Nature-Based Climate Solutions Require Us to Answer the "Where" and the "Who"

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Executive Summary: The protection and restoration of nature are critical for climate change mitigation. As such, many international initiatives have been launched to champion the implementation of nature-based climate solutions (NBCS) while supporting other societal goals. Given global momentum, it is critical that policymakers proactively define successful NBCS activities to avoid perverse incentives and harmful land-use change. We argue that effective NBCS will support clear goals and make transparent the relative costs and benefits to climate, biodiversity, and human livelihood. To do this, NBCS must be designed based on the best geospatial science and implemented alongside empowered local communities. Specifically, NBCS should be accompanied by strong benefit-sharing mechanisms that involve procedural equity. Further, where changes in land management and land-use are required, land restoration should be accompanied by financial incentives that make such restoration profitable. Carbon markets could be expanded to include land-based carbon, and auction proceeds or tax revenues could be utilized to fund restoration on private land where landowners may be required to forego other profits over the short term. NBCS will help the global community advance important societal goals if policymakers can be specific about *where* national goals will be implemented and *who* will be empowered to make decisions about their design.

I. Introduction

Over the next decade, many countries will experience the joint challenges of rebuilding their economies after COVID-19, raising political ambitions to curb the impacts of a warming planet, and pursuing broad-scale ecosystem restoration after decades of degradation (Naidoo and Fisher 2020; UN n.d.). Identifying solutions at the intersections of these challenges will be critical. Nature-based climate solutions (NBCS) provide a unique opportunity for countries to directly meet the needs of local communities while supporting broad societal goals (Owen and Durham 2020; Griscom et al. 2020). Further, those solutions which capitalize on natural regeneration and restoration can be particularly cost-effective (Crouzeilles et al. 2020). If implemented strategically, NBCS can help us "build back better" to safeguard future growth and align economic development with plans to reduce GHG emissions, slow biodiversity loss, and increase the circularity of supply chains to reduce waste (Lieuw-Kie-Song and Pérez-Cirera 2020).

Commitments to expand the implementation of NBCS have proliferated over the past several years. Under the Paris Climate Agreement, countries are looking to increase the contributions of land-based carbon to their Nationally Determined Contributions (NDC) (UNDP 2019). Currently, most NDCs indicate inclusion of land sector mitigation, and several indicate their participation in the framework on Reducing Emissions from Degradation and Deforestation (REDD+). However, less than a quarter of them quantify specific land sector mitigation contributions (Forsell et al. 2016). Further, land-based sequestration efforts receive only about 2.5%

of climate mitigation dollars due to uncertainties about potential carbon sequestration and related costs, concerns about the permanence of storage, and socio-political barriers to implementation (Buchner et al. 2019; Griscom et al. 2017). In parallel, the UN has launched the Decade on Ecosystem Restoration (2021-2030). Through this effort, the UN hopes to amplify restoration as an opportunity to simultaneously end poverty, combat climate change, and prevent a mass extinction event (UN, n.d). One specific initiative, predating but complementing the UN Decade on Ecosystem Restoration, is the Bonn Challenge, launched by the Government of Germany and the International Union for Conservation of Nature (IUCN) to restore 350 million hectares of degraded land globally by 2030 (Bonn Challenge, n.d.). Of particular focus is reforestation and afforestation, which promise to yield significant carbon sequestration benefits (e.g., Waring et al. 2020).

Given the momentum around NBCS, policymakers must design and implement strategic activities that embrace the best available science and draw upon local knowledge of ecosystems so that land restoration can be carried out in partnership with landowners. In May 2020, the Global Environment Facility (GEF) Science and Technology Panel reviewed lessons learned from past projects and programs and noted that mainstreaming NBCS policy is still a work in progress with a need for more transparency in the trade-offs associated with NBCS implementation (GEF 2020).

To avoid perverse incentives and harmful land-use change, we argue for a clear and common definition of NBCS, a strong commitment to scientific measurement and monitoring of NBCS benefits and costs, the development of an enabling legal environment that supports community-based ownership and management, and supportive financial markets that make restoration profitable (Figure 1).

II. Pathway towards effective design and implementation

i. Common definition—make the goals clear

With many emerging papers, reports, and initiatives focusing on the role of nature in climate change mitigation and securing related co-benefits, there is the potential for confusion in terms. Already, there are similar names for work with common elements, including nature-based climate solutions, natural climate solutions, nature-based solutions, ecosystem restoration with climate co-benefits, and activities that increase the ability of "natural and working lands" to sequester carbon and maintain ecosystem resilience (e.g., Griscom et al. 2017; USCA 2020; UNDP 2020). While all of these terms may imply that related projects have a positive impact on climate, biodiversity, and community development, this is far from guaranteed. Consistency in how related efforts are discussed and designed will encourage clearly defined goals with measurable and monitored progress.

In 2016, at the World Conservation Congress, members of the IUCN defined nature-based solutions (NBS) more broadly as "actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits" (IUCN 2016). They also created a global standard to ensure that NBS could achieve their potential to address societal goals. This guidance advances eight supporting principles, which together aim to ensure NBS are designed based on site-specific natural and cultural contexts that include traditional, local and scientific knowledge; produce societal benefits fairly and equitably in a manner that promotes transparency and broad participation; and maintain biological and cultural diversity and the ability of ecosystems to evolve over time (IUCN 2016). Although not focused specifically on climate mitigation, this guidance implies that true nature-based solutions will both advance human wellbeing and protect biodiversity in addition to any ancillary climate benefits they provide.

We suggest that any proposed NBCS make clear the intersectional and intended benefits for carbon/climate, nature/biodiversity, and human wellbeing/livelihoods. Although all three outcomes may not be simultaneously maximized in any single location, initiatives should endeavor to identify those areas where overlap can occur with justification. For example, while fast-growing and monocultured tree plantations may still support

climate change mitigation and promote local livelihoods, they will not provide the same level of benefit to biodiversity as the intact and diverse forest ecosystems they often replace (e.g., Osuri et al. 2020). In this sense, the best NBCS will also be NBS, as defined by the IUCN.

ii. Geospatial application—identify the "where"

One significant challenge facing the implementation of NBCS involves identifying specific geographic locations where these activities will occur. Global commitments must ultimately be resolved at local levels, especially regarding land-use decisions because they inherently involve rights, access, and ownership. NBCS are foundationally geospatial, with profound social and economic implications as the co-benefits are not the same across space (Brancalion et al. 2019; Strassburg et al. 2020). Furthermore, with regards to climate change mitigation, the global community must separately prioritize the ongoing protection of existing carbon stocks and the identification of opportunities for additional ecosystem restoration or reforestation. These strategies are likely to have different co-benefits, produce related benefits or costs across different time scales, and involve different actors.

For example, the Global Deal for Nature is a science-driven plan offered by scientific researchers to advance the Paris Climate Agreement's goals while increasing protected areas. This plan focuses on maintaining currently unprotected carbon stocks to support climate stabilization and curb biodiversity loss (Dinerstein et al. 2019; Dinerstein et al. 2020). In particular, this work signals that ~74% of all mapped indigenous lands globally overlap extensively with the additional land they identified for protection. In this case, recognizing land ownership and stewardship of indigenous communities could further advance climate mitigation goals.

In contrast, restoration on land areas where the carbon sequestration gap (i.e., remaining carbon sequestration potential) is highest and thus more attractive for additional climate mitigation is likely located on agricultural land or areas previously degraded due to land management activities (Chazdon et al. 2020). In this context, fostering alternative livelihood practices will be critical as local economies may no longer be forest-dependent. Recent work on the climate change mitigation potential of reforestation suggests that even with conservative estimates of carbon uptake, regrowth of natural forests in the absence of cost constraints remains the single largest natural climate solution (Cook-Patton et al. 2020). Further embedding reforestation within local economies will ensure this solution can be leveraged at scale.

Governments need a plan to be able to measure current and future carbon sequestration potentials. Part of this process includes a commitment to "ground-truthing" their goals with the best available science and technologies. Investing in sound geospatial science, such as that being advanced through the NASA Carbon Monitoring System (Hurtt et. 2014; NASA, n.d.), is critical for mapping carbon baselines, modeling carbon sequestration potential, and monitoring ongoing carbon changes at the landowner scale. Countries without the in-house capability to monitor and evaluate the carbon benefits of NBCS should enjoy support from and collaboration with those that do.

Further, if NBCS are also about improving livelihoods, there should be supporting entities responsible for measuring and reliably tracking other social and environmental benefits. Tracking such metrics can improve the design of NBCS interventions and ultimately generate demand from sources of market-based finance looking to support "win-win" strategies with measurable outcomes (GEF 2020). A geospatial approach to quantification would help to ensure policymakers are choosing sites for NBCS that are benefiting rather than harming local communities.

iii. Legally enable communities—identify the "who"

In addition to sound science, policymakers need to proactively build an enabling legal environment that secures and protects individual and community land rights and clarifies the allocation of costs and benefits. Many carbon-rich environments are home to indigenous peoples and local communities (IPLCs) whose fate is intertwined with their land. Further, IPLCs often maintain traditional ecological knowledge and embedded values of environmental stewardship and protection (Sangha et al. 2018). Studies show government recognition and

protection of indigenous and community rights drive the most successful forest conservation outcomes (Stevens et al. 2014). For example, when the government of Niger protected the forest rights of local communities, it led to the planting of 200 million new trees (Maclean 2018). Therefore, governments need to help IPLCs secure and protect a spectrum of land and resource rights, including those related to access, withdrawal, management, exclusion, and alienation (Schlager and Ostrom 1992). Governments can protect indigenous rights to forests by introducing legislation that recognizes those rights, mapping community forest boundaries, expelling illegal loggers, and not conceding forest areas to commercial interests (Stevens et al. 2014). IPLCs may be incentivized to sustainably manage their land towards specific national goals when their rights are protected, and they can derive financial benefit from generated ecosystem services, such as natural carbon storage and water purification (Camacho et al. 2016; Parrotta et al. 2016).

Governments must establish benefit-sharing mechanisms and codify these best-practices into law. In the context of REDD+, benefit-sharing mechanisms commonly refer to the set of institutional means, governance structures, and instruments that distribute resources and other net benefits from project implementation (Lutrell et al. 2013; Vhugen et al. 2012). As NBCS include but extend beyond the REDD+ framework, it makes sense to establish benefit-sharing as a foundational component of all planned activities. Further, any selected mechanism should exhibit a high degree of "procedural equity." That is, different stakeholders with varying perspectives need to have an opportunity to shape the decision-making process (Brown and Corbera 2003). Including the voices of local communities in NBCS design will contribute to overall effectiveness and increase the likelihood of realizing and maintaining multiple types of benefits for climate, biodiversity, and human livelihood. Local communities may already have context-specific knowledge about the ecosystems in which they live and how to manage them sustainably.

iv. Profitable restoration—provide strong financial incentives

Finally, countries will be able to advance ambitious NBCS if this work is accompanied by increased financial capacity. Targeted incentives will be important for maximizing climate, biodiversity, and livelihood benefits, especially where planned activities require a significant change in current land management or land-use. Given the current economic stressors that many countries face, private-public partnerships will be increasingly important for helping countries overcome financial barriers. One attractive option for funding this work may be the creation of land carbon markets, where every ton of carbon sequestered is assigned a monetary value that can be rented, purchased, or traded (e.g., Lintunen et al. 2016).

A recent analysis by the World Bank shows that if all planned carbon taxes and pricing systems were implemented worldwide, they would cover 22.3% of global GHG emissions (World Bank, n.d.). In the United States, the most mature carbon pricing schemes, such as the Regional Greenhouse Gas Initiative and the California Cap-and-Trade Program, have promoted significant reductions in greenhouse gas emissions even while focusing exclusively on CO_2 emissions from non-land-based sources (CARB, n.d.; RGGI, n.d.). The mechanics of including land-based carbon within existing cap-and-trade or carbon tax systems may be complicated, but much of the challenge comes from concerns about scientific accuracy. Current high-resolution carbon monitoring and modeling efforts may provide an unprecedented opportunity for integration at policy-relevant scales, with the ongoing expansion of this science globally (Dubayah et al. 2020; Ma et al. 2019; Ma et al. 2021). However, more must be done to operationalize this work and bridge scientific expertise with decision-making (Lamb et al. 2021a).

Even if land-based emissions are not directly traded, auction proceeds or tax revenues from existing governmental markets could be used to incentivize/fund reforestation efforts on private land (NJDEP 2020). Paying for carbon capture through NBCS can make reforestation or other forms of land restoration more feasible in regions where landowners may need to forgo other profits in the short term (Lamb et al. 2021b). Such an approach could build on other successful payment for ecosystem services (PES) schemes (CPI 2016). For

example, localized PES in the Bellbird Biological Corridor in Costa Rica have provided direct economic payments to individuals with lower income, education, and property sizes than otherwise engaged under national level programming (Brownson et al. 2020). These programs have also generated additional "spillover" benefits, as local NGOs leverage these payments to finance research, environmental education, and conservation on other lands not under PES contract.

III. Conclusion

Recent research suggests that NBCS can provide over one-third of the cost-effective climate mitigation needed between now and 2030 to stabilize warming to below two degrees Celsius (Griscom et al. 2017). As more good work is done globally to advance NBCS, policymakers must be sure that all activities are well designed, implemented, and evaluated relative to clear goals that are defined in partnership with local communities. If policymakers commit to making decisions based on the best geospatial science and maintain a strong commitment to local ownership and management, their efforts are most likely to advance local human well-being and ecosystem resilience in the process of securing a better global future.

Appendix

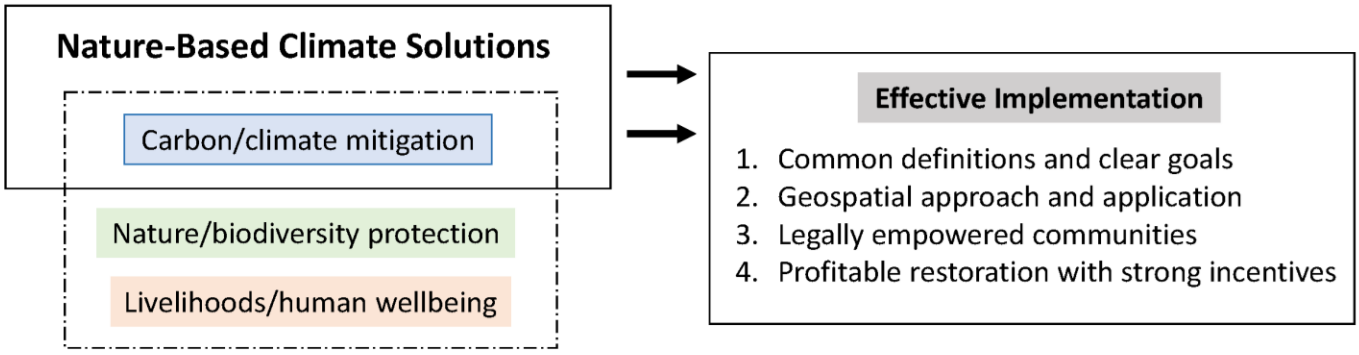

Figure 1. Nature-based climate solutions (NBCS) are fundamentally defined by their ability to advance climate mitigation through natural carbon sequestration; however, the best NBCS will simultaneously support biodiversity protection and human livelihood and wellbeing (dotted box), making transparent the tradeoffs among these three goals. Effective implementation of NBCS rests upon four foundational pillars (right box).

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