How Social Considerations Improve the Equity and Effectiveness of Ecosystem Restoration

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Ecosystem restoration is an important means to address global sustainability challenges. However, scientific and policy discourse often overlooks the social processes that influence the equity and effectiveness of restoration interventions. In the present article, we outline how social processes that are critical to restoration equity and effectiveness can be better incorporated in restoration science and policy. Drawing from existing case studies, we show how projects that align with local people's preferences and are implemented through inclusive governance are more likely to lead to improved social, ecological, and environmental outcomes. To underscore the importance of social considerations in restoration, we overlay existing global restoration priority maps, population, and the Human Development Index (HDI) to show that approximately 1.4 billion people, disproportionately belonging to groups with low HDI, live in areas identified by previous studies as being of high restoration priority. We conclude with five action points for science and policy to promote equity-centered restoration.

Keywords: land use management, social justice, climate change mitigation, restoration longevity, restoration policy

***Ecosystem restoration*, as it was defined by the** Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES 2018), is "any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state." Further refinements to the term have been focused less on the presence of an ideal state and more on bringing the ecosystem onto a trajectory that improves ecological functionality with respect to the baseline degraded landscapes. It is hoped that by improving ecological functionality, different types of restoration can simultaneously enhance biodiversity, increase resilience to natural disasters, and promote the well-being of people living in or near degraded landscapes (Besseau et al. 2018).

The potential of restoration as a multifaceted means of addressing multiple sustainability challenges has generated global enthusiasm, concurrent with a proliferation of global and regional restoration targets and commitments. The Bonn Challenge was the first major international restoration-focused initiative (established in 2011), and it pledged to restore 150 million hectares of land globally by 2020. This initiative was later endorsed by the New York Declaration of Forests, which aimed to bring 350 million hectares of land under restoration by 2030. When the Sustainable Development Goals were adopted in 2015, the importance of protecting and restoring forest ecosystems, among other sustainability measures, was articulated in goal 15, "Life on Land." The One Trillion Trees Initiative was launched at the World Economic Forum in January 2020 with the aim to conserve, restore, and grow a trillion trees by 2030. June 2021 marked the beginning of the United Nations Decade on Ecosystem Restoration, which is intended to catalyze restoration efforts globally. Most recently, the Glasgow Climate Pact emphasized the importance of protecting, conserving, and restoring ecosystems to meet the Paris Agreement temperature target (UNFCCC 2021). These large-scale policy pledges and the potential for restoration to yield carbon offsets has led to a growing interest from powerful financial actors in the Global North to fund restoration (Löfqvist and Ghazoul 2019), further catalyzing restoration initiatives globally.

Global restoration targets are often primarily based on spatial and quantitative metrics derived using high-level,

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top-down studies and broad spatial scale analyses. These targets mainly focus on numerical outcomes, estimating, for example, the potential numbers of trees that could be planted (as in the One Trillion Trees Initiative) or the number of hectares that could be restored (as in the Bonn Challenge). Such outcomes can lead to benefits for current and future generations whose well-being may decrease as a result of present-day ecosystem degradation, if restoration is implemented in an ecologically and socially sound manner. However, many lands with potential for restoration are crucial to the livelihoods of people who are often marginalized from economic and decision-making opportunities. Social dimensions such as power dynamics, governance systems, and trade-offs between different actors' values all influence both social and ecological outcomes of restoration. Therefore, insufficient attention to social considerations within high-level restoration discourses threatens the longevity of restoration outcomes and comes with tangible justice risks for some of the most vulnerable people globally.

Restoration science and practice should aim to simultaneously improve well-being for current generations while maintaining and restoring ecosystems for generations to come. Although the Bonn Challenge emphasizes that local socioeconomic outcomes influence the longevity of restoration efforts, it is not clear how to operationalize socioeconomic objectives within a technocratic (i.e., top-down government or expert driven) frame (Clewell and Aronson 2006). Social scientists and ecologists alike increasingly emphasize a need to elevate local people's perspectives within restoration discourses (Clewell and Aronson 2006, Erbaugh et al. 2020, Holl and Brancalion 2020, Puspitaloka et al. 2020, Di Sacco et al. 2021, Elias et al. 2021, Ghazoul and Schweizer 2021, Osborne et al. 2021), and calls to unite ecological restoration with environmental and social justice have been present for several decades (Holloran 1996). However, tangible pathways for better inclusion of community perspectives and environmental and social justice issues remain largely unclear for restoration practitioners and scientists.

There is still a lack of understanding in international fora on restoration about *what* constitutes equitable and effective restoration and about *how* the social aspects of restoration projects and contexts influence the social and ecological outcomes of these projects. In this article, we provide a definition of equity-centered ecosystem restoration, arguing that restoration approached through an equity lens in addition to sound ecological principles is more likely to improve ecological outcomes and to promote environmental and social justice. We then draw on literature from restoration and conservation social science, land system science, and political ecology to provide an overview of both the *rationale* and *approaches* for prioritizing the perspectives of the most vulnerable and most affected actors in restoration discourses. We outline how placing social considerations at the center of restoration planning, decision-making, and implementation can decrease the risk that restoration interventions exacerbate poverty and income inequality or result in political backlash and, instead, increase the chance that they empower and benefit local communities. We also describe how equity-centered restoration can increase the likelihood that the ecological benefits of restoration are realized and sustained over time.

To ground our arguments, we provide an empirical outlook from a diverse set of case studies to show how governance processes, power dynamics, and values influence the social and ecological outcomes of restoration. These cases show how representation in decision-making processes (procedural equity), recognition of values and identity (recognitional equity), and the distribution of costs and benefits (distributional equity) influence the overall equity of restoration (terms described in figure 1). To underscore the importance of placing these equity concerns at the heart of restoration, we then provide an estimate of the number of people living in regions identified as having high restoration potential and show that these people disproportionately belong to groups with below-average income, health outcomes, and education levels. To close the gap between the increasingly recognized imperative of making restoration people centered and participatory and the way restoration science and policy are conducted in practice, we conclude with five action points that can help promote more equitable and effective restoration globally. Through these measures, we argue that the momentum around restoration within science, policy, and finance can be leveraged to simultaneously advance both ecological recovery and prosperity for some of the most vulnerable people globally.

What is equitable and effective restoration?

Restoration is a social construct (van Oosten 2013) with a contentious history. What qualifies as restoration depends on what outcomes are valued from the perspectives of which stakeholder (Castillo et al. 2021). Similarly, whether a landscape is deemed degraded or not is a subjective judgement and depends on where a temporal baseline is placed (Lélé 1994). IPBES (2018) defined land degradation as "the many human-caused processes that drive the decline or loss in biodiversity, ecosystem functions or ecosystem services in any terrestrial and associated aquatic ecosystem." A landscape may be viewed as degraded forest land by conservationists according to this definition, whereas local communities may perceive the same landscape to be prosperous agricultural land or important herding grounds for pasture.

In addition to the subjectivity of classifying an ecosytem as degraded or restored, different definitions of restoration have also emerged within the ecological sciences to focus more attention on the trajectory of an ecosystem and its functionality rather than its state and outcomes. Both ecosystem restoration and forest and landscape restoration (FLR, as it was defined by Besseau et al. 2018) are focused explicitly on regaining ecological functionality and to enhance human well-being in deforested or degraded landscapes. Ecological restoration, on the other hand, was defined by Gann and colleagues (2019; reiterated from the definition by the Society for Ecological Restoration

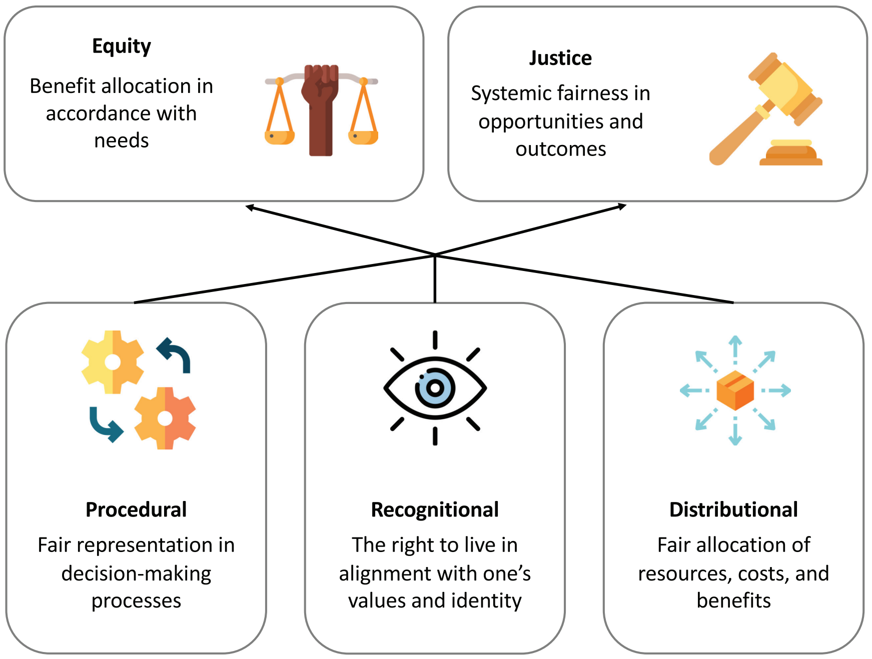

Figure 1. Presentation of the elements of justice and equity that are discussed in this paper (inspired by Leach et al. 2018).

International Science and Policy Working Group 2004) as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." They further explained the relationship between ecosystem restoration and ecological restoration: "Ecosystem restoration is sometimes used interchangeably with ecological restoration, but ecological restoration always addresses biodiversity conservation and ecological integrity, whereas some approaches to ecosystem restoration may focus solely on the delivery of ecosystem services" (Gann et al. 2019). Ecosystem restoration can therefore be seen as focused more on the final anthropocentric outcomes of ecosystem function than on the function itself.

We define *equity-centered ecosystem restoration* as restoration that places the most vulnerable and affected actors (current and future) of a restoration project at the center of decision making, whilst simultaneously promoting ecological recovery. Furthermore, all affected actors should be given the opportunity to participate in decision-making about the design, implementation, and monitoring of restoration projects, including the distribution of costs and benefits across actors. Distributional inequities should not be exacerbated as a result of restoration activities and should, if possible, be decreased. Particular attention should be given to the needs of systematically disadvantaged communities and to the vulnerabilities and privileges resulting from intersectional identities (linked to, e.g., class, race, gender, and physical and mental ability; Crenshaw 1991) among community members that affect an individual's ability to engage in, decide on, and benefit from a restoration project (Elias et al. 2021). Heterogeneity within communities must therefore be acknowledged, and inclusivity needs to recognize and reconcile these diverse values and desires (Waylen et al. 2013).

For restoration to be effective, not only equitable, restoration activities should bring back ecological functionality to degraded landscapes, enhance biodiversity, increase resilience to natural disasters, and promote improved social outcomes (Besseau et al. 2018). Our definition of equity-centered ecosystem restoration is compatible with the *International Principles and Standards for the Practice of Ecological Restoration* (Gann et al. 2019) and the principles of FLR (IUCN 2022), which both emphasize balancing ecological recovery with human well-being and incorporating procedural equity. We take an inclusive view of the types of restoration that can fulfill this definition, including improved grassland management, woodlots, and agroforestry, as well as assisted and passive recovery of native vegetation, so long as the restoration type aligns with community objectives and is part of a longer-term effort to restore native vegetation. Restoration is neither equitable nor effective if it ignores social considerations and prioritizes single outcomes (i.e., carbon drawdown or timber production) over sound ecological management. It is also important to emphasize that restoration need not involve trees. In grassy biomes such as savannas, open canopy landscapes, and grasslands, the introduction of trees can threaten biodiversity (Veldman et al. 2015) and can have negative impacts on landscape hydrology and carbon storage (Vetter 2020).

How the socioeconomic context affects equity and effectiveness of restoration interventions

It has been well established by a broad range of literature on conservation, land system science, and political ecology that whether land-use interventions succeed in enhancing ecological functionality and human well-being depends on the socioeconomic contexts on the ground, including, among other things, governance systems, power structures, and values (Ostrom and Nagendra 2006, Chhatre and Agrawal 2009, Klein et al. 2015, Erbaugh et al. 2020, Wells et al. 2020, Elias et al. 2021). Understanding the socioeconomic context of restoration is therefore a prerequisite for restoration to be executed in a way that promotes equitable and effective outcomes. Below, we outline general considerations regarding the importance of governance systems, power structures, and values and explore these through a number of illustrative cases. The cases are showcased in figure 2, and a summary of a larger set of cases are presented in supplemental table S1. Throughout

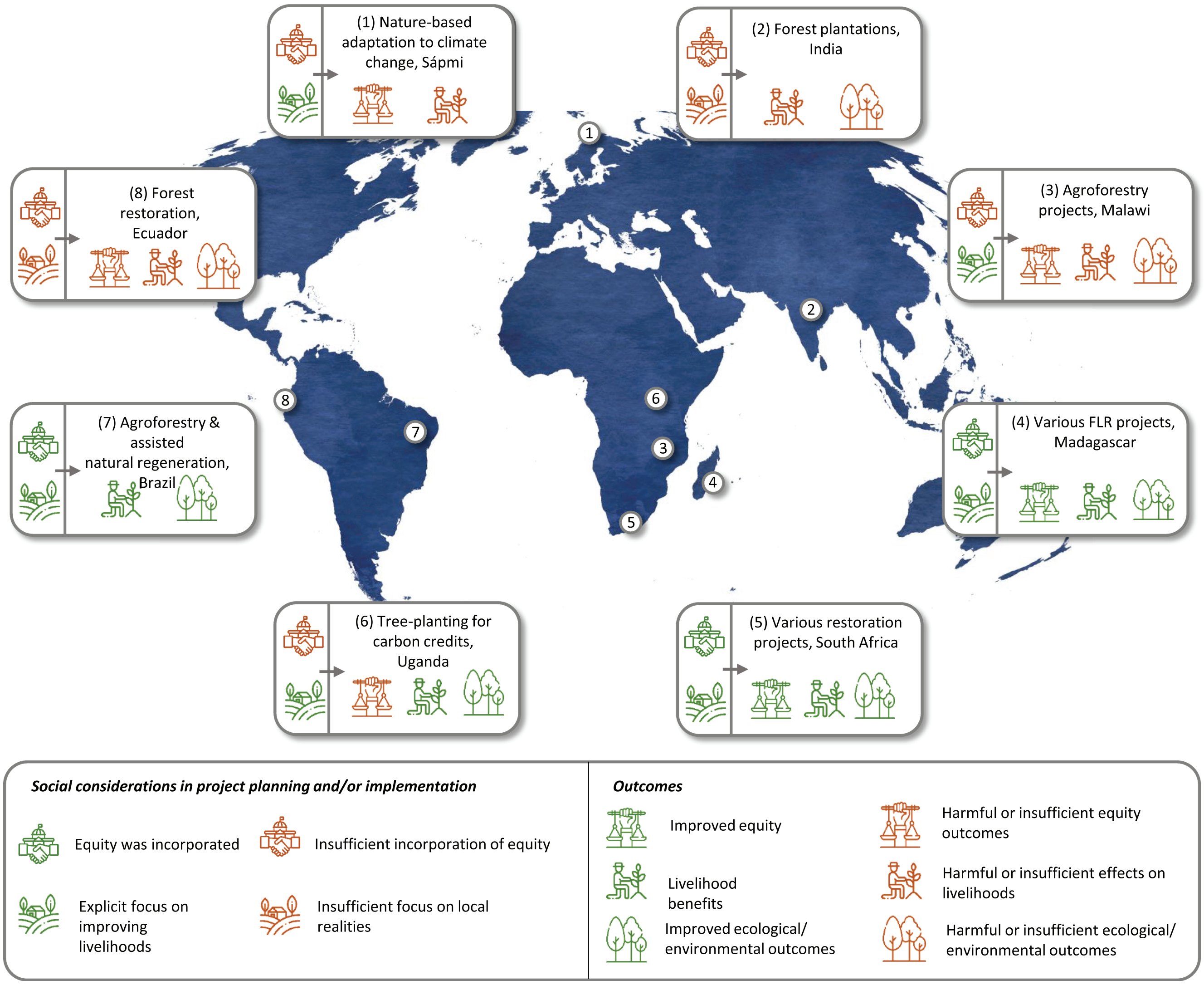

Figure 2. This figure visualizes how focus on equity and livelihood improvements (or lack thereof) can affect equity, livelihoods and ecological/environmental outcomes of restoration. The figure builds on studies presented in this paper, and is limited to their findings and study approach. This figure provides a coarse overview of how social consideration can affect restoration outcomes, and we acknowledge that there are ample features and nuances of each project that are not captured in this visualization.

the discussion, we will first synthesize key insights from the literature and then discuss concrete case studies that both embody good examples of equity-centered ecosystem restoration but also cases where a lack of attention to social considerations or sound ecological approaches led to reduced equity and effectiveness of interventions. Many of the cases we present also illustrate trade-offs associated with restoration interventions.

Governance systems. Several elements of landscape governance are likely to influence restoration outcomes: who participates in decision-making, at what scales, how policymakers and participants at different scales interact, and how resources get allocated. However, governance processes often receive insufficient attention inin large-scale restoration studies, target setting, and intervention design (Mansourian and Sgard 2021).

The case studies discussed below indicate that the level of coordination across scales, inclusivity across actors, and adaptability in the restoration governance system influence restoration outcomes. Evidence shows that “broad” (i.e., with inclusive membership across scales and actors) and “nimble” (i.e., with adaptive cogovernance built in) governance processes allow the actors involved in restoration to better perceive, understand, and respond to shocks and stressors to land systems and, therefore, to sustain land-use interventions over time (Garmestani and Allen 2015, Wells et al. 2020, Petersen-Rockney et al. 2021). Effective public participation in natural resource management further hinges on trust between communities and implementing agencies (Davenport et al. 2007).

When restoration planning is guided by a thorough understanding of the scale, inclusiveness, and procedures of governance systems on the ground, there is a higher chance that the restoration efforts exhibit a better institutional fit with local processes and capacities (Sapkota et al. 2018, Djenontin and Zulu 2021). Trusted organizational brokers, such as local nongovernmental organizations, can support communities to develop capacity in organization and technical planning, as well as leadership on monitoring processes (Elias et al. 2021). Conversely, where project designs and land planning institutions are not inclusive or adaptive—that is, do not consider existing social values and norms and do not respond to local (and evolving) social, economic, and environmental realities—interventions run the risk of diminishing local perceptions of fairness, legitimacy, and equity (Pascual et al. 2014, Klein et al. 2015), as well as ecological outcomes (Rana and Miller 2021).

For example, Mansourian and colleagues (2016) found that the inclusion of local authorities and adaptability of the governance system improved the implementation of a long-term FLR plan including various interventions, such as active restoration, passive restoration, and agroforestry in Fandriana Marolambo, Madagascar. The project area was chosen on the basis of criteria such as local communities' preparedness to adopt new technologies and approaches, their level of education, and their dependence on forests, as well as the local political support for the project and the ecological importance of the forest (Mansourian et al. 2016). Tenure insecurity in the project area posed challenges that affected the course of the project, and significant efforts were invested to address these issues. The promise of community contracts to strengthen tenure security was an important incentive for local communities to engage in restoration (Mansourian et al. 2014). Although centralized forest authorities were originally in charge of FLR decision-making, a new governance model emerged that placed local communities at its center, which helped with inclusivity as well, because the communities integrated multiple stakeholder perspectives. The project has been successful in terms of reestablishing native tree species on degraded landscapes (Roelens et al. 2010) and promoting alternative livelihood options, such as small animal and fish farming and the production of essential oils and honey (Mansourian et al. 2016).

In Central Malawi, Djenontin and Zulu (2021) examined governance processes in the implementation of the country's national forest landscape restoration strategy in the context of two agroforestry landscapes. A tradition of participatory and community-based forest management in the country translated into decentralized forest management decision-making processes with moderate adaptability. The governance had beneficial elements of polycentricity, which include decision-making on multiple levels, a shared system of rules that are enforced culturally or institutionally, and the integration of different set of beliefs and values (Bixler et al. 2018). However, the governance system did not foster sufficient cooperation across districts and social learning processes were not formalized in multistakeholder fora to allow for greater harmonization of knowledge and approaches across actors and regions. These gaps in coordination, adaptability, and feedback led to challenges such as limited resource capacity, inequitable resource distribution, and negative institutional externalities in the implementation of the national FLR plan. Furthermore, limited cooperation among resource-governance bodies and harmful competition over incentives and benefits undermined socioecological restoration goals. A similar example can be found in a study in which Wiegant and colleagues (2020) examined the governance of the national forest restoration plan in Ecuador's montane Chocó Andino and Bosque Seco landscapes. This case showed how a decentralized governance system that seemed appropriate on paper did not function as anticipated because of problems with coordination across scales. A spatial mismatch between the planning processes and the implementation decisions resulted in a political bias toward financing the planting of highly visible fast growing tree species for larger-scale political aims over restoration through natural regeneration, which provided stronger biodiversity benefits (Wiegant et al. 2020). Furthermore, finance was earmarked for tree planting or natural regeneration, whereas restoration projects that targeted livelihood improvements (such as agroforestry) were not included in the project (Wiegant et al. 2020).

Another example comes from a more localized initiative, partly bypassing the challenges of coordination across scales. The Tsitsa Project in the Eastern Cape Province of South Africa was intended to support sustainable livelihoods and improved ecological outcomes via restoration targeted at reducing erosion, increasing grazing vegetation cover, and reducing river silt loads (Palmer et al. 2022). The project was planned and executed with a governance system that promoted broad participation and a strong understanding of local people's needs and was explicitly aimed at promoting equity in access to ecosystem services. In the research process that informed the restoration project design, stakeholders from government institutions, members from nongovernmental organizations, commercial farmers, representatives from the forestry sector, traditional leaders, and local residents participated in a workshop to set a shared vision for the catchment that was restored, to learn about the catchment context, and to develop a hierarchy of objectives that would guide the catchment management strategy. The process experienced some barriers, including poor understanding and representation of some participants' perspectives. However, the Tsitsa project was perceived as having succeeded overall with fair inclusion of the local residents, government officials, and traditional leaders in its codesign (Palmer et al. 2022).

Power dynamics. Just as landscapes are influenced by ecological, hydrological, and climatic aspects, they are also shaped by power relations, colonial history, and disparities between genders (Lave et al. 2014). Restoration takes place in the context of both local and global power imbalances, and distant and financially powerful actors often have a large influence on how restoration is carried out (Elias et al. 2021). In the same vein, less powerful actors are often excluded from land-use decision-making processes, especially in light of increasing international interest in land systems for food security and climate change mitigation opportunities (Rudel and Meyfroidt 2014).

Western knowledge frameworks have a long history of dominating the discourse on conservation priority setting at the expense of other local non-Western value systems (sometimes referred to as *conservation colonialism*; Collins et al. 2021). If restoration is implemented in an equity-centered manner, this can empower currently disadvantaged groups and can lessen power inequalities on both local and global scales. However, restoration policies and targets designed by international and geographically distant actors alone run the risk of extending inequalities as land use and land values change (Elias et al. 2021). Fisher and colleagues (2018) demonstrated how these transcalar power dynamics play out in the context of the Trees for Global Benefit program in Uganda, which promotes tree planting funded by carbon credits. The researchers found that, by building on preexisting tree planting practices and institutional structures, and by offering direct financial benefits to participants, restoration was successful and perceived as fair by participants. However, project rules biased participation toward those with more private land and imposed rigid land management regulations, which ended up exacerbating inequalities and reducing the agency of some local land users (Fisher et al. 2018).

In Sápmi, Northern Europe, we find an example of how local power dynamics can lead to the prioritization of certain values above others in land-use decision-making (Hausner et al. 2020). This region is inhabited by the historically marginalized indigenous Sámi people who have been herding reindeers in these areas for centuries. Many Sámi people have traditionally lived a nomadic lifestyle, moving between settlements for summer and winter pastures, and used the natural environment around settlements for timber extraction and firewood collection (Östlund and Norstedt 2021). The region was undergoing the process of developing ecosystem-based adaptation strategies (which can include restoration and conservation to improve services that protect against climate change) and aimed to take Sámi values and desires into consideration when developing land-use plans. Sámi people's knowledge was incorporated through participatory tools, and extensive maps with the traditional herding areas of the Sámi people were provided. However, Sámi perspectives were not sufficiently safeguarded, and important pastures were threatened by competing land uses linked to green energy development, tourism, recreation, public road construction and power-line projects (Hausner et al. 2020).

Value trade-offs. Win–win situations are elusive in land systems and trade-offs are often inevitable (Lele and Kurien 2011, Hajjar et al. 2021, Loveridge et al. 2021, Meyfroidt et al. 2022). Different restoration interventions produce diverse mixes of outcomes linked to food production, carbon, biodiversity, watershed protection and livelihoods, among others. Human motivations and behaviors surrounding restoration are “enculturated” and “enearthed”—that is, influenced by their cultural and social context—and are therefore not readily predictable according to a single general model (Schill et al. 2019). Different actors therefore value different outcomes of restoration. These actors, furthermore, have various degrees of vulnerability to restoration outcomes and trade-offs between ecosystem services (and disservices) are not easily weighed against each other (Lele et al. 2013). In restoration this is especially problematic as the most vulnerable actors often have the least power over how restoration is executed, whereas distant actors with financial resources can push for their favored objectives to be realized. Therefore, there is a risk that the most vulnerable actors in restoration are disproportionately disadvantaged when trade-offs materialize.

Values and aspirations can vary widely across and within households, villages, and sites and are further subject to change over time (Dawson et al. 2017). Restoration cases show that benefits and trade-offs differ substantially across actors and regions, even when community preferences are considered in the design of restoration schemes (Hendrickson and Corbera 2015, van Oosten et al. 2018). Some cases show how communities benefit when agroforests and management of secondary vegetation (that conform to their preferences) are included in the restoration planning (de Souza et al. 2016, Wells et al. 2020), or when financial compensation is provided for restoration (Wunder et al. 2020). The inclusion of community preferences for certain types of land use can lead to ecological trade-offs, such as increases in nonnative species and less diverse forest landscapes (Kull et al. 2019, Kimambo et al. 2020). However, ignoring local social preferences in the design of restoration interventions can both harm those local actors and threaten restoration adoption and longevity (Fisher et al. 2018).

De Souza and colleagues (2016) provided an example of the importance of acknowledging local preferences to address trade-offs. Their study shows how a community-managed restoration project focusing on using agroforests and managed secondary vegetation to assist with natural forest regeneration in the Atlantic Forest of Southeast Brazil succeeded with both reestablishing forest cover and enhancing biodiversity through inclusion of threatened native species. The project simultaneously benefitted local communities by providing individuals with crops and forestry products that have both market value and cultural value, which reduced the pressure on protected areas. They further found that social and governance norms set by local communities were more effective than those set by environmental agencies to protect a threatened palm species from illegal harvesting, increasing longevity. The authors conclude that these traditional forest-based community systems of management are a promising avenue to enhance local livelihoods and maintain high levels of forest cover, even when supportive policies and financial mechanisms are lacking (de Souza et al. 2016).

Some cases explicitly show that a neglect of livelihood considerations and wider socioeconomic context in restoration projects reduces the adoption and longevity of such interventions. In Himachal Pradesh in Northern India, for example, Coleman and colleagues (2021) assessed the impact of large-scale tree planting projects undertaken over decades by the state forestry department on government owned land as part of a wider climate change mitigation strategy. The researchers found that tree planting programs have resulted in little additional tree cover. Using household surveys, they assessed the livelihood outcomes associated with the plantations (i.e., how people used them for fuelwood, fodder, and grazing) and found that the tree plantations provided little benefit to farmers. Coleman and colleagues (2021) concluded that an incentive to reach tree planting targets may have encouraged foresters to plant trees of low livelihood value, precisely because these trees may be less likely to be harvested by local people. Therefore, value trade-offs between farmers and foresters created a paradoxical challenge to longevity, whereby attempts to bypass farmers' incentives to use the plantations backfired, leading to a lack of longevity.

Despite these inevitable trade-offs, restoration discourses largely circle around win–win narratives in restoration, especially linked to biodiversity, livelihoods, and carbon sequestration (see, e.g., the 10 golden rules in Di Sacco et al. 2021). This may stem from a historical interest in the role of tree-based agricultural systems or agroforestry systems in providing additional food security and income diversification opportunities (e.g., Current et al. 1995, Leakey 2001). However, even if multiple actors benefit from restoration projects, some objectives will always be given supremacy over others, and landscapes provide different benefits to different actors that are rarely maximized simultaneously (Rudel and Meyfroidt 2014).

An empirical outlook from global mapping

To further underscore the importance of considering social aspects in restoration, we examined the distribution of the global population across socioeconomic gradients with respect to places identified by Strassburg and colleagues (2020) as having restoration potential. Specifically, we compared global restoration priorities for the ecosystems accounted for by Strassburg and colleagues (2020) with estimates of the global population distribution (Rose et al. 2019) in figure 3a and with the human development index (HDI; Kummu et al. 2018), which is a composite measure of education, health, and income, in figure 3b (the full methods appear in the supplemental material). We find that more than 1.4 billion people globally live in areas identified as having the top 20% restoration priority by Strassburg and colleagues (2020) on the basis of global spatial variation in benefits and implementation costs which cover around 10% of the global land surface (figure 3c). Higher restoration priority classes showed lower HDI values (figure 3d), meaning that people with among the lowest incomes, education levels, and health outcomes are likely to be the most affected (positively or negatively) by restoration investments guided by Strassburg and colleagues (2020). Many of these areas further coincide with the presence of indigenous communities that are often marginalized in public and private decision-making (https://native-land.ca). These numbers provide a global perspective, accounting for human vulnerability, to the estimate by Erbaugh and colleagues (2020) of people living on restorable land in tropical countries. Erbaugh and colleagues (2020) found that 294.5 million people in tropical countries live on land that has forest restoration opportunities (based on estimates by Potapov et al. 2011 of cost-effective restoration potential calculated for the World Resource Institute, in combination with data on carbon capture potential by Busch et al. 2019).

The sheer number of people living on land identified as restorable in large-scale mapping exercises illustrates the magnitude of risks and potential trade-offs if restoration projects are implemented without people in focus but also showcases the potential for improved well-being that equity-centered ecosystem restoration can yield. In a recent study, Fedele and colleagues (2021) found that 1.2 billion people in tropical countries are dependent on nature to meet basic human needs. The ecosystem services that forest-proximate people derive from these landscapes vary widely (Miller et al. 2020) and includes nonmaterial cultural and spiritual benefits (Cooper et al. 2016). Many people further derive positive benefits from landscapes (for example linked to recreation) even if their livelihoods and culture are not directly landscape dependent. The objectives and desires of so many people living in such a wide diversity of contexts cannot be reduced to a population density grid, but the extent of people living on restorable land—including so many of the world's most vulnerable—nevertheless highlights the scale of opportunities restoration could bring to people and places.

The way forward

So far, we have argued that placing social considerations, especially governance systems, power imbalances, and trade-offs between values, at the center of restoration planning and action is crucial to the equity and effectiveness of restoration interventions. Building on this, as well as recent calls for greater prioritization of livelihood considerations in restoration schemes (Clewell and Aronson 2006, Erbaugh et al. 2020, Holl and Brancalion 2020, Puspitaloka et al. 2020, Di Sacco et al. 2021, Elias et al. 2021, Ghazoul and Schweizer 2021, Osborne et al. 2021), we outline five actions for the restoration community, including scientists and policymakers, to better crystallize how these social considerations should be addressed. Our action points (summarized in figure 4) provide high-level guidance for promoting

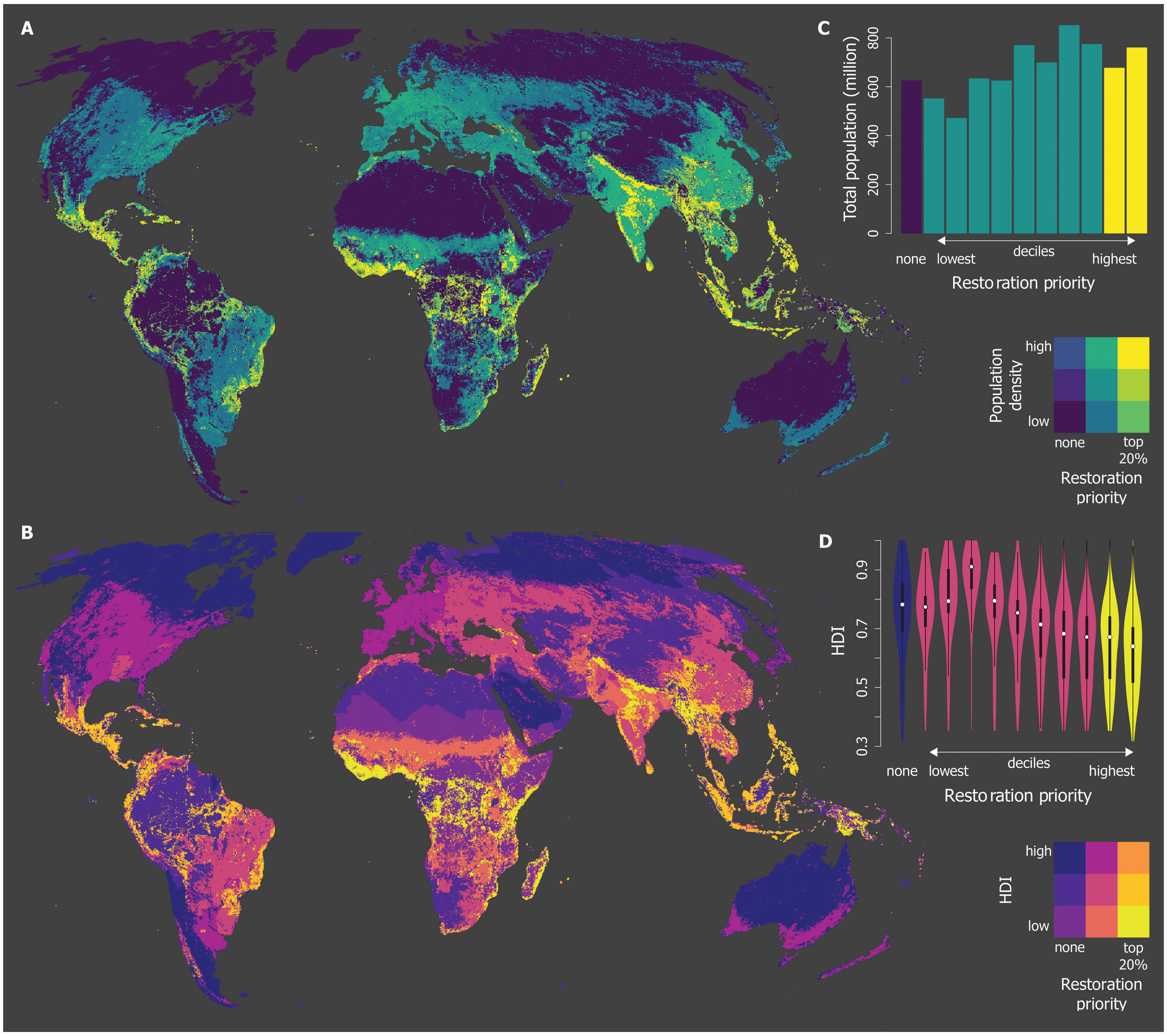

Figure 3. Bivariate choropleth maps of global ecosystem restoration priorities (Strassburg et al. 2020) compared with (a) human population density in 2018 (Rose et al. 2019) and (b) Human Development Index data (HDI) for the year 2015 (Kummu et al. 2018) on a global hexagonal grid (10 × 10 kilometer resolution) in Mollweide projection. (a) We classified areas as having no restoration potential (identified as lacking potential by Strassburg et al. 2020), intermediate (identified as the lower 80% of the areas identified as having restoration potential) or high restoration potential (identified as the areas with the top 20% restoration potential). We classified areas with less than 5 people per square kilometer (km^2) as low population density areas, areas with 5–50 people per km^2 as medium population density areas, and areas with more than 50 people per km^2 as high population density areas. The bright areas show high restoration priority and high populations, highlighting the strongest need for restoration approaches that place people at the center. Important to note is that even areas with low population may still be under indigenous or local community management, which should be accounted for in restoration planning. (b) We considered areas with an HDI of less than 0.6 as low, areas with an HDI of 0.6–0.8 as medium, and areas with an HDI of more than 0.8 as high. The dark areas indicate high HDI and low restoration priority, bright areas show low HDI (i.e., highest socioeconomic vulnerability) and high restoration priority. (c) Bar plot showing the total number of people living in each of 10 restoration priority classes based on Strassburg and colleagues (2020). The number of people in areas without restoration potential are highlighted in blue, the top 20% priority classes in yellow. (d) Violin plot showing HDI within pixels grouped by restoration priority class. White dots show medians, black bars show quantiles and colored envelopes indicate the distribution of the data. We have created this map for illustrative purposes. It should not be taken as a data product itself and is limited by the underlying data sets on which it is based. A more comprehensive method is provided in the supplemental material.

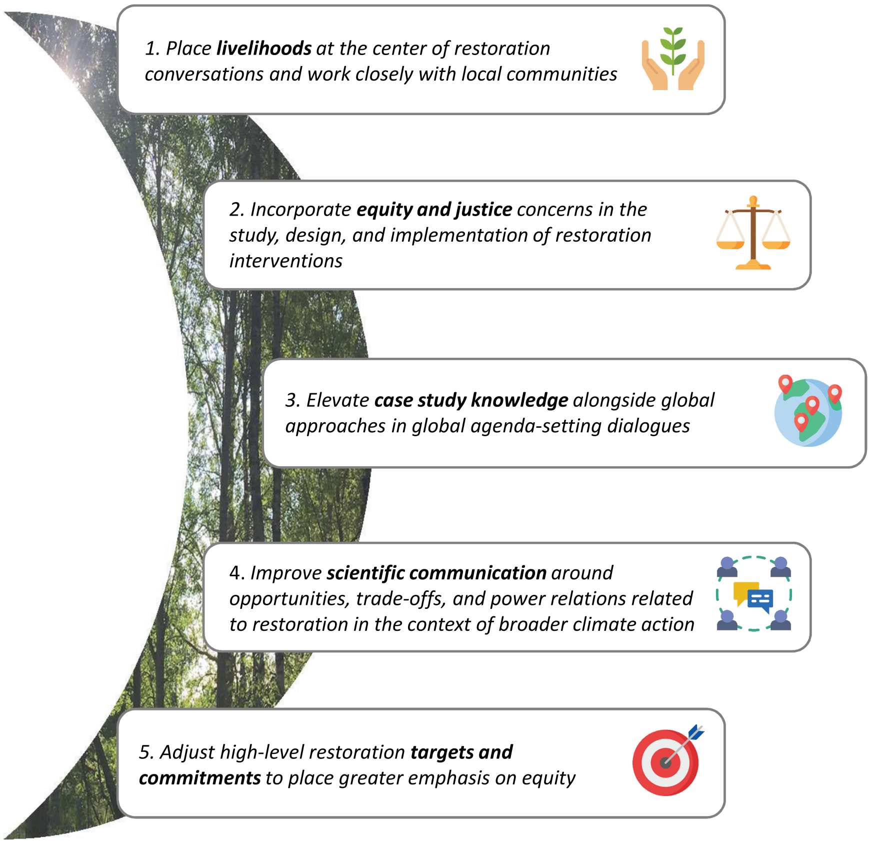

Figure 4. Summary of action points toward more equitable and effective ecosystem restoration.

equity-centered ecosystem restoration, complementing the 10 people-centered project level rules proposed by Elias and colleagues (2021).

Action point 1: Equity at the center of restoration practice. The first action point is placing equity at the center of restoration practice and working closely with local communities. Restoration can be an active and adaptive approach to landscape management that offers strong potential to involve local actors and improve livelihoods (Erbaugh et al. 2020). As some of the cases presented in this article illustrate, restoration can lead to improved life quality for members of local communities alongside the realization of ecological goals when livelihood considerations and equity are accounted for throughout the project. However, as other cases illustrate, the anticipated socioeconomic benefits of restoration do not always trickle down to local communities. Impacts can be highly heterogeneous, and there is a risk that already vulnerable groups may be further marginalized by restoration projects (figure 2, table S1).

Placing equity considerations at the center of restoration conversations entails involving multiple actors in a diagnosis of whether restoration is the best entry point to address ecological recovery and well-being or whether other local or broader systemic interventions are better placed to address local sustainable development concerns. For example, a recent study in central India showed that providing alternatives to fuelwood for cooking and more durable non-forest-based housing materials had both improved living standards and reduced forest degradation (DeFries et al. 2021). By prioritizing the study of how to simultaneously improve climate, biodiversity, and well-being, rather than the narrower subject of how to make conservation or restoration itself more effective, we may have a better chance of avoiding inequitable trade-offs (Sandbrook et al. 2013).

Working more closely with local communities is central to advancing the understanding of various realities on the ground to develop a more nuanced, context-specific representation of the possible futures for a particular landscape. Similarly, by developing a shared vision of pathways toward improving social and ecological outcomes, practitioners and local communities working together can design and implement ecosystem management and restoration practices that result in a greater clarity about roles and responsibilities toward that vision (Puspitaloka et al. 2020, Schmidt et al. 2021). Communities should not be viewed as homogeneous units but approached by identifying and assessing the multiple interests and actors that exist within a community and the role they all have in decision-making (Agrawal and Gibson 1999). It is important that intersectional identities within communities are acknowledged, because desires, opportunities, access to benefits, and vulnerabilities to risks may vary substantially between individuals with different genders, physical and mental abilities, sexual orientations, and races (to mention a few).

Action point 2: Equity and justice in study, design, implementation. The second action point is incorporating equity and justice concerns in the study, design, and implementation of restoration interventions. As has been voiced in recent critical introspections into the fields of conservation (Bennett et al. 2017a) and geography (Lave et al. 2014), among others, there is an urgent need to better integrate the social sciences and natural sciences in both research and communication on global sustainability and equity. Social processes, including governance, power relations, and values, are as important as biophysical processes in shaping socioecological landscapes. With complex governance arrangements, frequent trade-offs, heterogeneity within communities, and power imbalances among stakeholders and individuals, it is unlikely that any land system intervention can ever be fully equitable

(Waylen et al. 2013, Meyfroidt et al. 2022). Still, restoration scientists, policy makers, and practitioners can better promote outcomes that align with environmental and social justice by increasing their focus on social processes.

Moving forward, we propose that the restoration community consolidate a vision around equity-centered ecosystem restoration with substantial input from scientists and people in vulnerable communities. Equity-centered ecosystem restoration should place the rights and perspectives of the most vulnerable and most affected people at its core through measures that promote procedural, recognitional, and distributional equity. If restoration is deemed beneficial and desirable by local actors through consultative and equitable processes, then the restoration interventions should be designed on the basis of careful study of community and individual values, governance processes, power dynamics, and systemic inequalities and should be implemented in the context of inclusive and adaptive governance with strong coordination across scales. This is not only a moral imperative but is also crucial for restoration to realize environmental and ecological objectives (Velázquez-Rosas et al. 2018, Fleischman et al. 2020).

The historical marginalization of many communities, linked to the colonization of countries in the Global South as well as domestic structural inequalities, still affects living standards of many people. It is therefore important to not take a static view of equity, but to account for historical legacies of harms and injustices prevailing today, especially to capture procedural and recognitional injustices. Scientists, policymakers, and project developers can all play a part in increasing the chance that, to the extent possible, restoration is executed in a way that aligns with what is socially and environmentally just. A basis for this is to acknowledge that Western science and policy has been driving restoration trajectories and that this comes with justice risks especially when restoration is implemented in the Global South. Multiple narratives, especially those of vulnerable and local people, are needed to break out of epistemic domination and scientific imposition of traditionally Western values to non-Western contexts (Kleinschroth et al. 2021).

The principles set by the Society for Ecosystem Restoration, as well as the FLR principles (Besseau et al. 2018), already acknowledge this, but although both explicitly consider human well-being outcomes and involvement of local people, we urge associated researchers and practitioners to focus more explicitly on how equity in restoration can be achieved. This requires greater integration of expertise in land rights, environmental governance, political ecology, and environmental and social justice into restoration science and practice. It also requires better acknowledgement and synthesis of the existing vast social sciences literature on how land users derive meaning from their landscapes, how access to and control over those territories and landscapes are distributed, and how people are affected by land-use interventions. Restoration efforts will be more successful if social scientists with expertise in these areas are working alongside natural scientists, local actors, implementers, governments, and conservation agencies as coleaders of ongoing scientific syntheses and agenda-setting efforts. Diverse methods and approaches from across scientific divides are all necessary to understand how restoration can be scaled (Chaplin-Kramer et al. 2022), and scientists need to increasingly engage in interdisciplinary and transdisciplinary approaches (in regards to conservation; Bennett et al. 2017b).

By acknowledging the myriad ways in which any land use generates benefits and trade-offs across actors at different scales, restoration science could better anticipate how risks and opportunities to people may emerge from different restoration interventions in different contexts. Power imbalances prevail among funders, governments, and local communities and within those communities, and safeguards need to be included in restoration policies and practice to identify vulnerable actors and to ensure that their perspectives are prioritized.

This type of bottom-up equity-centered restoration may be both slower and more resource intensive than any government or private sector effort to merely increasing tree cover or the area under native ecosystem vegetation. Given that governance processes are subject to changes over time in light of policy and political changes at different scales (Mansourian and Sgard 2021), changes in decision-making processes and power structures should be monitored alongside the ecological outcomes to evaluate restoration activities. Because political cycles rarely match restoration cycles (Wiegant et al. 2020), a restoration outcome that looks technically and economically feasible at the beginning of a project may not be what will actually emerge if political support and financing is not sustained.

Action point 3: Case study knowledge. Next, we recommend elevating case study knowledge alongside global approaches in global agenda-setting dialogues. In recent years, there has been an increased proliferation of high-level global and pantropical maps outlining spatially distributed restoration potential (e.g., Bastin et al. 2019, Brancalion et al. 2019, Strassburg et al. 2020). The restoration and conservation community finds itself in an increasingly polarized debate regarding the utility of these maps in knowledge production and discourse. Schmidt-Traub (2021) argues that neither the biodiversity crisis nor climate change can be addressed without more global mapping studies, because global issues linked to land-use change cannot be successfully addressed without spatial planning. In contrast, Wyborn and Evans (2021) question the value of these maps in science and policy, raising concerns about how they are bound to misrepresent local realities and how the appeal of global maps may crowd out local-to-regional empirical studies with more contextual relevance.

In the present article, we argue that large-scale spatial studies play an important role in providing high-level insights on the potential global scope and impacts of restoration, and in raising awareness and mobilizing efforts.

However, to prevent this attention being mobilized toward harmful objectives, it is crucial that insights from these maps are complemented by site-specific knowledge in restoration planning and agenda setting. Restoration practice should always be informed by case studies, guided by local knowledge and consultative processes, and prioritize the perspectives of the most vulnerable people. Many outcomes simply cannot be measured well at a global scale or reconciled within an optimization framework. As argued by Chaplin-Kramer and colleagues (2022) both high-level and local studies are needed to successfully address environmental problems linked to landscapes. A dialogue between empirical cases and global analyses, as we've shown in this article, illustrates well the different types of information both approaches can present. The case studies we present help to highlight differences in contexts, mechanisms, and outcomes across restoration projects, whereas the global map gives a clear sense of the need to consider people in restoration science and practice, as well as the scale and geographical heterogeneity of the challenge.

To better represent the context dependency of values and governance systems in potentially restorable areas, existing case study work on restoration projects needs to be elevated via systematic review and meta-analysis in mapping exercises. Both the forest commons and deforestation literature provide useful examples of how case study knowledge can be used to generate a more generalized understanding of important phenomena and build toward middle-range theories. For example, Ostrom's (1990) foundational *Governing the Commons* brings insights from case studies throughout the world to challenge conventional economic assumptions of environmental behaviors in common pool resources and propose a new conceptual framework for understanding how community rules in use can govern these resources sustainably. Similarly, the Global Environmental Justice Atlas by Temper and colleagues (2018) broadens our understanding of environmental justice in ecosystem management by using case studies to showcase through what political, social, and economic processes certain groups are affected by socio-environmental conflicts.

Beside better visualization of these cases in a global matrix, archetype analysis could be used to "synthesize results from case studies, bridge the gap between global narratives and local realities, foster methodological interplay, and transfer knowledge about sustainability strategies across cases" (Oberlack et al. 2019). Case studies can incorporate more critical and pluralistic knowledge generation and will be crucial to gain a comprehensive understanding on what approaches actually hold potential for equitable and effective restoration outcomes in what contexts. In particular, case study approaches that include participatory, codesign approaches can help capture diverse restoration understandings and values (Nielsen et al. 2019).

Action point 4: Communication. The fourth action point is improving scientific communication around opportunities, trade-offs, and power relations related to restoration in the context of broader climate action. Authors of top-down spatial analyses showing where restoration theoretically *could* be done often provide caution about the limitations of their studies, especially that they are guided by a narrow range of globally or regionally available metrics or exclude certain areas. Despite these caveats, mapping studies have, in some cases, been taken up as blueprints for where restoration *should* be done. For example, in reference to the restoration potential map by Bastin and colleagues (2019) Christiana Figueres, the former UN Framework Convention on Climate Change executive secretary was quoted as saying, "Finally, we have an authoritative assessment of how much land we can and should cover with trees without impinging on food production or living areas. This is [a] hugely important blueprint for governments and [the] private sector" (Carrington 2019).

The aptitude for clear and simple messages and solutions in media and policy discourse is not surprising, and it is difficult for scientists to fully steer how their research output is taken up. However, scientists have a particularly important responsibility in making sure that studies are communicated in a way that reflects their complexity, and policymakers have a responsibility to engage more strongly with an interdisciplinary group of scientists before setting targets. Moving forward, the scientific community needs to better communicate what different types of studies show and can be used for and what they should not be used for. By clearly communicating the limitations of mapping exercises and the need to balance such approaches with a more thorough assessment of ecological and socioeconomic contexts on the ground, the scientific community will provide better guidance to restoration practitioners and policymakers. A narrow subset of natural science studies has had disproportionate influence on restoration discourses in media and policy. Social scientists need to improve communication beyond academic circles to increase the chance that insights on social dimensions from empirical, context-specific studies on restoration reach policymakers, financial actors, and practitioners.

This is particularly urgent, given the scale of the climate crisis. The Paris Agreement's global temperature target of 1.5 degrees above preindustrial levels may be reached as early as in the 2030s (IPCC 2021) and countries, companies, financial actors, and individuals need to take unprecedented action to rapidly eliminate fossil fuel dependence. Restoration can provide part of the solution, but trees planted today will make a limited contribution to climate change mitigation in the short run (Anderson et al. 2019). There is a risk that the enthusiasm around restoration as a climate change solution will decrease the sense of urgency for actions to reduce fossil fuel dependence. Indeed, politicians with little interest in measures to decarbonize have been quick to take up tree planting as a silver bullet solution to climate change (Friedman 2020). There is also a risk that emitting actors, absent stringent obligations to limit their own emissions, increasingly push for tree planting to offset emissions at the expense of local people in targeted regions. Therefore, it is important that measures to reduce fossil fuel dependence are implemented alongside restoration initiatives, so that the pressure on restoration to be a climate change solution can be reduced, allowing for a greater focus on the overall ecological and social outcomes of restoration activities.

Action point 5: Targets and commitments. Finally, we recommend adjusting high-level restoration targets and commitments to place greater emphasis on equity. As we show, areas with the highest estimated restoration potential are home to over a billion people, disproportionately belonging to some of the most vulnerable groups globally. Land-use policies driven by actors in northern countries but implemented in the Global South have a troublesome history of marginalizing people who have already suffered the consequences of colonization and climate change driven by actors in the Global North (in the case of REDD+ in Peru; see Espinoza Llanos and Feather 2011).

Current international targets and commitments are largely designed to measure success in metrics such as number of trees (as in the One Trillion Trees Initiative) or numbers of hectares restored (as in the Bonn Challenge), with insufficient focus on both equity and effectiveness of environmental, ecological, and social outcomes. Therefore, these targets can, in theory, be met through interventions with harmful effects on climate, ecological systems, and human well-being (Holl and Brancalion 2020, Osborne et al. 2021). To promote equitable and effective restoration, we propose that targets and commitments are refocused on equity-centered ecosystem restoration by measuring success in metrics that are linked to ecological recovery and improved human well-being and health. Such metrics could include increased employment, income, food and fiber security, biodiversity, and climate resilience but should also be adjusted to local demands and needs.

The societies that have benefited the most from the economic system that caused climate change are also those that have the best capacity to decarbonize without infringing on life quality. Therefore, global targets around climate should not prioritize restoration in the Global South above decarbonization in the Global North, especially if such restoration efforts are perceived as inequitable by historically disadvantaged groups of people.

Conclusions

Ecosystem restoration provides a powerful opportunity to improve the lives of current and future generations while contributing to healthy ecosystems. Improving the well-being of local people is often listed as a core objective of restoration initiatives. However, many of the key social considerations that influence restoration equity and effectiveness receive insufficient attention in restoration science, policy, and practice, which, in turn, jeopardizes both environmental and social justice as well as restoration longevity. In the present article, we argue that a greater focus on the values, governance processes, and power dynamics of actors involved in and affected by restoration, and an improved practice of engaging and including local actors, including systematically marginalized groups, is crucial to developing restoration that is more equitable and effective. We have suggested five action points for science, practice and policy to achieve these goals: Placing equity at the center of restoration practice and work closely with local communities; increasing focus on equity and justice in the study, design, and implementation of restoration; elevating of case studies in global agenda setting efforts; improving scientific communication around restoration; and promoting targets and pledges that better measure social and ecological outcomes. By centering restoration science, policy, and practice on equity there is a greater chance that restoration initiatives will succeed in mitigating climate change, safeguarding biodiversity and ecological processes, and improving well-being for people today and for generations to come.

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Supplemental data

Supplemental data are available at *BIOSCI* online.

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