The science needed for **robust, scalable,** *and* **credible nature-based climate solutions** *for the* **United States**

Summary for Policymakers

ADDRESSING THE CLIMATE CRISIS IS *fundamental* FOR THE NATIONAL INTEREST.

More frequent and intense wildfires, droughts, floods, and heatwaves are already posing grave and interconnected threats to agriculture, human health, biodiversity, and physical infrastructure. Scientists and societal leaders agree that limiting global temperature increase to below 1.5 °C is necessary to prevent dangerous tipping points that will damage our natural and built environment, economic growth, and societal well-being. There is still time to meet this target, but success depends on bold and collaborative leadership grounded in the best-available science.

Ultimately, stopping and reversing climate change hinges on reducing and eliminating net anthropogenic emissions of greenhouse gases (GHGs) from fossil fuel use. However, in the near term, complementary approaches for removing CO_2 directly from the atmosphere have been deemed necessary to prevent dangerously high levels of warming. One way to remove atmospheric CO_2 is to harness land-based Nature-based Climate Solutions (or NbCS). NbCS are a range of management strategies for croplands, grasslands, forests, and terrestrial wetlands that increase CO_2 sequestration from the atmosphere and/or reduce ecosystem emissions of non-CO_2 GHGs like methane and nitrous oxide. Unlike other CO_2 removal strategies, **NbCS confer well-known environmental co-benefits for biodiversity, air and water quality, and soil health, in addition to essential economic benefits for farmers, foresters, and other stewards of working lands.** NbCS can also enhance the resilience of landscapes to threats exacerbated by a changing climate – such as extreme weather events, wildfires, invasive species, and pests.

NbCS are receiving increased attention from a broad coalition of stakeholders, including bipartisan lawmakers, conservation groups, the private sector, and many federal and state agencies. In the first eight months of 2022 alone, tens of billions of U.S. federal dollars have been allocated for implementation of NbCS, and private-sector participation in offset markets that trade in carbon credits have experienced rapid growth. Given this momentum, NbCS will likely be a core feature of domestic climate mitigation strategies moving forward.

While there is ample justification for implementing NbCS on the basis of their co-benefits alone, for NbCS to meaningfully support climate mitigation, they must meet **four essential criteria:**

Criteria 1: Lead to **enhancements of carbon uptake and/or GHG emission reductions** that are additional to what would have occurred in a baseline scenario, and considering all potential sources and sinks.

Criteria 2: Lead to **net cooling** such that the biophysical effects of NbCS on water and energy cycling do not outweigh the gains in carbon uptake or emissions reductions.

Criteria 3: Achieve durability by accounting for social and environmental risks that threaten the permanence of NbCS climate benefits.

Criteria 4: Account for leakage so that mitigation benefits in one place or sector are not canceled out by shifting activities to another.

Right now, **knowing which NbCS meet these key criteria is highly uncertain**. At regional and national scales most relevant to policy-setting, estimates of the present-day mitigation potentials of NbCS vary widely from one study to the next. These potentials are usually estimated by focusing on a narrow set of soil and tree carbon pools, which can over- or under-estimate ecosystem-scale carbon storage, and which can't tell us much about non-CO_2 GHGs or direct impacts on water and energy cycling. For many NbCS, the existing data are sparse and unrepresentative of naturally occurring variability in working lands. The durability of carbon stored in soils and trees, as well as the leakage potential, are difficult to quantify and are not robustly considered in most NbCS accounting schemes. Finally, current methodologies used to monitor and verify the benefits of individual NbCS projects (e.g., in carbon markets) vary widely from one entity to the next and lack systematic evaluations and cross-comparisons.

Fortunately, substantial opportunity exists to address these uncertainties. The crucial role terrestrial ecosystems play in determining atmospheric CO_2 concentrations is well-established, and huge resource investments over decades have fostered innovative measurement technologies, analytical tools, and predictive models for quantifying ecosystem carbon cycles. These tools have historically been used for basic research and are not widely leveraged for what they reveal about expected and realized benefits of NbCS. Likewise, novel approaches for crediting and verifying the climate benefits of NbCS are proliferating at a range of scales, but most have not yet been widely deployed. Thus, right now, **we have a unique opportunity to integrate the best-available science into next-generation information systems to support effective NbCS programs and policies.**

In recognition of this opportunity, in June of 2022, a cross-sectoral group of academic, federal, and NGO scientists, program managers, and policy experts came together to evaluate the **science, data, and information necessary to support robust, scalable, and credible NbCS strategies for the U.S.** The resulting white paper identifies key knowledge gaps, and provides a roadmap for **actionable, cross-sectoral information to foster NbCS strategies that work,** and to avoid dedicating resources and attention to those that do not. **Coordinated investment in a national NbCS "Information Network,"** organized around strategic leveraging of existing research infrastructure, would provide the data and derived products necessary to close these knowledge gaps and foster robust, scalable and credible NbCS strategies.

Specific recommended network activities include:

Create a centralized, cross-sector NbCS task force

- Inventory existing data
- Identify data and information gaps
- Define best practices for measurement and data sharing
- Guide the development of cyber-infrastructure to make data, maps, and code openly available and usable by a wide range of stakeholders

Enhance and expand ground-based monitoring networks and distributed experiments

- Create robust gold-standard datasets against which models, mapping tools, and monitoring protocols can be evaluated and compared
- Create networks of distributed field trials and experiments to evaluate emerging or understudied NbCS strategies
- Enhance existing environmental observation networks with more representative sites and/or data
- Create a national soil carbon monitoring network

Develop rigorously benchmarked maps and scaling tools

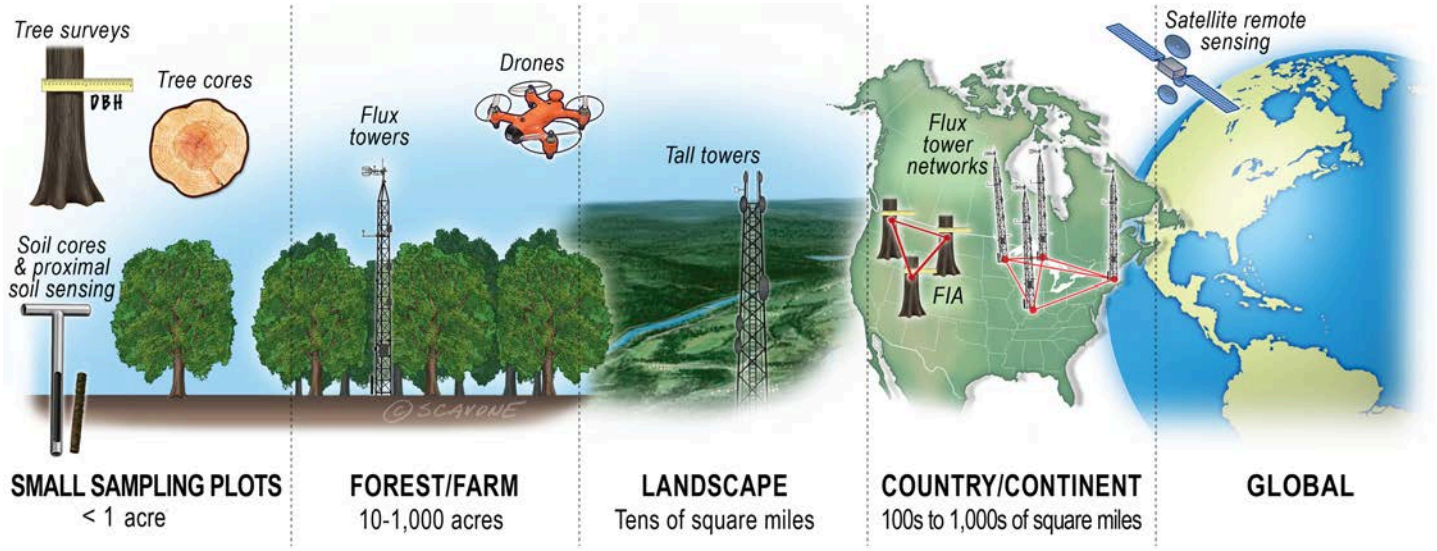
- Facilitate regional-scale mapping of NbCS mitigation potentials and biophysical impacts on temperature and water cycling
- Support new approaches for mapping baselines that are dynamic in time and can be regularly updated
- Create dynamic, wall-to-wall maps of forest biomass, soil carbon, and disturbance risk
- Improve model representation of NbCS management strategies

Create credible protocols and certification strategies

- Support systematic cross-comparison of protocols for project-scale crediting, monitoring and/or verification
- Evaluate approaches for implementing dynamic baselines in project-scale accounting schemes
- Make predictive models and other tools more accessible to non-experts

The biggest value of the network activities is through their integrated and coordinated execution – the whole is greater than the sum of the parts. Verification and transparency are critical for the success of any mitigation program, and fortunately, many of the needed technologies and tools to develop robust, scalable and credible NbCS policy are already available and tested. While the investment necessary to fully realize the vision of this network is sizable (~$1 billion USD over 5 years), it is substantially less than the tens of billions of federal dollars recently allocated for NbCS implementation. To every extent possible, the activities proposed in the report leverage existing infrastructure and pre-existing networks, so they can be executed at the rapid pace necessary to have a meaningful impact on the trajectory of climate mitigation policy. In any event, the **scope of the coordination and investment required to develop a network like this should not preclude near-term investment in individual components of the system,** which would generate much needed information relevant to many of the most pressing knowledge gaps.

This report focuses most strongly on assessing and quantifying the technical mitigation potential of NbCS. Whenever possible, we highlight additional research opportunities to better understand the socio-economic factors that determine the realizable potential of NbCS on the ground, and emphasize that multi-directional engagement between scientists, policymakers, Indigenous peoples, farmers, foresters, and other interested parties is critical for successful and equitable implementation of NbCS. Moreover, while this report presents a vision for a federal network, state governments, Tribal leaders, and the private sector undoubtedly have major roles to play in the development and implementation of more robust NbCS strategies. Sustained cross-sectoral and cross-scale outreach is crucial.



The data and analytical tools that could be more fully leveraged to inform NbCS policy and programs

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