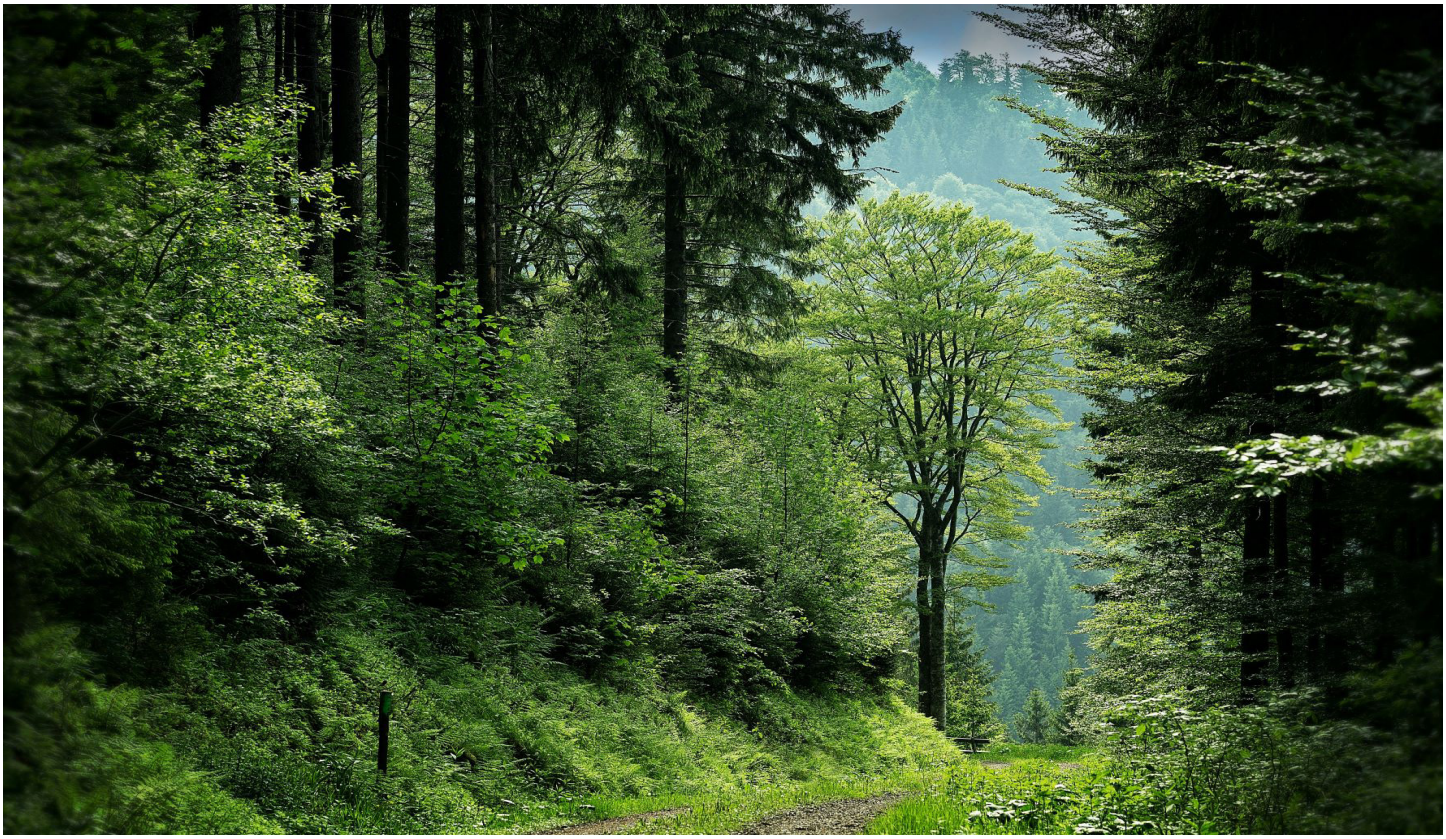

Achieving a Multi-Beneficial Nature-Based Climate Strategy: An Institutional Framework for Advancing Subnational Climate Action

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The Nature Conservancy

The California-China Climate Institute

The California-China Climate Institute was launched in September 2019 and is a University of California-wide initiative housed jointly at UC Berkeley's School of Law (through its Center for Law, Energy, and the Environment) and the Rausser College of Natural Resources. It is chaired by Jerry Brown, former Governor of the State of California, and vice-chaired by the former Chair of the California Air Resources Board Mary Nichols. The Institute also works closely with other University of California campuses, departments, and leaders. Through joint research, training, and dialogue in and between California and China, this Institute aims to inform policymakers, foster cooperation and partnership, and drive climate solutions at all levels.

The Nature Conservancy

The Nature Conservancy is a nonprofit organization dedicated to the conservation of lands and waters on which all life depends.

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Executive Summary

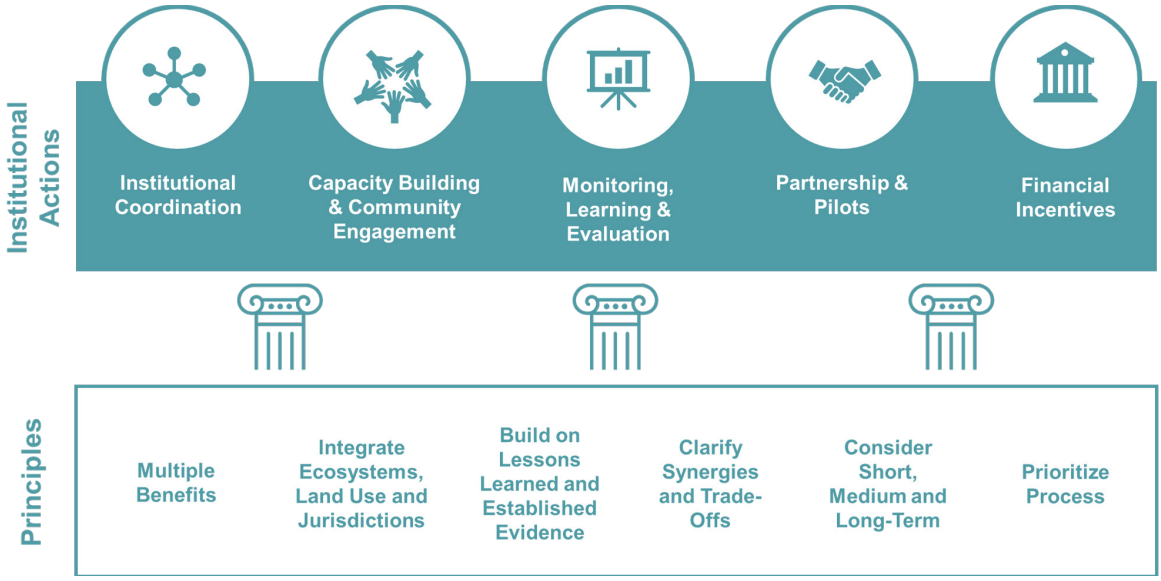
Integrating nature-based climate solutions (NbS) into our climate policies and related plans, strategies, and regulations is an essential tool in our policy toolbox. Nature-based climate solutions include restoration, protection, and improved management across forests, wetlands, rangelands, agricultural lands, oceans, and urban spaces. NbS approaches such as regenerative agriculture, forest restoration, and green infrastructure, confer concurrent benefits within and beyond the landscapes they improve. They can reduce emissions; build resilience to the impacts of climate change, urbanization and expanding development; protect biodiversity and habitats; improve water quality and quantity; ameliorate air quality; and create jobs and recreational opportunities. Recent Intergovernmental Panel on Climate Change (IPCC) reports have confirmed that rapid deployment of NbS is essential to meet global Paris Agreement compatible pathways.

In order to fully utilize well-known NbS approaches, address governance challenges, existing gaps in planning and implementation, and advance the use of NbS in subnational climate policies, we are calling for a re-imagining of NbS. NbS are often conceived in a narrow sense, centered on greenhouse gas emission reduction actions and allocating supplemental "co-benefits." This has led to siloed approaches and leaves behind a primary reason for using NbS — they are intrinsically multi-benefit. We know that climate issues are linked to other challenges. This means that our approach to addressing climate should be as well.

In order to spur this reimagining, this paper sets forth an institutional framework to support the integration of NbS into subnational policymaking. Following the diagram below, our framework includes key principles to guide the work and institutional approaches to translate principles into action. Our NbS policy principles are (1) Center around multiple benefits; (2) Integrate across ecosystems, land uses and jurisdictions; (3) Build on lessons learned and established evidence; (4) Make synergies and trade-offs clear; (5) Consider short, medium and long-term timeframes; and (6) Prioritize process. These principles are an important foundation as we define and develop our NbS actions.

Ultimately, for NbS to be integrated into climate policy and for multi-benefit NbS actions to be implemented effectively, requires changes to the ways governments work or new forms of governance. Our institutional approaches – coordination; capacity building and community engagement; monitoring, evaluation and learning; pilots and partnerships; and financial incentives – provide the enabling environments for successful NbS. Through applying our NbS Governance Framework, subnational governments can utilize the powerful and well-tested NbS tools to reduce emissions, build resilience, and make our society better places for us all to live and thrive.

Nature-based Solutions Governance Framework



I. Introduction

We are in the midst of multiple urgent crises of climate change and biodiversity loss. California, Chinese provinces and other subnational regions across the globe have set ambitious mid-century decarbonization goals. Reaching these goals at the pace and scale required, while addressing concurrent equity, environmental, and sustainable development challenges, demands using all the tools we have at our disposal.

Nature-based climate solutions (NbS) include restoration, protection and improved management across forests, wetlands, rangelands, agricultural lands, oceans, and urban spaces. NbS approaches such as regenerative agriculture, forest restoration, and green infrastructure, are powerful tools, which confer concurrent benefits within and beyond the landscapes they improve. They can reduce emissions; build resilience to the impacts of climate change, urbanization and expanding development; protect biodiversity and habitats; improve water quality and quantity; ameliorate air quality; and create jobs and recreational opportunities. Recent Intergovernmental Panel on Climate Change (IPCC) reports have confirmed that rapid deployment of NbS is essential to meet the global 1.5 or 2-degree Celsius pathways to avert the worst climate impacts.[1]

Specifically, as a climate policy tool, NbS can integrate mitigation and adaptation actions seamlessly. They reduce emissions through three pathways: (1) avoiding emissions from development and severe natural hazards such as fire; (2) sequestering carbon through restoration and conservation; and (3) improving land use and marine management to reduce carbon, methane, and nitrous oxide.[2] Additionally, NbS support adaptation and resilience through a variety of actions such as (1) reducing the impacts of extreme events such as floods, droughts, wildfires, and urban heat; (2) improving public and ecosystem health; and (3) improving soil and water quality.

The climate benefits of these actions are clear. As of 2019, nearly a quarter of global greenhouse gas emissions come from agriculture, forestry, and other land uses. The IPCC finds that protecting, restoring and sustainably managing carbon-rich ecosystems such as forests and peatlands can mitigate 20-30% of global mitigation needed for 1.5 or 2°C pathways. Halting the conversion of ecosystems can play an outsized role, as deforestation alone accounts for 45% of emissions from the land sector.[3]

While their importance is becoming increasingly apparent, NbS strategies have been largely left out of climate policies in many regions. In places where NbS have been integrated, it has been in international and national policies and focused primarily on reforestation practices. This narrow approach leaves many NbS options off the table while centering the focus of NbS policymaking at the international and national scale, far from land use and implementation decisions often made by local governments.

We need to address these governance gaps in order to support the implementation of NbS as a multi-benefit strategy. There are many existing, well-tested NbS actions that can be used at the subnational level to improve our environment and meet existing international, national, and local climate goals. In order to support this effort, we put forward an institutional framework that is grounded in principles and actions, to build more resilient systems that can enable comprehensive and integrated subnational climate planning.

Multi-Benefits of Nature-based Climate Solutions

NbS are intrinsically a multi-beneficial climate strategy. NbS are a unique policy tool in that there are numerous synergies at work that speak to more than solely climate goals.[4] The resulting effects of NbS policies have the potential to benefit climate change efforts as well as disaster resilience, human health, economic security, food security, and many other Sustainable Development Goals (SDGs).

1 (IPCC 2022)
2 (Girardin et al. 2021)
3 (IPCC 2022)
4 (IUCN 2020)

When NbS strategies are specifically designed to be an integrated response to social problems, they generate positive impacts — both in the communities where they are practiced, and in the world at large.[5] A pertinent example of this effect is that cycling crop varieties, planting hedgerows, and maximizing soil cover in agricultural settings works to accomplish primary benefits like improving soil health, improving irrigation, and increasing output. These primary benefits in turn create secondary benefits like fewer water requirements, fewer pest outbreaks, lesser need for fertilizer, cleaner water runoff, reduced expenditures on weed suppression, greater erosion control, and augmented plant disease control.[6] The Nature Conservancy broke this effect down further by calling it a 'triple benefit', with advantages in production and resilience, fighting climate change, and enhancing biodiversity.[7]

NbS forestry practices similarly have cascading benefits. A forest that is managed to maximize carbon sequestration can also improve air quality in urban areas many miles away, as well as provide water purification services, and prevent erosion and therefore reduced water storage capacity, catastrophic mudslides, and floods.[8] A final example of this cascading effect is also observed in urban environments, where the benefits of forestry projects can be ecological, social, and economic. Studies have found that in addition to ecological benefits of green spaces and natural elements in cities such as lowering overall temperature, improving air quality, promoting biodiversity, and sequestering carbon, green spaces also had a positive effect on the mental health of those who lived there, even improving the school performance of local children, increasing the sense of social connectedness of neighbors, and increasing economic activity.[9,10]

Current Status of Nature-Based Climate Solutions

Given the many benefits, international and national attention to NbS has grown in recent years. The United Nations' Intergovernmental Panel on Climate Change (IPCC), its Framework Convention on Climate Change (UNFCCC), its Convention to Combat Desertification (UNCCD) and the Paris Agreement all positioned NbS as central to addressing climate change. The Glasgow Climate Pact agreed to at the UNFCCC Conference of the Parties in 2021 included language indicating the increasing awareness and attention to NbS,

> "emphasizes the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement temperature goal…", including through forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases and by protecting biodiversity, while ensuring social and environmental safeguards."[11]

Meanwhile, 185 countries, mostly from the Global South, included mitigation and adaptation NbS approaches in their Nationally Determined Contributions (NDCs) as part of the Paris Agreement. The Global Center for Adaptation's recent State and Trends in Adaptation Report 2020 also recommended NbS as a crucial step in climate adaptation,[12] as did the Ramsar Convention on Wetlands, and the Sendai Framework for Disaster Risk Reduction.

As of 2021, 168 countries have signed on to the Convention for Biological Diversity, which is guided by the 'Ecosystem Approach'—an NbS policy.[13] The 'Ecosystem Approach' is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which includes 137 member states, endorsed NbS in 2019.

Clearly the call for integration of NbS at the international scale is growing across the globe. This international attention has brought increasing focus to the issue. Many of these organizations and plans mentioned reflect that NbS is inherently a climate policy tool. However, there is a growing divide between calls for NbS to be used as a

5 (Spano, Dadvand, and Sanesi 2021)
6 (The Nature Conservancy 2021)
7 Ibid
8 (Tian Hui-Ling et al. 2021)
9 (Spano, Dadvand, and Sanesi 2021)
10 (The Nature Conservancy 2016)
11 (UNFCCC 2021)
12 (Saghir et al. 2020)
13 (CBD 2004)

climate strategy, and how NbS are actually being studied and implemented in practice. In practice, NbS have often been left out of climate policies, especially at the subnational scale, and when they are included they are focused on mitigation benefits and primarily around forestry.[14] This leaves the many known NbS actions off the table and does not take advantage of the multiple benefits we know NbS can achieve.

Governance Challenges

The multiple benefits of NbS may lead one to expect to see a great deal of enthusiasm and energy among lawmakers to pursue these strategies. However, there are serious governance challenges facing the uptake of NbS at the subnational level. One of the greatest challenges of NbS that factors into all of these issues is its perceived status as a relatively new facet of environmental policy. NbS are considered a new policy tool and often policymakers lack experience or knowledge around NbS planning and implementation as well as have a shortage of locally adapted policy instruments to support mainstreaming across sectoral policies. In our review of subnational carbon reduction strategies, we found that the most often cited reason for the omission of NbS was the lack of sufficient data to quantify emission reductions. The most common treatment of NbS is a positive mention followed by a claim that the lack of hard data makes it impossible to quantify. A clear example of the results of this lack of information can be found in the 2019 US Climate Alliance Report, "Despite the importance of natural and working lands in addressing climate change, there is limited data available to help states fully understand both current and future sequestration contributions from this sector."[15]

These knowledge shortfalls dominate discussions of NbS governance. However, as we outline in the following section of this report, most NbS strategies build on long-standing ecological practices with significant evidence of their value and benefits. Therefore, this lack of knowledge and familiarity can be overcome through outreach, partnership, and capacity development. There have also been recent efforts to improve modeling of NbS, such as the draft 2022 California Scoping Plan.

Achieving the multi-benefit outcomes of NbS often requires multiple agencies and actors engaging in the policy, implementation, and maintenance of such policies. Existing institutional fragmentation and siloing of responsibilities can make it challenging to formulate effective governance mechanisms for cross-sectoral policies.[16] While society may benefit from the various benefits of NbS, that diffuseness also acts as a barrier to the implementation of NbS, with many actors at different levels struggling to internalize the positive externalities. This calls for supporting not only policy approaches but also institutional support systems to address NbS in an integrated manner.

Additionally, the financing of NbS is another limitation. Usually, an NbS action is funded by one agency with one primary benefit as its focus. For example, a water agency might fund water quality benefit action or a fire agency might fund wildfire resilience benefits. This occurs due to how the actions are categorized and how funding streams are determined and allocated. This approach does not allow the amount of funding or focus for the multi-benefits to be fully realized.

Studies on the necessary preconditions for successful NbS policy implementation highlight the importance of the political landscape for these policies to thrive. These preconditions include four main requirements: (1) Multi-leveled and multi-sectored public administration arrangements that support flexible policy, (2) Inventive stakeholder participatory processes that influence the final policy, (3) Diverse and active pro-NbS advocacy groups, and (4) Robust financial incentives for such policies.[17] Other often-cited requirements include applicable NbS implementation information as well as the presence of necessary space for NbS solutions.[18] These requirements for successful NbS policy have created gaps in both implementation as well as positive feedback loops in the research being done on the subject. The lack of research on practical NbS governance models makes it more challenging for policymakers to enact an effective framework for NbS. Therefore, we aim to fill this gap by providing a clear framework and policy options.

14 (Seddon et al. 2021)
15 (US Climate Alliance 2019)
16 (Ershad Sarabi et al. 2019)
17 (Martin et al. 2021)
18 (Sekulova and Anguelovski 2017)

In this report, we develop a framework to address these existing governance challenges and support the integration of NbS into subnational climate policies as a multi-benefit strategy. Section 2 will present many NbS actions that could be included in climate policies and evidence of their multiple benefits. Section 3 presents our NbS Governance framework which includes key principles to guide the work and institutional actions to translate principles into action. Section 4 explores the institutional actions and recommended activities. Section 5 has concluding thoughts.

II. Ecological Actions

As of 2019, roughly 15% of the earth's land was in protected areas.[19] While this is a significant number, many scientists agree it is far from enough to support global biodiversity in the long term. According to the 2019 Global Deal for Nature, by 2030 30% of the world's land area ought to be included in formal protected areas, along with an additional 20% in "climate stabilization areas." California, now followed by the United States, has made this commitment. The situation in the ocean is even more concerning. While 2% of ocean waters are currently protected, scientists argue that formally protecting 37% is the baseline for long-term sustainability.[20] As NbS, protected areas support not only biodiversity but also climate change, habitat preservation, and economic goals.[21] They can be implemented in a wide variety of ecosystems and scales. For instance, China has used an ecosystem-services approach to delineate 25% of its land as protected areas. Australia's Great Barrier Reef Marine Park supports not only vital reef ecosystems, but also a tourism economy valued at roughly $1.4 billion annually.[22] At a national level, as of 2000, Canada's nearly 40 national parks held in place roughly 4.5 billion tons of carbon.[23,24] Conservation, therefore, has become a key practice along with management and restoration.

What are some approaches that could be integrated into climate policies? This section presents ecological actions that we know work to address integrated climate goals. These best practices come from cases around the globe. While NbS might be applied in numerous environmental contexts, five ecosystem types are especially promising sites to intervene: agriculture, forests, wetlands, coastal/marine and urban. Within each ecosystem type, several modes of action seem to hold especially high potential as NbS. We present urban as its own category since it remains underappreciated in many NbS discussions, but with the understanding that urban areas often include many of these other ecosystems. While not all ecosystems are presented in the chart below, it should be noted restoration and conservation goals are important across all ecosystem types.

Nature-based Climate Solutions: Ecosystem-based Approaches				
AGRICULTURE & RANGELANDS	**FORESTS**	**WETLANDS**	**COASTAL & MARINE**	**URBAN**
Regenerative agriculture	Reforestation	Wetland restoration	Coastal ecosystem restoration	Ecological restoration
Agroforestry	Afforestation	Wetland construction	Marine renewable energy	Green and blue infrastructure
Sustainable rangeland management	Sustainable forest management	Sustainable wetland management	Sustainable fisheries & regenerative ocean farming	Urban and community forestry and farms/gardens

19 (World Economic Forum 2019)
20 (Dinerstein et al. 2019)
21 Ibid
22 (Commonwealth of Australia Department of Environment and Heritage 2003)
23 (Stolton and Dudley 2015)
24 (Kueppers et al.2021)

Agriculture

In the context of agriculture, various governments and private actors have turned to regenerative agriculture as a way to address the climate crisis alongside other social and environmental issues. While not restricted to a single definition,[25] regenerative agriculture generally refers to practices that "actively regenerate the natural resources used while supporting healthy, thriving communities."[26] Examples of regenerative agricultural techniques include no-till or low-till farming, planting cover crops and perennial crops, and composting.[27] Among other benefits, these activities help to trap carbon in the soil (called "soil carbon sequestration"), mitigating climate change. Some researchers estimate that soil carbon sequestration has the potential to capture about as many as 5 gigatons of carbon dioxide ($GtCO_2$) per year by midcentury.[28] In California, the government's Healthy Soils Program uses finances from the state's carbon cap and trade program to fund regenerative agricultural practices.[29] This action also reduces methane by reducing fertilizer use. The New Zealand government recently committed $5 million to projects researching the value of regenerative agricultural practices.[30]

Many NbS practitioners also endorse agroforestry, an agricultural practice in which farmers combine trees with crops and livestock on their lands. Like regenerative agriculture, agroforestry can help to sequester carbon. The practice is estimated to have the potential to offset up to 15% of annual global carbon emissions.[31] It supports other environmental goals, such as biodiversity and soil resilience, as well.[32] At the same time, it offers an array of material benefits to farmers. For instance, models have found that agroforestry systems in Panama are over 20% more profitable than methods that segregate trees and crops.[33] In Kenya, agroforestry increases livelihood security by expanding farmers' income sources.[34]

Occasionally considered a subset of regenerative agriculture, sustainable rangeland management is another key target for NbS projects. Rangelands cover about 50% of the world's land area.[35] Roughly 25% of these lands are degrading, in part due to unsustainable land management.[36] Examples of sustainable rangeland management practices include rotational grazing, multi-species grazing, avoiding overstocking, ecological management of weeds, and fostering plant biodiversity.[37] These and related practices can be found in communities around the world. Many are also part of longstanding indigenous land management practices which maintain healthy fire regimes, among other benefits. From 2010 to 2013, the IUCN, the Jordan Ministry of Agriculture, and The Arab Women Organization conducted a project in the Zarqa River Basin, Jordan, to increase the use of a traditional rangeland management system. The project helped to increase native plant biodiversity and improve water management while supporting the role of women in rangeland management.[38]

Forests

Covering roughly one third of earth's land area,[39] forests are key targets for NbS to address the climate crisis and other issues. Through various practices, this ecosystem type has the potential to remove up to 6 $GtCO_2$ from the atmosphere per year by 2055.[40] (To put this in perspective, in 2019 global emissions reached 36.7 $GtCO_2$.)[41] Among the most prominent forest-based NbS is reforestation, i.e., the restoration of forests in previously forested

25 (NRDC 2020)
26 (Rodale Institute 2019)
27 (American University 2020)
28 (Fuss et al. 2018)
29 (California Department of Food and Agriculture 2021)
30 ("Regenerative Agriculture Research Receives Government Boost" n.d.)
31 (Albrecht and Kandji 2003)
32 (Seddon et al. 2020)
33 (Paul, Weber, and Knoke 2017)
34 (Quandt, Neufeldt, and McCabe 2017)
35 (University of Idaho, n.d.)
36 (United Nations 2010)
37 (ATTRA 2008)
38 (UNEP 2016)
39 (World Bank 2018)
40 (Austin et al. 2020)
41 ("Global CO2 Emissions Have Been Flat for a Decade, New Data Reveals" n.d.)

areas.[42] Reforestation offers significant environmental and social benefits. As a climate mitigation tool, reforestation in the US alone could sequester nearly 0.4 $GtCO_2$ per year by 2025.[43] Reforestation also supports water quality,[44] biodiversity,[45] and other ecosystem components. For instance, through the African Forest Landscape Restoration Initiative, thirty African countries aim together to restore 100 million hectares of deforested and other degraded lands.[46] Many governments have recognized the value of reforestation and some have begun to act accordingly. Countries have integrated reforestation into climate policies and promoted the process through market and policy mechanisms.

Accompanying reforestation is afforestation, i.e., the "practice of planting trees on land that has not recently been used to grow a crop of trees."[47] According to one estimate, afforestation could sequester as many as 4.9 $GtCO_2$ annually by midcentury. It also provides numerous other environmental benefits, such as increased biodiversity,[48] decreased soil erosion,[49] decreased flood risk,[50] and improved soil health.[51] Case studies point to the diverse social and economic benefits of afforestation, as well. For instance, in 2020 the Indian state of Jharkhand established a scheme through which the government provided roughly 100 fruit trees and other plants to each of 500,000 migrant laborers for planting on unused government lands. Participants had complete ownership over the harvest they produced, valued at about Rs 50,000 ($663.42) per year.[52] Meanwhile, as part of the country's nationally determined contribution (NDC) to address climate change, Mongolia has pledged to expand its forests to "9% by 2030 through reforestation activities."[53]

In tandem with tree planting, sustainable forest management offers numerous long-term benefits. Relevant practices include "reduced impact" logging methods and increasing the time between logging.[54] In the US, sustainable forest management could prevent about 0.27 $GtCO_2$ per year by 2023.[55] In fire prone areas, sustainable forest management might include controlled burns, tree thinning, and other practices to reduce historically atypical fires. These activities help to support biodiversity as well as water and soil quality, among other benefits.[56] US-based forest fire management could mitigate roughly 0.18 $GtCO_2$ annually by 2023.[57] Various governments and non-governmental actors have endorsed the social and economic benefits of sustainable forest management. For instance, the province of Ontario, Canada has enshrined sustainable forest management of its publicly owned managed forests in law. These regulations are intended not only to support forest health but also local employment opportunities, material resources, and outdoor leisure activities.[58]

Last, nature-based solutions include not only what we do, but also what we choose not to do. In regard to forests, avoided deforestation could account for nearly half of all the emissions benefits that "low-cost solutions" offer.[59] The benefits of ecosystem preservation apply across ecosystem types and should not be underestimated.

42 (Conservation International 2019)
43 (Fargione et al. 2018)
44 (Keller and Fox 2019)
45 (Cunningham et al. 2015)
46 (African Union Development Agency, n.d.)
47 (Encyclopedia of Environmental Health 2011)
48 ("Forest Dynamics in Europe and Their Ecological Consequences — European Environment Agency" n.d.)
49 (Barry et al. 2012)
50 (Takata and Hanasaki 2020)
51 (Oldfield et al. 2014)
52 (The Times of India 2020)
53 (Seddon et al. 2020)
54 (Fargione et al. 2018)
55 Ibid
56 (The Nature Conservancy 2020)
57 (Fargione et al. 2018)
58 (Ministry of Northern Development, Mines, Natural Resources and Forestry of Ontario, n.d.)
59 (Minnemeyer, Harris, and Payne 2017)

Wetlands

Though they occupy only 7% of the world,[60] wetlands are globally crucial ecosystem types. They provide clean water, habitat for countless species, and flood resilience, among other benefits.[61] They are also the foundation for more than 600 million people's livelihoods.[62] As the world's wetlands disappear at an alarming rate,[63] one key NbS is wetland restoration. Restoring wetlands returns their environmental and social services, including increased water quality and biodiversity, as well as decreased flood risk.[64] Wetlands are also concentrated carbon reserves, hosting roughly 1/3 of the world's organic soil carbon, making their restoration an important climate mitigation opportunity.[65] Recognizing this ecosystem's value, governments and private actors around the world are working to restore wetlands. For instance, under the United States Department of Agriculture's Wetlands Reserve Program, the government has helped at least 11,000 private landowners to restore 2.3 million acres of wetlands.[66]

In addition to wetland restoration, some NbS practitioners aim to increase wetland area through wetland construction in sites not previously home to wetlands.[67] While more challenging than wetland restoration, wetland construction can bring the diverse social and environmental benefits of wetlands to new locales.[68] Governments have pursued wetland construction projects in both rural and urban areas, as well as across multiple scales. For instance, in the northern Italian municipality of Gorla Maggiore, local officials developed a network of constructed wetlands that offer more benefits than traditional gray infrastructure at a similar cost.[69] In India's Godavari River Basin, residents constructed small wetlands to increase crops' resilience to more variable rainfall under climate change while preventing the displacement that sometimes accompanies larger-scale infrastructure projects.[70]

Alongside wetland restoration and construction, sustainable wetland management is vital to achieving long-term NbS benefits in wetlands. Relevant practices include taking a landscape-scale approach to wetland management and allowing ecosystem processes to occur with as few hindrances as possible.[71]

Coastal and Marine Environments

Representing 70% of the earth's surface and 97% of its water, oceans are a crucial ecosystem type for NbS activities.[72] According to a 2019 study by the World Resources Institute, oceans could contribute more than 1/5 of the climate mitigation needed to keep global warming under 1.5° Celsius.[73] Carbon stored in ocean or coastal ecosystems, also termed blue carbon, is naturally sequestered in coral reefs, seagrass beds, oyster reefs, and kelp forests. While much of the oceans' NbS potential remains untapped, several core practices have already found success. Coastal ecosystem restoration projects around the world demonstrate the value of this approach. By reviving mangrove forests, seagrass meadows, tidal marshes, reefs, and other coastal ecosystems,[74] communities can minimize flooding, severe storm damage, and erosion while increasing biodiversity, water quality, and carbon reserves, among other benefits.[75]

Additionally, regenerative ocean farming (which includes growing algae and seaweed) works to absorb carbon, reduce ocean acidification and local pollution while also supplying nutrition and potential renewable fuels.[76] For

60 (Resource Watch 2019)
61 (The Department of Conservation of New Zealand, n.d.)
62 (Voice of America 2016)
63 (Ramsar Convention on Wetlands, n.d.)
64 (Victoria University of Wellington 2021)
65 (Villa and Bernal 2018)
66 (United States Department of Agriculture Natural Resource Conservation Service, n.d.)
67 (Kentula 2002)
68 Ibid
69 (Liquete et al. 2016)
70 (GUJJA et al. 2009)
71 (Smith et al. 2009)
72 (National Oceanic and Atmospheric Administration, n.d.)
73 (Hoegh-Guldberg et al. 2019)
74 (American University, n.d.)
75 (Environmental Energy Study Institute 2019)
76 (West Coast Ocean Acidification and Hypoxia Science Panel, n.d.)

instance, through a large seagrass restoration project in coastal Virginia, the Virginia Institute of Marine Science and The Nature Conservancy have successfully restored nearly 9,000 acres of seagrass. In the process, the project has increased biodiversity, improved water quality, and sequestered roughly 3,000 metric tons (mT) of carbon.[77] In Gazi Bay, Kenya, a voluntary carbon credit system has helped to restore mangroves across 117 hectares of forest. Mangroves support the livelihoods of 4/5 of the area's residents, making their recovery a social and environmental concern.[78]

Like coastal ecosystem restoration, marine renewable energy provides significant advantages to people and the environment. As an alternative to fossil fuels, marine renewable energy technologies could play a major role in mitigating global climate change. Types of marine renewable energy include offshore wind power, ocean wave energy, tidal power, ocean current energy, ocean thermal energy conversion, osmotic power, and marine biomass energy. Offshore wind energy alone could provide up to 22 TWa per year, which is 900% the annual energy produced worldwide.[79] Many governments have already adopted offshore wind and other marine renewable energy technologies. For instance, Scotland now has an offshore wind capacity of 1 gigawatt (GW), with an additional 4.6GW under development and a goal of 11GW by 2030.[80] While offshore wind is particularly popular, the larger marine renewable energy sector holds significant potential. Nor are its benefits limited to the environment. The US government recently unveiled a plan to create 77,000 jobs based on offshore wind energy, 44,000 through direct employment, through the development of 30GW of offshore wind energy by 2030.[81]

Urban Ecosystems

Cities are important and often neglected sites for NbS. Cities are the source of the majority of energy-related greenhouse gas emissions and therefore a contributor to climate change while also at risk from climate impacts. This means that reducing energy demand in cities is an essential component in climate policy as is increasing resilience to flood, drought, and urban heat effects. NbS approaches such as protecting and restoring urban ecosystems hold much promise. One effective means to achieve NbS goals in urban (and rural) settings is 'green-blue infrastructure,' defined as "the use of vegetation, soils and natural processes in an urban context to simultaneously deliver landscape and water management benefits."[82] Examples of green-blue infrastructure include green roofs, bioswales, community gardens, rain barrels, permeable paving, urban parks and open spaces, and wetlands.[83] These are more flexible, multi-functional and adaptable to an uncertain climate future than more commonly used 'gray infrastructure' approaches such as concrete levees and impermeable pavement.[84] For example, urban greening can significantly reduce energy demand by cooling the built environment through green roofs and urban green spaces which lower the urban air temperature while "global urban trees sequester 217 million tonnes of carbon annually."[85]

Managing water more holistically can help cities protect natural water sources and channels, track water consumption and stormwater runoff, and utilize water reservoirs to create zones of comfort from heat. Green roofs and greater tree cover can cool cities and reduce energy use, and wetlands and forests can temper floods and increase water supplies by protecting water sources. In many cases, these and other nature-based solutions are remarkably cost-effective: In São Paulo, for instance, the reduction of sediment flow from restoring 4,000 hectares of forests near the city's watershed was estimated to be $4.5 million cheaper than the cost of dredging reservoirs to improve urban water quality.[86] Such steps must be implemented carefully, however, to ensure equity in the implementation process and to avoid 'green gentrification': a process in which "existing and potential environmental amenities price out the current group of residents and draw in a wealthier group."[87]

77 (Orth et al. 2020)
78 (Wylie, Sutton-Grier, and Moore 2016)
79 (Dhanju et al. 2016)
80 (Scottish Government 2020)
81 (The White House 2021)
82 (Victoria State Government Department of Environment, Land, Water, and Planning 2017)
83 (Columbia Climate School 2019)
84 (Hobbie and Grimm 2020)
85 (IPCC 2022)
86 (Fargione et al. 2018)
87 (Gould and Lewis 2016); For more information on this topic, see the World Resources Institute and C40's recent paper on "Climate Action Planning," including "Inclusive Climate Action."

Green-blue infrastructure clearly offers numerous environmental and social advantages. A recent study found that parks help to conserve and purify water; improve water quality; support habitats; regulate climate; cycle nutrients; and offer spiritual, cultural, aesthetic, scientific, and educational services, among other benefits. The study was inspired by New York City's recent $1.5 billion commitment to increase sustainable infrastructure to reduce stormwater runoff.[88] Governments at multiple scales around the world have similarly pivoted towards sustainable infrastructure. For example, in 2010 the city of Copenhagen, Denmark, required all new flat roofs to include green roof construction. According to one report, "greening about 325,000 m2 of roof-tops is estimated to save 218 tons of CO_2 emissions annually."[89] One notable initiative is the "Sponge Cities" program in China, where the Ministry of Housing and Rural-Urban Development, the Ministry of Finance, and the Ministry of Water Resources have implemented water management plans that treat the city like a "sponge," absorbing, storing, infiltrating, and purifying rainwater and subsequently releasing it for reuse when needed.

88 (Elliott et al. 2020)
89 (European Commission, n.d.)

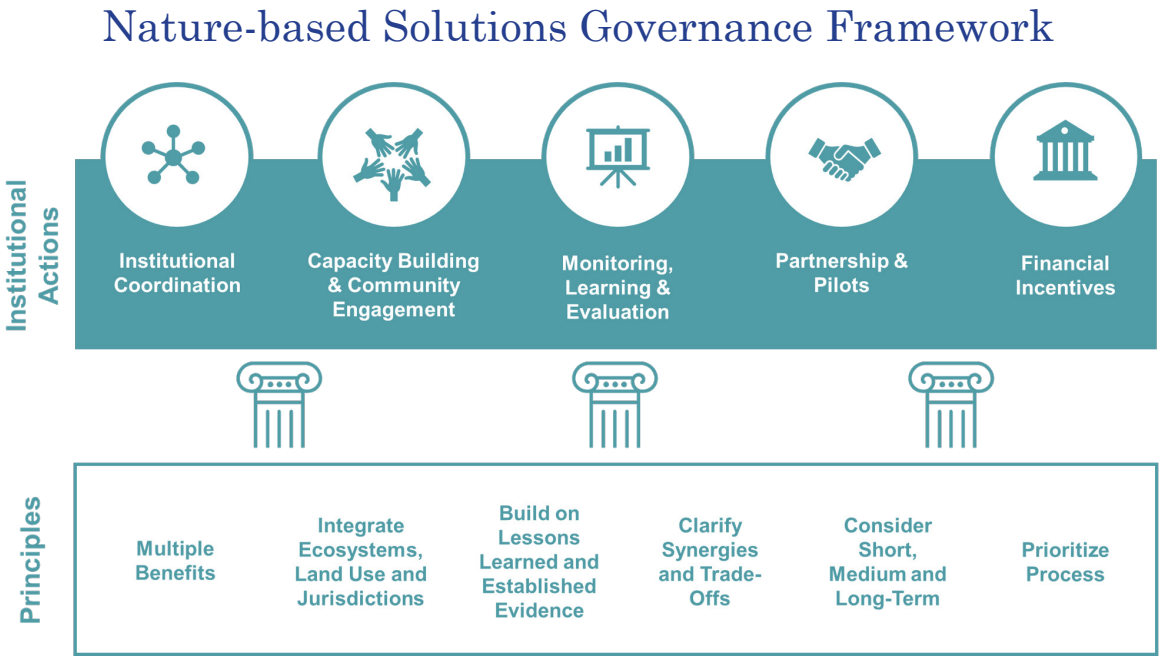
III. Building a NbS Governance Framework

In order to fully utilize these ecological tools, address the governance challenges, bridge existing gaps in planning and implementation, and advance the use of NbS in subnational climate policies, we are calling for a reimagining of NbS. NbS is often conceived in a narrow sense, centered on greenhouse gas emission reduction actions and allocating supplemental "co-benefits." This has led to siloed approaches and leaves behind a primary reason for using NbS — they are intrinsically multi-benefit. We know that climate issues are linked to other challenges, this means that our approach to addressing climate should be as well.

To support subnational governments to integrate NbS, we have developed an overall framework to advance implementation of the ecological actions presented in the previous section. This framework includes key principles to guide the work and institutional approaches to translate principles into action.

The key principles to guide NbS work are the following:

- Center around multiple benefits;
- Integrate across ecosystems, land uses and jurisdictions;
- Build on lessons learned and established evidence;
- Clarify synergies and trade-offs;
- Consider short, medium and long-term timeframes;
- Prioritize process.



Center around multiple benefits

The goal of our climate policies is to achieve a more resilient and decarbonized society. This goal requires considering the various aspects of social, economic, and environmental development including mitigation, adaptation, equity, jobs, public health, food security, and biodiversity. This multi-faceted approach to policymaking overall, and in NbS specifically, requires shifting from a co-benefit to a multi-benefit perspective.

Integrate across ecosystems, land uses and jurisdictions

We need to view NbS as part of an integrated approach to our common challenges. This means considering how natural solutions can reduce climate risks and emissions while advancing social and environmental equity. Policies should integrate across ecosystems (land, fresh water, coastal, oceans) and land uses (urban, natural, working lands) and across scales (local, regional, and states/provinces). It should also consider short-lived climate pollutants such as methane.

Build on lessons learned and established evidence

We don't need to reinvent the wheel. There have been years of work on NbS policy tools including natural resource management, ecosystem-based adaptation, green and blue infrastructure, integrated land management, agroforestry, agroecology, restoration, and conservation. We need to draw on this existing science and practice and continue to build an evidence-based approach to integrate these actions into our climate policies.

Clarify synergies and trade-offs

NbS can—if properly designed and implemented—enable synergies and minimize trade-offs between actions to achieve different goals. As part of this process, it's important to be transparent about the synergies and trade-offs to be able to determine what is the appropriate policy tool or intervention in a particular jurisdiction.

Consider short, medium and long-term timeframes

Climate policies need to consider which interventions may produce changes today and which may produce positive outcomes in the short term and address climate and environmental goals in the longer term. There are various NbS interventions that would improve resiliency for communities today and there are those which have a longer time horizon. This means paying attention to long-term carbon-sink potential and impacts on biodiversity, equity, and sustainable development goals.

Prioritize process

Much work on NbS has been outcome focused, primarily on the amount of carbon emissions sequestered. We know that for NbS to be successful the process must be evidence-based, include stakeholder participation, and center around equity. We also need to consider NbS, an adaptive management and learning process and incorporate monitoring and evaluation from the outset to understand change. We need to be able to localize approaches to fit the context and understand that NbS are one piece of the larger work toward shifting away from fossil fuels in the process of decarbonization.

IV. Institutional Actions

Across ecosystems, there are various institutional tools which support the development and implementation of the NbS strategies presented in the previous section. We know that subnational governments' current institutional systems are not well equipped to address the tenets of our framework, including considering the multiple benefits of NbS within our climate policies or related plans. Effective implementation of nature-based solutions, requires changes to the ways governments work or new forms of governance. This section provides some ways forward to update our current policy and institutional practices to better enable NbS to more readily be considered and implemented as a valuable strategy.

While integrating specific actions into climate policies, there are institutional approaches which support and provide enabling actions for NbS. In this section, we have identified five general policy approaches. This is not meant to be an exhaustive list, rather, a suite of integrated approaches that are widely applicable across subnational jurisdictions and will assist in advancing the use of NbS strategies in practice. The five identified approaches are:

- Institutional coordination
- Capacity-building and community engagement
- Evaluation and learning
- Pilots and partnerships
- Financial incentives

Institutional Approaches - Enabling Actions				
Institutional Coordination	Capacity-building and Community Engagement	Monitoring, Evaluation, and Learning	Partnerships and pilots	Financial Incentives

Institutional Coordination

In order to implement NbS as an integrated, multi-benefit strategy, planning and implementation needs to involve a range of government agencies (from federal to state to local) and departments. This requires setting up regular channels for coordination and communications across sectors and scales. Further, it requires both creating new types of coordinating institutions such as working groups and also incentivizing cross-sector collaboration.

Actions include:

- Implement incentives and support for cross-agency collaboration and cross-sectoral knowledge exchange on NbS
- Incorporate working across agencies and departments as part of key performance indicators
- Establish working groups with attached budgets to advance integrated NbS programs
- Develop mechanisms for informal dialogue and exchange
- Publish and transparently share information in a common website enabling all agencies to view related work in progress
- Align programs to more efficiently link implementation across agencies

Capacity-Building and Community Engagement

Tailored training and capacity-building programs for different stakeholders enable NbS strategies to be integrated into plans and implemented on the ground. This is necessary for all stakeholders from government agencies - which may not see the relation between climate and their existing work - to architects and contractors who need to understand the various ways that buildings can be energy efficient and use water recycling. Farmers can learn and share best practices and better understand how their land use decisions impact climate, water, land, and soil. Governments need to engage with other stakeholders such as land owners and tribes. In many parts of the world, this is done through agricultural extension services which will require additional training of the trainers and re-investment. Education and training is a huge effort that goes beyond the role of government to many others such as community organizations, trade unions, and universities. Schools need to include environmental education practices which present these issues from an integrated perspective.

Actions include:

- Provide capacity-building, technical assistance training, and resources to support adoption of best practices
- Make tailored NbS training and education programs to promote the various ecological practices and indigenous knowledges
- Support peer-to-peer learning and training the trainer approaches
- Support learning across jurisdictions
- Provide financing for education, training, and capacity-building programs in a range of public and civil society organizations
- Integrate NbS into agricultural and forestry curricula
- Share knowledge on NbS practices and approaches in ways that are useful for different stakeholders
- Incorporate NbS into public education

Monitoring, Evaluation, and Learning (MEL)

More effort is required to build robust evaluation and monitoring frameworks for NbS. We need to develop a baseline inventory to understand the existing state of ecosystem carbon stored in the land and ocean and what may be possible in the future. At the same time, we need to calculate more than just the carbon to be able to account for all the benefits of NbS. The ability to monitor NbS projects and evaluate outcomes is a critical ingredient in refining our understanding of what works when, where, and why in order to understand the best options and evaluate their various benefits including cost-effectiveness.

Monitoring systems need to be developed in order to integrate changes in our socio-ecological systems, especially under climate change, and to build in iterative learning. There are lessons from adaptive management practices for ecosystems as well as risk management approaches that can address uncertainty. At the same time, this is still a learning process across the globe. These systems should be built in ways that can integrate new knowledge, climate impacts, and data.

These MEL systems also need to integrate and allow access to data across subnational jurisdictions. This is important to share lessons and learning, and because of the intrinsic nature of ecosystems which do not stop at a city line. Often this means that MEL also requires new coordination mechanisms across different types of land ownership types (national, city, county, state/province, tribal land).

Actions include:

- Standardize and refine accounting methods for multiple benefits to be able to spur financing and greenhouse gas protocol frameworks
- Develop metrics to account for the various benefits from NbS approaches, including not only climate but also including equity, social, public health, and environmental benefits
- Create centralized information platform to capture lessons learned
- Integrate risk management approaches to address uncertainty
- Measure process and outcomes with an understanding that there is an underlying uncertainty that needs to be understood from the outset and some criteria are not easily measured
- Collect metrics over time and adapt as the science and ecosystems change
- Develop a state level repository for all the MEL information

Partnerships and Pilots

NbS requires us to collect, combine, and analyze new types of information (including on the ground measurements, remote sensing, and local and indigenous knowledge), develop pilots and programs to innovate, test and experiment, and adapt ideas to different socio-ecological contexts. This work is best done in partnership with a range of stakeholders such as research organizations, communities, government, academia, and civil society. Building partnerships can strengthen the sharing and build coalitions for action and co-learning.

Actions include:

- Build scientific and social science research collaborations
- Foster data and knowledge co-production platforms between government, civil society and community groups, and research and academic institutions to make NbS interventions specific to the needs of local decision-makers and users
- Build and strengthen multi-scale partnerships and knowledge communities between subnational and global, national, regional, and community-level institutions
- Support long-term science-policy-practitioner coordination with general public communication strategies
- Facilitate more comprehensive NbS strategies by harnessing networks and partnerships with academia, civil society, trade organizations, and arts and culture organizations
- Develop Technical Advisory Councils with a range of stakeholders to support coordination and integration of NbS into programs
- Develop pilots to test actions combined with research and engagement programs to learn and adapt pilots

Financial Incentives

Financial incentives are a regular component of successful NbS initiatives, although there is a significant gap in available financing. The world currently only spends $700 million on land sector approaches. For biodiversity financing alone, the funding shortfall reaches $600-800 billion annually.[90] Financial incentives can include grants, subsidies, green bonds, payments for ecosystem services, wages for labor, resource provisioning, and carbon markets, among other funding mechanisms.[91] These incentives operate in public and private sectors as well as across multiple scales.

90 (Deutz et al. 2020)
91 Ibid

Actions include:

- Prioritize and increase overall funding allocations for NbS investments and include them in the regular budget cycle
- Develop funding mechanisms where multiple agencies can receive funding for addressing multiple benefits
- Better monetize the multiple benefits on public and private land
- Develop frameworks and tools to systematically integrate climate considerations into local governments' fiscal and financial decision-making, including the full social and economic value of NbS investments
- Use appropriate financial tools to meet different interventions
- Explore how public budgets can be leveraged to attract private investment (municipal bonds, loans, private investments, insurance/reinsurance, individual private capital, pooled finances from communities)
- Include low-income and other marginalized residents in fiscal and financial decision-making
- Ensure national and state finance reaches local governments
- Promote innovative insurance models
- Align grant programs to combine and deploy NbS planning, prioritization, and interventions across agencies
- Offer subsidies to support the implementation of NbS on private land

V. Conclusion

Integrating NbS into our climate policies and related plans, strategies, and regulations is an essential tool in our policy toolbox. It can help address our urgent climate, social, biodiversity, and environmental and urbanization challenges. The ecological actions are well-tested approaches that meet the multiple benefit criteria and have offered significant evidence to support their value. It's clear that ecosystems beyond forests, especially urban and marine environments which have been largely neglected from NbS discussions, hold much promise in their ability to provide solutions. The framework we set forth calls for reimagining NbS in order for it to achieve the various benefits that we know are possible. The foundation for this vision is our key principles that guide our actions. Ultimately, for NbS to be integrated into climate policy and for these actions and principles to take hold, institutional change is required. Our institutional approaches — coordination, capacity-building and community engagement, evaluation and learning, pilots and partnerships, and financial incentives — provide the enabling environment for these changes in our policies and society.

While this report focuses on integrating NbS into subnational climate policies, it is important to note that this is just an initial step. For NbS to be effective, they need to be integrated into various policies, regulations, strategies, programs, and action plans across sectors and scales. Integrating NbS priorities into municipal laws, rules, and regulations is key to ensuring that they are recognized and implemented in practice. Subnational policies should also build on national and international policies and commitments, economic development plans, land use, zoning and transportation plans, water and other infrastructure policies and strategic, fiscal, and investment plans. This integrated cross-scale approach, from international to local levels, provides the strongest foundation for action.

During the last year, the impacts of climate change have been severe including enormous fires across the Western United States and Turkey and floods in China, Germany, and Kenya. The recent IPCC report has demonstrated that these events will become more frequent and intense. With this new information and continued impacts, we need to use all the tools at our disposal. NbS is just one of these, albeit an important one. We need to work on decarbonizing our economies, our buildings, our transportation and our infrastructure. This is not an either/or choice, it is a both/and. We need to do it all. By more broadly defining NbS and spurring its integrated implementation, we are recognizing the significant opportunities that exist to reduce emissions, build resilience, and make our society better places for us all to live and thrive.

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