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With Power Comes Responsibility – A Rangelands Perspective on Forest Landscape Restoration

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Tree planting has long been promoted to avert climate change and has received renewed impetus in recent years with the Bonn Challenge and related forest restoration initiatives guided by the forest and landscape restoration (FLR) framework. Much of the focus for reforestation and afforestation is on developing countries in Africa, Asia and South America, where large areas of rangelands in drylands and grassy biomes are portrayed as "degraded," "unused," and in need of more trees. This perception is rooted in persistent theories on forests and desertification that widely shaped colonial policy and practice and remain influential in today's science-policy frameworks. From a rangelands perspective, the global FLR thrust raises two main concerns. First, inappropriate understandings of the ecology of drylands and grassy biomes encourage afforestation, grazing restriction and fire suppression, with negative impacts on hydrology, carbon storage, biodiversity, livestock production and pastoral livelihoods. Second, their target-driven approach requires large-scale afforestation and massive funding to achieve. Nearly half of the area pledged to the Bonn Challenge is in fact destined for forestry and other commercial plantations, which threaten pastoral livelihoods and cause ecological damage while having very limited potential to mitigate climate change. As the officially endorsed framework of the Bonn Challenge and related global restoration initiatives, FLR has become a powerful instrument for guiding global restoration efforts and funding. Its proponents have a responsibility to ensure that the framework is evidence-based and underpinned by appropriate ecological models for different ecoregions.

Keywords: savanna, rangeland, pastoralism, grassland, climate change, Bonn Challenge, afforestation, drylands

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INTRODUCTION

In July 2019, Ethiopia was celebrated worldwide for planting over 350 million trees in a single day. "Afforestation is the most effective climate change solution to date and with the new record set by Ethiopia, other African nations should move with speed and challenge the status quo," responded the Director of the United Nations Environment's Africa Office (United Nations Environment Programme (UNEP), 2019). This example epitomizes the current momentum to promote large-scale tree planting as an urgent solution to climate change. The Bonn Challenge, a United Nations programme initiated in 2011 to restore biodiversity and mitigate climate change through restoration of degraded landscapes, has set targets of restoring 150 million ha (Mha) of deforested and degraded land by 2020, and 350 Mha by 2030. The Bonn Challenge has generated several offshoots, including the African Forest Landscape Restoration[1] initiative to restore 100 Mha of degraded forest landscapes in Africa. These massive forest restoration targets raise important questions about the implications for the world's drylands and grassy biomes and the rangelands they support.

The Bonn Challenge and related initiatives officially adopt forest landscape restoration as their guiding framework. Forest landscape restoration (FLR) is "a process that aims to regain ecological functionality and enhance human well-being in deforested or degraded landscapes[2]". From this original broad conceptualization, different constructs of FLR have emerged that reflect the knowledge, traditions and objectives of different disciplines including forestry, ecology and rural development (Mansourian, 2018). General FLR principles include the need to focus on landscapes with their complex socio-ecological and political dimensions, engage stakeholders and support participatory governance, restore multiple functions for multiple benefits, maintain and enhance natural ecosystems within landscapes, respond to local contexts using a variety of approaches, and manage adaptively for long-term resilience (Besseau et al., 2018; Bonn Challenge, 2020).

Despite this compelling win-win rhetoric of restoring ecological integrity, biodiversity and local livelihoods, the target-driven global forest restoration initiatives reflect an enduring, target-driven colonial legacy of forest and resource governance, as well as the progressive commodification of nature and top-down planning driven by international development agencies, national governments and commercial interests (Fairhead et al., 2012, Davis and Robbins, 2018). From a rangelands perspective, two particular concerns stand out.

First, the framework is explicitly forest-centered and targets "degraded" and "deforested" land[3] for "forest restoration." In fact, drylands and grassy biomes are ancient and have formed the resource base of pastoral and agropastoral populations for millenia (Davis, 2016; Bond et al., 2019). Their restoration requires approaches that maintain their structure and function as disturbance-adapted, open ecosystems (Bond, 2019). The strong forest-centered ideology underpinning FLR has a long and unacknowledged history rooted in centuries-old theories on the causes and effects of deforestation and desertification, which have widely shaped colonial policy and practice and remain influential today (Davis, 2016). This has had detrimental consequences for rangelands and pastoralists, which the current FLR initiatives uncritically perpetuate.

Second, achieving the ambitious targets set by the Bonn Challenge and its offshoots requires large-scale afforestation (i.e., the planting of trees where they did not previously occur, as distinct from reforestation of areas historically covered by forest). Currently used definitions of "forest" allow plantations to be included as forest restoration (Chazdon et al., 2016), and available data on country pledges show that nearly half the land pledged for FLR is in fact earmarked for plantations, in most cases with fast-growing exotic species (Lewis et al., 2019). Commercial forestry plantations typically provide a fraction of the ecosystem services of the natural vegetation they replace (Crouzeilles et al., 2017; Lewis et al., 2019) and they can negatively impact on local livelihoods when they target and appropriate land used by local people for food production (Fairhead et al., 2012; Morecroft et al., 2019).

As the approach officially espoused by the large-scale restoration drives, forest landscape restoration has become a powerful framework for guiding restoration globally. Its proponents thus have a responsibility to ensure that the guidance it provides addresses these important shortfalls to avert ecological and socio-economic damage on a massive scale.

RANGELANDS AND OPEN ECOSYSTEMS: UNDERVALUED AND NEGLECTED

Rangelands occur over a wide range of vegetation types and form the main land use in the world's drylands, shrublands, grasslands, savannas and open woodlands, the world's vast and ancient open ecosystems (Bond, 2019). Livestock play an important role in these vegetation types due to their ability to convert non-human edible feed into useful products, and their mobility, which allows pastoralists to make use of scarce and dispersed resources (Blench, 2001; Ayantunde et al., 2011; Hoffmann et al., 2014). Livestock production is estimated to contribute at least 40% of the global agricultural output and supports the livelihoods of nearly 1.3 billion people (Steinfeld et al., 2006). Where official statistics are available, they show that pastoralism contributes significantly to national gross domestic product (Johnsen et al., 2019). Livestock provide approximately 26 percent of human global protein consumption and 13 percent of total calories, as well as essential micronutrients (Hoffmann et al., 2014). Owning livestock reduces the prevalence of severe food insecurity and ensures higher diet diversity across a range of countries in sub-Saharan Africa (Fraval et al., 2019).

Extensive pastoralism is the most ecologically appropriate and sustainable use of drylands and grassy ecosystems (Veldman et al., 2015b; Behnke and Mortimore, 2016; Sayre et al., 2017). Pastoral land use in these ecosystems has adapted to this high highly variable and unpredictable resource base through mobility, opportunism and reciprocity, and the inherent resilience and adaptability of pastoralism make it likely to emerge as an increasingly important land use under climate change (Blench, 2001; Boone et al., 2018). Given appropriate support, rangelands can contribute to sustainable, climate-resilient diversified farming systems (Sayre et al., 2012).

Extensively managed grasslands have a high per-hectare value of ecosystem services, comparable to that of temperate forests, and they provide an estimated quarter of the ecosystem services provided by terrestrial biomes (De Groot et al., 2012; Costanza et al., 2014; Bengtsson et al., 2019). Grassy biomes store up to a third of the world's carbon in their soils (Parr et al., 2014), and grazing lands contribute significantly to global carbon sequestration (Conant, 2010; Henderson et al., 2015). Grasslands are better suited than many forest types to storing carbon reliably under increasingly hot and dry climates, which make forests

[1] https://afr100.org
[2] http://www.forestlandscaperestoration.org
[3] www.bonnchallenge.org

vulnerable to die-back and wildfires (Dass et al., 2014). Restoring them is also relatively cheap and has the highest benefit to cost ratio of all the world's biomes (de Groot et al., 2013).

Despite their ecological and economic importance, drylands and grassy biomes are undervalued and underrepresented in research and policy (Parr et al., 2014). Temperate grassland is the most threatened and least conserved biome globally (Davis et al., 1995; Hoekstra et al., 2005), and conservation efforts are biased toward forests even where grasslands are biodiversity hotspots (Ambarlı et al., 2016). For the tropics, far less literature exists on the diversity and conservation of grasslands and savannas compared to forests (Bond and Parr, 2010). The global extent of grassy biomes remains poorly documented, and a widely used map of the world's terrestrial biomes (Olson et al., 2001) misclassifies many areas of grassy biomes (Veldman et al., 2015b).

Rangelands and the pastoralists they support are similarly neglected in literature and policy. Global estimates of the extent and distribution of rangeland are highly variable due to the use of imprecise definitions (Phelps and Kaplan, 2017), and a tendency to map rangelands as a "residual category" of land that is not forest, cultivated or urban (Sayre et al., 2017). Data on agriculture, livestock and forestry are inadequate for informing policymaking on rangeland-based livestock systems (Johnsen et al., 2019). Rangelands have long been marginalized and under pressure from conversion to other land uses, due to their lower economic value compared to cropping, conservation, residential development and mining (Sayre et al., 2013; CELEP, 2018).

Undervaluing rangelands and portraying them as unused and degraded has led to a lack of resources for studying, protecting and monitoring rangeland resources, despite the pressing need to understand them as climates continue to change (Boone et al., 2018; Johnsen et al., 2019). Incomplete knowledge of their nature, extent and location means that appropriate targets cannot be set for their restoration and protection (Phelps and Kaplan, 2017).

DRYLANDS AND GRASSY BIOMES: MISUNDERSTOOD ECOLOGIES

Open ecosystems span a wide gradient from semi-deserts to mesic savanna woodlands and are functionally distinct from forest (Bond, 2019). For the purpose of this discussion, I use the terms "drylands" and "grassy biomes" to represent two intergrading categories of open ecosystems that span a continuum of ecological dynamics.

Drylands are arid and semi-arid areas that have been described as disequilibrium systems characterized by high climatic variability and loose coupling between herbivore population dynamics and vegetation productivity over large areas (Behnke and Scoones, 1993, Ellis et al., 1993). Their vegetation is not strongly controlled by herbivory or fire and the primary production of the herbaceous layer is highly variable and predominantly driven by rainfall (Archibald and Hempson, 2016). Under traditional pastoralism, the potential for degradation in these systems is low as their erratic rainfall and primary production limits the extent to which livestock numbers can build up to levels sufficient to have a strong feedback on the vegetation (Ellis and Swift, 1988, Behnke and Scoones, 1993). However, the artificial provision of watering points and supplementary feed las led to rangeland degradation in drylands by increasing the availability of dry season key resources, thus increasing and stabilizing livestock populations and reducing their mobility (Illius and O'Connor, 1999, 2000; Vetter, 2005).

Drylands have a long history of being misinterpreted as degraded and desertified (Behnke and Mortimore, 2016; Davis, 2016). The notion that drylands are the result of deforestation by nomadic pastoralists, which resulted in their climate becoming arid, was widely held in the 19th century (Davis, 2016). The solution was "reforestation" and other interventions such as irrigation to "green" the deserts. These actions have often caused salinization of soils, lowering of water tables, and invasion of fast-growing exotic tree species such as *Prosopis*. Ironically, more often than not the "solution" to the resultant resource degradation consists of more cycles of the same misguided interventions (Davis, 2016).

The grassy biomes include semi-arid, subhumid and mesic grasslands and savannas. These more mesic rangelands have stronger resource-consumer coupling than drylands and support bigger, more stable agro-pastoral populations. Large parts of the grassy biomes occur in seasonal climates with enough rainfall to support closed-canopy vegetation (thickets or forest), where they are often found occupying the same landscape in two-phase mosaics. The open-canopy structure of savannas is maintained by grass-fuelled fires and browsing (Bond, 2019). Because of their higher (potential) tree cover, many savannas are misclassified, mapped and managed as forest, even though forest and savanna have fundamentally different ecological dynamics, reflected in distinct species assemblages with different functional traits (Ratnam et al., 2011; Veldman et al., 2015a).

Since large areas of savannas are misclassified as degraded forest, they are targeted by inappropriate restoration and fire suppression policies that cause large areas of savannas to be lost through woody encroachment, forest expansion and plantation forestry (Veldman et al., 2015c; Ratnam et al., 2016; Joshi et al., 2018; Buisson et al., 2019; Kumar et al., 2020). Woody encroachment is a widespread global phenomenon that leads to substantial losses in livestock productivity in rangelands (Archer et al., 2017; Stevens et al., 2017; Venter et al., 2018). Afforestation and encroachment by native and exotic woody species lead to loss of biodiversity and ecosystem services in grassy biomes, including carbon storage (Guo and Gifford, 2002), streamflow and groundwater recharge (Jackson et al., 2005; Honda and Durigan, 2016; Fahey and Payne, 2017; Zastrow, 2019) and grazing for livestock and wildlife (O'Connor et al., 2014; Bond et al., 2019). The faunal and floral diversity of grassy biomes is rapidly lost under the shade of closed-canopy woody vegetation, and extremely slow and difficult to restore (Ratnam et al., 2011; Zaloumis and Bond, 2011, 2016; Parr et al., 2014).

Colonial policies widely promoted "reforestation" of grassy biomes to "restore" their climate and productivity, and these ideas and practices are still prominent in FLR today. As in the drylands, this is a legacy of colonial interpretations of these landscapes rooted in 19th century European understandings of vegetation ecology (Joshi et al., 2018; Pausas and Bond, 2019; Kumar et al., 2020). Forest "restoration" often involves fast-growing exotic tree species (including eucalyptus, pine and wattle) that have been the source of well-documented species invasions and other ecological impacts. Because of their higher productivity, the more mesic grassy biomes are the areas predominantly targeted for large-scale plantation forestry, carbon sequestration and climate mitigation projects.

APPROPRIATE METHODS FOR RESTORING OPEN ECOSYSTEMS

Restoration of natural and semi-natural terrestrial ecosystems has important potential to deliver climate change mitigation and other ecosystem services (Morecroft et al., 2019). Restoring savannas and grasslands improves carbon storage in soils, protects water resources, and reduces the risk of catastrophic fires (Archibald et al., 2013; Buisson et al., 2019; Morecroft et al., 2019; Wigley et al., 2020). To regain ecological functionality and ecosystem services in degraded grassy biomes requires restoring native grass cover, the removal of woody plants and the application (and often re-introduction) of appropriate fire and herbivory regimes (Buisson et al., 2019). These are fundamentally different from the methods used to restore forests, which require protection from fire and herbivory to build up tree cover.

In many areas of low tree cover, agroforestry, woodlots and other forms of tree-based restoration are important for meeting the food, forage and energy needs of increasingly dense populations. The fast-growing and drought-tolerant exotic species often chosen for this purpose can have unintended negative effects, however, such as lowering water tables and causing salinization where their water use and transpiration exceeds rainfall (Wang and D'Odorico, 2019; Zastrow, 2019). Well-intentioned but ill-conceived interventions to plant trees in rangelands have led to substantial and long-term losses in ecosystem services, especially when introduced species become invasive (DiTomaso et al., 2017).

In more mesic areas with high population pressure, some savannas and woodlands have lost tree cover through shifting cultivation and harvesting of wood for timber, firewood and charcoal (Shackleton et al., 2005; Matsika et al., 2012; Mograbi et al., 2017). Planting trees is not always necessary to compensate for localized loss of tree cover, however, especially in productive ecosystems where tree cover and biomass can recover rapidly. In the miombo woodlands of southern Africa, shifting cultivation and wood harvesting have led to a loss in tree cover and degradation, but the effects of this on carbon storage at the regional scale are offset by coppicing and increased woody cover in less intensely used areas (McNicol et al., 2018). Miombo woodlands are resilient to high levels of disturbance, as they have historically had high densities of elephant and frequent fires (Hempson et al., 2015; Osborne et al., 2018). This suggests that passive or assisted regeneration of natural vegetation is an effective way to restore carbon storage functions at the landscape level. However, promotion of "passive restoration" or "natural regeneration" can be problematic if it leads to fire suppression and grazing exclusion in open ecosystems that have co-evolved with these disturbances and need them to retain their ecological integrity and productivity.

AN UNHEALTHY OBSESSION WITH AFFORESTATION TARGETS

One of the conspicuous features of the current FLR drives is the foregrounding of ambitious targets, which are mirrored in many national initiatives such as the National Mission for a Green India. Afforestation targets have a long history going back to colonial forestry in the 1800's, which served the dual aims of providing enough timber and supporting "civilization" by stabilizing climate, increasing rainfall and improving soil fertility in the tropical colonies (Davis, 2016; Davis and Robbins, 2018). This was epitomized by the concept of the *taux de boisement normal* – the percentage of forest cover in any territory required by a civilized nation, regardless of its climate or other biophysical characteristics. This influential concept in French forestry of the late 1800's had its roots in desiccation theory, the notion that deforestation causes aridification and that reforestation increases rainfall, which had become widely accepted in Europe by the middle of the 19th century. Contemporary forest targets and their rationale (to mitigate climate and improve agricultural productivity) have changed remarkably little from their colonial origins (Davis and Robbins, 2018). They are now also based on the fallacy that a given amount of forest cover can store enough carbon to significantly mitigate climate change (e.g., Bastin et al., 2019a), a claim that has been widely refuted (e.g., Bond et al., 2019; Lewis et al., 2019; Veldman et al., 2019).

The current targets have gained additional power and apparent credibility by their presentations as digital maps based on scientific analysis of "global restoration potential." The two publicly accessible sets of maps intended to guide forest restoration globally are those published on the websites of the World Resources Institute[4] (WRI; Laestadius et al., 2011; Minnemeyer et al., 2011) and the Crowther Lab at the ETH Zürich[5] (Bastin et al., 2017, 2019a). Both sets of maps present restoration potential and opportunity in areas where tree cover is below that which is possible based on climate alone, which includes most mesic savannas globally. In Africa, areas identified as suitable for reforestation overlap significantly with the distribution of grassy ecosystems, which are important centers of vertebrate diversity and support the most important rangeland areas (see Figure 1 in Bond et al., 2019). Similarly, the WRI maps define "degradation" as a tree cover deficit relative to climatic potential, which automatically results in fire-maintained savannas as being mapped as degraded (Veldman et al., 2015a,b, 2019; Griffith et al., 2017). These maps reinforce the idea that these open ecosystems and the rangelands they support are anthropogenically created or modified "anthromes" (Ellis and Ramankutty, 2008; for a critique, see Sayre et al., 2017).

The definition of "forest" as any area > 0.5 ha with > 10 % tree cover (FAO, 2010) is similarly problematic. Its origins

[4]https://www.wri.org/resources/maps/atlas-forest-and-landscape-restoration-opportunities
[5]https://www.crowtherlab.com/maps-2/

can be traced to a time when timber management was the prevalent objective of forestry and it was designed to be useful for assessing wood harvesting potential (Chazdon et al., 2016). It was not intended to be used for planning and monitoring forest restoration and it has serious limitations for this purpose, as it does not distinguish between plantations and old-growth, recovering or degraded forest (Putz and Redford, 2010; Chazdon et al., 2016). Definitions of forest that do not distinguish forest from plantation allow natural forests to be severely degraded or replaced by plantations while technically remaining "forests" (Sasaki and Putz, 2009). For grassy biomes it has equally serious consequences, as large areas of savanna with naturally sparse tree cover are incorrectly classified and mapped as forest and thus in need of "reforestation."

The areas of grassy biomes misclassified as opportunities for tree planting are vast: some 1 billion ha, or 40%, of the areas mapped as "forest restoration opportunity" in the WRI maps are grassy biomes (Veldman et al., 2017). The dryland areas additionally identified by Bastin et al. (2017, 2019a) as having the potential for increased tree cover substantially increase this total. The powerful but misleading message these maps convey is that massive areas of grassy biomes are degraded and represent an opportunity for afforestation to mitigate climate change, with potentially devastating consequences for ecosystem services and biodiversity.

A RESPONSIBILITY TO PROVIDE ACCURATE GUIDANCE: HOW DOES FLR MEASURE UP?

There has been mounting criticism of the misleading message of the WRI's map of forest restoration opportunities (Veldman et al., 2015a,b; Bond, 2016) and the Crowther Lab's maps of tree restoration potential (Griffith et al., 2017; Veldman et al., 2017, 2019; Bond et al., 2019). The disingenuous response has been that the maps are not to be seen as prescriptive of what needs to be done, but rather what is possible in the absence of human disturbance. Their proponents argue that they need to be interpreted with caution, and that they merely provide large scale guidance that needs to be followed up with finer-scale planning, which is the responsibility of each country or region (Laestadius et al., 2015; Chazdon and Laestadius, 2017; Bastin et al., 2019b). However, if an area is mapped as "deforested" or "degraded" by experts, and at the same time there is pressure to pledge "ambitious" targets toward the Bonn Challenge and related initiatives (with strong positive publicity and promises of funding for countries that pledge large areas toward the targets), then how is one to interpret such maps? Those in charge of local assessments are unlikely to query their message since the maps are presented on authoritative websites, endorsed by reputable international development and conservation organizations, accompanied by articles published in leading journals, and their authors come with impressive credentials [as pointed out by Veldman et al. (2015b)].

Rangelands and grassy biomes are conspicuous omissions in the text of websites of the Global Partnership on Forest and Landscape Restoration, the Bonn Challenge and its offshoots such as AFR100. Document searches for the terms "grass," "grassland," "savanna," "grazing," and "rangeland" returned little or nothing in the documents guiding the planning, implementation and financing of FLR (PROFOR, 2011; IUCN and WRI, 2014; Berrahmouni et al., 2015; FAO UNCCD, 2015; Ding et al., 2017; Stanturf et al., 2017; Besseau et al., 2018). None of these sources recognize rangelands as a widespread and important land use, or caution that grasslands and savannas are areas that should be avoided for afforestation. A review of FLR projects in Africa turned up no examples of grassland restoration, but several instances of afforestation, including in savanna vegetation (Table 3 in Djenontin et al., 2020). A document reflecting on 13 years of successful FLR in central Madagascar mentions only tree planting and fire protection among the methods used, despite a third of the project area being in savanna vegetation (Mansourian et al., 2018). The handbook on the Restoration Opportunity Assessment Methodology equates restoration with planting trees and provides no caution against afforestation of open ecosystems (IUCN and WRI, 2014). A case study in this handbook illustrating the process in Rwanda makes it clear that no biome is exempt from afforestation: the highest priority actions identified for the eastern savannas were the creation of new large-scale commercial forestry plantations and woodlots.

The only criteria used to exclude an area from forest restoration are related to unavailability – urban areas, croplands and settlements of high human density (IUCN and WRI, 2014). Both the WRI and the Crowther Lab maps follow a similar logic. An important consequence of this logic is that afforestation will target more sparsely populated and "unused" areas – and this will affect large areas of untransformed grassy biomes used as rangelands. The WRI maps the ancient grasslands and savannas in the interior of Madagascar (Bond et al., 2008) as deforested or degraded, with low population density, and hence presenting forest restoration opportunity. While it is unlikely that the producers of the maps intended to give carte blanche to developers to turn large areas into biofuel or forestry plantations, if investors and the government agencies responsible agreed that such a venture would be in the country's best interest then who would stop them, and on what basis? If old-growth grasslands and savannas are to be "no-go" zones for afforestation, they need to be mapped, and documents guiding FLR needs to provide the correct guidance on how to restore them appropriately.

PLANTATION FORESTRY MASQUERADING AS ECOSYSTEM RESTORATION

Brancalion and Chazdon (2017) propose four principles to guide tree planting schemes focused on carbon storage and commercial forestry in the tropics in the context of FLR. Tree planting should enhance and diversify local livelihoods, avoid the transformation of tropical grasslands and savannas, promote landscape heterogeneity and biodiversity, and distinguish residual carbon stocks from those derived from reforestation and afforestation. By these criteria, large-scale monoculture plantations are not desirable as the cornerstone of FLR, and afforestation of grassy biomes should be avoided.

If this is what the Bonn Challenge is promoting, there should be no need for concern that old-growth grassy biomes will be lost to large-scale afforestation. However, examination of countries' reports on national pledges to the Bonn Challenge shows that almost half of the pledged area is set to become commercial plantations of trees such as eucalyptus, acacia, cacao and rubber (Lewis et al., 2019). If these proposed restoration plans are implemented, Lewis et al. (2019) estimate that the extent of plantations in the tropics and subtropics would more than double, increasing by 157–237 Mha. While a few countries target most of the area pledged for regeneration of natural forest (e.g., Chile, Lao, Mexico, and Vietnam) or agroforestry (Burkina Faso, El Salvador and Rwanda), countries such as Brazil, China, the Democratic Republic of the Congo, Ghana, Kenya, Uganda and Zambia plan to predominantly use plantations (Lewis et al., 2019). Most of these last-mentioned countries have large expanses of grassy biomes and rangelands, and they include the countries with the biggest areas pledged to restoration.

Plantations are necessary to meet global demands for timber and other wood products, but like commercial agriculture and urban expansion they represent a trade-off against many ecosystem services (such as water, forage, biodiversity) rather than yielding synergistic outcomes (Morecroft et al., 2019). There has been growing criticism of representing afforestation with forestry plantations as forest restoration, since plantations have less value for biodiversity or carbon sequestration compared to naturally regenerating forests (Chazdon and Guariguata, 2016; Crouzeilles et al., 2017). Monocultural tree plantations sequester 40 times less carbon than naturally regenerating forests when one takes into account tree harvesting (Lewis et al., 2019), and conversion of grassland to forest leads to losses in soil carbon stocks (Guo and Gifford, 2002). In degraded Mediterranean rangelands, grazing management yielded greater ecosystem services than afforestation (Papanastasis et al., 2017).

Forest restoration can make a valuable contribution to improving livelihood diversity, as natural and restored forests contribute to diet quality directly and via agropastoral and income pathways (Baudron et al., 2019). Large-scale forestry plantations, on the other hand, often compete with food production and other livelihood activities and reduce resilience by emphasizing a narrow bundle of market-related income streams (Ota et al., 2020). Large scale carbon forestry and bioenergy projects have been associated with land grabs that serve interests outside the affected area and lead to a loss of local access to natural resources and land (Lyons and Westoby, 2014, Busscher et al., 2020; Blum, 2020). Rangeland areas are particularly vulnerable to such appropriation, due to tenure insecurity and a widespread perception that pastoralism is an inefficient form of land use in degraded or "idle" landscapes (Blench, 2001; Cotula et al., 2009; CELEP, 2018). International investment for commercial plantations, carbon storage and other "green" initiatives show clear continuities from the colonial era in the appropriation of land, resources and access rights from their prior users for commercial gain (mining, large-scale agriculture, plantations) or in the name of conservation and halting land degradation (Cotula et al., 2009; White et al., 2012). Contemporary "green grabbing" involves an even greater variety of actors – including state agencies, national elites and a variety of private investors and consultants – who are "more deeply embedded in capitalist networks, and operating across scales, with profound implications for resource control and access" (Fairhead et al., 2012, p. 239).

AN OPPORTUNITY TO MAKE LANDSCAPE RESTORATION MORE INCLUSIVE, JUST AND EQUITABLE

The current global impetus to promote ecosystem restoration (Suding, 2011; Suding et al., 2015; IPBES, 2018) provides an opportunity to bring rangelands and grassy biomes onto the global restoration agenda. At the same time, one needs to interrogate the scientific and political-economic basis for the restoration agenda itself, with its uncritical perpetuation of target-driven forest planning and the logic of "the economy of repair" (Leach et al., 2012), which allows the problems created by emissions in developed countries to be "solved" by appropriating land and planting trees in developing countries.

To achieve an equitable, socially just and ecologically sound restoration agenda in rangelands, the following should be priorities.

Raise awareness of open ecosystems and rangelands. The misconception that drylands and grassy biomes are degraded forest continues to form the basis of major international programmes that address land degradation and climate change. These "pathological ecologies" (Davis and Robbins, 2018) continue to be transmitted to new generations of scientists and policymakers through outdated university and training curricula and postgraduate training. Breaking this "chain of transmission" will require a concerted effort at all levels, including decolonising of school and university curricula and lobbying to represent open ecosystems, rangelands and the interests of local land users in the major science-policy platforms that inform FLR[6]. It will also require efforts to capture the public's imagination with messages and imagery of drylands and grasslands as valuable, diverse and interesting, rather than degraded, fragile and desperate.

Strengthen innovative and strategic thinking and action around the future of rangelands. Pastoralism in many regions has proven to be resilient in the face of multiple pressures, such as fragmentation of rangelands, conversion of rangeland to other land uses, population growth, political marginalization, periods of severe drought and climate change (Galvin et al., 2008; Moritz et al., 2009; Sayre et al., 2013). Continued appropriation and afforestation of their seemingly "unused" and "degraded" land severely constrains the ability of pastoralists to continue their livelihood practices and to adapt to changing climates. Restoration and development in these regions should place the land and access rights of pastoralists and the need to support

[6]For example, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which emphasizes social-ecological linkages, quality of life and diverse local knowledge (https://ipbes.net/conceptual-framework).

resilience locally over the need for storing carbon to ameliorate global climate.

Provide the right guidance. Instead of promoting scientifically unfounded targets for increasing tree cover, the documents guiding landscape restoration need to include clear guidelines on where planting trees is appropriate and where it is *not* advisable. These resources also need to provide information on appropriate restoration strategies for the grassy biomes, such as clearing exotic vegetation, using savanna species for restoration and agroforestry, restoring grassland function through appropriate grazing management and burning, and avoiding or reversing bush encroachment (Buisson et al., 2019, Temperton et al., 2019; Silveira et al., 2020).

Correct or replace the restoration opportunity maps. Rather than leaving each country to work out the distribution and appropriate management of different ecoregions themselves, a concerted effort should go toward providing accurate global maps that provide appropriate guidance. There also needs to be greater resistance to the current maps' implicit message that it is the responsibility of countries with "restoration opportunity" to fix a climate crisis they did not cause by making their land and resources available for carbon sequestration investments. Judging from the debates in the scientific literature, it seems highly unlikely that the maps' original authors and their institutes will change the maps or the message, although pressure to do so should continue. There is thus an urgent need to bring together ecologists, geographers and others with relevant expertise to produce and promote a more accurate suite of products.

As the officially endorsed framework of the Bonn Challenge and related global restoration initiatives, FLA has become a powerful instrument for guiding global restoration efforts and funding. The proponents and practitioners of FLR thus have a responsibility to include the existence, distribution, requirements and value of rangelands and grassy biomes in their message to the world. The continued resistance of FLR proponents to criticism of its arborocentric focus suggest that open ecosystems are indeed an "inconvenient reality for large-scale forest restoration" (Veldman et al., 2017), perhaps by reducing appetite for investment from sources interested primarily in offsetting carbon by planting trees. Hopefully this is not the case, and by including a greater diversity of ecologists and other stakeholders, FLR can be strengthened in promoting restoration of ecosystem function and biodiversity in all biomes while safeguarding the rights and livelihoods of local land users. This would be more in keeping with its original ethos than allowing it to be used as a vehicle for expanding commercial plantations to offset carbon emissions.

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/s.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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