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# Opportunities for nature-based solutions to contribute to climate-resilient development pathways

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There is potential for nature-based solutions (NbS) to contribute to climate-resilient development (CRD) due to their integrated approach to mitigation, adaptation, and sustainable development. However, despite alignment between NbS and CRD's objectives, realization of this potential is not guaranteed. A CRD pathways (CRDP) approach helps to analyze the complexities of the relationship between CRD and NbS, and a climate justice lens enables the identification of the multiple ways that NbS can support or undermine CRD by foregrounding the politics inherent in deciding between NbS trade-offs. We use stylized vignettes of potential NbS to examine how the dimensions of climate justice reveal the potential of NbS to contribute to CRDP. We consider tensions in NbS projects between local and global climate objectives, and the potential for NbS framing to reinforce inequalities or unsustainable practices. Ultimately, we present a framework that combines climate justice and CRDP in an analytical tool for understanding the potential for a NbS to support CRD in specific places.

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## Nature-based solutions and climate-resilient development

Nature-based solutions (NbS) are localized interventions to approach societal challenges by working with nature [1,2]. The promise of NbS is that they can simultaneously address the socioeconomic drivers of climate change, increase resilience to climate impacts, and build social, environmental, and economic-adaptive capacity to meet climate and development challenges, and thus contribute to climate-resilient development (CRD) [1]. CRD is an approach to development that combines poverty and inequality alleviation with climate adaptation and greenhouse gas mitigation. It pursues synergies across these policy priorities in recognition that climate change exacerbates vulnerability and inequality, which limit the efficacy of climate action [3]. Yet, despite the alignment between their objectives, it is not guaranteed that NbS will always contribute to CRD. The details of how NbS are framed, designed, and implemented significantly impact the potential value of NbS [4], and it is possible that NbS can be framed, designed, or implemented in ways that cause harm and detract from CRD.

In this paper, we suggest that analyzing NbS using a CRD pathways (CRDP) approach that focuses on climate justice offers constructive opportunities to engage with the complexity of the relationships between NbS and CRD. Pathways approaches serve as both conceptual and planning tools that help to analyze the cumulative direction of many context-dependent decision points [5–11]. CRDP have been characterized as "the process of consolidating climate action and development decisions towards long-term sustainable development" [12]. A CRDP approach recognizes that CRD is not a finite endpoint but rather a continual process, where many factors can influence the trajectory of pathways, including external shocks and future interventions [13].

Literature on both NbS and CRD has been criticized for apolitical analysis that reifies these approaches without sufficient attention to the power dynamics of decision-making and implementation, and trade-offs across priorities and values embedded within these concepts [14,15]. Critics warn that the concept of CRD can ignore large-scale structural drivers of development and power asymmetries while reinforcing techno-managerial approaches [15]. Similarly, because of the large-scale impacts of NbS on landscapes and livelihoods, if NbS do not account for imbalances in power and knowledge, they may reinforce inequalities or unsustainable practices [16]. For example, allocating decision-making and influence in prioritizing among trade-offs across multiple benefits to a small number of people limits broader participation and may reinforce inequalities [1,14,17]. Minimizing or failing to acknowledge differentiated challenges may exacerbate marginalities and vulnerabilities for those for whom triple-win opportunities in

mitigation, adaptation, and sustainable development are infeasible [18–21]. To illustrate, a mangrove restoration project for carbon offsets may create compensation mechanisms that support aspects of sustainable development even as it replaces mitigation efforts by major polluters and limits space available for adaptive aquaculture. Incorporating a climate justice lens helps to address these concerns, as attention to power dynamics, structural drivers of inequality and vulnerability, and diverse visions for change are central to climate justice [22]. Therefore, a climate justice framework that brings the politics inherent in NbS to the forefront can identify the multiple ways that NbS can support or undermine CRD.

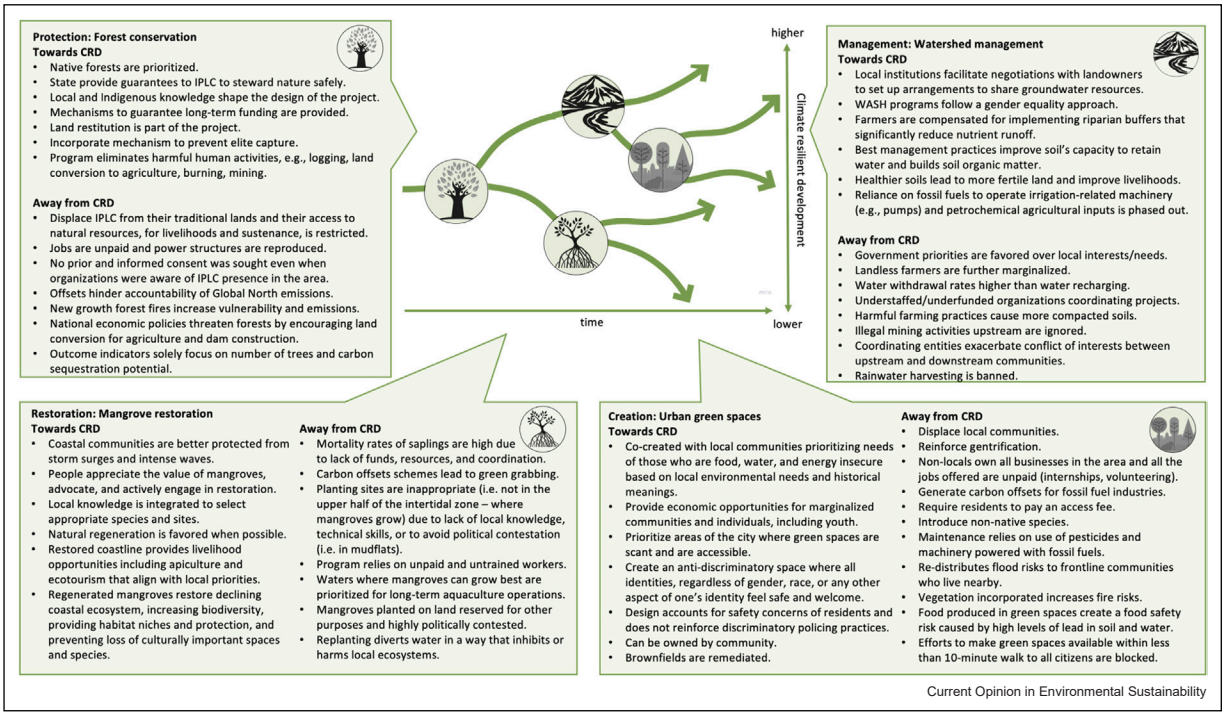
## Using a climate-resilient development pathways approach to analyze nature-based solutions

Using a CRDP framework, NbS can be conceptualized as decision points on a CRD pathway. The stylized diagram in Figure 1 illustrates that NbS can lead toward or away from CRD. Depending on how they are framed, designed, and implemented, NbS may be decisive junctures in CRDP. While represented as single decision points in the diagram, in reality, NbS framing, design, and implementation entail many decisions, so their contributions to CRD may change over time.

In our stylized framework, we represent a broad range of NbS interventions using Seddon et al.'s characterization of NbS categories: Protection, Restoration, Management, and Creation [1]. We illustrate protection with forest conservation, restoration with mangrove restoration, management with watershed management, and creation with urban green space. While the four examples are not exhaustive, they serve to exemplify that a CRDP framework has utility across a wide range of NbS. For each example, we developed vignettes, building on empirical literature, that illustrate factors that influence how each NbS example can contribute toward or away from CRD.

To complement the vignettes, in Table 1, we distill existing NbS literature to articulate specific contributions each type of NbS can make to the multiple goals of CRD, including incrementally advancing global environmental quality and human well-being. Forest conservation, for example, can contribute to mitigation by absorbing carbon and adaptation by reducing flood, drought, landslide, and salinization risks. It can also

**Figure 1**



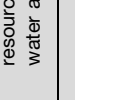

NbS contributions to CRDP. NbS have the potential to be important components of CRDP. Depending on the extent to which climate justice is centered in framing, design, and implementation of NbS, they can contribute to higher or lower CRD. Here, vignettes present stylized narratives of NbS using the four categories of NbS action: protection, restoration, management, and creation. Despite the stylized depictions of NbS either contributing toward or away from CRD, NbS interventions are quite complex and certain components may promote just CRD while others do not. Although this diagram suggests that these interventions are implemented sequentially, pathways to CRD are likely to incorporate multiple NbS strategies.

**Table 1**

**Potential contributions of NbS to CRD goals.**

| | | NbS | | | |
|---|---|---|---|---|---|
| *NbS type Example* | |  *Protection* *Forest conservation* |  *Restoration* *Mangrove restoration* |  *Management* *Watershed management (including sustainable agriculture)* |  *Creation* *Urban green spaces* |
| *Mitigation* | | • Absorb ~20% of annual global emission and have potential to mitigate between 6.6 and 18.6 Pg $CO_2$ per year (tropical) [35].<br>• Avoid emissions from degradation, livestock, fertilizers, and fires [36]. | • Store 3–5 times more carbon than tropical forests [37].<br>• Unlike terrestrial ecosystems, carbon in mangroves does not saturate [38].<br>• Avoid emissions from degradation and improve sequestration [36]. | • Reduce nonpoint source pollution from agricultural activities, including $N_2O$ [39] and sediment transport [40].<br>• Increase carbon sequestration through restoration of upper watersheds [41]. | • Capture carbon [42]<br>• Reduce car reliance by increasing walkability [43].<br>• Decrease contaminated land [44] and stormwater runoff [45].<br>• Reduce energy use for cooling and heating [46]. |
| *Adaptation* | | • Reduce flood [47] and drought risks, landslides, and salinization [48].<br>• Increase local cooling [49].<br>• Improve resistance to natural disturbances, for example, fires, pests, and diseases [50]. | • Provide coastal defense through the installation of entrapping sites that mimic nature [51] and reduce wave height [52].<br>• Minimize saltwater intrusion [53,54]. | • Reduce range and scale of flood/drought risk [40] and wildfires [55].<br>• Improve regulation of water flow and precipitation [56]<br>• Decrease pest and diseases [57]. | • Reduce heat island effect [58–60].<br>• Reduce flood risk by stormwater buffering [61].<br>• Build adaptive capacity via relationships between scientists and practitioners and using local policy levers [62,63].<br>• Create new food sources and regulate pest and diseases [57]. |
| Sustainable Development | *Social* | • Provide cultural values when local communities included [64].<br>• Improve governance through forest-based ecotourism that is operated by Indigenous People and local communities [65].<br>• Protect medicinal and spiritual plants [66]. | • Increase social cohesion and sense of pride [51].<br>• Deliver important cultural roles and recreational and tourism services [67,68]. | • Create participatory governance conditions [69].<br>• Provide aesthetic, educational, cultural and heritage values [70].<br>• Decrease conflict with local authorities, increase skills and knowledge, and sustain programs [71]. | • Increase walkability, access to services, health, and well-being [72].<br>• Create public spaces for social cohesion, communities to gather, and children to play, providing equitable access to recreation and physical activity [46].<br>• Build trust between cities and people [73].<br>• Improve public health through microbiome enrichment and improved immune regulation [74].<br>• Decrease social isolation [75], stress, and socioeconomic disparity [72].<br>• Reduce noise pollution [76]. |
| | *Env.* | • Enhance biodiversity (habitat protection), water quality and availability, air quality, and soil health [77].<br>• Restore landscape connectivity to support seasonal migration [25]. | • Serve as fish nurseries [78] and sustain high levels of biodiversity [79].<br>• Trap sediments out of the waterway, and reduce coastal erosion [80]. | • Improve water quality, pollinator habitat, nutrient cycling, soil health, and protection from invasive species [70].<br>• Increase groundwater recharge [81].<br>• Protect threatened/endangered species [55].<br>• Reduce urban-driven thermal pollution [82]. | • Improve local air quality and create biodiversity havens and habitat connectivity [45].<br>• Reduce air, soil, and water pollution [74]. |

**Table 1** (*continued*)

| NbS type Example | NbS | | | |
|---|---|---|---|---|
| |  *Protection* *Forest conservation* |  *Restoration* *Mangrove restoration* |  *Management* *Watershed management (including sustainable agriculture)* |  *Creation* *Urban green spaces* |
| *Econ.* | • Benefit governments and communities with carbon credits generated from sustainable harvesting of timber and nontimber forest products [83,84].<br>• Provide new revenue stream forest-based ecotourism [65].<br>• Provide access to new markets through sustainability certification [85]. | • Increase local- and near-coast fisheries productivity through improved nursery habitat [86].<br>• Reduce costs of infrastructure destruction and reconstruction [87].<br>• Strengthen tourist and recreation industry, for example, game birds [56]. | • Reduce costs in water filtration and need for infrastructure, strengthen recreation industry, and tax revenue [88].<br>• Improve livelihoods through income diversification and increased assets[71] and payment for ecosystem services [55,89]. | • Reduce energy and costs associated with cooling [90,91].<br>• Grow a food solidarity economy [92].<br>• Increase access and therefore lower costs to potentially scarce resources such as clean fresh water and produce [74]. |

contribute to social, environmental, and economic dimensions of sustainable development, for instance, by providing a cultural resource, enhancing biodiversity, and providing revenue streams.

## Trade-offs across priorities and values embedded in nature-based solutions and climate-resilient development

For NbS to contribute to CRD, they must be framed, designed, and implemented in ways that center climate justice. Consideration of the four dimensions of climate justice (distributional, procedural, recognitional, and restorative) [23,24] can help determine whether particular NbS are likely to contribute toward or away from CRD. A climate justice approach can explicitly identify the values, rules, and knowledge across different scales shaping NbS' contribution to CRDP [25].

Distributional justice concerns the ways that the impacts of NbS, both harms and benefits, are allocated "socially and temporally across society" [26]. Procedural justice refers to the extent to which all relevant interests are equitably involved and represented in the decision-making and implementation process, including in deciding between competing interests and project trade-offs [27]. Recognitional justice entails respect for differences by acknowledging, valuing, and accounting for the capacities, contributions, and humanity of NbS participants and others affected in the decision and action processes [28,29]. Finally, restorative justice is concerned with how the project addresses and redresses past harms that created or exacerbated inequalities and vulnerabilities, including by actively reshaping unjust systems for self-determination and global democratic equality [30]. Alongside the potential of a climate justice lens, however, it is important to recognize that, like CRDP, justice is not a static concept. Its definition and application require a deliberate approach; otherwise, mainstreaming justice can become a technocratic and mechanistic process that fails to meet the NbS or CRD goals [28].

NbS framing, design, and implementation are ideologically shaped [1,31] and inherent trade-offs mean there is no perfect NbS that can solve all problems for all stake- and rights-holders. Still, attention to how and for whom justice can be promoted in NbS can guide CRD toward more proactive strategies and frame CRDP in ways that address root causes and anticipate adverse outcomes, potentially transforming existing systems to meet the needs of the most vulnerable [32,33].

Table 2 synthesizes ways that embedding each dimension of justice throughout an NbS project can contribute toward CRD. For example, an NbS project that is restoratively just prevents institutional discrimination,

**Table 2**

**Types of justice, NbS, and CRDP.**

| *Type of justice* | Definition | How centering justice enables NbS to contribute to CRD |
|---|---|---|
| *Distributional* | The equitable distribution of climate "rights, duties, risks, hazards, and harms", including intergenerational justice: the preservation of nature for the survival and enjoyment of future generations [93] | • Prevent climate burdens from exacerbating existing inequities, including for future generations, by placing the responsibility on those most responsible for the crisis.<br>• Ensure that the benefits do not only accumulate among those who have more privilege.<br>• Do not impose or create risks and/or vulnerabilities for communities who live nearby or who may be affected (e.g. downriver).<br>• Avoid inequitable disbursement of NbS-related funds among small landholders or communities with limited resources or access to financial means and/or markets.<br>• Disaggregate data to prevent concealed impacts on marginalized communities and individuals or the environment. |
| *Procedural* | Accountable processes and institutions that result in just roles for all partners in decision-making and implementation, especially those who have historically been excluded and marginalized, following four principles: access to information, access to meaningful participation in decision-making, lack of decision-maker bias, and access to legal process for redress [94,95] | • Account for the goals of all partners, especially the least powerful.<br>• Create space for experimentation and negotiation.<br>• Enhance transparency, legitimacy, and accountability.<br>• Guarantee the right to participate effectively in project, programs, law, and public<br>• Policy aimed at attaining CRD through NbS.<br>• Free prior and informed consent is always obtained.<br>• Does not follow a top-down consultation process.<br>• Build strong local communication channels (e.g. information sharing during farmers' cooperative meetings). |
| *Recognitional* | The recognition of all partners, their capabilities, and their relationships including direct, inequitable climate burdens, especially those traditionally excluded — includes epistemic justice, or recognition specifically of the knowledge of those often excluded from decision-making [94,96] | • Coproduce NbS goals and implementation with Indigenous and local knowledge.<br>• Acknowledge potential for contributions of different types of knowledge and expertise.<br>• Design NbS responsive to partner barriers, burdens, and capabilities.<br>• Do not weigh the preferences of funders more than Indigenous and local partners.<br>• Include an Indigenous Peoples expert when working in Indigenous territories.<br>• Provide historically marginalized communities and individuals voice and vote to approve/deny and to shape projects or interventions (i.e. redistribution of power in decision-making procedures). |
| *Restorative or reparative* | Addresses past harms, including genocide and slavery, to marginalized groups that exacerbated or created inequalities [23,30] | • Identify historic injustices that have created contemporary disadvantages and excluded vulnerable groups from self-determination and decision-making.<br>• Prevent institutional discrimination<br>• Acknowledge that Indigenous Peoples and local communities (IPLC) interests must be prioritized in NbS goals and implementation to build justice.<br>• Provide the substantive means necessary for people to have prosperous lives by, for instance, giving land back to those who have been displaced from their homes.<br>• Guarantee that IPLC can exercise their right to steward the land in a safe manner, including defending environmental justice without threats or fear of violence.<br>• Ensure redress and remedy to victims of environmental harms and long-standing injustices. |

identifies and repairs historic injustices that have exacerbated current disadvantages and vulnerabilities, and prioritizes the interests of Indigenous Peoples and local communities, including by returning their land.

Conversely, when justice is not present, NbS will not align with CRD, instead contributing to CRDP that lead away from CRD. Table 3 describes challenges in NbS framing, design, and implementation with examples

**Table 3**

**Challenges of NbS for CRD and connections to injustice.**

| *NbS for CRD challenge* | Challenge description | Type of (in)justice | Challenge examples | Potential solutions |
|---|---|---|---|---|
| *Narrow technological emphasis* | • Focus on replication and upscaling of technological NbS (e.g. BECCS, smart agriculture, and collecting knowledge in databases), a major objective across NbS projects that may obfuscate key local challenges and needed structural change [97]. | • Distributional<br>• Recognitional | • Technology-dominant solutions align with powerful international actors' goals, emphasizing mitigation at the expense of adaptation at both the local NbS scale and the global CRD scale [98].<br>• Complex social goals such as reducing vulnerability or building resilience by increasing adaptive capacity or increasing food sovereignty are complicated to achieve and, importantly, to measure, so are underemphasized.<br>• A gender-responsive technology needs assessment is not undertaken to inform how women can use/access a given technology (e.g. WASH, cookstoves) [99]. | • Techno-managerial solutions, for example, carbon offsets cannot substitute Global North investments in ending fossil fuel use and funding adaptation in the Global South.<br>• Climate action plans must be developed holistically rather than through a narrow, technical lens to prevent reinforcement of inequities and disparate vulnerabilities.<br>• Technology assessments consider different needs and roles for women and men (e.g. clean cookstoves). |
| *Short-term emphasis* | • Investment in strategies with short-term benefits at the expense of longer-term adaptation or resilience. | • Distributional<br>• Recognitional | • The need to demonstrate results to funders and achieve organizational goal are incentives for short-term progress at the potential expense of long-term goals.<br>• Participants have high short-term needs, so focus on long-term challenges is limited. | • Effectiveness criteria must center social and temporal distributional justice.<br>• Climate projections should be incorporated into decision-making to ensure that solutions are compatible with future challenges. |
| *Land rights and tenure* | • IPLC goals, needs, and roles in NbS are minimized because IPLC land rights are ignored or unrecognized. | • Procedural<br>• Recognitional<br>• Restorative | • Land grabs flout land rights and displace people from their homes, their livelihoods, and frequently their ancestral lands for little if any compensation. | • Constructive reparation includes enshrining and enforcing land rights and tenure [30]. |
| *Neocoloniality* | • NbS can reproduce colonial relationships in the global economic system or inadequately respond to legacies of colonialism.<br>• Because NbS objectives are often large-scale and abstract, there is a disconnect from the scale of activities to the scale of outcomes, including distribution of activities and outcomes. | • Distributional<br>• Procedural<br>• Recognitional<br>• Restorative | • There are limited resources allocated to achieve both mitigation and adaptation objectives and global mitigation goals do not necessarily benefit local communities.<br>• NbS in the Global South may help the Global North meet climate targets without changing behaviors, economic systems, or land use.<br>• Emphasis on mitigation 'solutions' distracts from truly phasing out fossil fuels from the energy system, particularly in the Global North, by displacing responsibility to the Global South [2]. | • Anticolonialism requires returning land decisions and ownership to IPLC [100].<br>• IPLC voices need to be centered in decision-making as coproducers, rather than sidelined compared with private sector actors.<br>• Local solutions do not substitute global structural change.<br>• NbS support a larger effort to restructure the Global South's financial debt through improved environmental and livelihood outcomes. |
| *Loss and damage* | • Displacement and adaptation costs increasingly disproportionately fall on vulnerable groups through loss and damages due to climate change. | • Distributional<br>• Restorative | • There is a lack of process for people to share loss and damage grievances in NbS projects.<br>• Despite high burdens, there are limited opportunities for people to seek redress for loss and damage. | • Governments and partners need to provide opportunities and processes to file and receive sufficient compensation (whether monetary or otherwise) for loss and damage [30]. |
| *Projectization* | • Projectization entails preferences for what is 'scalable', easily measurable, or evaluateable, and connected to existing | • Distributional<br>• Procedural | • Neoliberal assumptions and biases continue to inform worldviews and perceptions. | • Rejecting assumptions that increased income directly results in increased climate-resilience limit financialization in favor of evidence-based |

**Table 3** (*continued*)

| *NbS for CRD challenge* | Challenge description | Type of (in)justice | Challenge examples | Potential solutions |
|---|---|---|---|---|
| | capacity at the expense of needs, goals, and context.<br>• Emphasis on outcomes without attention to process may result in interventions that do not address climate vulnerability drivers. | | • NbS used by the private sector to achieve corporate goals, resulting in focus on financial maximization.<br>• Risk, vulnerability, and potential maladaptive outcome considerations are ignored in CRD planning [17].<br>• Technical goals are prioritized over activities that address the root of the problem because they correspond to the expertise of the implementation team. | solutions for economic opportunities and well-being [101].<br>• NbS planning and implementation should not be led by self-interested private partners, but rather by local needs, including considering potentially maladaptive or risky outcomes. |
| *Power dynamics* | • Powerful partners such as private sector actors can exclude those who are marginalized or more vulnerable and their needs from decision-making. | • Procedural<br>• Recognitional | • "Build[ing] platforms within existing institutions… can facilitate [IPLCs'] involvement" but are unlikely to fully "address the deep systemic, structural barriers" to IPLC inclusion in decision-making [98].<br>• Diverting adaptation resources toward ineffective 'solutions' that do not reduce vulnerabilities or build resilience. | • Considering differences in needs, power, and access, and other inequities in "how nature becomes a solution and for whom". while developing NbS theories of change is essential to building justice in NbS implementation [14].<br>• Recognizing mitigative behavior change by those least contributing to climate change as a distraction from change by high emitters. |
| *Contested value preferences* | • Partners' values are not uniform and IPLC needs, preferences, and values may not be recognized where more powerful partners overwhelm decision-making processes. | • Recognitional | • NbS projects, especially Payment for Ecosystem Services (PES) projects, promote biodiversity and reduced deforestation for mitigation, but more nature is not inherently desirable to NbS participants who more urgently need adaptation.<br>• Informal structures are frequently not recognized in CRD planning as limitations in municipal capacities necessary to successful implementation of NbS are not considered [102]. | • Accounting for differences in perspectives, experiences, and needs is important to address local priorities in tandem with sustainability.<br>• Framing NbS as actions of responsibility and solidarity for both people and the planet can help to achieve the crucial step of value articulation in developing CRDP [33]. |
| *Barriers to knowers' involvement* | • If framed in terms of ecosystem services and other technical or scientific language, NbS are likely to empower external experts at the expense of IPLC and ILK [16]. | • Procedural<br>• Recognitional | • Poverty and climate vulnerability are assumed to extend from a lack of education and knowledge, but legacies of colonialism and systemic marginalization, are disregarded as causing or reinforcing a lack of adaptive capacity and resilience [103]. | • Identifying partners' barriers to decision-making is essential to addressing them.<br>• Recognizing other ways of knowing and being is crucial to addressing fundamental sources of vulnerability [103]. |

from the NbS literature. Each of these challenges reveals the injustices that can arise when trade-offs between competing priorities and values are determined by power imbalances, structural drivers of inequality and vulnerability, and/or failure to recognize diverse knowledge and visions for change. For example, NbS projects using bioenergy with carbon capture and storage (BECCS) that prioritize the net-zero goals of powerful international actors without considering the complexities of local needs and adaptation priorities may not contribute to CRD despite addressing mitigation. In this example, a narrow technological focus on BECCS may be distributionally unjust because it mostly benefits already-powerful actors and limits the structural changes that could reduce local vulnerabilities. It may also not be recognitionally just if it prioritizes funder preferences over local people's needs. A climate justice framework allows for the interrogation of how NbS fail to contribute to CRD by identifying the ways that it is unjust and analysis of opportunities to amend the project.

Historically, many climate interventions have prioritized mitigation, but adaptation is equally urgent and of high priority, especially for many developing countries that have contributed little to causing climate change [3]. This emphasis on mitigation is often in tension with local climate justice goals as well, as communities face inequitably distributed vulnerabilities and exposure to climate change, including colonial legacies and neocolonial efforts of violent cooptation of environments and resources for unsustainable extraction [28,34]. To contribute positively to CRD, NbS need to be implemented more justly. First, to improve distributional and restorative justice, projects need to ensure that they are not crowding out adaptation funding in the local context and are actively contributing to CRD goals. Second, to improve recognitional and procedural justice, NbS need to acknowledge the local context and knowledge, including by coproduction with Indigenous People and local communities.

By using a climate justice lens to analyze NbS, the vignettes distill how issues of justice affect CRDP. While NbS have the potential to make the contributions identified in Table 1, they are not necessarily universally beneficial; injustice in framing, design, or implementation of NbS will also reduce CRD. Mangrove restoration, for example, can contribute to pathways toward CRD, when it helps to protect communities from storm surges, sites and species are selected using local knowledge, the coastal ecosystem is regenerated, and/or livelihood opportunities are produced. Conversely, mangrove restoration may contribute to a pathway away from CRD when sites and species are inappropriate or chosen without local input, when benefits accrue to external groups via green grabbing of offsets, when local labor on the project is unpaid, and/or when the project exacerbates ecological degradation.

## Conclusion

The CRDP approach presents an opportunity to analyze NbS as decision points along a pathway that can lead toward or away from CRD, rather than assuming that all NbS are necessarily meeting CRD goals. We argue that the determining factor shaping the trajectory of pathways is the extent to which the dimensions of justice are fully incorporated in NbS framing, design, and implementation. While this framework has potential relevance across many contexts, its true value is in its application in specific places. The framework could be usefully applied at any stage in the NbS process, but the sooner these issues are considered, the greater the opportunity to ensure NbS contribute positively to CRDP.

Through the four vignettes in Figure 1, we illustrate that there are overarching ways that NbS can contribute toward or away from CRD. In every case, NbS that contribute to CRDP are implemented with (rather than on) the community and are appropriate to the local social, ecological, and economic contexts. On the other hand, NbS that are implemented without the collaboration of the community, that ignore Indigenous or local knowledge, that exacerbate existing harms or inequalities, and that benefit external privileged communities are unlikely to lead toward CRD.

This paper presents a framework that uses climate justice and CRDP together as an analytical tool for understanding the potential for a NbS to enable CRD. NbS are inherently political projects with limited resources that entail multiple ongoing trade-offs between competing values and priorities. Critical engagement with the dimensions of justice, or how the NbS consistently recognizes partners and their roles in framing, design, and implementation, accounts for and addresses historical harms, and delivers enduring equitable outcomes, enables the assessment of whether that NbS leads toward or away from CRD on a CRDP [28]. If the goal of NbS is to contribute toward CRD, they cannot ignore the need to consistently prioritize justice throughout and after the project, or they risk reinforcing the structural dynamics that are constraining CRDP in the first place. There is significantly more to unpack in terms of analyzing NbS using a pathways approach that centers justice, and we hope that this contribution can serve as a framework for enabling more such analysis.

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## References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as:
• of special interest
•• of outstanding interest.

## Data Availability

No data were used for the research described in the article.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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