, an agreement not to purchase soy produced in illegally deforested lands. In the following years, illegal deforestation due to soy production fell from 30% in 2004 to 1% in 2014 (Gibbs *et al* 2015). Tailored after the Soy Moratorium, in 2009 the Beef Moratorium was agreed upon between cattle farmers not to commercialise beef produced in illegally deforested land. These market restrictions together with the PPCDAm and the Critical County programme played a key role in Brazil's remarkable 80% reduction of deforestation in the Amazon occurred between 2004 and 2012 (Nepstad *et al* 2014). Despite these results, a 'leakage' effect (land-use restrictions in one area shift environmentally destructive activities to another non-restricted area) has been observed to occur due to the moratoria, with soy plantations and cattle ranching shifting to the neighbouring, non-forest, Cerrado region in southern Brazil, where more than 20 Mha of natural vegetation are suitable for agriculture, and up to 11 Mha could be legally converted under the Forest Code's regulatory framework (Gibbs *et al* 2015). In 2017, and in response to deforestation leakage from the Amazon into the Cerrado region, a multi-stakeholder forum led by the Brazilian soy industry signed the Cerrado Manifesto to signal support for reducing soy, cattle, and other commodity-related deforestation in the region.

4.2.7. Action plan for the prevention and control of deforestation in the legal Amazon (PPCDAm)

The Action Plan for the Prevention and Control of Deforestation in the Amazon (PPCDAm) is not a restoration-dedicated policy either. However, it sets a crucial policy framework for coordinated forest protection in the Amazon States. Established in 2004, the PPCDAm elevated the issue of Amazon deforestation to the President's Chief of Staff, who coordinates the activities of 15 ministries, facilitating operations across many agencies, including the Federal Police, the Army, and the Public Prosecutors Office. The activities under PPCDAm are organised under four major pillars: (a) tenure regulation and territorial planning; (b) environmental monitoring and control; (c) promotion of sustainable forest management; and (d) economic and regulatory instruments. The PPCDAm also sets a target initially aimed at reducing deforestation by 20%, which later increased to 80% relative to the 1996–2005 baseline. Tacconi *et al* (2019) report that following the implementation of the PPCDAm, infractions issued by environmental enforcement agencies rose seventy-fold between 2004 and 2010, relative to 2000–2004, resulting in a significant reduction in deforestation rates (Assunção *et al* 2015, Bustamante *et al* 2019). Furthermore, the institutional framework of the PPCDAm facilitated the creation of the Critical County in 2008, a government programme that 'blacklisted' municipalities failing to address deforestation requirements, leading to fiscal punishments such as restricted access to rural credit. Koch *et al* (2019) estimate the effects of the Critical County and find a reduction of deforestation rates of 44%–55% between 2004 and 2014 in targeted municipalities. Furthermore, they also find a significant positive effect of the Critical County programme on the productivity of cattle ranching

in listed municipalities, suggesting that strong forest protection in the form of policies that induce land scarcity may lead to agricultural intensification and high-yield farming without the need of clearing forests.

5. Indonesia

5.1. Restoration targets

Over the last decade, Indonesia has pledged different restoration targets. In its 2016 submitted NDC, the Government of Indonesia (GoI) committed to reduce its carbon emissions by 29% from a business as usual scenario, represented by 2010 levels of emissions, and by 41% conditional to receiving international support. According to the NDC's projections, emissions from AFOLU should drop 70% unconditionally and more than 90% with external support in order to meet its target. Chief among the measures outlined by the government to reduce emissions are *'the rehabilitation of 12 Mha of degraded land and the restoration of 2 Mha of peat ecosystems*' (GoI 2016). The GoI confirmed this restoration commitment in its recently updated NDC submitted to the UNFCCC in July 2021, where it also specified that the 12 Mha will be achieved through 6.4 Mha of timber plantations and through 5.4 Mha of land rehabilitation (GoI 2021).

In parallel, during the period of 2015–2019, the GoI set the domestic target to restore 5.5 Mha of degraded forest lands, and 2.6 Mha of peatlands. Initially, the projection was to rehabilitate 1.25 Mha or degraded forest lands per year from 2015 to 2018, and 500 000 ha in 2019, while the peat restoration target was to be achieved by 2020 (MoEF 2020). According to the latest government estimation, by late 2019, ∼1.1 Mha of forestlands had been restored, which represents 20% of the projected 5.5 Mha of restored land by 2020 (MoEF 2020). Regarding peatlands, by the end of 2020, the government reported achieving only 45% of the 2.6 Mha, and the deadline was subsequently extended to 2024 together with also adding a new target for mangrove restoration—600 000 ha to be restored by 2025 (World Bank 2021).

It remains unclear if the 5.5 Mha domestic target should be understood as subsumed under the 12 Mha NDC restoration target or whether they should be independent from each other. The submitted NDC and other official government publications make no crossed references between both restoration targets. The same applies to the 2 Mha NDC peat restoration target and its 2.6 Mha equivalent.

5.2. Main policies supporting the implementation of the restoration target

5.2.1. Forestry Law No. 41 of 1999

The main regulatory instrument supporting forest and landscape restoration efforts in Indonesia is Forestry Law No. 41 of 1999. According to the Forestry Law, all forests in the Indonesian territory are controlled by the government: an area of ∼120 Mha equivalent to ∼60% of the country's territory. These forests are called Forest Estate and fall under the administration of the Ministry of Environment and Forestry (MoEF). Most of Indonesia's remaining land area is made up of non-forest public lands, known as Area for Other Purposes (APL). Forest Estates are in turn divided into three functional areas: production, protected, and conservation forests (figure 2). Under this framework, the MoEF issues permits and licences over Forest Estate areas that allow for private and public companies to operate in production forests. Permit-holders with licences to conduct productive activities including timber and non-timber products' collection must maintain and preserve forests where they operate and pay a fee in contribution to the afforestation and conservation fiscal funds.

An important aspect of the area definition in the Forestry Law is that land designation does not always correspond to the actual land use or cover (Siskawati *et al* 2017). An area designated as production forest, for example, may be covered with primary native vegetation, and an area legally designated to be protected may have a productive palm oil plantation. This discrepancy between land designation and actual land use can have important implications for forest management and environmental protection. Policies and incentives supporting restoration will follow the legal designation of the land before the actual land use. As such, a landholder with standing native vegetation in a productive forest may be incentivised to deforest the land and switch to agriculture given the regulatory and economic costs of forest conservation. Also, a very sensitive issue related to land designation, is that under the Forestry Law, ancestral occupation by indigenous communities was not initially acknowledged and recognised. As a result, large areas of the Forest Estate have overlapping claims between license holders and indigenous communities, with disputes on who should manage and control forestlands (Siscawati *et al* 2017).

5.2.2. Ecosystem restoration concessions

Under the regulatory framework set by the Forestry Law, one policy instrument that was explicitly designed for forest and landscape restoration is the Ecosystem Restoration Concession (ERC). When launched in 2004, the ERC represented a new paradigm in Indonesian forest governance; a shift from extractive to ecosystem-based management (Pareira *et al* 2020). The idea is to create a market-oriented governmental instrument to incentivise private sector investment in ecosystem restoration. Under an ERC, the licence holder must promote restoration activities to re-establish a biological balance, and only after the balance has been reached,

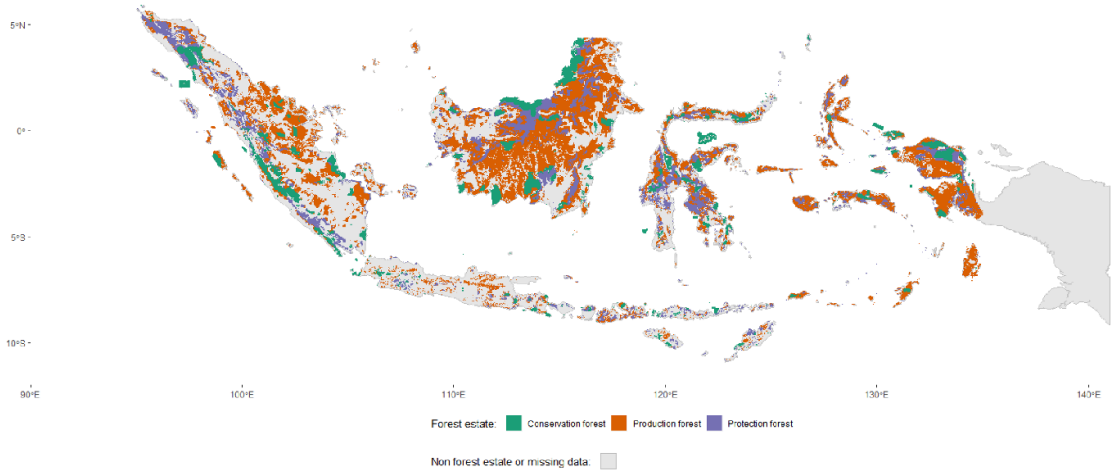

Figure 2. Map of Indonesia showing in colours the distribution of the different functional areas of the forest estate: conservation forest in green, production forest in red, and protection forest in violet. Non-forest estate areas, including areas for other purposes and land with no designation in grey. Disclaimer: this map is indicative. It is a composite of provincial maps for different years. Legal designations may have changed over time. (Own illustration, based on data from the Kawasan Hutan 2019—Kementerian Lingkungan Hidup Dan Kehutanan Republik Indonesia. Ministry of Environment and Forestry).

productive activities such as timber production or palm oil plantations may resume. Until then, companies may sell credits for carbon offsets or profit from other activities, such as ecotourism or production and sales of non-timber forest products. The licence also requires an equitable sharing of benefits with local communities, such as through job creation (Buergin 2016). In 2010, the MoEF set the target to license and allocate 2.5 Mha of production forests by 2014 and later expanded the target by 500 000 ha by 2019 (MoEF 2020). Note that ERC are only granted in severely degraded areas designated as production forests, somewhat limiting the potential for private sector interest in ERC given the considerable investment required to rehabilitate and fertilise degraded land. According to recent estimations, the MoEF has granted 16 ERC over ∼622 000 ha of production forests, equivalent to 20% of the 3 Mha target (Pareira *et al* 2020).

5.2.3. Social forestry programme

Forestry Law No. 41 also set the legal basis for the development of one key instrument for forest and landscape restoration: the Social Forestry Programme (SF). According to article 42 of the law, 'forest and land rehabilitation shall be chiefly implemented primarily by participatory approach to develop potential and empower community'. As a policy instrument, SF has a relatively similar promise compared to that of landscape restoration: aims to secure access to forests, improve communities' livelihood and address deforestation with more sustainable forest management. Under the SF programme, communities are allowed to benefit from non-timber products, practice agroforestry, do selective logging and, in some cases, have timber plantations. Community titles are granted for 35 years.

The idea behind the SF is that if local communities are incentivized to protect the forests where they live, deforestation should decrease, while the ecological condition of the forest should improve. However, the relationship between communal land tenure and forest protection remains unclear. Resosudarmo *et al* (2019) find that SF reduced users' ability to benefit from the forest and that areas managed under SF demonstrate higher rates of forest cover loss compared to state-managed forest areas. More recently, Kraus *et al* (2021) estimate the early effects of the programme's roll-out. By analysing data from 2009 to 2019 covering ∼2.4 Mha they find that, contrary to its objective, community titles tended to increase forest loss when there was no additional income from timber. Conversely, Santika *et al* (2017) find reduced deforestation in village forests, noting, however, that a more systematic evaluation of the outcomes of SF is lacking. Despite inconclusive evidence on its effectiveness, in 2015 the GoI promised to redistribute 12.7 Mha under the SF programme by 2019. The idea was to formalize *de facto* land occupation, benefit small and landless farmers, and ensure the availability of land to forest-dependent communities. By 2020, however, only 1.7 Mha of the 12.7 Mha had been allocated to SF schemes (MoEF 2020).

5.2.4. Moratorium of new licences on primary forests and peatlands

Similar to Brazil, the moratorium on the utilisation of primary natural forest and peatlands is not a restoration-dedicated policy, but arguably Indonesia's chief command-and-control mechanism to reduce deforestation (Tacconi and Muttaqin 2019).

The moratorium involves the temporary suspension on the issuance of new licenses for productive activities in primary natural forest and peatland areas, including conservation, protection and production forests, as well as APL. The legal basis for the moratorium is a 2011 Presidential Instruction introduced as a result of a bilateral agreement with the Government of Norway, in which Norway pledged one billion US dollars for the preparation and implementation of REDD+ policies in Indonesia. The moratorium had an initial validity of two years and suspended the issuance of logging licences over an area of approximately 22.5 Mha. The moratorium was subsequently renewed four times, until August 2019 when the President turned the moratoria permanent (MoEF 2020).

There are contesting views on the moratorium's effectiveness in halting deforestation. According to WRI Indonesia, the moratorium achieved a 45% drop in deforestation rates inside moratorium areas in 2018 compared to 2002–2016 (Wijaya *et al* 2019). Similarly, Chen *et al* (2019), based on a spatially explicit temporal analysis of forest loss from 2001–2017 in logging, timber, and oil palm concessions, find that land concessions outside the moratorium experience higher rates of forest loss than in comparable land concessions within the moratorium. Contrarily, using data from the University of Maryland, a Greenpeace study finds the opposite: deforestation rates in areas within the moratorium increased since 2011 (Jong 2019). In addition, Tacconi and Muttaqin (2019) note that sensitive issues remain unaddressed, such as the non-inclusion of secondary forests, lack of monitoring and enforcement, and mapping inconsistencies.

5.2.5. One map policy

Envisioned as a key instrument to improve spatial planning, and subsequently contribute to the implementation of SF schemes and the ERC, the original One Map initiative was launched by the GoI during 2012 to digitise data and information related to forest areas in one single public portal. Similar to Brazil's SICAR system, the One Map Policy aims at building one single database consolidating all government maps to ensure that all agencies refer to the same land use information. It is intended to facilitate the resolution of conflicts associated with overlapping claims over the same land, keep a record of forest cover change, monitor compliance with forestry law, and detect illegal logging. Inconsistencies in references and standards in the generation of maps by different government agencies issuing licences have resulted in overlapping permits over the same territory. The Geospatial Information Agency is therefore tasked with collecting, standardising and integrating different maps to detect concessions' overlaps, inconsistent borders and other irregularities. Some progress has also been made in the area of customary mapping, by allowing local and indigenous communities to submit their own maps. However, the GoI remains reluctant to fully integrate these maps, on the basis of different methodologies and standards for generating them (Shahab 2016). More recently, in 2018, the Government launched the One Map Geoportal (https://portal.ina-sdi.or.id), where public agencies and the public may access the latest updated mappings of Indonesian territories.

5.2.6. REDD+ initiatives

Indonesia was an early mover on the REDD+ mechanism, which helped the country to better understand the drivers of deforestation and forest degradation (Dwisatrio *et al* 2021), and still today, the GoI considers REDD+ a key policy to provide national-scale incentives to reduce forest and landscape degradation (MoEF 2020, GoI 2021). Following Norway's US$1 billion pledge, Indonesia undertook the task of setting up the institutional architecture for the implementation of REDD+ activities. As part of this process, significant initiatives were developed alongside the REDD+ preparation activities, including the moratorium and the One Map Policy. Following this initial progress, in 2015 President Widodo dissolved the REDD+ Agency which had been established in 2013, and reorganized it under the MoEF, but with less autonomy and hierarchy (Dwisatrio *et al* 2021). In 2019, the GoI established the Environmental Fund Management Agency as the last institutional component of its REDD+ strategy. Accordingly, Indonesia is to benefit from international funding, including the Green Climate Fund, to which it has already applied for US$ 103 million, and the BioCarbon Fund, from which it expects to receive US$ 70 million (MoEF 2020).

A recent study by the Centre for International Forestry Research (CIFOR), concludes that REDD+ initiatives in Indonesia have been too focused on implementation technicalities rather than addressing forests degradation, or contributing to restoration activities. More recently, some REDD+ initiatives have been slowly progressing from stand-alone local projects to larger subnational jurisdictions. Despite showing some progress, these projects have yet to be fully implemented at the local level to evaluate their mitigation impact, including biodiversity and community co-benefits (Dwisatrio *et al* 2021).

5.2.7. Presidential regulation no. 1 of 2016: peat and mangrove restoration agency (BRMG)

Following the massive peatland fires of 2015, the GoI passed the Presidential Regulation No. 1 of 2016 which created the Peat Restoration Agency with the specific mandate to coordinate and facilitate the restoration of 2 Mha of degraded peatlands. The agency has prioritised restoration in seven provinces: Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, South Kalimantan, and Papua. In 2020, the PRA was amended to include the restoration

of 600 000 ha of mangroves and was subsequently renamed as Peatland and Mangrove Restoration Agency (Badan Restorasi Gambut dan Mangrove, BRMG) (MoEF 2020). The BRMG is responsible for adopting policies related with governance and management of peatlands, including: (a) preventing forests and land fires occurrence; (b) suspending the issuance of new licences for the utilization of peatlands; (c) prohibiting further land clearing in protected peatlands; (d) reviewing current forest plantation licences and rearranging concessions' configuration; and (e) monitoring restoration activities in production, protected and conservation forests. The BRMG together with the MoEF have collected and consolidated a National Peat Ecosystem Function Map to support peatland ecosystem protection, management and restoration. According to recent estimations, ∼24 Mha of Indonesia's peatland fall under the classification of damaged peatland (MoEF 2020). The restoration of peat lands in production forests is conducted by licence holders such as timber and palm oil companies and requires the submission of Peat Ecosystem Restoration Plans with a detailed strategy, timeline and budget regarding the restoration activities to be conducted. Companies are required to regularly report to the MoEF restoration progress (MoEF 2020).

6. Restoration challenges

In the previous section we identified the restoration targets that Brazil and Indonesia have announced to be implemented by the end of the decade. We have also identified and provided a descriptive analysis of the strategy and main policies that will support the implementation of these targets in both countries. Our analysis also identified some relevant challenges that Brazil and Indonesia face in the implementation of their restoration targets. We have summarised our findings below.

6.1. Target misalignment and unclear implementation strategy

Perhaps the most evident observation that can be drawn from this overview, is that while Brazil has one restoration target, namely to restore 12 Mha by 2030, Indonesia has multiple, including two forest, and three wetland targets (figure 3). As noted, from the consultation of government documents and official publications, there is no apparent relation nor contradiction between the 12 Mha and the 5.5 Mha forest restoration targets. Since the latter was originally meant to be achieved my 2019, it is possible that the GoI is no longer considering it as currently valid, and that it has been effectively absorbed by the 12 Mha. Something similar occurs with the peatland restoration target. While the NDC indicate the restoration of 2 Mha by 2030, the BRMG and the MoEF (2020) refer to the restoration of 2.6 Mha by 2025. The recently announced target of restoring 600 000 ha of mangroves by 2025 adds to the confusion. There seems to be a divide between what the GoI pledges to internationally with what is announced domestically. Perhaps the NDC targets have yet to be officially ratified at the domestic level or translated into policy by the MoEF and the BRMG. The latest government documentation does not provide clarification on this point.

One second observation directly related to the first one is that following the announcement of its restoration target, the GoB announced a specific and dedicated plan for its implementation. Under the institutional framework of the PLANAVEG, the government will strengthen the implementation of the Forest Code by enforcing the recuperation of the 21 Mha deficit of RL and APP in private landholdings. This process will be in turn facilitated with the expansion of the SICAR to improve mapping and monitoring systems and enforce forest and environmental regulations, prevent and detect illegal deforestation, and identify degraded areas to prioritise restoration activities. In the case of Indonesia, however, that specific plan is missing for its forest restoration target(s). Besides from projecting how many hectares will be restored annually, no restoration-dedicated strategy has been advanced by the GoI with indication of the policies that will support its implementation, ultimately limiting Indonesian capacity to coordinate instruments and agencies' efforts towards the achievement of one unique restoration target. The Forestry Law establishes some provisions on land and forest rehabilitation, and ERCs are dedicated instruments to restore degraded land, but there is no evident linkage between these regulations and Indonesia's restoration targets.

The case is somewhat different with wetland restoration. The 2.6 Mha peatland restoration target was announced simultaneously with the creation of the agency responsible for implementing it: the BRMG. The same applies to the restoration of 600 000 ha of mangroves. The BRMG has outlined a clear timeline and strategy for implementation, with indication the territory where restoration will be prioritized, the policy instruments that will support the process and a dedicated budget for operation.

6.2. Deficient mapping and land tenure conflicts

Since restoration takes place on the landscape, it is critical to have detailed and updated mapping systems to identify which areas are deforested or degraded, and therefore need to be restored. In addition, complete and accurate mapping systems allow for data-sound spatial planning, and to design land-use policies based on imagery that reflects the actual vegetation on the ground. As such, the CAR in Brazil and the One Map Policy in Indonesia are pivotal for the implementation of their restoration commitments.

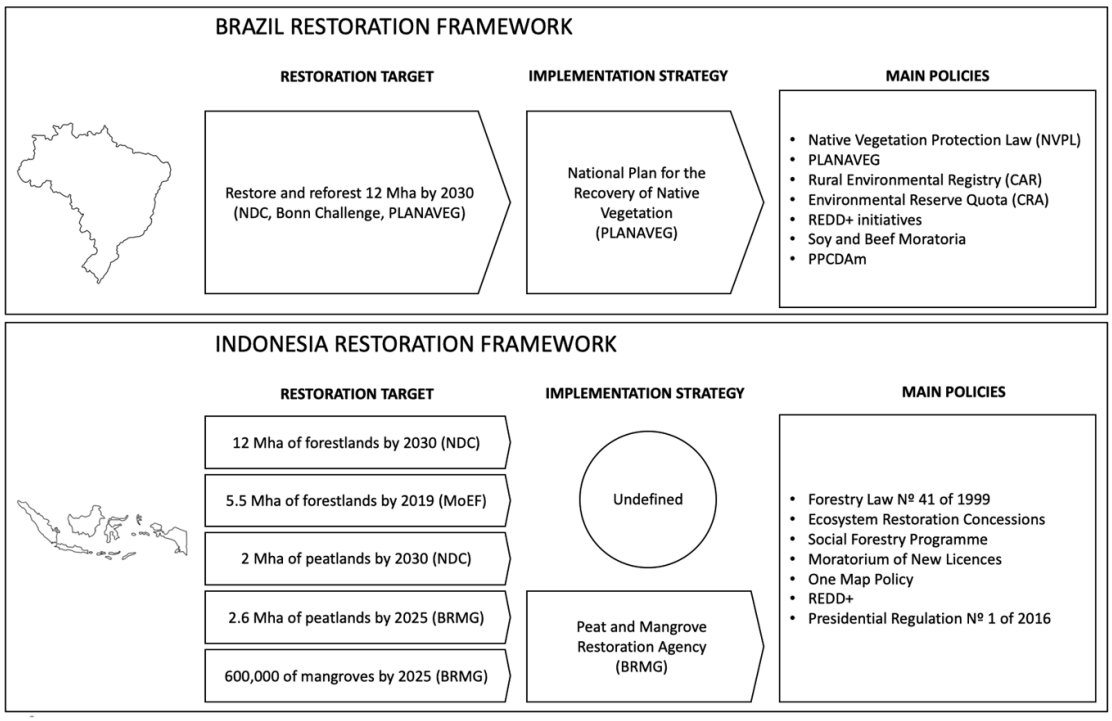

Figure 3. Diagram showing the restoration framework of Brazil and Indonesia. The framework identifies restoration targets, implementation strategy and the main policies supporting the implementation of the restoration target and strategy. In the case of Brazil, the framework identifies one restoration target, a national strategy to implement it and the main policies supporting the implementation of the restoration target and strategy. In the case of Indonesia, the framework identifies five different restoration targets from different sources (NDC, MoEF, BRMG), with different extensions of land and periods for implementation. A clear strategy for implementation was identified only in the case of the targets belonging to the BRMG (2.6 Mha of peatlands and 600 000 ha to be restored by 2025) (source: Author).

Despite important progress with over 560 Mha of properties registered, the CAR system in Brazil continues to face significant problems, particularly with registration and validation of rural properties. The high number of registrations and the low quality and resolutions of the imagery submitted, coupled with limited staff to analyze the registrations are the biggest challenges at this stage (Chiavari, Lopes and Nardi 2020). In addition, ex-post analyses of the CAR's implementation reveal sensible problems with the geo-referenced mapping, including: (a) overlap of georeferenced private lands; (b) registration of private lands inside protected areas (e.g. indigenous areas where agricultural production is not allowed); and (c) landowners dividing single properties into several smaller properties and titling them to their relatives with the aim of staying below the threshold for environmental compliance, thus avoiding the legal mandate to restore (L'Roe *et al* 2016). Furthermore, and against one key assumption and important purpose of the NVPL, Azevedo *et al* (2017) finds that registration with CAR has not necessarily reduced illegal deforestation, and they conclude that the economic benefits of restoring illegally deforested land continue to be outweighed by the costs of compliance with the NVPL.

Improved mapping systems can also help to resolve discrepancies between land-designation and actual land-cover. The Indonesian One Map Policy was explicitly designed to integrate and synchronize divergent geospatial databases with the aim of resolving persistent conflicts related to misalignment between the ownership, legal designation, and the actual standing vegetation on the same land. With unclear land tenure coupled and inaccurate mapping of the landscape, the distinction between productive or protected forests becomes a challenge, and therefore distinguishing whether a particular activity is legal or not may become contested. Also, without clearly defined property boundaries, identifying the landholder is difficult, which in turn poses challenges for targeting incentives for sustainably managing the forest, implementing programmes, collecting taxes and enforcing legislation. Figure 2 hints on the magnitude and complexity of governing the fragmented Indonesian Forest Estate. The One Map Policy could become an efficient instrument for spatial planning, monitoring and enforcing environmental regulations and prioritizing areas for large-scale restoration. However, its development process has been criticised by civil society organisations due to the government's lack of transparency, opposition to participatory mapping approaches, and its refusal to accept contributions from private landowners or local communities (Dwisatrio *et al* 2021).

6.3. Over-politicisation of environmental governance

Despite both Brazil and Indonesia having committed to highly ambitious restoration targets, recent political developments have raised international concerns over the course that climate policy and environmental governance has taken in both countries.

Following Brazil's historical drop in deforestation rates, since 2015 onwards the country has been experiencing an upward trend in forest loss. According to estimates from the Brazilian Amazon Deforestation Monitoring Program (PRODES), since 2019 deforestation rates inside the LA have systematically surpassed the 10 000 km^2 for the first time in decades, with 2021 showing the highest rates of the last 15 years (INPE 2021). This upward trend has been associated with a multiplicity of factors, including the economic crisis affecting the country from the onset of 2015 (Dobrovolski *et al* 2018), and more importantly, due to the progressive weakening of environmental governance initiated under President Temer in 2016, and further exacerbated under President Bolsonaro since 2019 (Abessa *et al* 2019). In April 2019, President Bolsonaro issued Presidential Decree 9759, which established new integration, rules and limitations for climate and environmental public administration collegiate bodies, including the Forum on Climate Change, the National Biodiversity Commission, the National Forestry Commission, and the PLANAVEG directive commission, the CONAVEG. The implementation of the PLANAVEG as a national restoration strategy has been effectively suspended since (ASCEMA 2020).

More recently, in March 2022 Brazil submitted its updated NDCs to the UNFCCC, announcing that it would reduce its mitigation ambition, increasing by hundreds of million tons the level of allowed carbon emissions to be released into the atmosphere. As far as its land-based targets are concerned, the NDCs remained silent on the 12 Mha restoration commitment and the zero illegal deforestation target in the Amazon by 2030 (Unterstell and Martins 2022). In a revealing study, Vale *et al* (2021) examined legislation and institutional change in Brazil since Bolsonaro took office. They find that nearly 60 legislative acts are aimed at deregulating or weakening environmental protection, with a number of them aimed at dismantling federal agencies, such as the Brazilian Institute of Environment and Renewable Natural Resources, and the Chico Mendes Institute for Biodiversity Conservation, including severe budget cuts, reduction of staff and limiting participatory processes. In sum, the current administration has not reiterated the 12 Mha restoration commitment, has suspended the implementation of the PLANAVEG, and withdrawn financial support to large-scale restoration.

In Indonesia, restoration initiatives have also been affected by changing political circumstances. As noted, in 2015 President Widodo disbanded the REDD+ Agency which his predecessor, President Yudhoyono, had established only two years before in 2013, affecting the degree to which the implementation of the REDD+ architecture was helping to coordinate climate change policies across different sectors and ministries (Dwisatrio *et al* 2021). More recently, the current Widodo administration has received criticism for its pro-business tendency and inclination for neoliberal economic development by deregulating and weakening environmental protection (Jong 2020). In October 2020, Widodo's controversial 'Omnibus Law' was passed to facilitate business enterprises and job creation by simplifying licencing processes on forested areas. Under the Omnibus Law, environmental permits are no longer a prerequisite to obtain a business licence to operate in forested areas, community involvement and participation during the licencing process is severely limited, the requirement to maintain 30% of native vegetation along the river basin is eliminated, and significant changes to the designation of forest areas and their functions no longer require the Congress' authorisation. Experts have warned that the rollback of environmental protection might result in greater deforestation and also undermine the institutional conditions that make restoration economically attractive (Jong 2020).

6.4. Unclear methods to measure restoration progress

Brazil and Indonesia have aligned their restoration agendas under specific land targets: number of hectares to be restored by a specific year. Measuring progress, therefore, should be straightforward. Brazil, for example, should be able to determine if their restoration target has been achieved by simply counting how many hectares have been restored by the end of 2030. However, progress is not only measured in terms of hectares restored, but more importantly in terms of its multiple co-benefits, including climate change mitigation and adaptation, protection of biodiversity, increased provision of ecosystem services, and support to local communities. The PLANAVEG elaborates on the environmental, social and economic benefits that are expected to follow from its implementation, but apart from projecting the creation of 112 000–191 000 jobs, provides no baselines or metrics against which to measure progress. In 2018, the Bonn Challenge assessed restoration progress in Brazil and found that ~9.4 Mha have been brought under restoration since 2010, identified a sink of 1.3 billion tonnes of CO_2 equivalent in secondary vegetation from 2005 to 2017, and the creation of 151 000 jobs (Dave *et al* 2019). According to this, Brazil would have reached 78% progress of its target 12 years before 2030. Fagan *et al* (2020) considers Brazil's target already met. Puzzles also that the

Bonn Challenge baseline year to measure restoration progress was set in 2010 while in the PLANAVEG is 2017. In the case of Indonesia, the NDC links restoration to carbon sequestration, and indicates a baseline to calculate progress. Apart from climate change mitigation, no other co benefit is measured as a result of restoration progress. The NDC also establish that 6.4 Mha of its restoration target will be achieved though timber plantations, somewhat suggesting that mitigation and economic co benefits might be preferred to biodiversity conservation in those areas. Similarly, Brazil's NVPL allows up to 50% of the RL to be restored using exotic species, deviating slightly from restoration's purpose of recuperating the ecological integrity of forests.

6.5. Opportunity costs and financial constraints

Given Brazil's and Indonesia's strong economic dependence on the export of agricultural commodities, the introduction of restoration initiatives face important opportunity costs. While converting forests to agricultural land use usually brings quick returns to landowners who can sell the resulting timber and benefit from fast-growing crops or cattle ranching, restoring degraded and deforested land provides benefits only later. In addition, restoration will require also some upfront investment. Whereas passive restoration, such as natural regeneration, usually requires no more than avoiding the drivers of land degradation, active regeneration, such as planting seedlings, carries more significant investment. In the case of Brazil, for example, landowners with an RL deficit must replace crops and cattle for native vegetation and potentially pay penalties for non-compliance with the NVPL. This requires access to funds or credit, as well as bearing important losses of earnings. The challenge, therefore, is to furnish a policy framework conducive to synergies between socioeconomic activity and environmental conservation that turns restoration into a competitive land-use option. One alternative is to tie credit to environmental compliance, similar to what the Critical County programme does in the Amazon, where induced land scarcity led to agricultural intensification with positive effects on cattle-ranch productivity (Koch *et al* 2019). In addition, it is expected that obligatory restoration will upscale the market for and expand supply chains of native seeds and seedlings, creating jobs and opportunities for investment. In addition, PES such as REDD+ initiatives will play a fundamental role in advancing restoration activities, particularly in the case of small farmers with limited access to credit and financial resources. Still, regularisation of land tenure and land tilting are fundamental to incentivise private sector investment in long-term restoration, since landowners will be reluctant to disburse funds as long as their property rights are not fully secured.

7. Conclusion

In this paper we identified Brazil's and Indonesia's restoration targets and the main policies that support their implementation in both countries. We offered a descriptive analysis of these policy instruments and discussed some common challenges faced in the implementation of their targets. Our analysis shows that Brazil has one restoration target and a clear strategy to achieve it, with expected co benefits to follow form its implementation, including carbon sequestration, conservation of biodiversity and community support. However, since 2019, Brazil's federal government has suspended the implementation of the restoration strategy in the context of a broader process of weakened climate and environmental governance. In the case of Indonesia, our analysis shows that the government has announced both forest and wetland restoration targets. We find that the government has more strongly focuses and progressed on the restoration of the peatlands, whereas its commitment to restore forestlands has yet to benefit from a dedicated plan that allows to coordinate policies and agencies' efforts towards the achievement of its restoration target.

Differences aside, we have seen that both countries continue to face several institutional, financial and technical difficulties to implement large-scale restoration initiatives on degraded lands. To meet their ambitious restoration targets, both Brazil and Indonesia will have to devise mechanisms to better align policies, creating the appropriate economic incentives for broader environmental engagement and regulatory compliance. Restoration strategies should be advanced together with improving mapping systems to facilitate monitoring of forest landscapes and on-the-ground implementation. Spatial planning and land tenure regimes will also benefit from improved mapping systems, further strengthening the conditions that support restoration and forest protection. Additional efforts could be put forward in encouraging and facilitating local community participation in mapping activities, favouring accuracy, transparency and inclusion. With robust and technologically sound databases, the costs for monitoring and enforcement would be drastically reduced, liberating budget and staff for other environmental purposes, including scientific research and knowledge transfer. Clearly defined land tenure and secure property rights could possibly enable agricultural intensification, thus reducing incentives to expand plantations by deforesting additional land. In addition, international funding channelled through REDD+ initiatives could help bridge the gap between the ambitious restoration targets and domestic capacity. Perhaps these funds could help support more community engagement with restoration activities, increasing reliance on local and indigenous

knowledge, which would, in turn, provide opportunities for low-cost and innovative solutions, tailored to the specific local circumstances. Furthermore, bottom-up initiatives, encouraging public participation throughout the whole restoration process, could increase the feeling of local ownership and involvement and the likelihood of environmental compliance.

Ultimately, these initiatives will depend on the existence of a robust institutional framework that promotes the integration of public and private actors at the national and sub-national level to facilitate the utilisation of forests and natural landscapes in a way that allows for continued economic activity in an ecologically sustainable way. Both countries will have to find ways to better address these policy challenges.

Data availability statement

All data that support the findings of this study are included within the article (and any supplementary files).

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Author contributions

Constantino Dockendorff conceived of the study, performed the literature review, performed the analysis of the implementation challenges, planned and partially designed the figures and wrote the manuscript. Constantino Dockendorff and Sabine Fuss discussed the results. Sabine Fuss supervised the project and contributed to the manuscript. Raquel Agra provided expert advice on the Brazilian restoration policy landscape and contributed to the manuscript. Valentin Guye designed the map in figure 2. Florian Kraxner and Diego Herrera contributed elements to the manuscript based on their expertise with forestry, international mechanisms and region-specific restoration.

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