natural capital PROJECT

Report on **Natural Capital** Approaches

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The Natural Capital Project pioneers science, technology, and partnerships that enable people and nature to thrive.

We work to integrate the value nature provides to society into all major decisions. Our ultimate objective is to improve the well-being of all people and nature by motivating greater and more targeted natural capital investments.

Centered at Stanford University, we operate as a partnership between the Chinese Academy of Sciences, the University of Minnesota, the Stockholm Resilience Centre, The Nature Conservancy, and World Wildlife Fund. We are an interdisciplinary network of over 300 research and collaborating institutions comprising academics, software engineers, and real-world professionals, all working to make valuing natural capital easier and more accessible to everyone.

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The Natural Capital Project

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Executive Summary

Financial institutions, governments, and civil society increasingly recognize that incorporating the values of nature into investments in infrastructure, agriculture, water, climate adaptation, livelihood support, and other development goals can bring substantial benefits to both people and nature. Recent years have seen an explosion in commitments and demand for natural capital approaches from diverse finance and policy institutions, as agendas and action on climate and biodiversity become more intertwined and bold new targets emerge. Yet increasing understanding of and commitments to address biodiversity and climate crises is not enough. The urgent need now is to help financial institutions and governments take action—to move beyond vision statements and commitments to drive real change in decision processes, policies, and investments. A parallel need is to learn from early adopters what is working, or what more is needed, to realize, scale-up, and make durable new advances in greener, more inclusive economies and societies.

Implementing natural capital approaches can help achieve these ambitious visions, conferring climate resilience and bolstering socio-economic prosperity through the protection and restoration of natural systems. Natural capital approaches are defined here as science-policy processes that make use of natural capital assessments and/or natural capital accounts and that are designed to secure or enhance biodiversity, ecosystem services, and human well-being. Natural capital approaches drive changes in policy and/or investment decisions that incorporate the values of biodiversity and ecosystems to people, aiming to improve human wellbeing by securing Earth's life support systems.

There is now sufficient understanding and a wide range of on-the-ground demonstrations to allow a practical articulation of what the implementation of natural capital approaches looks like, how to get started, and how to enlist the expertise and creativity needed to guide their application in specific contexts. The evidence for this statement is briefly summarized in this Report and is based on a synthesis of 15 years' experience of the Natural Capital Project (NatCap) working with decision makers around the world to test and refine natural capital approaches. Furthermore, the innovations, successes, barriers, and ongoing challenges presented here draw from NatCap's 100+ engagements in diverse decision contexts around the world (with a particular focus on a database of 41 cases with demonstrable impact), from our experience engaging with over 7,000 people in in-person and virtual trainings, from information on the use of our ecosystem service software InVEST, as well as from peer-reviewed publications, a recent synthesis of case studies, a review of GEF projects, and supplementary perspectives from additional reviews, reports, and personal interviews with GEF agency experts.

In the set of over 100 applications of natural capital approaches reviewed, key elements of natural capital and the flows of its benefits to people are quantified and mapped. In the most impactful of these, policy or investment strategies are devised, changed, and/or acted upon as a result of the natural capital approach (i.e., new information, co-developed processes, etc.). Three primary factors are associated with achieving greater levels of impact, in terms of generating action and yielding improvements in outcomes for people and nature. These factors include: 1) a clear policy window, mandate, and/or financing that motivates natural capital approaches; 2) leadership–both top-down and bottom-up–to support science-policy processes that include natural capital; and 3) exploration of the likely impacts of alternative future climate or management scenarios on natural capital together with assessment of the current gaps in and opportunities for implementation, as powerful tools to deepen policy coherence, durability, and impact.

The growing realization that ecosystem approaches are an efficient and effective way to address the climate agenda and co-benefits points to promising opportunities to link climate commitments to biodiversity policy and financing. Among Natural Capital Project engagements, these include carbon storage and sequestration (both terrestrial and blue carbon), water quality regulation (in terms of nutrients and sediments), coastal vulnerability, and water yield. Assessment of nature-based tourism and recreation is also frequently demanded and used by decision makers.

This Report summarizes the areas of greatest demand and momentum in implementation of natural capital approaches across four dimensions: 1) actors, 2) interventions; 3) sectors; and 4) ecosystem services. Successful projects that result in new plans and

policies often involve collaboration among lead actors from national government agencies, research institutions, and non-governmental organizations. Natural capital approaches can successfully guide a diversity of interventions. These include: the development of spatial plans and zoning policies, permitting and mitigation of activities such as mining, the creation and implementation of payments for ecosystem services (PES) programs and other financial incentives, the design and implementation of commodity certification, and targeting specific conservation and restoration activities.

In the Natural Capital Project's experience, over 60% of cases with policy or finance impact had more than 4 sectors involved. Similarly, of the GEF's portfolio of funded projects relating to natural capital approaches, all projects involved a multi-sector approach. Engagements often start with a particular sector as the lead or focus, bringing in other sectors as the approach progresses and inter-connections among sectors through ecosystem change becomes apparent. The water sector and disaster risk reduction sector often serve as starting points for effective engagement. Seven case studies illustrating such applications around the world, representing diverse decision contexts and sectors, are provided in *Appendix A*.

Significant challenges to implementing natural capital approaches stem from governance and institutional structures that do not readily accommodate needed changes in policy design, investments, implementation, and evaluation of novel interventions connecting ecosystem benefits to societal goals. A systematic assessment of barriers to implementation, examining missing or counter-productive policies or practices, finance mechanisms, or governance impediments, in addition to identifying opportunities for greater efficiency and coherence in policies and investments, will help science-policy teams target new interventions or ways to adapt existing ones. Solution scanning approaches also can help winnow opportunities for locally relevant and effective interventions.The science-policy engagement processes outlined in this Report are designed to help overcome barriers and illuminate opportunities for needed policy and institutional reforms by involving experts in local policy and investment decision contexts in defining challenges and co-designing solutions.

There is a great need for additional capacity, within countries and implementing agencies, to conduct natural capital assessments and approaches. Experience has shown that building capacity can occur by involving both local experts and natural capital approach specialists throughout the science-policy engagement process, so that participants 'learn by doing.' Involving local experts and natural capital specialists in natural capital engagements can increase trust, offer legitimacy to the process, and build the technical and science-policy relationships within countries to provide sustained pipelines of experts.

It also is crucial to broaden accessibility to both technical trainings and high-level conceptual offerings to grow the community of experts and practitioners. Ultimately, highly nimble and flexible technical natural capital teams (in GEF agencies and/or in a Technical Assistance Facility) that can rapidly conduct natural capital assessments themselves and train local experts are key elements of a strategy to grow the needed armies of experts who can help mainstream these approaches.

This report identifies four key principles for success: (1) Ensure enabling conditions are in place so that political, social, and financial will, combined with leadership from government and other stakeholders, increase the chance of successful implementation; (2) Identify clear policy or finance entry points to guide the characterization of natural capital and policy/finance pathways for implementation; (3) Involve impacted groups or stakeholders in natural capital assessments to co-create the natural capital approach, so that the results are more likely to lead to plans and policies with local relevance, impact, and support; and (4) Iterate on and evaluate both the results and the science-policy process itself— throughout the course of the work.

The primary elements of an iterative, science-policy framework for using a natural capital approach to inform decisions are presented in the Report. To meet the demand for implementing such a framework, the Report outlines the functions that could be provided in a Technical Assistance Facility that would connect policymakers, GEF agencies, and technical staff with natural capital experts, new data, methods, tools, and relevant examples, and engage directly in collaborative projects that advance understanding and demonstrate solutions. To meet and continue to grow demand in the near term, examples of success summarized here suggest a several-pronged strategy, including: engaging collaboratively to co-develop solutions for countries; offering compelling cases and lessons learned from natural capital approaches that successfully provide information that can be integrated into tangible policies and biodiversity, climate, and development finance projects; fostering high-level dialogue to inspire concrete action using natural capital approaches that support countries' biodiversity, climate, and development aims; and providing systematic training and software tools to build capacity in countries and GEF agencies, while providing opportunities for technical experts to engage directly with policymakers, building collaboration skills for ongoing impact.

Glossary of Key Terms

- **Biodiversity:** The variety of life on Earth, ranging from genes to species to ecosystems.
- **Climate mitigation:** Refers to efforts to reduce or prevent net greenhouse gas emissions that contribute to global warming. Activities can include curbing emissions in responsible sectors (transportation, energy, etc), capturing emissions using new technologies, or reducing net emissions by increasing carbon sequestration globally through the expansion and protection of ecosystems that store and sequester carbon.
- **Ecosystem services:** The material and non-material benefits that people derive from nature, which sustain and fulfill human life. Ecosystem services flow from stocks of natural capital and are often co-produced in combination with other forms of capital, including human labor and manufactured goods. Examples of ecosystem services include everything from food, fuel, fiber and the provision of clean water, to protection from flooding and coastal storms, to nature-based recreation and tourism, to a sense of place and cultural identity. Ecosystem service benefits can be quantified in many different ways, including biophysical terms (e.g., tons of eroded sediment avoided), monetary terms (avoided water treatment costs), and other indicators of human well-being.
- **Impact assessment:** Impact assessment is the process of identifying the consequences of a current or proposed action (1). Impact assessment can be both a technical tool for evaluating the effects of a policy, plan or project, as well as a legal and institutional procedure linked to formal decision-making processes, such as when governments or financial institutions require Environmental Impact Assessments or Strategic Environmental Assessments.
- **InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs):** A suite of free, open-source, spatially explicit software models used to map and value ecosystem services, produced by the Natural Capital Project and used in 185 countries worldwide. InVEST enables decision makers to assess tradeoffs associated with alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation. InVEST includes models for 18 ecosystem services, with more in development (see *Appendix C*).
- **Natural capital:** The living and nonliving components of ecosystems—other than people and what they manufacture—that contribute to the generation of goods and services of value for people (2). Natural capital includes soils, waters, forests, coastal marshes, rangelands, farmlands, and the diversity of life living in ecosystems.

1. International Association for Impact Assessment. 2009. "What is Impact Assessment?" Accessed at https://www.iaia.org/uploads/pdf/What_is_IA_web.pdf
2. Guerry, A. D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G. C., Griffin, R., ... & Vira, B. (2015). Natural capital and ecosystem services informing decisions: From promise to practice. Proceedings of the National Academy of Sciences, 112(24), 7349.

Glossary of Key Terms

- **Natural capital accounts:** Natural capital accounts track current stocks of natural capital, flows of ecosystem service benefits and their change over time using a standardized, replicable approach. Natural capital accounts can include both biophysical and monetary metrics. Natural capital accounts can provide the foundation for cross-sectoral dialogue about the role of natural capital, inform the design of policies and investments, and enable evaluation of the impacts of such interventions.
- **Natural capital approaches:** Natural capital approaches include both natural capital assessments and natural capital accounts. Natural capital approaches inform policy and finance mechanisms designed to secure or enhance natural capital and human well-being.
- **Natural capital assessments:** Natural capital assessments involve quantifying and mapping stocks of natural capital and flows of ecosystem services to people as well as outcomes for other species. They use multiple metrics (qualitative, quantitative, and/or monetary), and consider overall as well as distributional effects. Natural capital assessments can take many forms, including evaluation of past performance, exploration of future scenarios, optimization of decisions, and assessments of policies. Natural capital assessments can be used to guide and evaluate cross-sectoral policy, planning, and finance to meet integrated sustainable development aims.
- **Nature-based solutions:** Actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits. They are underpinned by benefits that flow from healthy ecosystems and target major challenges like climate change, disaster risk reduction, food and water security, health and are critical to economic development (3).
- **Strategic Environmental Assessment (SEA):** a range of analytical and participatory approaches that aim to integrate environmental considerations into policies, plans and programs and evaluate the interlinkages with economic and social considerations (OECD 2006) (4).

3. IUCN. (2022). "Defining Nature-based solutions". Accessed at https://www.iucn.org/theme/nature-based-solutions/about
4. [OECD] Organisation for Economic Development and Co-operation. 2006. Applying strategic environmental assessment. Good practice guidance for development co-operation [Internet]. DAC Guidelines and Reference series. http://www.seataskteam.net/guidance.php

Introduction

- ***The challenge and the opportunity***
- ***What is a natural capital approach?***

Introduction

The challenge and the opportunity

In just the past few years, the conversation about how to support more resilient economies and societies has changed dramatically; the case for nature's contributions to people has been made (Díaz et al., 2019; IPBES, 2019). The benefits of nature are now featured prominently in visions to withstand, ameliorate, and adapt to the combined effects of climate and land use change, the global pandemic, and other shocks. Financial institutions, governments, and civil society increasingly recognize that incorporating the values of nature into the planning and implementation of investments in infrastructure, agriculture, environment, climate adaptation, livelihood support, and other development goals can bring substantial benefits to both people and nature. Recent years have seen an explosion in commitments and demand for natural capital approaches from diverse finance and policy institutions, as agendas and action on climate and biodiversity become more intertwined and bold new actions emerge (Almeida et al., 2022; TNFD, 2022).

Increasing understanding of and commitments to address biodiversity and climate crises is not enough. Biodiversity loss, ecosystem degradation, and climate hazards are accelerating at a pace that is outstripping conservation and restoration countermeasures, imperiling Earth's life support systems, and undermining the goal of sustainable prosperity for all (Allan et al., 2021; Díaz et al., 2019; Steffen et al., 2015). The expansion of economic activity over the last century, which has lifted billions of people out of poverty and raised living standards around the globe, has also caused rapid changes to planetary systems. Forest clearing, degradation of soils, and destruction of wetlands have reduced the fertility of land and the function of watersheds, with measurable socio economic consequences (Johnson et al., 2021). Land use change alone has contributed 4.8 billion tons of carbon per year to the atmosphere since 1900, representing 35 percent of total CO2 emissions over that time period (Friedlingstein et al., 2021). And natural habitat conversion is accelerating the loss of flora and fauna with impacts on biodiversity and critical ecosystem services like pollination, water purification, and disease regulation that are vital for support to healthy economies and healthy populations (IPBES, 2019). Natural capital and biodiversity, once plentiful, are on the decline almost everywhere on Earth.

The urgent need now is to help financial institutions and governments take action—to move beyond vision statements and commitments to drive real change in decision processes, policies, and investments. Policies can be more coherent and efficient, removing harmful subsidies, unintended countervailing regulation, and strengthening

incentives for biodiversity and climate resilient development (Johnson et al., 2021; Mbanda and Fourie, 2019; Tosun and Leigninger, 2017). A parallel need is to learn from early adopters what is working, or what more is needed, to realize, scale-up, and make durable new advances in greener, more inclusive economies and societies. Understanding and overcoming institutional and governance challenges to support implementation is a significant need (e.g., IPBES 2019, Ruhl et al. 2021, Sutherland et al. 2014). This will require reaching broader constituencies—governments, communities, private financial institutions, and businesses who can either facilitate or hinder needed transformation in how their lands and waters are managed, how and where investments in biodiversity and ecosystems are made, and relevant actions targeting those who benefit or are harmed.

Promising new pathways for green, inclusive development approaches are opening up with governments and financial institutions capable of scaling innovations. Innovative policies and financial instruments harnessing nature's benefits are emerging in governments and MDBs, but their details remain relatively unknown to the broader world. The Joint Statement on Nature, People, and Planet by eight MDBs calls for "mainstreaming nature into our policies, analysis, assessments, advice, investments, and operations" by 2025 (*MDB Joint Nature Statement*, 2021). Across Latin America and the Caribbean, natural capital approaches have been adopted to secure coastal communities from climate risks, promote sustainable development, and secure freshwater supplies for cities, hydropower producers, and the agricultural sector. The InterAmerican Development Bank (IDB) is driving the scaling of these advances through their innovative Natural Capital Lab, launched in 2018 (IDB, 2018). The Asian Development Bank (ADB) has just launched a Natural Capital Lab (at the CBD CoP in Oct 2021), as well as an Innovative Natural Capital Financing Facility (Zhang, 2021). The Global Environment Facility (GEF) also is gearing up to mainstream natural capital assessment and accounting approaches through ambitious new commitments for financing, policy reforms, and targeted engagements with their member countries (GEF, 2021).

Despite these advances and the wide availability of appropriate tools, the uptake among GEF agencies and policymakers in countries to inform nature-based investment is not advancing fast enough to address the pressing sustainability challenges of our time. There is a yawning gap between recognizing conceptually the values of nature and having – in practical terms – the science, tools, and experience required to integrate them effectively into policy, planning, and finance. Key hurdles include: ability to draw on existing policy and finance mechanisms within existing institutions and governance structures, designing and implementing innovative new policy and finance mechanisms that can change the status quo, accessing the latest data, and streamlining guidance and building capacity to employ cutting-edge analyses and tools. Key institutions implementing these ambitious visions need streamlined mechanisms over decision-relevant timelines to identify innovative, effective, and bankable investments in nature-based solutions for development aims.

This report aims to inform: (i) acceleration of the integration of natural capital into GEF policy and investment decisions within and across key development sectors (including energy, water, agriculture, infrastructure, and natural-resource based commodities) in the service of nature-positive, resilient, and inclusive development; and (ii) increase in the uptake and use of natural capital assessments and accounting – by governments, MDBs, businesses, communities, and NGOs – in development plans, policies, strategies, practices, investments, and other decision-making.

What is a natural capital approach?

Natural capital refers to Earth's lands, waters, and biodiversity – "nature" writ large. Ecosystem services are the benefits that flow from (stocks of) natural capital to people. **Natural capital approaches drive changes in policy and/or investment decisions that incorporate the values of biodiversity and ecosystems to people, aiming to improve human wellbeing by securing Earth's life support systems.** They meld diverse disciplines, perspectives, and methodologies, and can include both 1) *assessments of natural capital stocks and ecosystem service flows* and 2) *natural capital accounts* (see Glossary of key terms above). *Assessments* involve quantifying, mapping, and valuing stocks of natural capital and flows of ecosystem services to people. Assessments use a variety of metrics (qualitative and quantitative; biophysical, health, socioeconomic, and/or monetary). Natural capital assessments characterize change and trade-offs of natural capital stocks and their flows through ecosystem services to benefit people, under present and future scenarios. Many cases exist of natural capital assessments being used to guide policy, planning, investments, and management practices to meet integrated sustainable development aims (e.g. Arkema et al., 2015; Ouyang et al., 2016; Ozment et al., 2021; Ruckelshaus et al., 2015; Mandle et al., 2019). Best practice entails a close and iterative engagement process with scientists, communities, policy-makers, and other decision-makers, including key stakeholders (Guerry et al., 2015; Mandle et al., 2019; Rosenthal et al., 2014).

Natural capital accounts track current stocks of natural capital and their change over time using a standardized, replicable approach for designing and evaluating policies and investments. In March 2020, the UN Statistical Division approved the SEEA Ecosystem Accounting Framework (SEEA EA), which allows quantification of ecosystems' (1) extent and (2) condition plus the (3) supply and use of ecosystem services in both physical and (4) monetary terms, and finally (5) asset accounts that quantify the net present value of stocks of ecosystem assets (United Nations, 2021a, 2021b). The UN Statistical Division approval included Gross Ecosystem Product (GEP) (Ouyang et al., 2020) as a legitimate metric for the SEEA EA, laying out encouraging pathways to policy applications that are already being demonstrated in China. National natural capital accounts can *in principle* identify, measure, and value natural capital from the public sector perspective, but these exercises take considerable time, and they have too rarely influenced decision making and policy instruments (GEF, 2021). Recent reviews of natural capital accounting indicate encouraging progress in systematically calculating accounts, but implementation of natural capital accounting information in decisions still greatly lags that of natural capital assessments (Bagstad et al., 2021; Ruijs et al., 2019). For this reason, in synthesizing evidence of natural capital approaches influencing policy and investment decisions, we focus here primarily on natural capital assessments, but include natural capital accounts where they have been used to inform decisions.

If co-developed with decision makers and stakeholders, natural capital assessments and accounts can underpin decision-making for an inclusive and sustainable future, integrating people and life-support systems into economic development. Integrated,

cross-sectoral engagement encompassing multiple ecosystem services in natural capital approaches are the gold standard (e.g., *Appendix A*), as they can highlight 'win-wins' and key tradeoffs among locations, sectors, and societal goals. Multi-sectoral natural capital approaches provide the best opportunities to inform the design and implementation of integrated management as well as greater policy coherence and efficiency of investments in biodiversity and ecosystems (Farrell et al., 2021; Mandle et al., 2019). Nevertheless, incorporating natural capital information in decision processes involving one or more sectors can be a promising way to grow understanding of nature's value and affect specific sector outcomes. Single sector entry points can be a practical way to address a particular policy problem problem, before attempting more systemic, structural reforms (see *Appendices A & B*).

The world is ready to undertake natural capital approaches, incorporating the values of biodiversity and ecosystems into transformative policy and investment decisions, and tracking resulting outcomes for nature and people over time. Scientific breakthroughs–in measuring and mapping nature's benefits, new data technologies, computing power, and algorithms reflecting new understanding—as well as novel networks of researchers and practitioners are transforming what is possible to quantify in terms of biodiversity and the values of ecosystems to people. **There is now sufficient understanding and demonstrations to allow a practical articulation of what implementation of natural capital approaches looks like, and how to get started, including growing needed expertise and creativity to guide their application in specific contexts.** The evidence for this statement is briefly summarized in this Report, and is based on a synthesis of 15 years' experience of the Natural Capital Project (NatCap) working with decision makers around the world to test and refine natural capital approaches. The innovations, successes, barriers, opportunities, and ongoing challenges presented here draw from NatCap's 100+ engagements in diverse decision contexts around the world (with a particular focus on a database of 41 cases with demonstrable impact), from our experience engaging with over 7,000 people in in-person and virtual trainings, from information on the use of our ecosystem service software InVEST, as well as peer-reviewed publications, a recent synthesis of case studies (Mandle et al. 2019), a review of GEF projects (GEF STAP Review 2021), and supplementary perspectives from additional reviews, reports, and personal interviews with GEF agency experts.

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2. Innovations in Implementing Natural Capital Approaches—Lessons Learned

- ***Current state of play***
- ***Common guiding questions motivating a natural capital approach***
- ***What is working? Factors associated with success***
- ***Where are demand and momentum greatest?***
- ***Opportunities to overcome barriers***

Innovations in Implementing Natural Capital Approaches—Lessons Learned

Current state of play

Natural capital approaches–as defined above to include both natural capital assessments and accounts–are being implemented in a number of geographies and decision contexts around the world. The innovations are inspiring, as governments, NGOs, civil society and other stakeholders realize how the benefits from biodiversity and ecosystems underpin many sectoral and sustainable development aims. For example, the Chinese government is making ever-increasing investments in nature, using a natural capital approach (*Appendix A*; Case Study #1). China has zoned 51% of the country for ecosystem benefits and regeneration, targeting payments to over 200 million people for ecosystem restoration (Ouyang et al., 2016). Still more investments using a natural capital approach are underway in China, in cities, in new protected areas, and along coastlines (Fang et al., 2018; Lü et al., 2017; Yu et al., 2010). The impacts of these policies and investments are now being integrated and tracked through Gross Ecosystem Product (GEP), an accounting approach and metric approved by the UN Statistical Commission in 2021 as a key indicator of change in ecosystem value to economies (Ouyang et al., 2020).

Through 15 years of learning from implementation of natural capital approaches to inform decisions, key principles and components of successful approaches have emerged over time (see Section 3, below). Natural capital information can fruitfully enter policy and investment decision processes in diverse ways, sometimes via a single sector (*Appendix B*), and in other cases, multi-sector, multiple objectives are the focus (*Appendix A*). Single-sector foci, such as including ecosystems in water-use planning and policy, can be a good way for a government, private sector, or multi-stakeholder group to get started incorporating ecosystem benefits into their decisions. Natural capital approaches starting with a single sector (e.g., water) often lead to multi-sector engagements as the intertwined connections between land-use sectors (e.g., agriculture, energy, transportation) and water become apparent (e.g., Ozment et al., 2021, *Appendix A*, Case study #3). Multi-objective, multi-sector demonstrations illustrate the full potential of natural capital approaches to integrate the benefits of nature in actions to

improve human wellbeing. To illustrate this diversity, we offer brief descriptions of 7 compelling cases around the world in which natural capital information is changing policy and investment decisions for the betterment of biodiversity and human wellbeing (*Appendix A*). **In all of these cases, key elements of natural capital and the flows of its benefits to people are quantified and mapped, and policy or investment strategies are changed based on the information.** Natural capital assessments in these cases track changes in land uses and land cover due to climate and/or human activities and interventions. Such assessments are useful in designing and evaluating policies and investments to improve biodiversity, food, water and hazard security, fisheries and forestry production systems, water quality, tourism and other nature-based livelihoods, and cultural and spiritual wellbeing.

The most productive demonstrations of natural capital approaches use a co-development approach, whereby key actors and stakeholders are engaged with technical experts from the beginning of an engagement, helping to articulate a vision for the future that is based on local political, social, and cultural values and priorities (Fig. 1; Burdon & Potts, 2020; Mandle et al., 2019; Posner et al., 2016; Ruckelshaus et al., 2015). The integrated science-policy team also co-produces knowledge and a mutual understanding of how their system works in both a biophysical and socio-political sense, through iterative improvement of input data and other information, modeling results, understanding of barriers to and opportunities for more efficient and coherent implementation of policy and finance innovation, and interpretation for greatest local and policy/financial relevance. Ideally, local technical and policy experts are involved throughout the process, helping shape the approach and building local capacity for future iterations, communications, and an adaptive management cycle of learning and ongoing innovation.

In the remainder of this section, we draw on the Natural Capital Project's 15 years of implementing natural capital approaches and trainings around the world. In our collection of over 100 NatCap engagements, we summarize attributes from a subset of 41 cases that had the deepest impact. We also draw on a review of a subset of GEF projects including natural capital information (GEF STAP Review, 2021), and include perspectives from key experts in this arena to augment our findings. We present common guiding questions of natural capital approaches. Then we explore the specific elements of a 'natural capital approach' that have worked best – or not worked, and where and why. Next, we outline the barriers to uptake, and how these are being lifted – through enablers and opportunities, leading to durable outcomes. Finally, we develop principles for natural capital assessment that can be embedded into all near-term GEF proposals.

Common guiding questions motivating a natural capital approach

Natural capital approaches are not one-size-fits all and there are multiple pathways into a natural capital approach. Out of our 15 years of experience and the results of the current review emerged a set of common questions that often motivate a natural capital approach, such as:

- What benefits do natural assets/ecosystems provide and to whom?
- What are the values of these benefits (social, economic, cultural, and/or well-being)?
- How are these benefits likely to change in the future, due to changes in policy, investment, climate, or other factors?

Additional motivating questions are specific to different decision contexts such as strategic development planning, environmental restoration and conservation, sectoral investment design, safeguards, and climate and biodiversity financing. Table 1 summarizes common motivating questions by policy context, building on the common set of questions listed above. We have found that regardless of the scale of the policy engagement–whether national, regional, local, or project-specific, these motivating questions remain essentially the same.

Table 1. Common guiding questions motivating a natural capital approach by decision context. More detail and references for example cases can be found in *Appendix A* and in the Natural Capital Project's publications database.

Decision Context	Motivating Questions	Examples
ALL	• **What benefits do natural assets/ecosystems provide and to whom?** • **What are the values of these benefits (social, economic, cultural, and/or well-being)?** • **How are these benefits likely to change in the future, due to changes in policy, investment, climate, or other factors?**	
Identify development priorities	• Where are priority investments needed to ensure the flow of benefits into the future? • How do these policies and investments confer resilience to climate, land use pressures, and other shocks over time, in a way that does not overly deplete natural capital? • What barriers and opportunities exist in implementing policy and finance innovations for greater efficiency and coherence?	Country Development Plans in Belize, The Bahamas, and China (*Appendix A,* Case Studies #1, 2, & 5)
Environment strategy	• What and where are the strategic ecosystems for my country/region? • What stressors, threats, and enablers will affect the flow of ecosystem benefits in the future? • Where are investments in restoration & conservation of strategic ecosystems needed to ensure the continuing flow of benefits? • What benefits accrue, and to whom, that could motivate private or public sector finance for environmental conservation?	Natural Capital Assessment, Myanmar (Mandle et al., 2017)

Decision Context	Motivating Questions	Examples
Planning and Zoning	• How are natural capital benefits likely to change in the future in response to specific development options? To climate? • What policy or zoning mechanisms are needed to promote nature-positive development in the planning region? • How can barriers to cross-sectoral zoning or other regulations be turned into opportunities for greater efficiency and coherence in implementation?	Integrated Coastal Zone Management Planning, Belize (*Appendix A, Case Study #2*) China's EFCAs and redlining (*Appendix A,* Case Study #1)
Sectoral Investment: Project Identification & Design	• How can sectoral policies and investments (e.g., in transportation, energy, water, agriculture) –individually and in an integrated sense– be targeted and designed in a way that secure ecosystem benefits for specific sectors and communities? • How will sectoral policies and investments impact ecosystems and the benefits that they provide? • Are these policies and investments coherent with other policies and regulations that aim to protect and enhance ecosystems? • What benefits accrue to the private sector, to help mobilize private investment?	Tana, Nairobi and Cauca Valley, Colombia water funds (*Appendix A*, Case Study #3)
Sectoral Investment: Impact Assessment	• How will sectoral policies and investments impact ecosystems and the benefits that they provide? • How and where can the potential impacts on ecosystems and their benefits be mitigated (by applying the mitigation hierarchy)?	Pucallpa-Cruzeiro Road, Peru (*Appendix A,* Case Study #6)
Sectoral Investment: Monitoring & Evaluation	• How do ecosystems and benefits change over time in response to the project and/or mitigation efforts? Are these interventions effective? • Do the project and/or mitigation efforts achieve their performance targets (e.g., for performance-based financing)? • How can improvements to institutions, policy, finance, or capacity help improve outcomes?	The Bahamas IDB performance based loans (*Appendix A,* Case Study #5)
Climate change mitigation & adaptation	• How will ecosystem benefits change under future development and climate change trajectories? • How will people's dependence on ecosystem benefits change in the future, considering climate change and development? • How do climate policies and investments confer resilience to climate, land use pressures, and other shocks over time, in a way that does not overly deplete natural capital? • What level of investment (public, private, etc.) is needed and where should it be directed to preserve and enhance natural capital and ensure the flow of benefits?	Climate adaptation for the Mesoamerican Reef (Ruckelshaus et al., 2020); San Francisco Bay (*Appendix A,* Case Study #7)

What is working? Factors associated with success

Based on the Natural Capital Project's 15 years of experience co-developing natural capital assessments, we see 3 primary factors associated with achieving greater levels of impact, in terms of generating action and producing documented improvements in outcomes for people and nature. These factors include: 1) A clear policy window, mandate, and/or financing that motivates natural capital approaches; 2) leadership, both top-down and bottom-up, to support science-policy processes that include natural capital; 3) exploration of the likely impacts of alternative climate or management scenarios on natural capital and current gaps in implementation as a powerful tool to deepen policy resilience and impact.

1) Clear policy window, mandates and/or financing. Natural capital approaches can reveal opportunities for win-wins, highlight the shared stake that different sectors and segments of society have in conserving or enhancing nature, and help navigate tradeoffs among different benefits and beneficiaries. In many cases, implementing natural capital approaches requires a change from the status quo – bringing together stakeholders in new ways, evaluating new sources of information, and considering new policy and investment scenarios and options. Clear policy windows, and especially mandates, for incorporation of natural capital are an important catalyst for bringing different sectors and stakeholders together and increasing the likelihood that natural capital information contributes meaningfully to plans, policies, and on-the-ground change.

Where a policy mandate does not already exist, a natural capital approach can also be used to take advantage of a clear policy window to help build support for such approaches. For example, a strategic development planning process may not initially mandate inclusion of natural capital information, but where champions help to generate and advocate for such information, it can lead to natural capital inclusion in a plan, and stronger policy mandates or financial incentives for future iterations of the plan. We see this repeatedly across Natural Capital Project engagements. For example, the creation of Belize's Integrated Coastal Zone Management Plan–considered a gold-standard for marine and coastal zone planning–was driven by the Coastal Zone Management Act of 2000. The Act called for the development of a Coastal Zone Management Plan and established the Coastal Zone Management Authority and Institute (CZMAI) to develop the plan with consultation from a wide range of stakeholders, including government agencies, NGOs and the private sector (*Appendix A*: Case Study #2; K. Arkema, 2019; Arkema & Ruckelshaus, 2017; Belize Coastal Zone Management Act, 2000). Belize's ICZM Plan is widely hailed as a gold standard globally (Douvere 2016), and has led to significant policy and financial innovations in support of its biodiversity and human wellbeing outcomes (*Appendix A*: Case Study #2).

Financial incentives are another notable motivator for implementing natural capital approaches. This includes standards from multilateral development banks and other financial institutions that make consideration of natural capital either a prerequisite for lending or a pathway to speedier and more certain financing processes. For example, in

Mongolia, the Oyu Tolgoi mining project is funding efforts to improve rangeland conditions and herder livelihoods. Oyu Tolgoi, which is jointly owned by the Mongolian Government and Rio Tinto, is undertaking this effort to meet the requirements of its IFC (International Finance Corporation) financing, which requires projects to offset their environmental impacts (Ruckelshaus et al., 2019).

Financial incentives may also be driven by policy or regulatory requirements. For example, the Clean Water Act in the United States sets standards for maintaining water quality and provides flexibility in how those standards are met, whether through gray infrastructure, nature-based approaches or a combination of the two. This provides an incentive for local governments and developers to consider where nature-based approaches are a more cost-effective option for compliance, and has enabled a stormwater credit market in Washington, DC that includes nature-based approaches (Mandle et al., 2019). The United States Environmental Protection Agency's Surface Water Treatment Rule provided the incentive for New York City to invest in conservation of the source watershed for its drinking water as a cheaper option to building a new filtration plant (Mandle et al., 2019).

2) Leadership to support inclusion of natural capital in ongoing science-policy processes. The importance of strong leadership consistently emerges as an additional critical component for success. Leadership is important at multiple levels, including both top-down and bottom-up engagement and communication (Brodie Rudolph et al., 2020). High-level leadership is important for setting the policy context (e.g., through mandates, financial or other incentives, or simple encouragement; see #1 above) and requiring or supporting a strong science-policy and stakeholder engagement process. Leadership at high levels is also important for ensuring adequate resources and capacity are directed at the undertaking and for ensuring that recommendations generated through natural capital approaches are implemented. Bottom-up leadership also is key to successful outcomes from natural capital approaches. Sector and community stakeholders are important in developing a compelling, shared vision, choosing priority ecosystem benefits and beneficiaries to include, and strengthening buy-in to results from communities and decision-makers who will be involved in, or affected by, implementation.

Leadership and buy-in at other levels are important too; for example, ensuring consistency and coherence in processes and implementation through changes in government administrations and for developing the technical information and capacity needed to support decision making. In the Natural Capital Project's experience, long-term engagement with government partners who shepherd meaningful cross-sector and stakeholder engagement in science-policy processes is a key ingredient to successful outcomes. In addition, working with individuals who are likely to remain in decision-making positions within government and scaling institutions such as multi-lateral development banks is important to durability of outcomes from natural capital processes. Several examples of the contributions of top-down and bottom-up leadership in natural capital approaches are provided in Case Studies (*Appendix A*).

3) Exploration of the likely impacts of alternative climate, management, or budget scenarios on natural capital. Using alternative future scenarios to explore how different plans, policies, or climate might affect natural capital and the services that flow to

people yields deeper policy impact. Scenarios are a powerful tool for scientists, policy leaders, and stakeholders to explore the dynamics of complex social-ecological systems (Priess & Hauck, 2014; Wardropper et al., 2016). Scenarios can envision different futures organized around different priorities (e.g., local agriculture or technological advancement; Carpenter et al., 2015). They also can be used to organize complex and critical uncertainties in a biophysical or socio-political setting into a limited set of contrasting futures, to anticipate trajectories of possible change and to evaluate trade-offs (Peterson et al., 2003). The co-creation process can facilitate the incorporation of stakeholder perspectives for greater credibility, legitimacy, relevance; foster the exchange of information and ideas between community members; and lead to collective action (Cobb & Thompson, 2012; Johnson & Karlberg, 2017). In our collection of over 100 NatCap engagements, the cases that had the deepest impact used scenarios to explore the likely outcomes of alternative plans, policies, and investments, leading to tangible shifts in policy and investment (Ruckelshaus et al., 2015; NatCap unpubl. data). Coupled with assessments of barriers to innovative policy and finance innovation, and opportunities to overcome such barriers, scenario results can help guide more coherent, efficient, and effective implementation pathways (Sutherland et al. 2014, Ruhl et al. 2021).

Where are demand and momentum greatest?

As the importance of nature to a sustainable, livable future has become increasingly apparent and as the science and technologies to assess natural capital has matured, interest in natural capital approaches is accelerating. Here we assess the areas of greatest demand and momentum across four dimensions: 1) actors, 2) interventions; 3) sectors; and 4) ecosystem services.

Actors. The large and growing demand for natural capital approaches from multilateral development banks (MDBs) is particularly notable. In 2021, a consortium of MDBs released the joint statement "Nature, People, and Planet," which acknowledges the critical role nature plays in supporting human health and well-being, economic growth and livelihoods, and climate regulation, and commits to mainstreaming consideration of nature throughout their policies and activities (*MDB Joint Nature Statement*, 2021). Individual banks have numerous initiatives underway to mainstream natural capital approaches into their operations. For example, the InterAmerican Development Bank has created a Natural Capital Lab and its Board of Directors approved a new Mainstreaming Action Plan for Environmental and Social Sustainability in 2020 which includes development of a Natural Capital Action Plan (IDB, 2018, 2020). The Asian Development Bank has launched its Innovative Natural Capital Financing Facility, which includes a Natural Capital Lab, Natural Capital Fund and Agribusiness Services Platform (Zhang, 2021). The European Investment Bank created a Natural Capital Financing Facility. Efforts within the World Bank are less centralized, and include a recently launched Global Program on Nature Based Solutions for Climate Resilience under the Global Facility on Disaster Reduction and Recovery (*Global Program on Nature-Based*

Solutions for Climate Resilience, n.d.), the Biodiversity, Ecosystems and Landscape Assessment (BELA) Initiative under the PROGREEN partnership. The World Bank is also leading a Finance Task Force for the UN Decade on Ecosystem Restoration 2021-2030 (UNEP, 2021). In addition, the World Bank has been supporting natural capital accounting efforts for over a decade through its Wealth Accounting and Valuation of Ecosystem Services (WAVES) partnership and the more recent Global Program on Sustainability (GPS).

Demand from national and regional governments has been long standing and remains strong. In the Natural Capital Project's experience, environment ministries, protected area management agencies, and regional and national planning agencies in particular understand the value of incorporating natural capital approaches into their strategies and activities. On the other hand, ministries of finance, transportation, and mines have rarely initiated natural capital approaches. Instead, these ministries tend to be involved when they are convened by colleagues from other ministries. Demand from governments in Latin America and the Caribbean has led to long-term, ongoing Natural Capital Project engagements in a number of countries including Belize, Colombia, Costa Rica, China, and Peru. The Central Bank of Chile is now actively engaged in that country's cross-sectoral 'Natural Capital Committee', modeled after a similar governance structure in the UK that led to the *Dasgupta Review on the Economics of Biodiversity* (Banco Central de Chile, 2021; Dasgupta, 2021). The government-led integration of natural capital approaches in China from zoning to ecological compensation to accounting is inspiring other country governments, including elsewhere in Asia and in Latin America. Interest also is growing for investment in natural capital in cities and the many benefits it brings to the growing global population in urban areas (e.g., Global Platform for Sustainable Cities, Elmqvist et al., 2015, Guerry et al., 2021, Mansur et al., 2022). Recent reviews of Payments for Ecosystem Services (PES) programs and nature-based solutions confirm the importance of government actors. The most common lead actors for projects centered on nature-based solutions in Latin America and the Caribbean have been local/national NGOs (4o projects) and national governments (37), followed by regional governments (30) (Ozment et al., 2021). Among 387 watershed PES programs identified by Salzman et al. (2018), 203 were government financed.

Private sector engagement in natural capital approaches often is a result of incentives created by policies and regulations from governments and other entities. For example, as of 2017, the IFC performance standards have led to 9 active projects on nearly 6.5 million hectares targeting no net loss of biodiversity, and another 12 projects in development (Bennett et al., 2017), including the Oyu Tolgoi mining company's engagement on improving rangeland conditions and herder livelihoods described previously (Ruckelshaus et al., 2019). In the United States, the Clean Water Act and the Endangered Species Act both provide incentives for the private sector to engagement in mitigation banking, both in terms of generating credits through restoration or implementation of nature-based solutions, and in terms of purchasing credits where biodiversity of natural values are harmed (Mandle et al., 2019).

In the Natural Capital Project's experience to date, successful projects that result in new plans and policies involve collaboration among lead actors from national government agencies, academia and non-governmental organizations. Specifically, approximately 40% of the cases in our database were led by government actors, 40% by NGOs, 30% by

academia, and 10% by MDBs (multiple lead actors leads to >100%) (Natural Capital Project, 2022b). Many of NatCap's strongest engagements also included diverse stakeholder representatives who brought crucial local knowledge, authorities for some actions, and legitimacy to the process, including indigenous groups and leaders of small and large businesses. Indication of demand also comes from participants in trainings led by the Natural Capital Project. Since 2013, we have engaged over 7,300 people in formal training efforts, with thousands more involved in our online course and other virtual offerings. Of participants in these engagements, 44% are from academia, 20% from NGOs, 16% from government entities, 6% from business/private sector/consultancies, and just over 1% (93 individuals) from MDBs (with the rest unknown or "other"). Through these formal training engagements we have reached people in 119 countries (the top 2 are US (29%) and China (16%) (Natural Capital Project, 2022c). As another indication of the distribution of global demand for these approaches, of 300,000 recent InVEST runs, the top computer default languages are English (49%); Chinese (20%); Spanish (8%); Portuguese (7%); German, French, Italian, and Korean (each 3%); and Thai and Japanese (each 1%) (Natural Capital Project, 2022a).

Interventions. Natural capital approaches can successfully guide a diversity of interventions. These include: the development of spatial plans and zoning policies, permitting and mitigation of activities such as mining, the creation and implementation of PES programs and other financial incentives, the design and implementation of commodity certification, and targeting specific conservation and restoration activities. This diversity of interventions indicates broad motivations and entry points for government, private sector and civil society actors to get engaged in Natural Capital Project demonstrations. For example, natural capital assessments have supported the creation of water funds (*Appendix A*, Case Study #3), bringing together government, the private sector and community groups in a particular location to pool resources and share governance based on a common interest in improved watershed management for secure, clean downstream water supply. Natural capital approaches have helped water fund investors target their annual budgets to invest in areas with the greatest potential to generate benefits to water users and to local communities, using ecosystem value maps and estimates of the costs of alternative interventions such as fencing, riparian planting, and support for enforcement patrols in protected areas (Mandle et al. 2019).

Other natural capital assessments have been used to target conservation and restoration of coastal ecosystems to protect populations and properties from hurricanes and support livelihoods in economic recovery. These projects have identified areas for mangrove restoration projects funded by governments and MDBs, and expanded marine protected area networks for coral reefs that provide the greatest overall value in return for the investments (e.g., see Appendix A, Case Studies #2 and #5). Similarly, some jurisdictions are using natural capital approaches to target investments in nature-based adaptation strategies to improve resilience to climate change and sea-level rise (see Appendix A, Case Study #7, Guerry et al. 2022). Although nature-based interventions often target certain activities, sectors, ecosystem types, or geographic areas within a broader region, we have found that an integrated natural capital assessment that examines the consequences of different scenarios on multiple outcomes of interest, or that optimizes fixed budgets for multiple objectives, is frequently a valuable initial step towards creating an integrated spatial plan that then is used to target and drive resource interventions to achieve that plan (see *Appendix A*, Case Studies #1 and #2).

Sectors. Natural capital approaches are often most powerful when they bring together multiple sectors, allowing integration of impacts on biodiversity, ecosystem services, and beneficiaries, and identification of trade-offs and synergies in spatial assessments. The 'win-win' outcomes among sectors that can be highlighted in natural capital approaches helps to bring efficiencies to planning, policy and investment strategies, and also identifies opportunities for greater policy coherence (Mandle et al., 2019). In the Natural Capital Project's experience, over 60% of our cases with policy or finance impact had more than 4 sectors involved. The median number of sectors involved in NatCap's natural capital engagements is 5. Similarly, of the GEF's portfolio of funded projects relating to natural capital approaches and assessments, all projects involved a multi-sector approach.

Engagements often start with a particular sector as the lead or focus (see *Appendix B, Table 1B*), bringing in other sectors as the approach progresses and inter-connections among sectors through ecosystem change becomes apparent. The water sector (see *Appendix A*, Case Study #3) and disaster risk reduction sector (see *Appendix A,* Case Studies #2, 4, and 5) often serve as starting points for effective engagement with natural capital approaches. Both of these sectors are inherently integrative, with the natural capital approaches they spur clearly connected to other sectors, such as agriculture, urban development, transportation, and energy, and thus are a useful entry point for cross-sector coordination. Consistent with the Natural Capital Project's experience, a review of nature-based solutions projects in Latin America and the Caribbean found that 72 percent have been focused on the water and sanitation sector (Ozment et al., 2021), and watershed PES are the most mature form of PES, with 387 water-related PES programs in 62 countries with US$24.7 billion in transaction value as of 2015 (Salzman et al., 2018).

In the database of NatCap projects, 95% are multi-sectorial. 85% of them explicitly included the environment sector (e.g., through engaging Ministries of the Environment). Nearly 70% of them addressed water resources, and approximately 40% touched forestry, infrastructure, agriculture, aquaculture, tourism and recreation, and disaster risk and response sectors. Approximately 20% addressed fisheries, energy, and/or private finance. Projects that reached higher levels of impact tended to involve the environment and water resources sectors. For example, of 21 projects that resulted in plans and policies that now consider ecosystem service impacts and dynamics, 18 of them (86%) included the environment sector and 16 (76%) addressed water resources. Of these 21 projects, over 50% included forestry, disaster and risk response, and agriculture/aquaculture sectors (Natural Capital Project, 2022b).

Although the environment sector is the most commonly engaged sector across the Natural Capital Project's experience, its involvement is not necessarily sufficient for success (Ruckelshaus et al., 2015). Of 14 projects in our database identified as high-impact (i.e., in which new policy and finance mechanisms emerged as a result of natural capital approaches), all of them involved the environment in collaboration with other sectors. Other reviews of nature-based engagements also have found that outcomes are stronger when the environment sector is not the sole participant (Ozment et al., 2021). Environment ministries are typically under-funded and can have less influence when decisions affecting other sector outcomes are weighed (GEF Implementing Agency Experts, personal communication, 2022). Buy-in from multiple sectors in crafting a

shared vision, outcomes, and solutions is therefore important.

The climate sector–both in terms of mitigation of GHG emissions and adaptation using nature-based approaches– increasingly is emerging as an area of particular momentum (GEF Implementing Agency Experts, personal communication, 2022). The growing realization that ecosystem approaches are an efficient and effective way to address the climate agenda and co-benefits points to promising opportunities to link climate commitments to biodiversity policy and financing. The transportation sector also is a potentially strong integrator of multiple ecosystem benefits and other sectors touching land- and water uses. However, fostering wider uptake of integrated transportation planning and finance with cross-sectoral strategies and processes remains a challenge (Ozment et al., 2021).

Services**.** The dominance of the water and disaster risk reduction sectors, as well as the momentum around climate adaptation and mitigation are reflected in the most commonly assessed services. Among Natural Capital Project engagements, these include carbon storage and sequestration (both terrestrial and blue carbon), water quality regulation (in terms of nutrients and sediments), coastal vulnerability, and water yield. Assessment of nature-based tourism and recreation is also frequently demanded and used. The most-used InVEST software tools (based on tracking publications and reports from the Natural Capital Project as well as those authored independently) include water yield, carbon, water quality in terms of sediment and nutrients, habitat quality, and coastal vulnerability (Mandle & Stanford Natural Capital Project, 2021).

Beyond NatCap's direct experience in over 100 demonstrations and what we see with the use of our tools, similar patterns are apparent: Among 156 projects employing nature-based solutions in Latin America, the most common objectives targeted were water quantity and quality (80 and 76 projects, respectively), urban flooding (36 projects), coastal flooding (31 projects), landslide risk (28 projects), and river flooding (20 projects) (Ozment et al., 2021).

Common barriers and challenges

Within any sectoral or regional context, there are barriers to uptake when integrating natural capital approaches into decision processes. Significant challenges to implementing natural capital approaches stem from governance and institutional structures that do not readily accommodate needed changes in policy design, investments, implementation, and evaluation of novel interventions connecting ecosystem benefits to societal goals. As discussed above, cross-sectoral governance is not easy in siloed government and financial institutions. Nature-based solutions are interdisciplinary and cross-sectoral by nature, so design of new policy and implementation can require close coordination between agencies both within and across geographic borders (Portman 2013). Inter-agency communication is not always well-established, so new partnerships or institutional structures may need to be formed. Even in cases involving a single sector, incorporating ecosystem values in policy or finance implementations requires an understanding of specific government and

and investment decision processes (Sutherland et al. 2014, Ruhl et al. 2021), and creative thinking in how to change such policies as zoning, compensation schemes, permitting, and investment practices to reflect and sustain benefits from biodiversity and ecosystem services. A systematic assessment of barriers to implementation, examining missing or counter-productive policies or practices, finance mechanisms, or governance impediments, in addition to opportunities for greater efficiency and coherence in implementation, will help science-policy teams target new interventions or ways to adapt existing ones. Solution scanning approaches also can help winnow opportunities for locally relevant and effective interventions (e.g., Sutherland et al. 2014).

The science-policy engagement processes we outline in this Report are designed to help overcome these policy and institutional barriers and highlight key opportunities for innovation, by involving experts in local policy and investment decision contexts in defining challenges and co-designing solutions. But developing and maintaining these processes take time, and more examples of implementation successes and evaluation of novel policy and investment interventions are needed (rev. multiple chapters in Mandle et al. 2019; *Appendix A*).

Where natural capital engagements have resulted in tangible changes in policy and investment decisions (*Appendix A*; GEF STAP Review, 2021), they also demonstrate the common barriers and obstacles that could hinder implementation across various contexts. Some barriers are technical and can be overcome with advances in science and technology. Others are more institutional and political, requiring improved coordination, collaboration, and greater resources across sectors and agencies.

A paucity of up-to-date and/or region-specific data is a common technical challenge during natural capital assessments. Acquiring or collecting relevant local data and information from traditional knowledge can be quite resource and time-intensive for on-the-ground partners. Global data sets are helping to alleviate this issue as their availability and resolution are consistently improving. However, locally-sourced data are often necessary for high-quality, accurate assessments at small scales, and for building trust and relevance through inclusion of local knowledge and diverse ways of knowing. A combination of increased investment, engagement of local experts and knowledge holders in ongoing science-policy processes, and technological advancement is necessary to fill this information gap.

Sustained engagement with stakeholders throughout a natural capital approach can also be challenging. It is essential to include the perspectives of all project stakeholders within the planning and management stages, but this requires a highly participatory and iterative process with significant time and resources. It can be difficult to provide incentives for local stakeholders and communities to be an active part of the discussion, especially on projects with notably long time horizons (difficult to maintain engagement) or projects with notably short time horizons (difficult to find the right people to engage and/or to align timelines). Coordinating different stakeholder engagement processes with similar goals can help to avoid stakeholder fatigue, which arises when actors are continually asked to engage in multiple, marginally different assessments from different ministries, agencies, or academic groups. Long-term relationships with key actors and institutions can enable effective connections between natural capital assessments and

relevant leaders. Efforts to build capacity within local research and policy institutions can help improve durability of such processes over time (Guerry et al. 2015).

The time lag between policy and finance implementation and accrual of ecosystem benefits to people makes it difficult to make the case for natural capital approaches when the focus of policy decisions is only on short-term benefits.. It can take years, or even decades, for the benefits of improved sustainable ecosystem management to reach beneficiaries downstream (Mandle et al., 2016). Stakeholders that contribute upfront investment may be leery of such long return horizons, so innovative financial mechanisms may be necessary to de-risk engagements and secure support. Similarly, political leaders often seek short-term wins to secure support from constituents. Reframing definitions and metrics of success with voting publics to include both short-term indicators and long-term sustainability metrics—as is beginning to happen with the conversation about climate change—can help address this.

There is also a great need for additional technical and policy capacity, within both countries and implementing agencies, to conduct natural capital assessments and approaches. Demand for natural capital approaches is rising around the world, but there is insufficient technical support for participation in science-policy processes, particularly in developing nations. Implementing agencies would benefit greatly from in-house technical teams specializing in natural capital that are nimble, dynamic, well-versed in the variety of approaches available, and with strong relationships among the diverse field of experts in the academic and consulting realms that are on the forefront of innovation. This could improve uptake of natural capital approaches throughout the MDB/implementing agency, increasing opportunities for scaling.

Opportunities to overcome barriers

Table 2. Summary of key factors enabling natural capital approaches to proceed in the face of challenges.

Barriers/ Challenges	**Enabling Conditions**	**Examples**
Awareness is low of how natural capital approaches can be helpful to decision making	• Provide specific examples of implementation with diverse sectors, starting decision contexts, and geographies. • Recruit trusted leaders to help share success stories, lessons, roadmaps, and visions.	*Appendix A*
Difficult to secure participation and support from local partners and stakeholders, especially when time, financial commitments are required	• Involve local actors and stakeholders from the beginning to increase buy-in and interest in the benefits of natural capital approaches. • Showcase successfully implemented examples with real world results wherever possible; this engenders greater faith in the approach than model results. • Implement post-project monitoring and evaluation to learn what works and to build a portfolio of successfully implemented examples that can be communicated broadly. • Provide equitable and transparent institutional and financial support to enhance stakeholder participation.	Mandle et al., 2019; Ruckelshaus et al., 2015; Upper Tana Nairobi Water Fund, Kenya (*Appendix A:* Case Study #3)
Scoping and identifying feasible starting points (e.g., priority ecosystem services, sectors, geographies, policy and finance mechanisms) takes science-policy experience that is in short supply	• Assess policy/finance barriers to implementation and implement solution-scanning approaches to identify opportunities . • Provide specific examples of implementation with diverse sectors, starting decision contexts, and geographies. • Recruit trusted leaders to help share success stories, lessons, roadmaps, and visions.	Mandle et al., 2019; Ruckelshaus et al., 2015; personal experience of NatCap; pers. commun. GEF agency experts

Barriers/ Challenges	Enabling Conditions	Examples
Often challenging to gain the level of funding necessary for an integrated natural capital approach that transforms decisions	• Partner with the Ministries of Finance (and government infrastructure actors) to help mobilize more investment than solely engaging the Ministries of Environment. • Engage investors early (such as GEF agencies and the private sector) to mobilize greater resources, linking outcomes to an iterative process, followed through to implementation. • Ensure cross-sectoral participation in natural capital approaches to leverage diverse sources of funding.	Pers. commun. GEF agency experts
Challenge to increase uptake of natural capital approaches in decisions, by including both 'upstream' (e.g., Country Strategies, national development plans) and 'downstream' processes and projects, to increase pace at which mainstreaming occurs.	• Link natural capital approaches to specific, existing policies, projects, or processes within an implementing agency or country to accelerate uptake. • Consider a single sector entry-point and then broadening to other sectors if multi-sectoral engagement is initially a non-starter. • Identify opportunities for and examples of novel, more efficient, and coherent policy or finance interventions.	Mandle et al. 2016; personal experience of NatCap; pers. commun. GEF agency experts
Limited technical, policy/finance, and science-policy capacity to carry out natural capital approaches	• Involve local technical and policy experts in all natural capital engagements to 'train as you go.' • Broaden accessibility to technical, policy, and conceptual trainings. • Build highly nimble and flexible technical natural capital teams (or technical assistance facility) that can rapidly establish introductory assessments. • Consider creating in-house technical teams within GEF agencies that are nimble and dynamic and can advise country partners on tools and approaches. • Improve availability of funding to bring on external expert consultants.	Mandle et al. 2019; Ozment et al. 2021; pers. commun. GEF agency experts
Lack of appropriate and/or complete data for project contexts	• Increase access to new data technologies and global data sets. • Consider increasing funding to local agencies that can collect data. • Improve access to free, open-source tools for analyzing and sharing data.	Ruckelshaus et al. 2020; pers. commun. GEF agency experts

3. Principles and a Framework for Including Natural Capital in Decisions

- ***Key principles***
- ***Elements of a framework for using a natural capital approach to inform decisions***

Principles and a Framework for Including Natural Capital in Decisions

Key principles

1. **Ensure enabling conditions are in place.** For natural capital approaches to take root, they must land in fertile soil. Enabling conditions can take many different forms. They include clear policy mandates (such as national policies directing the incorporation of natural capital into zoning plans), compelling examples as incentives, and/or financing (such as consideration of natural capital as a prerequisite for lending) and true champions for the importance of the work. But they also include well-selected teams with the necessary technical capacity, deep understanding of local policy and investment decision processes, and involvement of and connection to leaders and decision-makers. In addition, they include inclusion of areas and decision contexts in which nature is likely to play a significant role.

2. **Identify clear policy or finance entry points.** There are multiple pathways into a natural capital approach. To improve the likelihood of a natural capital approach informing decisions, it is essential to target specific policy or investment decisions that are likely to be influenced by new information about natural capital, and to use those entry points to guide the characterization of natural capital (e.g., the ecosystem services mapped, modeled, or valued; the types of policy or investment scenarios explored; the metrics reported). Such information can come from an analysis of policy, finance, governance, and other barriers to implementation, complemented by solution-scanning approaches (e.g., Sutherland et al. 2014). Natural capital assessments may be designed to inform such diverse contexts as: zoning decisions (e.g., *Appendix A*, case study #2), loans for development projects (e.g., *Appendix* A, case study #5), transportation infrastructure decisions (e.g., *Appendix A*, case study #6), or water planning (e.g., *Appendix A*, case study #4). Natural capital understanding can also be used to inform impact assessment for permitting or for policy evaluation (e.g., Mandle et al., 2019; Ouyang et al., 2016). It can be used for climate adaptation and resilience planning (e.g., *Appendix A*, case study #7) and for climate mitigation (e.g., to inform choices about Nationally Determined Commitments; *Appendix A*, case study #2).

3. **Co-create.** For natural capital understanding to make its way into decisions, it is important to engage key actors and collaborators to envision a shared future with better outcomes for nature and people. When impacted groups or stakeholders are involved in natural capital assessments, those assessments are more likely to lead to plans and policies with local relevance and support. It is essential to build in a diversity of knowledge sources and to critically value the cultural and traditional knowledge available through local collaborators. Early, iterative engagement builds trust, relationships and capacity to use innovative approaches in ongoing science-policy processes. Co-creation increases the likelihood of enacting durable policy and finance mechanisms that successfully integrate ecosystems into single-sector and multi-sector development planning; payment, permitting and certification schemes; climate commitments, and more. Clearly, the initiating actor(s) of the natural capital approach can help identify other stakeholders to include in the process, and how best to engage them. It is useful also to consider the chosen policy/decision entry points to help identify additional actors to include. In most cases, it will make sense to include government officials; and the entry points and scale of analysis will help determine the scale of government to involve– international, national, regional, departmental, or municipal. In some cases, it will make sense to involve private sector actors such as leaders from companies and financial institutions whose operations may fund or be impacted by new plans or policies. Local communities and civil society stakeholders are often key actors to engage. Finally, it is often beneficial to involve local research institutions who can help provide–and build–technical capacity, bring local legitimacy, and help research and test the effectiveness of innovative approaches.

4. **Evaluate and iterate.** Iteration and evaluation--of both the results and the science-policy process itself-- should occur throughout the course of this work. Building in evaluation and iteration from start to finish ensures that both the process and the end results are tailored to the needs of decision-makers. Once new policy and financial interventions are designed and implemented, monitoring of results helps set up the adaptive management cycle to ensure learning and the ability to alter plans and policies to achieve desired results over time.

Elements of a framework for using a natural capital approach to inform decisions (Fig. 1)

1. **Build a Solid Foundation:** First, policy and other stakeholder leaders establish the outlines of the work: policy and investment entry points, future vision, goals and objectives, team members, stakeholders/advisors, timeline, and workplan. The team identifies and engages with key stakeholders and community voices to ensure that local needs are prioritized and that local knowledge and experience are incorporated. Key questions: Whose voices do we need to hear from? What is our shared vision for the future? What roles might nature play in that future? How will this project move our region

forward? Key outputs: An expert team with improved capacity, co-created project goals, a shared vision for the assessment in terms of desired policy and investment outcomes, and a strategic, inclusive project plan.

2. **Leverage Resources, Compile Data and Information:** In the second stage, the team identifies key data sources and experts within their network. The team compiles available project-relevant data and information about natural capital and its beneficiaries in the area of interest. These data come from sources including satellite imagery, local government databases, and community members. Incorporating traditional, cultural knowledge through an integrated stakeholder process is key to ensuring that diverse community voices and values are considered. ***Key Questions:*** What data and resources do we need to achieve our goals? How can we leverage our networks to acquire them? ***Key Outputs:*** Full set of available data and information and identified resources and driving questions for carrying out the natural capital assessment.

3. **Ask Questions and Explore Options:** Stakeholders, communities, and leaders might articulate possible alternative development plans or investment priorities for the region of interest. These plans might translate alternative visions, policy/finance options and climate impacts into possible future maps. Different maps might represent different visions and policies or different climate scenarios. Alternatively, algorithms can be used to explore optimal investment solutions to clearly articulated questions. ***Key Questions:*** How and where can we best invest in natural capital to achieve our stated goals? What are some possible alternative futures for our region? What biodiversity and ecosystem service metrics do we want to use to compare the outcomes of these policy and investment scenarios? What metrics can be used to express the diverse values that these services provide? Do we want to optimize investments in our landscape or seascape for particular ecosystem services? ***Key Outputs:*** Alternative future maps of the region reflecting different policy and investment interventions, climate futures, and agreed-upon metrics with which to compare those maps.

4. **Analyze and Synthesize:** Next, the team uses the outputs from the previous step to compare the likely outcomes of each alternative with respect to the chosen metrics. With the original project objectives in mind, the team incorporates the data and uses models or other projections to understand how policies, management choices, or investments change biodiversity and the flows of ecosystem services to people. Spatial, open-source tools such as InVEST that can help to identify potential changes in biodiversity and ecosystem services associated with different decisions, which decision-makers can then use to weigh tradeoffs. ***Key Question:*** How do environmental or societal changes and interventions affect biodiversity and the provision of benefits to people? ***Key Outputs:*** Maps, summary tables of metrics, etc.

5. **Interpret Results and Inform Decisions:** This process is all about learning together and equipping decision-makers with the tools they need to succeed. The team has been working with stakeholders throughout the process, but this is when final results are delivered and discussed. With target audiences in mind, the team packages up and presents the results in compelling ways to key stakeholders, often in an iterative process so that feedback on interim results can be incorporated before finalizing. Using the new information, the team can work with leaders to design, implement, and measure impacts of nature-positive policy and financial interventions. As information on policy and finance effectiveness becomes clear, the whole process from Step 1 begins again, as new sectors or stakeholders are engaged, information updated, etc. (e.g., Appendix A, Case study #2). ***Key Questions:*** How do we present results in a way that is most accessible to and trusted by decision-makers, equipping them with the information and tools they need? How can our results be used to efficiently and effectively target resources and adapt policies to protect natural capital and ensure that it continues to provide critical ecosystem services to important beneficiaries? ***Key Outputs:*** interactive maps, simple diagrams, local workshops, new strategies and activities for conservation and restoration of natural capital, new finance mechanisms, clear pathways to use natural capital assessment and accounting to inform specific decisions.

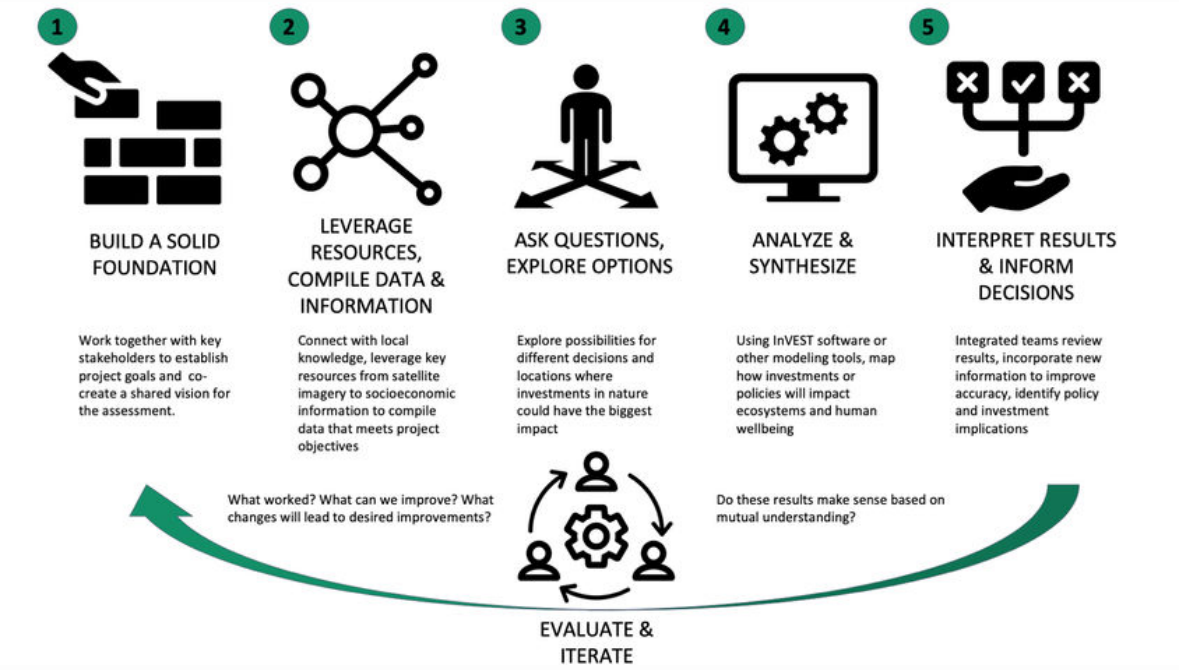

Figure 1. A science-policy framework for using an iterative natural capital approach to inform decisions.

Key Findings and Looking Ahead

Key Findings and Looking Ahead

Over the past several years, intensifying crises–with their alarming interactions and propagation across the world–have opened profound shifts in thinking. No shift is more crucial to humanity's future as that underway in development planning and finance. For the first time, major financial institutions and countries are focusing their attention on the vital role of nature as an engine of prosperity and foundation for well-being. They now seek to integrate the values of nature throughout their operations to improve: climate and energy security, food and water security, health, livelihoods and socioeconomic equity, as well as the engineering–and the policy design–of infrastructure and other investments intended to support these realms of well-being.

Yet change is not advancing nearly fast enough. Among research institutions, GEF agencies, policymakers in countries, and especially in the private sector, there is a massive gap between recognizing conceptually the values of nature and having–in practical terms–the science, tools, and experience required to integrate them effectively into policy, planning, and finance. There is also a profound mismatch between the demand for practical approaches and the availability of skilled professionals to support their implementation. Key hurdles are in making the latest data, science, and experience *accessible and actionable*, and in building technical capacity to deploy cutting-edge approaches and drive further innovation.

This Report summarizes an in-depth stock-taking of more than 15 years of experience by the Natural Capital Project in working to co-develop natural capital value information with decision makers who are implementing change. These findings are augmented by experience from the GEF, expert interviews, and select reports and papers reviewing lessons learned from implementing natural capital approaches to change decisions. Results indicate that **there is now sufficient understanding and a wide range of on-the-ground demonstrations to allow a practical articulation of what implementation of natural capital approaches looks like, how to get started, and how to enlist the expertise and creativity needed to guide their application in specific contexts.**

The entry point for many natural capital approaches can initially appear within single sectors, in which sector experts incorporate ecosystem values, both in terms of opportunities to better support sector objectives and also to identify and manage risks to critical outcomes. For example, the water sector may be interested in incorporating natural capital into their water security strategies and investments. They might wish, for example, to identify places and ecosystems that are providing water recharge and where loss of ecosystems could increase flood risk or exacerbate water quality concerns. Because ecosystem functions integrate across many benefits and sectors, even single

sector natural capital approaches often transition into multi-sector engagements. Cross-sectoral foci for natural capital approaches are demonstrably more efficient and effective, as they can explicitly identify win-wins and tradeoffs among objectives, informing greater policy coherence, as summarized above. Practically speaking, where multi-sector engagements are not initially possible, applying natural capital approaches through iterative, science-policy processes in just one or two sectors can help those getting started to scope out manageable starting points and to envision moving towards multi-sector, cross government approaches through later iterations.

As outlined in more detail in Section II "What is working? Factors associated with success", elements of successful policy and finance incorporation through natural capital approaches include:

1 *Clear policy windows, mandates and/or financing*. Legal frameworks in countries and standards from multilateral development banks and other financial institutions can either require that natural capital be included in policy processes or lending decisions, or incentivize pathways to speedier and more certain financing processes.

2. *Leadership to support inclusion of natural capital in ongoing science-policy processes.* High-level leadership is important for providing an enabling policy context, e.g., through mandates, financial or other incentives, or simple encouragement, by requiring or supporting a strong science-policy and stakeholder engagement process, and by ensuring that adequate resources and capacity are directed at the undertaking. Such leaders can also use their leverage to help ensure that recommendations generated through natural capital approaches are implemented. Bottom-up leadership is also key to successful outcomes, through sector and community stakeholders who help craft a compelling, shared vision, choose priority ecosystem benefits and beneficiaries to include in the analyses, and strengthen support for results from communities and decision-makers who will be involved in, or affected by, implementation. Long-term engagement with government partners who shepherd meaningful cross-sector and stakeholder engagement in science-policy processes is a key ingredient to successful outcomes.

3. *Exploration of the likely impacts of alternative climate, management, or budget scenarios on natural capital.* The use of alternative future scenarios to explore how different plans, policies, investments, or climate might affect natural capital and the services that flow to people is associated with natural capital approaches that go beyond assessment to yield deeper policy impact. Scenarios informed by analyses of policy, governance and finance barriers and opportunities for more efficient and coherent implementation of natural capital approaches are sorely needed to help sharpen the vision for action and target interventions.

The case for a Technical Assistance Facility

There is now tremendous momentum for accelerating the uptake of natural capital approaches at scale. **The time is now to accelerate deployments of natural capital approaches, activate leadership, deepen technical and science-policy capacity, and deliver novel policies and financial investments to achieve measurable outcomes.**

Key leverage points where natural capital approaches could bring enormous value include: identifying development priorities and tradeoffs; generating nature-based strategies to meet biodiversity and development goals; crafting finance packages with public, private, and international components; and monitoring impact. Experienced experts are now poised to address these leverage points on decision-relevant timelines, while creating a pipeline of upcoming professionals and researchers with the knowledge and skills to meet this growing demand.

Mid-term vision:

- By 2026, governments, other country stakeholders and GEF agencies will have well-established mechanisms and best practices for using natural capital approaches in development financing, resulting in measurable progress toward the post-2020 Biodiversity Framework, nature-based commitments under UNFCCC, and other country-scale and private sector commitments.
- Science, policy, and finance innovations for natural capital are rapidly incorporated into development and biodiversity finance operations, generating a pipeline of investable projects through streamlined collaboration and impact, dialogue among leaders, and technical knowledge-sharing mechanisms.
- A Technical Assistance Facility connects policymakers, GEF agencies, and technical staff with natural capital experts, new data, methods, tools, and relevant examples, and engages directly in collaborative projects that advance understanding and demonstrate solutions.

It is possible to enable rapid scaling now through:

- Engaging collaboratively to co-develop solutions for countries, offering compelling cases in which natural capital approaches provide information that can be integrated into tangible policies and biodiversity, climate and development finance projects. Cross-institutional collaborative teams involving experts from GEF agencies, countries, and external consultants can work iteratively from problem formulation to final deployment, providing specific examples of what is possible, now, and how to get started in implementing natural capital approaches to inform decisions.
- Fostering high-level dialogue to inspire concrete action using natural capital approaches that support countries' biodiversity, climate, and development aims, accelerating progress towards national and international commitments. For example, a convening similar to the Natural Capital Symposium to be hosted at Stanford in February of 2023 will bring together researchers, NGOs, businesses, governments, MDBs, and other institutions to share experiences on the frontiers of science, co-development and application of practical approaches, and examples of natural capital information being used to transform decisions.
- Providing systematic training and software tools to build capacity in countries and GEF agencies, while providing opportunities for technical experts to engage directly with policymakers, building collaboration skills for ongoing impact.

These engagements will build capacity in GEF agencies, country governments, and within research institutions and consultancies, training the next generation of scientists, leaders, and professionals in natural capital approaches. Together, these efforts will accelerate capacity building of researchers and development professionals with the knowledge, skills, and connections to support policymakers and GEF agencies in their transition to green, inclusive growth.

Appendices

Appendix A: **Natural Capital Approach Case Studies**

Appendix B: **Sector-specific Questions**

Appendix C: **Additional Resources**

Appendix A: Natural Capital Approach Case Studies

1. China's Ecological Civilization
2. Integrated Coastal Zone Management for Climate Resilience in Belize
3. Securing Water Resources with the Upper Tana-Nairobi Water Fund
4. Cross-Sectoral Benefits of Integrated Watershed Management in Nepal
5. Sustainable Development and Coastal Resilience in The Bahamas
6. Natural Capital Approaches for Road Development
7. Nature-based Solutions and Sea-Level Rise: A case from the San Francisco Bay Area, USA

Natural Capital Approach Case Studies

1. China's Ecological Civilization

China has invested over USD $150 billion in restoring natural capital through a suite of pioneering initiatives since 2000. These investments have dual goals: securing critical ecosystem services and alleviating poverty, especially in rural regions. Now entering a new phase of investment, the country has zoned 51 percent of its total land area for improving the provision of ecosystem services and is paying over 200 million people to perform ecosystem restoration and conservation activities. Building on this experience, China is pioneering a new metric of progress, Gross Ecosystem Product (GEP), to incorporate the value of natural capital systemically into decision-making. GEP reveals the flow of ecosystem services to society, guides investments from consumers to upstream providers, and evaluates performance of policies and leaders.

China is the largest country by population on Earth, home to more than 1.4 billion people (World Bank Group, 2020). Nearly ⅔ of the population lives in urban areas and this proportion is expected to rise as urbanization advances (Statista, 2022). Rapid industrialization has led to widespread environmental impacts and ecosystem degradation throughout the country. China is currently the largest emitter of greenhouse gasses (GHG) globally, producing more emissions than all other developed countries combined (Larsen et al., 2021). Land use change across the country has also resulted in significant impacts for downstream beneficiaries of ecosystem services. For example, in 1998, extensive deforestation contributed to disastrous flooding and landslides along the Yangtze River, killing thousands and rendering 12 million homeless. At the same time, hundreds of rivers have begun to run dry before reaching the cities that depend upon them because of water diversion for agriculture and because of clearing of forests whose sponge capacity retains water and releases it gradually. This history of development at very high environmental cost led China to reform its approach to growth.

Promising Advances

In 2012, China's leadership declared a national goal to harmonize people and nature, creating an "Ecological Civilization of the 21st Century." China’s ecosystem service investments are massive in scale, duration, and innovation. Following the extreme

droughts and flooding in the late 1990s, China recognized that investing systematically in ecosystem conservation and restoration is essential to the country's long-term prosperity and its approach is unparalleled anywhere in the world. For instance, in the wake of the 1998 flooding, the central government launched the largest payment-for-ecosystem-services programs in the world. The Sloping Land Conversion Program and Natural Forest Conservation Program together involve 120 million households, with payments exceeding USD $100 billion over the first decade (2001-2010) (Duan et al., 2015).

The investments are based on national ecosystem surveys and ecosystem services mapping, supporting a series of new policies. These policies include, first, ecological function zoning based on ecosystem service importance and ecological sensitivity. Presently, Key Ecosystem Function Zones (KEFZs) span 51 percent of China's total land area (Ouyang et al. 2019). KEFZs are mapped using data and analytics that show where important ecosystem services, such as freshwater provision, flood control, erosion control, and carbon sequestration take place. Second, ecological compensation policies and restoration policies pay people living within these areas to change farming practices, restore landscapes, and in some cases, to move out of sensitive areas.

Third, China is designing a new metric for tracking progress–Gross Ecosystem Product (GEP), the total economic value of ecosystem goods and services. Being reported alongside GDP, GEP reveals the contributions of ecosystems to society, guides investments from downstream beneficiaries to upstream ecosystem service providers, and provides a basis for evaluating the performance of policies and leaders meant to implement them (Ouyang et al., 2020). The UN Statistical Commission officially adopted the metric as part of its System for Environmental Economic Accounting (SEEA) in 2021 (United Nations, 2021b).

Solutions: Science and Tools

The Chinese Academy of Sciences (CAS) and the Chinese government partnered with the Natural Capital Project (NatCap) to develop a plan that would achieve the government's vision for an ecological civilization that accounts for nature's benefits to people. The researchers helped to co-develop new tools, policy and finance mechanisms, and compelling demonstrations that could be scaled across the country. One such tool was the Natural Capital Project's InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) modeling software that quantifies and values the flows of various ecosystem services across landscapes to beneficiaries. These models helped China launch its National Ecosystem Assessment, the most sophisticated of its kind in the world. The software made it possible not only to map the ecological features of the landscape, but also to overlay information about people and their livelihoods and to explore scenarios that indicate which restoration activities to do in which places to get the most return on investment. The software is now used to help calculate GEP.

The CAS and NatCap researchers have also assisted with the South-to-North Water Transfer Project, the largest water diversion ever undertaken. This project aims to supply dry northern regions with water from rivers to the west and south. Natural capital approaches are being used to minimize environmental impacts of project activities while ensuring a reliable supply of water and other benefits to downstream users. InVEST modeling approaches have also been used to develop sustainable crop production systems and improve the livability and sustainability of some of China's largest cities. NatCap has provided scientific training on natural capital approaches as well as technical training for InVEST modeling to top government decision-makers and thousands of technical support staff.

Scaling Up

China is road-testing natural capital approaches at scale. Through careful design, monitoring, and study of project and policy and outcomes, China is showing how with funding and government leadership, ecosystem services can be restored, while also improving people's livelihoods and creating greater security for businesses. The work is happening at national, regional, city, and community scales. China has recently established a new national parks network totaling 230,000 square kilometers (88,800 square miles). Once it is complete, it will be the world's largest national park system, containing nearly 30% of China's key terrestrial species (Wan & Kan, 2021). The current and potential future impacts of ecosystem service investments in China are enormous, certainly within the country–and also globally, in the form of enhanced carbon sequestration, biodiversity conservation, and perhaps most importantly in lessons on making the investments needed to secure and harmonize natural capital and human well-being.

2. Integrated Coastal Zone Management for Climate Resilience in Belize

Belize's Integrated Coastal Zone Management Plan harmonizes the country's aims for sustainable tourism, lobster fisheries, and protection from sea-level rise and storms. National legislation and commitment to reduce climate impacts, combined with bottom-up community engagement in science-policy processes throughout the country are informing zoning, permitting, and ambitious new targets for coastal ecosystem protection and restoration aimed at mitigating greenhouse gas emissions, supporting livelihoods and reducing vulnerabilities to coastal hazards.

Coastal and marine ecosystems provide many benefits to both people and economies, including food supply, livelihoods, coastal protection, and climate resilience. 75% of countries globally are coastal with direct access to the ocean and its resources (Geographyrealm, 2017). Belize is one such country, home to extensive mangrove forests, seagrass meadows, and the second largest barrier coral reef system in the world (Arkema & Ruckelshaus, 2017). These ecosystems in Belize and elsewhere are increasingly threatened by both development and climate change, putting provision of ecosystem benefits to people at risk. Nature-based tourism plays a significant role in Belize's economy, drawing roughly 800,000 tourists annually, and employing 25% of the country's workforce (Arkema & Ruckelshaus, 2017). Thirty-five percent of the country's population lives in the coastal zone, relying upon the reefs and mangroves for protection from sea level rise and storms. As development and climate pressures in the coastal zone increase, demands on the government are growing to regularly assess and account for the values provided by their ecosystems, to ensure that they continue to support lives, livelihoods and the post-COVID recovery of the Belizean economy.

Promising Advances

Belize's Coastal Zone Act of 2000 (the 'Act') recognizes the value of multi-sectoral, integrated spatial planning to guide policy and investment for more sustainable use of the coastal zone (Belize Coastal Zone Management Act, 2000). Such laws in and of themselves do not necessarily lead to transformation of ocean management. The Belizean government's coordinating authority for coastal use across all Ministries, the Coastal Zone Management Authority and Institute (CZMAI), played a key role in designing a co-development process for an Integrated Coastal Zone Management Plan, and continues to oversee its ongoing implementation and adaptation. In 2010, CZMAI partnered with the Natural Capital Project (NatCap) and World Wildlife Fund to accomplish the sustainable development goals outlined in the Act. An interactive stakeholder engagement process–engaging relevant stakeholders from government ministries, NGOs, business, and community groups representing diverse stakeholders–identified shared objectives for artisanal and commercial lobster and conch fisheries, reducing risk of coastal infrastructure, property and people from sea-level rise and storms, and sustainable tourism benefits, the largest sector of the Belizean economy.

The final Plan incorporates the value of Belize's priority ecosystem services to guide coastal zoning and permitting. It is projected to improve coastal protection from storms

storms and sea level rise, and increase revenue from fisheries and tourism more than alternative plans emphasizing either conservation or development alone (Arkema et al., 2015; CZMAI, 2016). At the same time, the plan's resulting zoning scheme improves protection for mangroves, coral reefs, and seagrass beds—the natural capital upon which coastal populations' safety and livelihoods depend. Belize's Plan highlights the importance of coordinating the management of, and investment in, a diverse set of activities and actors implicated in sustainable outcomes for the nation, ranging from those engaging in or affecting coastal pollution, dredging, fisheries, aquaculture, and tourism development, to education, social resilience to climate change, and preservation of cultural heritage. It facilitates coordination of decisions on where to allow development, commercial and artisanal fisheries, shipping lanes, oil and gas extraction, and primary tourism activities in the coastal zone.

Photo Credit: Antonio Busiello (WWF)

The Belize Plan and resulting zoning have been hailed by UNESCO (the United Nations Educational Scientific and Cultural Organization) as "one of the most forward-thinking ocean management plans in the world" (Douvere, 2016). In 2017, the Belize Barrier Reef was removed from the World Heritage List in Danger because of the protections provided in the government ICZMP.

Climate change impacts and the global pandemic have added urgency to the resilience objectives driving the Plan's provisions. Now 5 years into implementation, the Belizean government has commissioned an independent review of the Plan's impacts. CZMAI is tracking changes in how policies and investments have changed human uses and activities, and in turn, how coastal ecosystem benefits are flowing to communities, livelihoods, and the broader economy. The review will inform specific adaptation measures in the revised Plan, and will target ongoing capacity building needed to strengthen cross-government coordination for implementation (C. Clarke-Samuels, CZMAI, personal communication, May 2022). In addition to its novel science-policy approach and cross-sectoral prioritization process,

Belize is also a role model in ensuring that its ICZM Plan drives and coordinates 'downstream' actions and financing. For example, Belize focused on blue and green carbon commitments in advance of the UNFCCC Glasgow Pact. A cross-ministerial committee used the ICZM Plan priorities to set ambitious new targets for mangrove blue carbon and ecosystem co-benefits for tourism, coastal protection, and fisheries in their updated Nationally Determined Contribution (NDC). The ICZMP's priorities also informed protection and restoration activities to be financed through Belize's new blue bond, representing the largest bond for ocean conservation in the world (CGD, 2021). The debt restructuring will provide US$180M for marine conservation in Belize, to protect 30% of its ocean, strengthen governance frameworks for domestic and high sea fisheries, and establish a regulatory framework for coastal blue carbon projects.

Solutions: Science and Tools

NatCap worked with CZMAI to first identify 3 priority ecosystem services as targets of sustainable development aims: protecting people and property from sea-level rise and storms, supporting commercial and artisanal lobster fisheries, and securing a nature-based tourism economy. The team harnessed the expertise and local knowledge of 9 established 'Community Action Committees' representing interests in the watersheds and coastlines for the entire country, to identify a future vision and scenarios, key sources of scientific information, priority needs, and feedback on technical results and outcomes. NatCap's free and open-source InVEST software was used to answer three questions to inform the Plan: 1) What is the delivery of ecosystem service benefits to people, now and under future management scenarios? 2) How do ecosystem service values vary among coastal planning regions?, and 3) Can we use these results to adjust zones, management of human activities, and target restoration to reduce risk to habitats and enhance the flow of ecosystem benefits (Arkema & Ruckelshaus, 2017)?

The team worked together to model spatially the impacts and dependencies of diverse uses in the coastal zone: coastal development, aquaculture, dredging, conservation, agricultural runoff, oil exploration, fishing, marine transport, and marine recreation. Alternative scenario outcomes were expressed in terms of monetary and biophysical value metrics (lobster fisheries catch and revenues, number of people and avoided damages from coastal hazards, and tourism visitation and revenues), and were iteratively discussed and improved through stakeholder input. The final zoning and management provisions in the Plan represent the most optimal balance of conservation and economic outcomes, yielding improvements in the tourism industry, fisheries productivity, habitat quality, and coastal resilience.

In 2021, NatCap again worked with technical experts from the cross-sectoral climate office of the Belizean government to update its Nationally Determined Commitment (NDC) under the Paris Climate Accord. The team co-designed and conducted spatial-optimization modeling, using updated spatial priority areas from the ICZMP to inform targets for the first ever nature-based solutions in Belize's climate commitment. Specific areas and amounts of mangrove protection and restoration are included in the updated NDC, reflecting optimal locations for reductions in GHG emissions and coastal vulnerability, and improvements in tourism and fishery values.

Scaling Up

Lessons from the innovative use of natural capital value information in planning, blue bond, and climate mitigation commitments in Belize are transferable to any coastal country in the world. The government-led scenario analysis helped policymakers, stakeholders and scientists understand how development activities impact Belize's vibrant ecosystems and the benefits they provide, now and in the future. The dedication of CZMAI in using its ICZM Plan to drive management, policy and ongoing financing for implementation of priorities is a model for others.

Belize also is a leader in demonstrating the opportunities to use nature-based solutions to meet climate mitigation and adaptation needs. As a member of the High Ambition Coalition to meet GHG commitments under the Paris Climate Accord, and the Meso-American 'Ridge 2 Reef' coalition, Belize's updated NDC has shown the great advantage of using an integrated coastal zone management plan to help set specific nature-based targets, using priority objectives and areas identified through a multi-sectoral, stakeholder- and science-driven process.

Belize has been nimble in re-structuring ministries to better meet governance needs for multi-sectoral planning in its coastal zone and to help coordinate climate responses. A new Ministry inspired by the integrated development planning was formed in 2015, connecting in one department Agriculture, Fisheries, Forestry, the Environment and Sustainable Development (CZMAI, 2016). Belize again innovated in creating the Ministry of Sustainable Development, Climate Change and Disaster Management as the lead agency for implementing the SDG 2030 agenda, and coordinating the efforts among Departments such as forestry, fisheries, disaster risk, etc.

This highly participatory, inclusive process to inform sustainable coastal development in Belize was not without its challenges. A significant amount of time, effort, and resources was required to achieve the level of stakeholder engagement necessary to ensure an optimal and equitable development plan. Belize continues to commit government resources to build capacity in its ministries and civil society, and further resources and efforts will be needed to support ongoing implementation and adaptation of its ICZM Plan.

3. Securing Water Resources with the Upper Tana-Nairobi Water Fund

Water funds are founded upon the idea that it is easier and more cost-effective to prevent water problems at the source rather than treating them downstream. They can provide a voluntary, self-sustaining financial model that funds source water protection while channeling benefits to a variety of local users and stakeholders. A study for the Upper Tana-Nairobi Water Fund in Kenya demonstrated how integrated watershed management activities would more than double a US$10 million investment through benefits to drinking water, hydroelectric generation, and agricultural productivity.

Water is one of Earth's most precious resources. Central to life on Earth, water enables food production, sanitation and hygiene, power production and so much more. However, water supplies are at risk across the globe, in both quantity and quality. Unsustainable practices degrade rivers and surrounding lands that transport and store water. Deforestation and poor land management result in the loss of healthy soils, decreasing agricultural productivity and affecting how efficiently water is captured and slowly released into streams and rivers. Such practices can also increase soil erosion, clogging streams and reservoirs with sediment that reduces drinking water quality and hydropower production (Hu et al., 2021). Downstream water users must then bear the significant cost of water treatment and dam maintenance.

Integrated watershed management holistically addresses these challenges by preventing water problems at the source. Healthy upstream ecosystems with good vegetative cover retain fertile soils and regulate water flows, significantly reducing the amount of sediment that enters streams and reservoirs and supporting dry season stream flows. However, landholders and stewards often lack the incentives and resources to adopt sustainable management practices.

Promising Advances

A **water fund** is an innovative financing mechanism that supports integrated watershed management to protect water quantity and quality. Water funds (also known as payments for hydrologic services or reciprocal watershed agreements) are typically public-private partnerships that unite downstream users (water utilities, etc.) with upstream stewards (farmers, landowners) (Brauman et al., 2019). The downstream beneficiaries pay the upstream stewards to sustainably manage and restore the land, typically through an intermediary trust fund or other transparent financial mechanism. The investment is then recouped through the benefits of improved water quality, which lowers drinking water treatment and hydropower maintenance costs. Water funds shift the focus of creating sustainable water systems from primarily gray infrastructure to a combination of gray and green infrastructure, which provides long-term, sustainable benefits for both the ecosystem and local communities (Castillo & Crisman, 2019). This model has been successfully implemented hundreds of times around the world, and interest is growing (TNC Water Funds Toolbox, 2022; Salzman et al., 2018).

Water funds often operate with limited budgets, so their interventions must be directed to areas that will see the greatest returns on investment. Developments in technology and science have enabled more detailed development plans that map where and how investments in restoration and improved practices can provide benefits to people, and in some cases estimate a monetary value for those benefits. These tools can also help users determine the distribution of benefits across different stakeholders and sectors, given different portfolios of interventions.

The Upper Tana-Nairobi Water Fund (UTNWF) became the first water fund in Africa in 2015 (The Nature Conservancy, 2015). The Upper Tana River basin has significant environmental and economic importance in Kenya. The 17,000km2 area is home to roughly 5.3 million people and supports one of the country's most important agricultural regions. The watershed provides 95% of Nairobi's water supply and half of Kenya's hydropower production (Vogl et al., 2017).

However, the Tana basin and its water supply are under threat. Nairobi is in a water deficit with roughly 60% of its citizens being water insecure (Apse et al., 2020). There has been significant land use change since the 1970s, replacing large swaths of forests with agricultural lands. Roughly 300,000 small farms exist within the Upper Tana watershed. Declining soil health and land scarcity have caused farmers to expand production towards steeper slopes and riparian zones (The Nature Conservancy, 2015). Soil erosion, landslide risk, and sedimentation in local rivers have all increased due to these land use changes, impacting the local water quality and increasing maintenance costs for hydropower. Dry season flows have also been reduced from encroachment on wetlands that typically store runoff and recharge aquifers (The Nature Conservancy, 2015). These impacts affect farmers, power companies, and water utilities alike, prompting the

creation of a new watershed investment scheme. In 2012, Nairobi City Water and Sewerage Company (NCWSC), Kenya Electricity Generating Company (KenGen), and the Water Resources Management Authority (WRMA) came together to form the UTNWF in partnership with The Nature Conservancy (TNC) (Vogl et al., 2017). A public-private steering committee was formed, representing a diverse array of stakeholders from major utilities to government agencies to prominent corporations. The steering committee commissioned a study with the Natural Capital Project and FutureWater to model and understand the ecosystem benefits that would result from various management activities in order to build support for further private sector investment and to guide implementation of the fund.

Solutions: Science and Tools

The study estimated the economic benefits that could result from the fund's proposed activity portfolio, including revenues to farmers, treatment costs for Nairobi's water supply, and KenGen's hydropower production. An investment of US$10 million over ten years was modeled for three sub-watersheds selected as critical priorities given their economic and environmental importance to the fund partners (Apse et al., 2020). The management activities by which upstream stewards would restore and protect the watershed included agroforestry, reforestation of degraded forest edges, grass filter strips in farms, terracing of hills on steep farmland, riparian management, and mitigation of road erosion.

The Resource Investment Optimization System (RIOS) tool was used to determine where the fund should invest for maximum cost-effectiveness, and the Soil & Water Assessment Tool (SWAT) was used to model the impact of the activity portfolios on erosion and water flows. Economic analyses were used to assess the return on investment (ROI) that both upstream and downstream users could expect from the improvement in watershed services. The primary benefits modeled were: 1) increased agricultural yields from improved soil and water retention, 2) reduced water treatment costs from sedimentation, 3) increased hydropower production from improved water yields, and 4) increased hydropower production from reduced sedimentation.

This analysis found that the water fund's proposed activities would result in significant reductions in soil erosion, reducing suspended sediment in streams and resulting in seasonal water flow benefits. Biophysical and monetary benefits to people and nature by 2025 were estimated. The study found an 18% decrease in annual sedimentation in the Masinga reservoir, one of the most important sources of hydropower for KenGen; more than 50% reduction of sediment concentration in rivers; 15% increase in dry seasonal flows; and improved water quality for more than 0.5 million people dependent on local streams as their primary water supply.

Overall, the project was estimated to more than double the initial investment of US$10 million invested, returning US$21.5 million over a 30–year period. The water fund's activities are projected to increase KenGen's annual revenue by more than US$600,000 by 2025, improving energy security for users. Cost savings to NCWSC are projected at US$250,000 each year from reduced maintenance and treatment. Smallholder farmers are projected to increase annual yields by US$3 million, or 30% from 2014, due to healthier soils, improved water holding capacity, and increased yields.

Scaling Up

As of 2021, the UTNWF officially became an independent Kenyan entity managed by local leadership (The Nature Conservancy, 2015). It presents an inspiring example of how water funds can scale up, reach maturity, and establish continuity. The fund has continued to build capacity for integrated watershed management by sharing resources knowledge, and equipment with 40,000 farmers to date. 13,600 of these farmers are directly involved with sustainable practices in the watershed.

One factor to note in this engagement, and many others, is that the actual partners participating in the water fund were not the ones to initiate its development. A different actor, such as an NGO, development bank, or philanthropic group, is often needed to kickstart the coordination effort. In the case of the UTNWF, The Nature Conservancy raised funds independently, through the GEF and other philanthropic sources, to demonstrate the potential benefits of the initial set of proposed interventions and to gain buy-in from local partners (water company, hydropower company, farmers). Moreover, scientific evidence is not always sufficient to secure support at the level needed for a self-sustaining financial model. Some partners/actors may be hesitant to adopt the natural capital approach, even if theoretical modeling has been used for proof of concept, since many uncertainties remain regarding whether benefits will be realized upon implementation. There are a variety of policy, governance, and technical hurdles that need to be overcome before projected benefits can be realized (Lima et al., 2017). **Model results can help inform planning and design, but stakeholder engagement in the analytical process is key to build durable support, and monitoring and evaluation efforts after implementation are also crucial** to measure outcomes through time, identify shortcomings, and build faith in natural capital approaches.

Photo Credit: John Wollwerth

4. Cross-Sectoral Benefits of Integrated Watershed Management in Nepal

Integrated watershed management can provide significant benefits to both downstream and upstream users. This study in the Kaligandaki watershed in Nepal demonstrates that investing in holistic management at the watershed-scale can consistently result in positive returns on investment (ROI) for both small and large budgets. These benefits include reduced maintenance costs for hydroelectric production, avoided loss of life and structural damage from landslides, improved drinking water quality and improved agricultural productivity.

Integrated watershed management can have a myriad of benefits for both downstream and upstream beneficiaries. Natural vegetation and healthy forests improve sediment retention, reducing soil erosion, improving downstream water quality, and improving hydroelectric production efficiency. A holistic approach to proactive watershed management tends to be significantly more cost-effective than treating problems after they occur, and these economic benefits can be demonstrated across sectors.

The renewable energy sector is one that heavily relies on natural capital and a steady provision of ecosystem services. Hydropower is one of the most important sources of renewable energy, accounting for greater than 16% of global electricity production (IHA, 2019). 35 countries rely on hydropower for more than half of their national energy demand, and some, such as Nepal, generate more than 90% of their electricity using hydropower (Wasti et al., 2022).

The agricultural sector benefits from practices that prevent soil erosion and soil nutrient losses, and improve soil moisture, thereby improving crop yields. Water supply and irrigation infrastructure downstream benefit from the regulation of runoff and baseflow generated by healthy watersheds. Further, healthy vegetation also acts to stabilize slopes and helps prevent small- to medium-sized landslides that pose a risk to lives and to infrastructure in many parts of the world.

Cost-benefit analyses are frequently used in sectors such as energy and infrastructure to plan investment strategies. Efficiency and revenue are often prioritized when designing and operating large-scale infrastructure projects such as dams, roads, and irrigation. However, these optimization analyses often fail to incorporate the value of natural infrastructure in the equation, and short-term benefits are generally prioritized over long-term returns.

Promising Advances

Natural capital assessments and multi-scenario modeling incorporating both biophysical and economic data allow for comprehensive cost-benefit analyses of land management interventions that reflect the value of ecosystem services to local, regional, and global users. Framing natural capital gains in the context of stakeholders' financial benefits promotes focused inter-sectoral cooperation on watershed management projects in key

locations that provide broad benefits across land, energy, water, and environment sectors.

While financial metrics are often the focus of traditional cost-benefit analysis, sustainable management can also yield quantifiable benefits to human lives and safety, supporting disaster risk reduction efforts. Sustainably managed, diverse forests can reduce the risks of deadly wildfires. Natural vegetation on slopes and upstream forests in mountainous regions can significantly reduce the risk of landslides, avoiding losses of life and property damage. Both people and nature will benefit if these important services from natural capital are prioritized in land use planning and development. Rapidly advancing technology and data allow for relatively precise quantification of these services to society.

Solutions: Science and Tools

The Natural Capital Project, the World Bank, and Kathmandu University conducted a novel analysis to estimate the return on investment from integrated watershed management applied in the Kaligandaki watershed in Nepal. The Kali Gandaki A Hydropower Plant (KGA) is one of the largest power plants in Nepal with a capacity of 144 MW, situated at the confluence of the Kali Gandaki and Aahdi rivers in the Himalayan range. The US$350 M plant came online in 2002, but it has since experienced significant issues from regional sedimentation, such as turbine abrasion and cavitation, that has led to frequent maintenance and unplanned shutdowns (ADB, 2012). As sediment accumulates in the KGA reservoir, the dead storage capacity of the power plant slowly decreases, requiring more frequent flushing. The power sector is not the only one impacted by this landscape degradation. Agriculture, water resources, and disaster risk are also heavily impacted by environmental degradation, highlighting the importance of cross-sectoral cooperation for land management. The environmental ministries in Nepal have invested in watershed management for years, but their programs tended to prioritize single sub-watersheds at a time with localized interventions. Integrated watershed management aims to take a broader landscape perspective for planning and implementing interventions, based on the principle that it is easier to treat problems preventatively at the source rather than addressing them later, or downstream.

The natural capital assessment implemented in this case demonstrates a systematic approach to evaluate how watershed management can reduce erosion and sedimentation, and mitigate its impacts to local and downstream stakeholders. The team, taking into account the biophysical and socio-political context, chose a range of plausible interventions to reduce sediment transport to the KGA plant, and the impacts and of these interventions were evaluated using InVEST sediment modeling, along with other analytical tools to evaluate landslides and sediment transport. These interventions included soil and water conservation activities like cover cropping, agroforestry, and hedgerows as well as landslide mitigation activities such as slope correction and revegetation.

Several downstream benefits of the integrated watershed management activities were analyzed. Benefits for the KGA plant included reductions in maintenance costs and equipment damage and improvements in storage capacity and efficiency. Benefits for local communities included avoided lives lost and avoided structural damage due to reductions in landslide risk. The team modeled other benefits as well, such as the global

service of carbon sequestration, but the economic returns to stakeholders primarily consisted of localized service streams. The team explored a range of investment budgets from US$500,000–US$50 million to determine optimal, spatially targeted intervention portfolios to maximize economic return to stakeholders.

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Photo Credit: A. Vogl

The results demonstrated a positive return on investment across the entire budget range. At the lower US$500K bound, every dollar yielded $4.38 in benefits. This return on investment diminished as the budget increased, although it remained positive at the US$50 million level of investment, yielding $1.20 for every dollar invested. The most significant benefits were those to landholders and local communities, particularly in the value of avoided loss of life from landslides. Many residences and roads are in sites of medium risk for landslide danger in the watershed, and the benefits from reduced risk accounted for up to 75% of the total benefits from integrated watershed management, depending on the budget and activity portfolio (World Bank Group, 2019). Landholders would significantly benefit from improved management of the land for a variety of reasons, such as increased agricultural productivity and improved water quality. Benefits to the hydropower sector were the next largest as maintenance costs and flushing requirements decreased with reduced sedimentation to reservoirs.


Photo Credit: A. Vogl

Scaling Up

This natural capital assessment and valuation in the Kali Gandaki watershed demonstrated a novel attempt to quantify and value the multiple benefits of watershed management along a range of investments using conservative assumptions. Human safety and well-being were considered alongside more typically valued benefits such as infrastructure operations and maintenance costs. In the Kaligandaki watershed, the project resulted in a renewed commitment on the part of the Nepal Department of Forest And Soil Conservation to improve their programmatic approach to watershed management, including improving coordination between affected sectors (land, water, energy, forestry), creation of a GIS cell within the Department to increase capacity for applying natural capital approaches and spatial modeling to planning, and monitoring sedimentation in rivers.

The results highlight the importance of considering multiple benefit streams and sources of value to make the case that investments in watershed services are sound, and these lessons are applicable in many country contexts. Except for the benefits from landslide mitigation, no one sector receives enough benefits to justify 100% of the investment cost, and in some cases targeting investments to benefit one sector will reduce the benefits accrued to other sectors. Mapping and quantifying the sources of sediment and benefit pathways helps policymakers to design watershed management programs that address conservation and development goals as well as the need for sustainable energy and rural development. It also helps to ensure equitable programs that distribute the costs of watershed management across different actors who receive its benefits.

5. Sustainable Development and Coastal Resilience in The Bahamas

The Bahamas, a region prone to coastal hazards, created a national sustainable development plan aimed at improving safety from climate hazards, access to markets and schools, and better human health. Strategies to meet these human development priorities were informed by natural capital assessments. By taking stock of coastal ecosystems such as mangroves and coral reefs, the government was able to determine which areas provide the most benefits to Bahamians through coastal protection from sea-level rise and storms, opportunities for tourism, and provision of fishery livelihoods. The most valuable coastal habitats were prioritized for protection and restoration in the Plan, and implementation of nature-based and green infrastructure solutions are financed by two major loans from the Inter-American Development Bank.

Island nations, especially small island developing states (SIDS), are particularly vulnerable to the threats of climate change. While these states are geographically and culturally diverse, they face several common challenges that have placed them on the climate change "frontlines" (Thomas et al., 2020). Tropical island states are the most threatened by rising global temperatures as warming is expected to be most extreme in equatorial regions (Karnauskas & Cohen, 2012; Liu et al., 2005). Sea-level rise is also a prominent risk as SIDS are often low-lying with much of the population residing in the low-elevation coastal zone (Martyr-Koller et al., 2021). Climate change may also be increasing the intensity of hurricanes and typhoons that batter small island communities with gale force winds and floods (Emanuel, 2020). SIDS have deep cultural ties to their natural environment, and their economies are often dependent on the local ecosystems as well. Coastal and marine ecosystems provide food security, protection from erosion and flooding, and a stable source of livelihoods for local communities through food production and tourism.

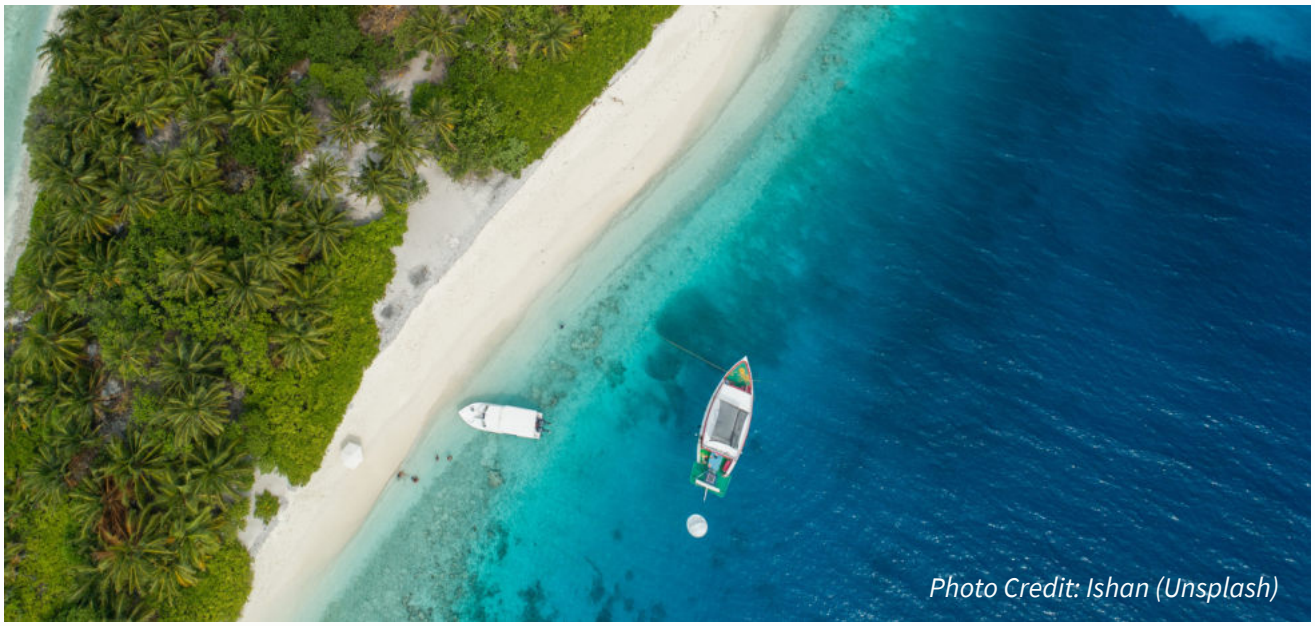
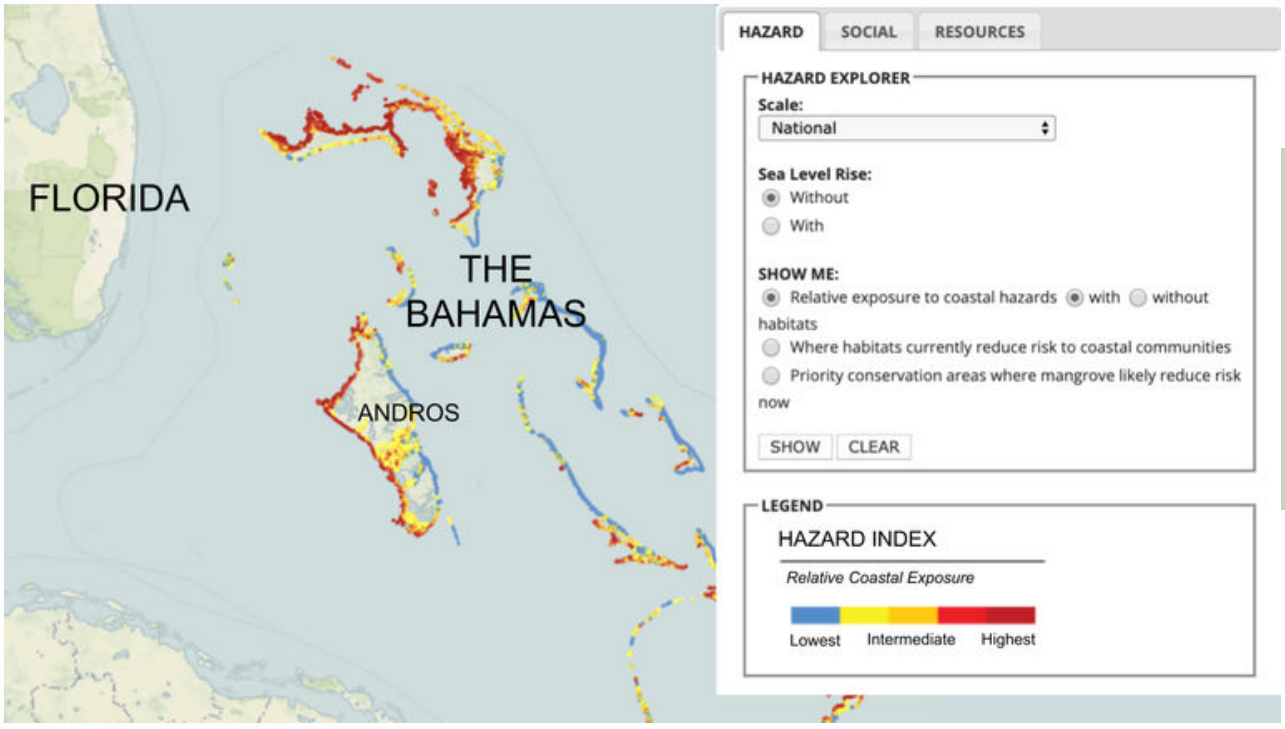


Photo Credit: Ishan (Unsplash)

The Bahamas, a Caribbean archipelago consisting of 700 islands and over 2,400 cays, is an island nation whose economy is largely driven by tourism and financial services, as the archipelago acts as an offshore financial center used globally. Overseas investors have played a major role in boosting the nation's tourism sector, establishing resorts and restaurants across the country. However, the economic crash in the 1980s led many investors to withdraw, leaving stranded assets and incomplete developments in their wake. Alongside these economic shocks, intense hurricane seasons have taken their toll on the archipelago. Development across the islands has led to the degradation of key coastal ecosystems such as coral reefs and mangroves that provide significant protection from storm surges, erosion, and flooding. These economic and natural shocks have inspired the Bahamian government to create a more independent and resilient economy, sustaining livelihoods with the country's wealth of natural capital and beauty.

Promising Advances

The Bahamas aimed to create a national sustainable development plan that would sustain the country's economy and livelihoods, supported by the ecosystems upon which they depend. The Office of the Prime Minister, Natural Capital Project, local universities and consultants as well as stakeholders used a natural capital approach to co-create a spatial development plan on Andros Island, the largest island in the archipelago. With an area greater than the other 700 islands combined, Andros is home to some of the most intact marine and coastal ecosystems in the archipelago. Commercial fishing fuels nearly half of the island's economy, producing US$70 million in annual revenue through activities like crabbing and sponging (Government of Bahamas, 2017). Nature-based tourism is also a significant contributor, bringing in more than US$44 million in direct revenue (Hargreaves-Allen, 2010). The Bahamian government identified food and water security, livelihood and income equality, climate change and coastal resilience, land tenure security, and health and well-being as key pillars when developing the Andros Island Master Plan.



Solutions: Science and Tools

A comprehensive assessment of Andros Island's natural capital and ecosystem services was the first step to designing a sustainable development plan. The Natural Capital Project (NatCap) partnered with the Bahamian government to take stock of the current natural assets on the island and map where the benefits were flowing to people. Three different InVEST ecosystem service models, developed by NatCap, were used in the assessment: lobster fisheries, sustainable tourism, and coastal vulnerability. NatCap mapped the coastal ecosystems and assessed the coastal risk along the entire coastline of The Bahamas using both current and future scenarios of climate change and sea-level rise (Silver et al., 2019). Coral reefs, seagrass beds, and mangrove forests protect the shoreline across the archipelago. NatCap's results demonstrated that even under current sea-level scenarios, the amount of shoreline exposed to high levels of coastal hazards would quadruple if these coastal ecosystems were lost (Silver et al., 2019). Nearly 15% of the Bahamian population at present rely on their coastal ecosystems for storm protection. Model results showed that if these ecosystems were lost, the fraction of people at high risk would at least double across the country. In some regions, risk could increase by an order of magnitude (Silver et al., 2019).

The final Andros Island Master Plan outlines a lasting nature-based economy. Information from a national scale coastal vulnerability assessment confirmed that greater coastal climate resilience was conferred through protection and restoration of coastal habitats. The coastal vulnerability assessment was unfortunately validated a few years later when Hurricane Dorian struck The Bahamas in 2019. Damage from flooding and storm surges was greatest in the same regions designated as high risk in the InVEST models due to various factors including bathymetry, coastal ecosystems, and elevation. The lobster catch model estimated that the chosen development scenario would result in a 50% increase from the current baseline in export value of the lobster catch for Andros Island, and increased tourism revenue in all four districts of the island, resulting in enhanced livelihoods and a more equitable distribution of wealth (Government of Bahamas, 2017).

A US$35 million green infrastructure loan from IDB is funding mangrove restoration as a nature-based coastal resilience strategy in priority areas designated in the Plan. Another loan from IDB is supporting expansion and management of The Bahamian marine protected area (MPA) network. Baseline natural capital assessments were used to make the ecosystem and economic case for the loans, identify priority areas for financing, and monitoring and evaluation metrics from the Plan are used as loan performance indicators. Using data and models from the natural capital approach provides investors with estimates for their returns, building faith in ecosystem services and driving demand. This case demonstrates how a natural capital approach to development planning, using comprehensive assessments and scenario analysis, can integrate local perspectives and priorities, drive long-term investments in nature, and sustain a thriving economy.

6. Natural Capital Approaches for Road Development

Land use change from road development and operation can impact surrounding natural capital and the provision of ecosystem services. At the same time, the sustainability of road infrastructure itself depends on ecosystem services such as hazard mitigation from the surrounding environment. Strategically planning roads to minimize impacts on natural capital can lead to long-term benefits for roads and their users.


Photo Credit: L. Mandle

Roads are fundamental to economic development strategies around the world, increasing connectivity and access to markets and services for communities across the globe. They are a vital component of the transportation sector and require careful planning and regular maintenance to ensure they deliver their intended benefits in a sustainable manner. Construction of roads can have significant adverse impacts on the surrounding ecosystems and the flow of services they provide to local beneficiaries. Local water quality, flood regulation, and erosion control are examples of key services that are often affected by road construction (Helsingen et al., 2015). Road developers and users also benefit from healthy surrounding landscapes. Well-managed natural ecosystems can reduce landslide risk, erosion, and flooding, helping to minimize maintenance and repair costs for roads, in addition to improving access and safety for its users (Mandle et al., 2014).

Promising Advances

Transportation projects that consider the value of ecosystem services can achieve more cost-effective results, improving economic benefits for local communities and road users while bolstering the surrounding environment and road itself from climate change and urbanization shocks (Mandle et al., 2014). The negative impacts of roads can be minimized or mitigated by incorporating natural capital concerns into road planning processes.

This type of approach often requires multi-sectoral planning to ensure optimal outcomes for all stakeholders involved. For example, protecting a wetland upstream from a road can protect its users from flooding risks by enabling the wetland to retain more water. Doing the same for an upstream forest can reduce landslide and erosion risk by increasing sediment retention. Hence, involving actors outside of the transportation sector in the planning and decision process can result in positive outcomes for both people and nature. Strategic environmental assessments (SEA), environmental impact assessments (EIA), and land use plans are all examples of entry points for incorporating ecosystem services into transportation planning.

Solutions: Science and Tools

Natural capital approaches can add value at all stages of road planning and maintenance. Natural capital assessments provide the opportunity to select routes that avoid the largest impacts to biodiversity, ecosystems and ecosystem service benefits. Such assessments also enable the integration of landscape management with transportation planning, for example allowing road planners to identify natural areas that protect roads from hazards such as floods, erosion and landslides.

Working with local partners in the context of proposed roads in Peru and Myanmar, the Natural Capital Project developed new approaches to quantifying roads' impacts to and dependence on ecosystem services. The proposed Pucallpa-Cruzerio do Sul road (hereafter "Pucallpa road") connecting Peru and Brazil presented a compelling opportunity to bring the value of natural capital into the decision and planning process. This road has been considered for over 45 years, but a proposal finally gained traction in 2014 after the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA) included it in their development plan (Conservation Strategy Fund, 2022). Impacts to ecosystem services and the equity of possible mitigation measures were not addressed in the project's original impact assessments. Where the Pucallpa road would cut through the Peruvian Amazon, it would likely impact local ecosystem services for 250,000 people including more than 15,000 indigenous people (Mandle et al., 2015). Provision of ecosystem services such as clean drinking water, climate regulation, and food and medicine supply for Amazonian communities would be at risk under the proposed development plan. Additionally, the road could facilitate access to undeveloped areas of the rainforest, encouraging increased timber production, ranching, and some illegal deforestation.

The Natural Capital Project, in partnership with The Nature Conservancy, conducted an assessment of the impact the completed road would have on ecosystem services, including the flow of benefits to people. This included direct impacts of the road's construction as well as associated impacts that would occur from increased access and use (i.e., agricultural conversion, deforestation, etc.). Four InVEST ecosystem service models were used to estimate the impacts of the proposed road development and determine whether mitigation activities could equitably offset these impacts. Drinking water quality, in terms of sediments, nitrogen and phosphorus, and carbon storage for climate regulation were the principal services investigated. The analysis found that the proposed Pucallpa road would result in substantial losses of ecosystem services for certain populations. Development could result in up to 50% loss of sediment, 20% loss of phosphorous regulation and 15% loss of nitrogen regulation services, impacting downstream drinking water quality. Carbon storage services would also be lost.

Mitigation through restoration and avoided deforestation could offset some ecosystem service losses. However, the Natural Capital Project's analysis showed that indigenous communities were likely to bear disproportionately high losses of ecosystem services, and these losses could not be fully offset (Mandle et al., 2013).

A similar study was conducted in Myanmar for the construction of Dawei road link, a 138-km two-lane road connecting the Dawei Special Economic Zone (SEZ) to Thailand (Helsingen et al., 2015). This road would run through the Dawna Tenasserim (DT), one of the largest contiguous forests in Southeast Asia, threatening the bountiful natural capital it provides for both countries (Bassi et al., 2016). NatCap and WWF, incorporating known concerns of local and national stakeholders, partnered to conduct an assessment of the ecosystem service provision areas that may be impacted by the development of the Dawei road and SEZ. Three scenarios were designed to simulate local land use change context around proposed development: limited conversion of land uses, more conversion, and high conversion. These scenarios demonstrate varying levels of land use change and deforestation that may occur with the Dawei road link due to increased transportation, mining, and agricultural activities. Sediment transport to downstream reservoirs was modeled to estimate impacts on drinking water quality and energy production.

The study also investigated how upstream land conversion and deforestation would impact the road itself and associated infrastructure, particularly bridges. Bridge scour occurs when a stream or river erodes soil around the foundation of a bridge. It is the leading cause of bridge failure and has resulted in significant economic loss and fatalities around the world (Wang et al., 2017). Upstream forests can protect bridges from a dangerous and costly failure by retaining sediment that would otherwise wash through bridge supports. Natural vegetation can also reduce the risks of flooding through water retention, improving infrastructure security. The assessment identified where nature-based solutions could best be implemented to reduce erosion surrounding the proposed Dawei road most effectively.

Scaling Up

The engagements described above revealed the consequences of road development on natural capital and ecosystem service provision, including benefits to local communities and impacts to road infrastructure. In both Peru and Myanmar, the results have informed discussions and decisions about whether and how to proceed with development. The Pucallpa road still lacks approval and is currently not under development. Many stakeholders in Peru believe the costs outweigh potential benefits (Vélez and Romo, 2021). The Dawei road in Myanmar was approved by the Government of Myanmar in 2018, but included new plans to minimize and mitigate impacts to biodiversity and natural capital, based explicitly on the work by WWF and collaborators.

The approaches used in the assessments for the Pucallpa and Dawei roads can be readily adapted to road planning in other locations. A guidance document that NatCap produced with the Inter-American Development Bank synthesizes natural capital approaches for road investments, capturing lessons and examples from Latin America and beyond (Mandle et al., 2016). This document has been downloaded over 18,000 times, indicating broad interest in incorporating natural capital into road planning and development.

7. Nature-based Solutions and Sea-Level Rise: A case from the San Francisco Bay Area, USA

Sea-level rise threatens coastal communities and infrastructure across the globe. Nature-based solutions to coastal threats can be as effective as gray infrastructure solutions while providing significant additional benefits to people both locally and globally.

Sea-level rise is one of the many threats that climate change poses to communities around the world. Globally, sea level is predicted to rise about 0.3m on average over the next 30 years, but these levels can vary dramatically by region due to differences in land and ocean height (NOAA, 2022). Around 1 billion people live in areas that are less than 10m above sea level today and the homes of nearly 340 million people could be below annual flood levels by 2050 (Kulp & Strauss, 2019). As seas rise, these communities and their associated infrastructure will be at increasing risk from storm surge and flooding events (Kulp & Strauss, 2019).

California is one of the US states most vulnerable to sea-level rise, and within California, the San Francisco Bay Area is particularly at risk (California Ocean Protection Council, 2018). In a scenario where global emissions are not curbed, the Bay Area could see up to 7 feet of sea-level rise by 2100 (Ehlers et al., 2020). Sea-level rise and land subsidence to date has already led to increased flooding in parts of the Bay (Blackwell et al., 2020).

Engineered solutions (or gray infrastructure) such as seawalls and levees are often the status-quo solutions to coastal flooding. These traditional engineering solutions are an important component of adaptation strategies, but they are not without challenges. They can be costly, require regular maintenance and inspection, can exacerbate flooding for neighboring regions, and–if they fail–can result in rapid, catastrophic flooding (Hummel et al., 2021; van Onselen et al., 2022).

Promising Advances

Including nature-based solutions in the portfolio of adaptation options can lead to better outcomes for people and nature. Nature-based solutions can not only reduce flood risk, but also provide multiple additional benefits to people. In some cases, nature-based solutions can be more effective, longer-lasting, and less costly than gray infrastructure alternatives (Bridges et al., 2021). They also offer a more flexible adaptation alternative; marshes can migrate up slope as sea level rises, concrete cannot. Coastal ecosystems such as tidal marshes, wetlands, beaches, mangroves, oyster reefs, and coral reefs help protect people and property by absorbing wave and wind energy and by storing water. They also provide a myriad of other benefits to people alongside coastal protection–such as opportunities for recreation, climate change mitigation through carbon sequestration and storage, runoff and nutrient retention, and habitat for wildlife.

Solutions: Science and Tools

The Natural Capital Project partnered with regional and local government agencies, science institutes, and NGOs to explore how nature-based solutions could be better incorporated into adaptation planning throughout the San Francisco Bay Area. From the beginning, the integrated team representing interests from local and regional perspectives thought carefully about how the work would most effectively inform adaptation planning throughout the region. At the regional scale, the team (in this case the Bay Conservation and Development Commission, a consulting firm, the NatCap team, and many stakeholders throughout the region) worked together to explore how regional assets such as transportation infrastructure, developed areas, disadvantaged communities, and natural lands are vulnerable to sea-level rise and how natural lands can reduce those vulnerabilities (SFBCDC, 2011). For example, they examined the capacity of natural lands to store floodwaters and demonstrated that conserved lands and lands under easements could provide $129M in flood accommodation services. In a companion study, they examined the regional impacts of hard infrastructure (such as seawalls) and showed that seawalls in just one region can lead to up to 36M m3 of flooding and $723M in economic damages from displaced flood waters throughout the Bay Area (Hummel et al., 2021). At a more local scale, they investigated San Mateo County's risk from sea-level rise and the potential solutions, determining where nature-based solutions are feasible, and comparing the co-benefits provided by different adaptation scenarios. The study showed that investing in green infrastructure to combat sea-level rise can provide the same level of protection as hardened shoreline while delivering eight times the benefits through carbon sequestration, recreational opportunities, runoff retention, and wildlife habitat (Guerry et al., 2022).

Scaling Up

Results from this work are yielding multiple pathways to impact. One key impetus for the regional scale work was a grant from a transportation agency (to regional government bodies) to develop a regional adaptation planning process that would increase the resilience of regional transportation and community assets. From the beginning, the assessments were designed to answer crucial questions being asked by policy makers. The regional scale work helped inform Plan Bay Area 2050, a long-range plan for the future of the San Francisco Bay Area, has sparked numerous conversations with government agencies that are in charge of multi-jurisdictional planning, and laid groundwork for the adoption of the Bay Adapt Joint Platform, a strategy for protecting Bay Area people and places from rising seas. The county-scale work led to the distribution of fact-sheets about vulnerabilities, nature-based adaptation options, and co-benefits throughout the county so that leaders of cities and other jurisdictions within the county can easily access the information when making adaptation planning decisions. One city in the region, for example, has used the results to inform the creation of a shoreline adaptation plan for their hotel district. This work is still new and it remains to be seen what further action will occur on the ground.

Incorporating nature-based solutions into climate adaptation planning in large metropolitan areas is only one of many critical arenas for exploring strategic investments in nature to improve the wellbeing of people while supporting Earth's life support systems. Today, urban decision-making is typically compartmentalized, such that urban planning occurs without much consideration of biodiversity and nature, and conservation planning typically ignores cities as places with little of either. The time has come to change this. Destroying or degrading remaining natural systems imperils drinking water, food security, security from flooding and heat stress, as well as human health. Choosing a different future can demonstrate the leadership, vision, and innovation that are hallmarks of cities. Practical tools and approaches together with policy and finance innovations are allowing cities around the world to recognize the vital benefits of nature and biodiversity in cities and the tremendous ways in which cities can benefit both biodiversity and humanity (Guerry et al., 2021).

Appendix B: Sector-specific Questions

Table B.1.

Example questions often asked by sectoral actors that can be addressed through a natural capital approach. Examples where these approaches are demonstrated accompany each sector. More detail and references for example cases can be found in Appendix A and in the Natural Capital Project's searchable publication library.

Sector	Guiding Questions	Example Cases
Agriculture	1. How to reduce inputs without reducing yield? 2. How to reduce environmental impacts while maintaining the necessary food supply? 3. What to farm and where? What are efficient and sustainable crops? 4. How to incentivize farmers to adopt sustainable ag. practices? 5. How to finance the transition for industrial/commercial farmers?	China's national ecosystem assessment–agricultural policy impact (Ouyang et al., 2016) Unilever supply chains (Chaplin-Kramer et al., 2015)
Water Resources	1. What activities have the greatest impact on water supply, quality, and regulation? 2. How has land use change and/or climate change impacted water? 3. Which actors are most incentivized to maintain water quality and supply? 4. What are costs of maintenance and purification?	Upper Tana water fund (*Appendix A,* Case Study #3) and PRO-Agua case in Peru, Bolivia and Brazil (Guevara et al., 2020)
Energy	1. How to improve efficiency of energy production? 2. How to sustainably extract resources? 3. How to reduce maintenance and operation costs? 4. How to enable a transition to renewable energy?	Kaligandaki Hydropower case study in Nepal (*Appendix A,* Case Study #4)

Sector	Guiding Questions	Examples Cases
Forestry	1. How to protect healthy, old-growth regions in a financially stable way? 2. How to incentivize landowners to sustainably manage their lands? 3. How has land use change impacted ecosystem services to local communities?	Myanmar NatCap Assessment (Mandle et al., 2017)
Disaster Risk Management	1. How to bolster communities and improve resilience to climate change? 2. Which areas and populations are most vulnerable to future changes in climate?	The Bahamas, Belize (*Appendix A*, Case Study #5)
Infrastructure & Government Planning	1. How do current policies account for the value of natural capital? What is the best way to integrate? 2. Which sectors/regions/operations have the greatest impact on ecosystems and their services? 3. How to mobilize funding for infrastructural changes? 4. What are the engineering alternatives to NBS and how do the costs compare?	Belize upland sustainable development planning (Government of Belize, 2020) San Francisco Bay Area sea-level rise adaptation (*Appendix A*, Case Study #7)
Transportation	1. Where and how to secure or enhance nature to maximize the longevity/sustainability of transportation infrastructure (e.g., minimizing road closures or damages from landslides, erosion, flooding, etc.). 2. How to minimize the impact of transportation development on natural ecosystems?	Pucallpa, Peru and Dawei, Myanmar road cases (*Appendix A*, Case Study #6)
Corporate/Finance	1. How to ensure long-term sustainability throughout the entire supply chain? 2. How to achieve corporate emissions standards through reductions and offsets? 3. How to choose business development locations to minimize impacts to ecosystem service provision? 4. How to mobilize private capital into nature-based solutions and yield profitable returns?	Unilever (Chaplin Kramer et al, 2015)

Appendix C: Additional Resources

(i) Publications Library

Natcap searchable publications library; and collection of peer-reviewed literature for all publications using InVEST and other NatCap software: Mandle, Lisa and Natural Capital Project. (2021).

(ii) Database

Database of publications using InVEST and other Natural Capital Project software. Stanford Digital Repository. Available at: https://purl.stanford.edu/bb284rg5424

(iii) InVEST Resources

- Software support and resources
- Virtual training resources

(iv) Sample of NatCap Training Resources

Making the case for using natural capital information in decisions

- Green Growth that Works book highlighting practical examples of implementing biodiversity and natural capital approaches.
- Recent recorded talks by some of NatCap's leaders featuring case examples of demonstrations:
  - CBD COP in Kunming: Natural Capital Accounting and Ecological Value (~10 min)
  - Ocean Panel Perspectives: Accelerating the transition to a sustainable Ocean Economy: The Ocean Transition The ocean transition: what to learn from system transitions (talk starts at 16:29).
  - In the wake of a changing climate: Energy security and solutions: Strategic hydropower planning for renewable, low-impact energy systems in Southeast Asia (talk starts at 51:00).
  - World Bank Global Platform for Sustainable Cities talk: Bringing Nature to Cities--Integrating Nature and Biodiversity into Land Use and Ecological Planning

Making the case for using natural capital information in decisions (cont.)

- Natural Capital Singapore: Integrating ecosystem services into urban planning and An official Gross Ecosystem Product (GEP) accounting system at Shenzhen (download the file, the two talks start at the 38 min mark);
- Advancing Data Technologies to Inform Disaster Risk Reduction (DRR) and Integrated Coastal Zone Management (ICZM): Mesoamerican Reef IDB webinar

- A map of where NatCap has engaged in informing decisions
- Our prototype online global data viewer helps make nature's diverse benefits to people easily accessible and understandable. An introduction to the viewer is here.
- Introduction to GEP (Gross Ecosystem Product) and its application in China. (16 minutes)
- Short (3.5 min) video introduction to the Natural Capital Project and how we work.
- Natural Capital Conversations (These are convenings we hold online that are conversations with expert panelists from across NatCap's network of scientists, practitioners, and leaders.). A couple of example are here:
  - Nature-based solutions and water: Navigating the transition to a climate-resilient future
  - Bringing the value of nature into the economic mainstream
- Podcasts
  - Resources for the future podcast: Green Growth that Works: Discussing ecosystem services with Lisa Mandle
  - Sirius XM radio podcast Top of Mind: Sustainable Cities

Materials for learning to use natural capital approaches and tools in decisions

- A number of guidance documents created for application of natural capital information and approaches/tools in standard decision processes for multi-lateral development banks, governments, and NGOs. (too many to list here, but available upon request).
  - e.g, IDB roads (2016), IUCN protected areas and KBAs (2018), World Bank Environmental and Social Safeguards Framework (2021), World Bank Urban policy briefing (2021)
- Recorded training in China: Introduction to the Natural Capital Approach and InVEST Software Suite (1.5 hrs)
- Virtual Training page on our website. This page gathers many different resources including:
  - An online course (free, self-paced online course through Stanford; available in English and Spanish; takes ~8-10 hours to complete).
- InVEST training tutorials (all free, online on YouTube)

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