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ISSUE BRIEF

REVALUING ECOSYSTEMS: PATHWAYS FOR SCALING UP THE INCLUSION OF ECOSYSTEM VALUE IN DECISION MAKING

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SUMMARY

Ecosystems provide essential services to society, from pollination and filtering of pollution to climate and water regulation. These services are often treated as though they have no value, with ecosystems too frequently managed for short-term gain at the expense of broader, longer-term societal benefits. There is an increasing array of tools to evaluate the tradeoffs associated with these developments, as well as a growing body of ecosystem service assessments which highlight the changes in value. Efforts to incorporate ecosystem values in decision making are growing – through partnerships, in government, and in the private sector. This issue brief highlights barriers, opportunities, and pathways to broader consideration of ecosystem services in decision making.

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BOX 1

KEY TERMS

- **Ecosystem**—a dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit.[a]
- **Ecosystem services**—the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept "ecosystem goods and services" is synonymous with ecosystem services.[a]
- **Ecosystem service tradeoff analysis**—a comparison of the potential future effects of an action on multiple ecosystem services. Tradeoffs can result from actions that intentionally or otherwise alter the quantity, quality, or timing of one or more ecosystem services at the expense of others. Tradeoffs can be separated in time and space.
- **Human well-being**—a measurable, context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health, good social relations, and security.[a]
- **Land degradation**—the loss of actual or potential productivity or utility as a result of natural or anthropic factors; the decline in land quality or reduction in its productivity.[e]
- **Natural capital**—the stock of natural ecosystems that yields a flow of ecosystem goods and services into the future. It is the foundation of the rural economy. It is an extension of the economic notion of capital (manufactured means of production) to goods and services relating to the natural environment.[f]
- **Natural capital accounting**—a subset of national wealth accounting that attempts to measure the extent to which natural capital contributes to comprehensive wealth.[b]
- **Natural infrastructure**—refers to the "strategic use of networks of natural lands, working landscapes, and other open spaces to conserve ecosystem services, providing benefits to human populations." Forests, wetlands, riparian buffers, coral reefs, and other natural elements on the landscape can comprise natural infrastructure when strategically used and managed to provide services for communities.[c]
- **Restoration**—the process of regaining ecological functionality and enhancing human well-being by bringing back the biological productivity of an ecosystem to benefit people and the planet.[e]
- **Valuation**—the process of expressing a value for a particular good or service in a certain context (e.g., for decision making), usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (such as sociology, ecology).[a]
- **Value**—the contribution of an action or object to user-specified goals, objectives, or conditions.[a]

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CONTENTS

EXECUTIVE SUMMARY

Ecosystems provide essential services to society, from pollination and flood protection to climate and water regulation. Until recently these services have largely been treated as if they have no value. Developers have drained marshes to make way for housing, losing the water filtration and flood protection services marshes once provided. Forests have been converted to crop and grazing land, increasing food production but degrading the water- and climate-regulating services that forests provided.

The most recent global assessment of the conditions and trends of ecosystem services found that about 60 percent (15 of 24) services assessed were degraded. Ecosystems are too often managed for the short-term gain of a few at the expense of broader, long-term societal benefits. The loss and degradation of ecosystem services poses a serious threat to human development goals.

To ensure a more sustainable and equitable future, businesses, governments, and communities need more accurate tools to comprehensively measure the contributions of ecosystems to human well-being. We also need to do a better job communicating the valuable benefits ecosystems provide to people and society, creating incentives for their sustainable management and developing creative business models that reward investment in restoring and managing ecosystem services. The challenge is to scale up the inclusion of the value of ecosystem services in the multitude of decisions that affect or depend on them. Ideally, this would extend to the development of financial mechanisms—such as the market for biologically stored carbon—that incorporate the value of natural capital in financial transactions.

In November 2013, The Rockefeller Foundation—in collaboration with World Resources Institute (WRI), Forum for the Future, and the Economist Intelligence Unit—convened a meeting in Bellagio, Italy on "The Future of Revaluing Ecosystems." The meeting brought together thirty-two participants from the public, private, nonprofit, and research sectors to consider how society can better incorporate the full range of benefits that ecosystems provide in public and private decisions. The goal of this "revaluing" is to promote longer-term thinking and create incentives to protect and restore ecosystems and ensure their sustainable use. Participants explored the benefits provided by ecosystems at a range of scales, from the global economy to very local decision making. The topics spanned the private, public, and research sectors. The meeting focused on what we need to do between 2014 and 2025 to achieve this goal.

The meeting in Bellagio offered a preliminary exploration of visions, barriers, and solutions, which served as a starting point for further discussion and exchange. After the meeting, WRI worked with participants and other experts to advance the visions and solutions proposed in Bellagio. This issue brief synthesizes six of the critical ideas discussed at the Bellagio meeting. These ideas represent complementary pathways to scale up the inclusion of ecosystem values in public and private decision making. On their own, none is likely to be sufficient to drive the scale of ecosystem services integration needed in decision making. However, in combination they offer the

promise of igniting a movement to promote mainstreaming ecosystem services. For each pathway, we present a vision, barriers and opportunities, solutions, and preliminary ideas on what needs to happen to "get started" moving toward this vision.

The six pathways to scaling up the integration of ecosystem values in decision making explored in this issue brief are:

1. Redefining economic well-being: mainstreaming ecosystem values in national economic accounts.

National economic accounts do not do a good job of keeping track of natural capital. Governments should expand traditional and too-limited measures of economic well-being, such as gross domestic product, with indicators that assess sustainable development and social progress. More comprehensive indicators would provide invaluable insights into whether current trajectories of ecosystem condition and resource use undermine future economic development or support a transition to an economy that reduces environmental risks and supports sustainable development. This pathway focuses on:

- Advancing the work of existing environmental-economic accounting initiatives
- Improving data availability and technical capacity for environmental-economic accounting and new indicator development
- Creating incentives for private-public coalitions to use accounts of ecosystems and ecosystem services and alternative economic, social, and environmental indicators in support of local decision making.

2. Making ecosystem service valuation count in local decision making.

This pathway explores what is needed to persuade public and private sector decision makers to take ecosystem health and ecosystem service benefits into account when making local planning, development, and policy decisions. It identifies four critical changes to help advance this transformation:

- compiling better evidence of human influence on ecosystem services
- applying ecosystem service assessment tools in more pragmatic ways, focused on specific policy questions
- encouraging greater engagement of local stakeholders
- supporting clearer and wider communication of valuation results.

These changes would be catalyzed by a corps of ecosystem service analysts that collaborate on ecosystem service assessments and communication around the world.

3. Scaling up investments in natural infrastructure.

Ecosystems provide a wide range of valuable services, including water quality protection, flood and drought risk mitigation, and coastal defense. Services such as pollutant filtering by wetlands, water supply regulation management by forests, and shoreline protection by coral reefs, are sometimes referred to as "natural infrastructure." Yet most infrastructure investments do not consider natural infrastructure as an option, instead focusing on engineered solutions. This pathway focuses on making the consideration of natural infrastructure standard practice in water management and land use planning agencies. To achieve this mainstreaming of natural infrastructure as a viable complement and alternative to traditional built infrastructure, this pathway focuses on:

- improving documentation and communication of the economic benefits of natural infrastructure, which include its potential to increase resilience to climate change through ecosystem-based adaptation approaches
- identifying opportunities for the cost-effective conservation or restoration of ecosystems as natural infrastructure and quantifying the scale or magnitude of the benefits
- incorporating consideration of natural infrastructure in the land use planning and water management decision-making processes.

4. Scaling up corporate investments in ecosystems to secure vital inputs for the food and beverage sector.

The food and beverage sector is especially dependent on healthy ecosystems, since its main ingredients—freshwater and food—are themselves ecosystem services. Raw material insecurity for the sector is tied to degradation of ecosystem services such as erosion control, soil fertility, and water timing and flows. Assessment and increased knowledge of those connections, along with transparent ecosystem service targets and management plans, will

increase investment in ecosystem services in ways that align with business interests. This pathway lays out an action plan for scaling up corporate investments in ecosystems to secure a sustainable supply of these ingredients through:

- conducting systematic ecosystem service dependence and impact assessments on corporate operations and supply chains
- establishing corporate-wide goals and plans to manage ecosystem risks and capitalize on opportunities
- investing in large-scale watershed and landscape restoration efforts through partnerships with suppliers, other companies, local stakeholders, and relevant national and local governments.

5. Catalyzing the increased protection, improved management, and restoration of ecosystem services in agricultural landscapes through restoration bonds.

This pathway focuses on increasing the productivity of tens of millions of hectares of degraded agricultural landscapes through increased investment in sustainable agricultural practices. "Restoration bonds" would be modeled on experiences with successful "green bonds," development impact bonds, and similar social financing innovations. They would provide financing and technical support to enable smallholder farmers to transition from conventional practices that degrade ecosystems to more sustainable production systems that protect, sustain, and restore ecosystems. The restoration bonds proposed in this pathway would:

- provide a risk-adjusted financial return for investors
- restore ecosystem services and increase resilience of smallholder agricultural production
- support social and economic goals by helping farmers transition from practices that degrade ecosystems toward more sustainable food production systems and livelihoods.

6. From shock to action: making ecosystem and community resilience visible through communication.

Natural disasters, such as floods, droughts, fires, and pest outbreaks, provide an opportunity to draw attention to the role of ecosystems in mitigating disasters and supporting recovery. This pathway focuses on seizing opportunities to raise awareness of ecosystems' natural hazard regulation benefits through a fact-based, coordinated, and sustained communication process. It aims to put in place well-informed networks of communicators who are prepared to use the aftermath of natural disasters to make the case for investing in ecosystems as a strategy to build community resilience. The proposed network of communicators will draw on the best available science to encourage rapid, transparent, and informed decisions that safeguard ecosystems and build more resilient communities.

The six proposed pathways aim to increase the inclusion of ecosystem services in decision making. They take a broad look at issues across a range of topics and scales. The pathways target different decision makers, but are mutually reinforcing. Making ecosystems count in local decisions can help increase calls for national governments to include ecosystem values in economic accounts. Scaling up corporate investments in ecosystems can drive support for restoration bonds in agriculture landscapes. A wide range of stakeholders—mayors, local planning commission members, state governors, national ministers, international development agencies, and business managers in the food and beverage sector—should consider the benefits that ecosystems provide in their planning and development decisions. The pathways are not intended to be exhaustive, but provide a broad look at both the need to value ecosystems in more comprehensive ways and the opportunities that could benefit from a "revaluing of ecosystems."

We need to better communicate the valuable benefits ecosystems provide, create incentives for their sustainable management, and develop business models that reward investment in nurturing ecosystem services.

INTRODUCTION

There is an urgent need to scale up the integration of ecosystem value in the myriad of public and private sector decisions that affect or depend on ecosystem services. Ecosystems are the "natural capital" of our economies. They provide goods such as food, fiber, and timber; regulating services such as filtering pollutants, regulating water flows, and protecting shorelines; and cultural services such as recreation and inspiration. Yet in markets, ecosystems are typically valued only for their ability to supply marketed goods—such as fish, crops, and timber. Ecosystem services such as water filtration, natural hazard regulation, and climate regulation often have no value in the marketplace until they are degraded or lost.[1] (Throughout this issue brief we use the term "ecosystem services" to include both goods and services provided by ecosystems.)

When the full range of benefits from ecosystems is underappreciated, ecosystem management practices are likely to enhance market-based ecosystem goods at the expense of non-marketed ecosystem services. For example, forests are managed for the supply of timber. Overharvesting timber degrades other forest ecosystem services, such as climate and water regulation. Likewise, draining wetlands to make way for crops results in the loss of wetlands services related to flood control and water filtration. The Millennium Ecosystem Assessment found that 60 percent of the ecosystem services assessed (15 out of 24 services) had been degraded globally in the past 50 years[2] (see Table I.1).

The world's poor and vulnerable rely directly on the benefits provided by nature and are disproportionately affected by the loss and degradation of ecosystem services.[3] Strengthening the rights of local people to use and manage ecosystems can help provide incentives for the long-term stewardship of ecosystems.[4] To restore and maintain our essential life support systems, we also need to do a better job of incorporating the full range of benefits provided by ecosystems into

TABLE 1

ECOSYSTEM SERVICES BY CATEGORY AND TREND

Service Type / Status	Degraded	Mixed	Enhanced
Provisioning	■ Capture fisheries ■ Wild foods ■ Biomass fuel ■ Genetic resources ■ Biochemicals, natural medicines ■ Fresh water	■ Timber ■ Wood fiber and other fiber (e.g., cotton, hemp, silk)	■ Crops ■ Livestock ■ Aquaculture
Regulating	■ Air quality regulation ■ Climate regulation ■ Erosion regulation ■ Water purification and waste treatment ■ Pest regulation ■ Pollination ■ Natural hazard regulation	■ Water regulation ■ Disease regulation	■ Global climate regulation (carbon sequestration)
Cultural	■ Spiritual, religious or cultural heritage values ■ Aesthetic values	■ Recreation & ecotourism	

Note: Ecosystem services described as "mixed" services have increased in quantity and/or quality in some places and decreased in others.
Source: Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being—Synthesis. Washington, DC: Island Press.

the metrics of national economies, as well as into local decision making.

Over the past several decades, recognition of the need to rethink how the human economy relates to the natural world has gained ground. Economist Herman Daly has argued for a paradigm shift in economics, one that would treat the economy as a subsystem of the world's ecosystems. Under this paradigm, a steady state economy begins with the physical world and seeks to maximize both the productivity and supply of natural capital.[5] Robert Costanza and others have raised awareness of the potential economic value of the world's ecosystem services by making numerical estimates of the value of the biosphere.[6] As background in describing recent advances in ecosystem science and management, Gretchen Daily and others have noted that appreciation of the value of ecosystems as capital goes back centuries and that it grew starting in the mid-twentieth century as, for example, environmental economists examined the value of natural resources such as fisheries.[7] While there is growing recognition that natural capital is a scarce and limiting factor rather than a free good,[8] in practice, most decision makers continue to assume growth in consumption of natural resources is a valid measure of progress. Broader indicators of wealth, which include changes in natural capital, would provide a more accurate gauge of progress.

Awareness of the full value of ecosystems to society is emerging but remains the exception. A few governments have launched national and subnational efforts to increase the incorporation of ecosystem service values in decision making. These include payment for water services in Costa Rica, Mexico, and Ecuador. Global efforts include the United Nations REDD+ (Reduced Emissions from Deforestation and forest Degradation) and WAVES (Wealth Accounting and the Valuation of Ecosystem Services), a global partnership to promote the integration of the value of natural resources in national economic accounts. A major effort toward that goal is the adoption of a new international statistical standard for environmental-economic accounting—System of Environmental-Economic Accounting (SEEA) Central Framework—by the United Nations Statistics Commission. In addition, the Natural Capital Coalition (formerly TEEB for Business Coalition), is a global, multistakeholder open source platform for supporting the development of methods for natural and social capital valuation in business.

While these efforts are promising, a range of barriers hamper the scale-up of the inclusion of nature's value in decision making. These barriers include people's inability to make the connection between healthy ecosystems and the attainment of their social goals; the lack of local-scale information on ecosystem value; limited access to financing for restoration, management, and protection; misalignment of economics and financial incentive to support ecosystem stewardship; and the absence of local and national champions able to make a compelling case for including the value of ecosystems in decisions that affect or depend on them.[9]

Ecosystems and the valuation of the benefits they provide to society are an important thematic focus for both The Rockefeller Foundation and the World Resources Institute (WRI). In November 2013, The Rockefeller Foundation—in collaboration with WRI, Forum for the Future, and the Economist Intelligence Unit—convened a meeting in Bellagio, Italy on "The Future of Revaluing Ecosystems." The meeting brought together thirty-two participants from

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the public, private, nonprofit, and research sectors to consider how society could include a more complete valuing of the benefits ecosystems provide to people in public and private decisions.

The participants discussed ecosystem valuation trends and the barriers to promoting more comprehensive ecosystem valuations. Discussions focused on what needs to be done to help achieve these goals by 2025. The barriers were divided into three categories: the lack of a compelling case for the benefits of protecting and restoring ecosystems, insufficient reward for safeguarding ecosystems, and fragmented authority for managing ecosystems. Participants identified solutions to these barriers:

- The lack of compelling argument for taking action can be addressed by engaging the community in identifying information needs, developing credible information on the costs and benefits of protecting ecosystem services, communicating benefits more clearly and broadly, and identifying and using persuasive messengers on ecosystem services.
- Insufficient incentives for safeguarding ecosystem services can be addressed by strengthening tenure and local rights, and by tracking natural capital in national accounts.
- Fragmentation of authority for evaluating and managing ecosystem services, which impedes cross-sectoral collaboration, can be addressed by providing a mandate for agencies to coordinate on these issues, requiring ecosystem service tradeoff analysis in environmental impact assessment, and by assisting finance ministries to incorporate ecosystem service considerations.[10]

In addition, participants discussed trends that inspire optimism and offer opportunities for scaling up consideration of ecosystem services in decision making. Promising trends include:

- Advances in information and communication technologies (high resolution satellite data and crowd sourcing, increased internet access, social media, tablets and smartphones)
- Consolidation and expanded access to ecosystem valuation results (such as via The Economics of Ecosystems and Biodiversity initiative and online valuation databases)
- Improved tools and guides to support valuation of ecosystem services
- Significant growth in partnerships and forums on ecosystem services[11]
- Growth in government and multilateral efforts to incorporate ecosystem service information in decisions
- Significant growth in private sector initiatives and tools to incorporate ecosystem services in corporate decision making.[12]

The ideas discussed in Bellagio provided a starting point for further exchange and idea development. This issue brief fleshes out some of the visions and proposed solutions that emerged from Bellagio, organizing them into six "pathways" for scaling up consideration of ecosystem benefits in decision making. For each pathway, we present a vision, barriers and opportunities, a solution, and ideas on what needs to happen to "get started" moving toward this vision. The six pathways are not intended to be exhaustive.

The pathways cover a broad range of scales—from increasing consideration of ecosystem benefits at the national level through to very local decision making. This reflects both the range of ideas discussed in Bellagio and that solutions across a range of scales are needed. The first pathway proposes targeted steps to advance the inclusion of ecosystem values in national accounting systems. The second focuses on changes required to increase the use of ecosystem values in local decision making, advocating for an "ecosystem service corps" to catalyze those changes. The third looks at ways to shift water treatment and flood control infrastructure toward greater use of natural—rather than built—infrastructure. The fourth focuses on how food and beverage companies—key developers and users of ecosystem information—can transform their practices to promote their own sustainability. The fifth pathway proposes a means to finance restoration of degraded agricultural lands and a transition to more sustainable food production systems. The final pathway focuses on increasing awareness of the benefits of healthy ecosystems by setting up a communication network to operate in the aftermath of natural disasters.

1. REDEFINING ECONOMIC WELL-BEING: MAINSTREAMING ECOSYSTEM VALUES IN NATIONAL ECONOMIC ACCOUNTS

NORBERT HENNINGER, JANAKI ALAVALAPATI, LAURETTA BURKE, ROBERT COSTANZA, BEKELE SHIFERAW

VISION FOR 2025

By 2025, most governments move beyond gross domestic product (GDP) as their main indicator of economic growth by complementing GDP with indicators that inform and evaluate the sustainability of economic and social development. Considering natural capital assets in economic and social planning and policy formulation, both at national and local levels, becomes common practice. Governments implement the system of environmental-economic accounting (SEEA), an international standard to track the interaction between the environment and the economy. The SEEA becomes a widely applied extension of the system of national accounts, the foundation of GDP estimates.

In addition, countries develop an agreed-upon methodology for measuring and reporting on ecosystem services, building on an accounting framework that assesses how ecosystems provide a range of services for economic and other human activities. Including ecosystem services in national economic accounts supports national and local decision making, providing invaluable insights on current trajectories of resource use and whether they undermine or support the transition to a greener economy.

Finally, coalitions of private and public actors take advantage of the greater availability of data, analytical tools, and online platforms for establishing common interest groups and produce locally relevant information (e.g., natural capital accounts, ecosystem service valuations). These efforts advance alternative indicators of social, economic, and environmental progress. National and local decision makers adopt such indicators in their regular reporting and target setting, enhancing their tracking and management of economic output, welfare, and ecosystem stewardship. Civil society holds policy makers and decision makers accountable for maintaining the capacity of ecosystems to deliver ecosystem services.

BARRIERS AND OPPORTUNITIES

In most countries, the statistical institutions and associated information systems and accounting frameworks overlook the importance of functioning ecosystems and nonrenewable resources. Yet these resources play a central role in the economic development and sustainable well-being of all nations. The predominant indicator of economic activity—GDP—poorly reflects a country's reliance on these assets and natural processes (and the ecosystem services they provide), and how they are changing over time.[13, 14, 15] GDP also provides insufficient information on whether economic growth is at the expense of these assets and processes.

The idea of integrating ecosystems and the services they provide into national accounts is not new. It surfaced at the 1992 UN Conference on Environment and Development in Rio de Janeiro, and again twenty years later at the Rio +20 UN Conference on Sustainable Development. But efforts launched in the 1990s to measure the economic value of clean water, forests, and other natural resources did not initially expand beyond the pilot stage.[16]

Valuing the full range of ecosystem services requires an approach that is based not solely on conventional markets—such as for timber, minerals, or fish—but also on services, such as water flow regulation or purification. In the last decade, case studies and tools to quantify and value the benefits derived from ecosystems using different methodologies have grown rapidly. But further standards are needed for defining ecosystem services and reporting these values across countries, with attention to

approaches that work best to inform decision making.

What is standing in the way of more comprehensive accounting of ecosystems and ecosystem services in national economic accounts? Barriers include uncertainty about statistical methods, a lack of standardized modeling and accounting methods, reluctance to shift to a new and unfamiliar approach, and limited capacity of statistical agencies. Furthermore, efforts to build new accounts have focused too narrowly on the "supply side" (methods), failing to build demand from important economic sectors by convincing key decision makers of their relevance to economic and development goals. Economic interests that benefit from the short-term gains associated with activities that deplete natural resources can also present a hurdle in overcoming the status quo.

While these barriers are real, they are not insurmountable. Recent trends in measuring, valuing, and accounting for ecosystem assets and ecosystem services offer opportunities to advance such values in economic accounting and decision making:

- **A new standard for environmental-economic accounting.** In 2012, the UN Statistical Commission adopted the System of Environmental-Economic Accounting (SEEA).[17] The SEEA is an international framework to account for natural resources; ecosystem inputs (e.g., water); flows from the economy to the environment (e.g., liquid and solid wastes); and environmental protection expenditures, taxes, and subsidies.[18] It uses definitions and classifications consistent with the System of National Accounts and includes a central framework—the first international standard for environmental-economic accounting. Several countries have implemented the SEEA, often beginning with accounts focused on water or forests (see Box 1.1 on water accounts in Botswana).

BOX 1.1

WATER ACCOUNTS IN BOTSWANA

Botswana is one of eight core implementing country partners in the World Bank's WAVES Global Partnership. With strong support from its national Economic Advisory Council, Botswana has constructed water accounts to better manage this scarce resource that is essential to economic growth, diversification, and poverty reduction.

The water accounts provide detailed information on water supply, use, and efficiency. Findings include:

- **Water supply:** About half of all water used comes from groundwater.
- **Water use:** Self-providers—predominantly mines, livestock, and irrigated agriculture—use more than half of the total water used in the country.
- **Use efficiency:** Botswana's total water use increased by a third between 1991 and 2011, but per capita water use decreased by 10 percent in the same period, reflecting efficiency improvements.
- **Use by sector:** The agriculture sector (livestock and irrigation) is the largest user of water (at 43 percent), followed by households and the mining sector. The value added per unit of water use is very low from agriculture ($0.03 pula/$m^3$), compared with mining ($0.41 pula/$m^3$), manufacturing ($9.4 pula/m^3) and services ($31 pula/$m^3$). Although the per-unit value added from agriculture is low, agriculture supports a large share of informal employment, providing a critical social safety net.

Botswana's mid-term review of its 10th National Development Plan and the president's State of the Nation address to parliament both emphasized the importance of natural capital accounting as a tool for better decision making. Natural capital accounting will feature in the forthcoming 11th National Development Plan. In addition, the Department of Water Affairs' restructuring plan includes a new office for water accounting, suggesting a national commitment to water accounts.

Botswana is also moving toward developing accounts for minerals, land, tourism, and energy.

Source: WAVES. 2014. Wealth Accounting and the Valuation of Ecosystem Services. WAVES Annual Report. Available at: <https://www.wavespartnership.org/sites/waves/files/documents/WAVES_2014AR_REV_low-FINAL.pdf>.

- **A proposed international multidisciplinary research framework to account for ecosystems and ecosystem services.** The UN Statistics Division and partners have developed a companion document to the SEEA central framework to better account for ecosystems and their associated services: the *SEEA Experimental Ecosystem Accounting framework*.[19] Although the document provides a conceptual framework to guide research for measuring ecosystems and defining ecosystem services, it offers no detailed guidance on compiling accounts; further testing is needed to determine the methods that work best for country implementation.

- **Demand for information on the status of (and trends in) ecosystems and ecosystem services is increasing.** Growing government concern about scarcity and degradation of natural resources is increasing interest in better environmental-economic accounting to determine optimal resource use among sectors (e.g., water for energy, food, human use, and ecosystem benefits). About twenty-four countries now regularly compile at least one type of natural capital account, including natural resource assets accounts, physical and hybrid flow accounts, or ecosystem accounts.[20] Since Rio+20, seventy countries, including forty low- and middle-income countries, have signed on to a Natural Capital Accounting Initiative to advance natural capital accounting in their countries.[21] In addition, countries are developing a set of new global sustainable development goals, which require quantifiable targets and indicators. Detailed water accounting, for example, can provide the information to track a possible global target of doubling water productivity by 2030.

- **Environmental-economic accounting capacity is expanding beyond formal government processes.** Nongovernmental partnerships and coalitions—such as the Wealth Accounting and Valuation of Ecosystem Services (WAVES) partnership, the Natural Capital Coalition, the Economics of Ecosystems and Biodiversity initiative, and others—have provided training, built some capacity and improved ecosystem valuation information for a few countries. Emerging nongovernmental groups have proposed new indicators of social and environmental change (see Box 1.3 on other metrics), monitored environmental and social progress, and held decision makers accountable on sustainable development issues. Operating outside intergovernmental and governmental processes reforming statistical systems, these nongovernmental groups are seeking more rapid change in resource management. The Water Footprint Network,[22] for example, has developed methods to track water supply and use at national, commodity, and basin level, which is being applied in supply chain management and company operations to quantify and reduce water consumption. Similarly, a coalition of universities and conservation organizations is working with governments and companies to develop new ecosystem services mapping and valuation tools to change policies and resource management practices. Examples include the Natural Capital project, Artificial Intelligence for Ecosystem Services (ARIES), and Waterworld / Co$ting Nature. [23]

SOLUTIONS

We propose the following actions to encourage more widespread adoption of natural capital accounts and broader indicator development of social, economic, and environmental well-being:

- **Build political will by publicizing the benefits of accounting for ecosystems and ecosystem services.** Even when there is considerable interest in such accounting, there may be competing interests and priorities within national governments. Integrating ecosystem values into national economic accounts will require greater participation and leadership from national and subnational governments and institutions. Successful, influential applications of environmental-economic accounts should be documented and publicized to highlight the benefits of this investment and encourage political buy-in.

- **Develop country capacity to implement environmental-economic accounts.** The SEEA central framework is typically implemented by national statistics offices. Most countries will need to invest in creating capacity within their statistics offices to implement and institutionalize these accounts. Engaging stakeholders and decision makers interested in a sustainable supply of ecosystem services

can help to identify useful definitions and approaches for implementation. Many developing countries will require technical and financial support to establish and advance their accounts.

- **Structure environmental-economic accounts to answer critical policy questions.** Environmental-economic accounts can help guide more efficient land management and resource use in general. However, interest in and uptake of the broader indicators will be strongest if the application addresses a critical policy question already in play, such as improving water management in water-scarce areas (see Box 1.1 on water accounts in Borswana). Close collaboration with ministries of planning and finance will identify which accounts are most useful. The use of environmental-economic accounts to answer specific policy questions can help create the incentives and political will required to institutionalize such accounts.

- **Promote the development of consistent tools and methods to accurately quantify the value of ecosystems and ecosystem services, reflecting the current situation and a range of alternative futures.** Although statistical tools and frameworks such as the SEEA exist for quantifying natural resource use and environmental degradation, additional research could enhance the usefulness of ecosystem services accounting and reduce the uncertainty of ecosystem service benefit estimates. Modeling should be supported by more extensive physical and social measurement of ecosystems and their services (see section 2 on ecosystem values for decision making). In addition, ecosystem service valuation methods should align with the accounting principles in the system of national accounts. They should, for example, use a current market price to value the associated good, service, or asset, and when prices are not observable, they should provide an approximation based on market-price-equivalents valuation.[24] Furthermore, countries should adopt a new international standard on accounting for ecosystems and ecosystem services.

- **Encourage the development of a wider set of indicators of social, economic, and environmental well-being, and stimulate alternative public-private coalitions seeking ecosystem value indicators in decision making.** Countries differ in social, environmental, and economic characteristics and have different policy goals. Although accounting for ecosystems and ecosystem services is an important initial step to incorporating sustainability into national planning, additional indicators can highlight other important aspects of development, including equity and vulnerability (see Box 1.3 on alternative metrics). Coalitions seeking to apply new indicators in decision making or to integrate ecosystem valuation into economic development planning need to be stimulated and strengthened.

Including ecosystem services in national economic accounts supports national and local decision making, providing invaluable insights on current trajectories of resource use and whether they undermine or support the transition to a greener economy.

BOX 1.2

CURRENT PARTNERSHIPS AND EFFORTS

The Wealth Accounting and Valuation of Ecosystem Services (WAVES) partnership, which is led by the World Bank, is working in eight countries (Botswana, Colombia, Costa Rica, Guatemala, Indonesia, Madagascar, the Philippines, and Rwanda) to implement environmental-economic accounts using the System of Environmental-Economic Accounting (SEEA). It is also supporting efforts to develop an agreed upon methodology to measure, value, and account for ecosystem services. WAVES is planning to double the number of country engagements. Although WAVES typically works in a country for four to five years to implement and institutionalize the SEEA, additional national budgetary and technical support is needed to ensure that the effort will be sustained over the long term.

In seven countries (including Brazil, Indonesia, and Vietnam), the UN Statistics Division is working with the United Nations Environment Programme, the Economics of Ecosystems and Biodiversity initiative, and the Convention on Biological Diversity to test the SEEA Experimental Ecosystem Accounting—a system that requires considerable technical capacity. The UN Statistics Division is helping to build the requisite capacity by developing a global strategy to prepare guidance and training materials for country implementation, and establishing mechanisms through which countries can share experiences.

The Ecosystem Services Partnership is a network organization that connects researchers working on ecosystem services to NGOs, environmental agencies, educators, policy makers, and the general public, to advance and implement best practices for managing ecosystem services sustainably. Currently over fifty organizations are members of the network.

Source: Moving Beyond GDP—How to factor natural capital into economic decision making. 2012. WAVES partnership. Available at <http://www.wavespartnership.org/sites/waves/files/images/Moving_Beyond_GDP.pdf>

GETTING STARTED

To integrate environmental and ecosystem values into national accounts and advance broader indicator development, we propose three next steps:

1. Amplify the work of major environmental-economic accounting initiatives

- Governments, NGOs, and researchers should collaborate to document and communicate the benefits of environmental-economic accounting. WAVES, the Economics of Ecosystems and Biodiversity initiative, and others are collecting case studies and documenting the benefits of accounting for ecosystems and ecosystem services. A wealth of information is already available in reports such as *SEEA 2012 Experimental Ecosystem Accounting (UN 2013), Inclusive Wealth Report 2012,* and *Inclusive Green Growth (World Bank 2012),*[25] but this information mostly reaches and supports people who are already working on ecosystem services. A broader and more public-focused advertising campaign is needed—utilizing advertising firms and journalists to both help develop products and spread the word (see section 6 on communicating ecosystem resilience). Making the case for more comprehensive economic accounts is vital to creating the political will to initiate and institutionalize such accounts.
- International development cooperation agencies and statistical offices should collaborate on improving capacity to develop and use accounts of ecosystems and ecosystem services. Although efforts are under way to boost countries' capacity to develop and apply natural capital accounts (see Box 1.2), more is needed. Additional effort and resources are necessary to build capacity in statistical offices, and to ensure efforts are institutionalized. International development cooperation agencies should make investing in this technical capacity a priority. Another means of providing reliable funding is through revised national budget allocations.

2. Improve data availability for environmental-economic accounting and new indicator development

- Identify data needs to create base accounts and fill data gaps. Creating simple base accounts (e.g., on land cover stocks and flows, water, carbon or biomass) requires reliable and up-to-date

data. A detailed assessment of data availability within a country and an action plan to fill data gaps are the first steps to improve the data supply for simplified ecosystem capital accounts. Such efforts could be supported through WAVES, by NGOs, or by members of an ecosystem service corps (see section 2)

- Encourage national institutions to supply data and provide incentives for open government data initiatives and strengthened public access. A range of institutions may be custodians of (or have access to) the data needed to advance natural capital accounting. These institutions include national statistics offices; water resources management agencies; sectoral ministries, including agriculture, livestock, fisheries, and natural resources; remote sensing and mapping agencies; and NGOs with expertise in remote sensing, mapping, and natural resource issues. Policies that encourage open government data and strong public access are often the best approach to overcoming the parochial barriers that inhibit these institutions from sharing their data holdings. The entry point could be a new mandate for stronger, more coordinated statistical systems that support a country's transition to a green economy and improve decentralized planning and decision making. A special role must be played by national institutions to provide central services and supply baseline data regularly at different spatial scales in various formats.
- Advance international and regional efforts to overcome data scarcity. Insufficient data collection, incomplete and incompatible data archiving processes, and other factors can contribute to data scarcity stymying meaningful natural capital accounts and new indicators. International and regional efforts can demonstrate good practices and fill data gaps by supporting repositories of land and water data. For example, the European Environment Agency's land use data center provides central and simplified data access for land and ecosystem accounting (see http://www.eea.europa.eu//themes/landuse/dc). Similarly, the International Water Management Institute, The Institute for Water Education (UNESCO-IHE), and the Food and Agriculture Organization of the United Nations are collaborating to establish a public data repository to advance water accounting (see http://www.wateraccounting.org/).

3. Create incentives for private-public coalitions to use accounts of ecosystems and ecosystem services and alternative economic, social, and environmental indicators in support of local decision making

In many countries, local planning and economic development efforts can provide an entry point for better environmental-economic accounting and wider indicator use. For example, a regional master development plan, a strategic environmental assessment, or a visioning exercise for a new economic growth corridor can each create direct demand for more comprehensive ecosystem valuation and a broader set of progress indicators. Foundations, development cooperation partners, and governments should create incentives (e.g., financing, technical support, data sharing arrangements) for ad-hoc public-private coalitions to use natural capital accounts and alternative indicators to address location-specific development challenges. For example, an ecosystem services mapping assessment helped a large private landowner in Hawaii to explore different land use scenarios reflecting different environmental, economic, and social priorities.[26] Similarly, Vermont and Maryland are using the Genuine Progress Indicator to measure progress more comprehensively (see Box 1.3).

BOX 1.3

METRICS OF NATIONAL SUCCESS AND HUMAN WELL-BEING

Measures of progress that look beyond gross domestic product can be divided into three broad groups:

- adjustments to economic measures to reflect social and environmental factors
- subjective measures of well-being drawn from surveys
- weighted composite indicators of well-being.

1. ADJUSTMENTS TO REFLECT SOCIAL AND ENVIRONMENTAL FACTORS.
Measures are expressed in monetary units, which make them more readily comparable to GDP. These consider annual income, net savings, and wealth. Environmental costs and benefits (such as destroying wetlands or replenishing water resources) can be factored in as well.

For example, the **genuine progress indicator (GPI)** starts with personal consumption expenditures. It is weighted by income distribution, and then adjusted by positive factors (such as the value of volunteer work) and negative factors (such as the costs of divorce, crime, and pollution). Inclusion of income distribution is an important feature of GPI—a dollar's worth of increased income to a poor person boosts welfare more than a dollar's increased income to a rich person. Additionally, a big gap between the richest and the poorest within a country—as in the United States and, increasingly, in China and India—correlates with social problems, including higher rates of drug abuse, incarceration, mistrust, and poorer physical and mental health.*

These adjustments matter. A recent study of seventeen countries comprising just over half of the global population found startling divergences.* While GDP per capita and GPI per capita were highly correlated from 1950 to about 1978, the metrics moved apart as environmental and social costs began to outweigh the benefits of increased GDP. Tellingly, life satisfaction is highly correlated with GPI per capita, but not with GDP per capita.

2. MEASURES BASED ON SURVEYS OF WELL-BEING.
The most comprehensive survey-based measure of well-being is the World Values Survey, a global network of social scientists studying human beliefs and changing values. The World Values Survey has been conducted in five implementation "waves" covering seventy-three countries since 1981, and includes questions about how satisfied people are with their lives. Another example is Bhutan's Gross National Happiness index, which uses elaborate surveys to assess how content people feel across nine domains: psychological well-being, standard of living, governance, health, education, community vitality, cultural diversity, time use, and ecological diversity.

Subjective well-being has been highly studied, and even recommended as the most appropriate measure of societal progress. But subjective indicators are tricky to compare across societies and cultures. And, people are not always aware of the things that contribute to their well-being. For example, few understand or credit ecosystem services for water supply and storm protection.

3. WEIGHTED COMPOSITE INDICATORS OF WELL-BEING.
A comprehensive picture of sustainable societal well-being should integrate subjective and objective indicators, including things like housing, jobs, life expectancy, health, leisure time, and democratic engagement. One example is the Happy Planet Index, developed by the New Economics Foundation in 2006. This index multiplies life satisfaction by life expectancy and divides the product by a measure of ecological impact. Another example is the OECD Better Life Index, which allows users to choose how to weight variables on its website, revealing how the emphasis on different variables can influence countries' rankings. Variables include income, housing, jobs, health, civic engagement, safety, and life satisfaction.

Many other indicator experiments are also under way (see www.wikiprogress.org and http://ec.europa.eu/environment/beyond_gdp/indicators_wellbeing_en.html). None of these measures is perfect, but collectively they offer a variety of means for governments, NGOs, and others to develop meaningful indicators beyond GDP.

Sources: Costanza, R., I. Kubiszewski, E. Giovannini, H. Lovins, J. McGlade, K. E. Pickett, K. V. Ragnarsdóttir, D. Roberts, R. De Vogli, and R. Wilkinson. 2014. "Time to leave GDP behind." *Nature* 505:283–285. Available at: <http://www.nature.com/news/development-time-to-leave-gdp-behind-1.14499>.

*Kubiszewski, I., R. Costanza, C. Franco, P. Lawn, J. Talberth, T. Jackson, and C. Aylmer. 2013. "Beyond GDP: Measuring and Achieving Global Genuine Progress." *Ecological Economics*. 93:57–68.

2. MAKING ECOSYSTEM VALUATION MORE MEANINGFUL FOR LOCAL DECISION MAKING

LAURETTA BURKE, TUNDI AGARDY, LINWOOD PENDLETON, AND NORBERT HENNINGER

VISION FOR 2025

By 2025, public and private sector decision makers take ecosystem services into account when making local planning, development, and policy decisions. They are motivated by clear, robust information on the links between ecosystem health and ecosystem service provision; better communication of the benefits provided by ecosystems; and closer linking of ecosystem service assessments and valuations with relevant policy questions.

These changes are, in part, spurred by a global corps of ecosystem service analysts, collaborating on ecosystem service assessments and communication. This ecosystem service corps provides a resource and means for performing ecosystem service assessments and valuations around the world. Over a thousand corps members provide their services in forty countries. They have worked with 10,000 local and national staff and volunteers, creating a global movement of people who understand the importance and value of ecosystem services.

BARRIERS AND OPPORTUNITIES

A proliferation of tools for ecosystem service assessment and valuation is offering new opportunities to bring information on ecosystem services to bear in local decision making. Information generated by the application of these tools is growing, and some public and private sector decision makers are beginning to use ecosystem service assessments. In addition, more people are beginning to see the critical value of ecosystem services—often after natural disasters—such as the value of wetlands and dunes mitigating storm surge (see Box 3.1 in section 3).

Nonetheless, the use of ecosystem service values in decision making remains limited and their influence on public and private decision making modest. Barriers to their broader application and influence include:

1. Most locations lack information on ecosystem service values.

Although tools to support ecosystem service assessment, tradeoff analysis, and valuation are proliferating, they are usually used by scientists and economists, often as one-off, ad-hoc applications. Application outside the ecosystem services community is limited. Data and technical requirements for these tools are often significant, impeding their use in many locations.

2. Many ecosystem service assessments rely on models, yet such models cannot represent the complex dynamics of ecological and human systems.

Ecosystem service assessment and valuation tools are simplified representations of biophysical and economic realities. They are not yet able to holistically account for the full range of goods and services from ecosystems, and their projections can have wide error ranges (significant uncertainties), complicating and discouraging adoption by decision makers. Additionally, they are often either built for specific local contexts or they are regional or global models that lack local specificity. (It should be noted, however, that some tools are moving toward addressing uncertainty; for example, Bayesian belief networks, Monte Carlo simulations, and fuzzy sets.[27])

3. Lack of local participation hinders understanding of and uptake of analysis results.

Ecosystem service assessments and valuations are sometimes executed by third (external) parties, independent of local stakeholders, and are not adopted or used to inform decisions. The lack of participatory processes and poor communication to stakeholders and decision makers can impede uptake of results. Lack of stakeholder participation also hinders appropriate framing of the assessment, which can lead to invalid results.[28] Furthermore, unless the ecosystem service valuation is linked to real-life policy questions, there tends to be little demand for or uptake of results.

4. Ecosystem service values can be challenging to communicate.

One obstacle to greater use of ecosystem service information in decision making is the general lack of awareness about why this sort of information matters. But even when there is demand for information about ecosystem services, their values, and the things that affect delivery of nature's benefits, clearly communicating the science can be difficult. Results, even from simplified models or basic ecosystem service assessments, are too often presented in complex ways that are difficult for decision makers and other stakeholders to understand. As a result, the benefits that natural, healthy ecosystems provide are not fully appreciated or understood by those in a position to influence their management.

SOLUTION

Overcoming these barriers requires a strategy to make the quantification and valuation of ecosystem services more practical for both public- and private-sector decision makers. Here, we offer eight recommendations for developing such a strategy. Many of these recommendations come to fruition via a network of on-the-ground ecosystem service practitioners—an ecosystem service corps.

1. Conduct comparative assessments of the impact of development on ecosystems and their capacity to provide services.

The uncertainty associated with many ecosystem service model outputs limits their usefulness. Monitoring actual changes in ecosystem health and their capacity to provide ecosystem services—both before and after a development intervention or policy reform—is a valuable complement to modeling and can help inform and validate models. In addition, monitoring is essential to ensure that project /policy/enforcement standards are maintained, and to equip decision makers with information on new factors, such as changing climate. Such monitoring could cover the main ecosystem services of interest, as well as cobenefits. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES—http://www.ipbes.net/) and Future Earth (http://www.icsu.org/future-earth) could support monitoring of biophysical relationships influencing ecosystem service use and help consolidate existing information on this topic.

Ecosystem service assessments and valuations tend to have most influence when they are used to inform a clear policy question or development decision.

2. Explicitly address uncertainty in ecosystem service models.

As new statistical and modeling methods are adopted by tool developers and users, some of the challenges described above can be addressed. A new generation of models could use a wider range of information sources and apply methods that work with and represent the levels of certainty or uncertainty produced by tools (e.g. Bayesian statistics). Irrespective of their approach, developers should subject their tools to rigorous independent validation and disclose to users the likely accuracy of results, along with any critical assumptions underpinning the tools' operations.

BOX 2.1

ECOSYSTEM SERVICE VALUATION AND PLANNING IN BELIZE

Two projects in Belize have successfully applied ecosystem service valuation tools and influenced regulations or policy to protect coastal ecosystem services. In both, NGO staff served a role similar to that envisioned for an ecosystem service corps: building local capacity, catalyzing data sharing to support the valuation, promoting broad stakeholder engagement, and collaborating to communicate results.

Under the Coastal Capital: Belize project,[a] the World Resources Institute (WRI) worked closely with Belize-based partners at WWF-Central America and World Conservation Society, along with more than 10 Belizean NGOs and government departments, to design and conduct an assessment of the annual contribution of Belize's coral reefs and mangroves to the economy. The analysis used a standardized method for valuation of coral and mangrove-associated fisheries, tourism, and shoreline protection services[b] (see wri.org/coastal-capital). The valuation found that tourism dependent on coral reefs and mangroves contributed an amount equivalent to 15 percent of Belize's GDP in 2007, and that the shoreline protection afforded by reefs and mangroves avoided damages that would have had a value roughly equal to more than 20 percent of GDP.

The project's Belizean partners had critical access to decision makers, giving Coastal Capital influence in the country. NGO partners put the valuation results in front of national legislators, including the prime minister, who later cited videos featuring the valuation results as key to his decision to approve several new fishing regulations. Several months after the launch, when a container ship ran aground on the Belize Barrier Reef, the government sued for damages—something it had not done with past groundings. NGOs also used the Coastal Capital results to successfully advocate a ban on offshore oil drilling. Armed with hard economic data, Belizean partners are still using the results of Coastal Capital to further their advocacy.

A subsequent project in Belize (beginning in 2010) used an ecosystem service assessment and valuation to inform a national coastal zone management plan. The process brought together scientists, local experts, coastal and marine stakeholders, and government officials. Key partners in this effort—Belize's Coastal Zone Management Authority and Institute, the Natural Capital Project (NatCap), and the World Wildlife Fund (WWF)—worked together to gather existing information about habitat distribution and current and potential uses of Belize's coastal and marine areas. They then worked with local stakeholders (particularly via Coastal Advisory Committees) to co-develop scenarios of alternative coastal zoning schemes that emphasized conservation, development, or informed management.

To understand the implications of each scenario, the team used a decision-support tool for mapping and valuing ecosystem services called InVEST (Integrated Valuation of Environmental Services and Tradeoffs), which was developed by NatCap. During stakeholder meetings, maps of zones of human activities (e.g., marine transportation, coastal development, dredging) under the three future zoning schemes were presented. In the meetings, stakeholders helped refine the scenarios or generate alternative scenarios based on local knowledge and preferred outcomes. Through this process, local stakeholders learned about key coastal ecosystem services and how alternative choices could affect the value and distribution of those services. The "informed management" scenario, honed through several iterations, is now the cornerstone of the national Integrated Coastal Zone Management Plan[33] that is under public review and expected to become law.

Sources: Summarized from: 1. Waite, R., L. Burke and E. Gray. 2014. *Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean.* Washington, DC: World Resources Institute. Available at: <http://www.wri.org/coastal-capital>. 2. Ruckelshaus, M., E. McKenzie, H. Tallis, A. Guerry, G. Daily, P. Kareiva, S. Polasky, T. Ricketts, N. Bhagabati, S. A. Wood, and J. Bernhardt. 2013. "Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions." *Ecological Economics.* Available at: <http://dx.doi.org/10.1016/j.ecolecon.2013.07.009> 3. Coastal Zone Management Authority and Institute (CZMAI). Available at: <http://www.coastalzonebelize.org>.

Notes: a. Cooper, E., L. Burke, and N. Bood. 2009. "Coastal Capital: The Economic Contribution of Belize's Coral Reefs and Mangroves." Washington, DC: World Resources Institute. Available at: <http://pdf.wri.org/working_papers/coastal_capital_belize_wp.pdf>. b. World Resources Institute. 2009. "Value of Coral Reefs & Mangroves in the Caribbean: Economic Valuation Methodology V3.0." Washington, DC: World Resources Institute. <http://www.wri.org/sites/default/files/uploads/coral_reefs_methodology_2009.pdf>

3. Apply assessment and valuation tools where there is an opportunity to influence decisions.

Application of ecosystem service assessments (biophysical, social and economic models) should be targeted where they are most likely to make a difference. Ecosystem service analyses and valuations, for example, tend to have most influence when they are used to inform a clear policy question or development decision regarding who wins/loses, and what is at stake—in economic terms and in terms of changes to livelihoods, health, security, and culture. Ecosystem service assessments and valuations can highlight the benefits ecosystems provide, as well as tradeoffs or losses resulting from ecosystem changes associated with different scenarios that decision makers are considering. Ecosystem service valuations also have greater influence in locations with good governance, high transparency, and low corruption—where results are less likely to be ignored.[29]

4. Engage the public, especially stakeholders, in ecosystem assessments and valuations.

Stakeholders can help frame and inform ecosystem service assessments, encourage the use of results in decision making, and inform qualitative assessments when more analytic approaches are not possible or warranted.[30] They are also important conduits for communicating results. Stakeholders include those who benefit and those who lose from policy actions, as well as those who can influence decisions. Stakeholders can be engaged through consultations with valuation practitioners and participation in data collection and valuation processes, workshops, and scenario development exercises. Stakeholder engagement helps ground the assessment: it ensures that local priorities and values inform the design of the assessment and fosters buy-in and ownership of the results, which is vital for uptake. It also aids stakeholders in understanding the sources of uncertainty and extent of uncertainty, which helps to guide appropriate use of results.

5. Match tools with available data and technical capacity.

Many datasets and tools are available for mapping and evaluating how resource management decisions will affect ecosystem condition, ecosystem service generation and use, and human well-being. These range from relatively coarse-scale global and regional integrated assessment models (IAMs)[31]—which are useful for raising awareness, providing a broad understanding of trends, and setting priorities—to more local ecosystem service assessment models, which produce outputs at a scale useable for local decision making (see Box 2.1 for examples from Belize).[32]

Strategic application of assessment tools in specific landscapes and targeted sites can help support the case for investment in ecosystems and their services, but these models tend to require substantial data and technical skills. The next two recommendations help overcome these hurdles.

6. Share ecosystem service assessment and modeling tools, outputs, and products online.

Online modeling tools and their outputs can be used even when there is insufficient data for detailed, local-scale ecosystem service analysis, provided the limitations of the tools are clearly communicated. Online tools serve up analytical results for different future scenarios and can generate awareness about threats to ecosystems and the associated risks to ecosystem services, although the results may not be sufficiently detailed for all types of decision making. Coastal Resilience (www.coastalresilience.org), Aqueduct (http://www.wri.org/our-work/project/aqueduct/aqueduct-atlas) and WaterWorld (http://www.policysupport.org/waterworld) are examples of these types of online tools for analysis of coastal defense and watershed vulnerability. In addition, Co$tingNature (http://www.policysupport.org/costingnature) is a web-based tool for natural capital accounting and ecosystem services assessment across a range of ecosystems. When tools allow for exploration of scenarios, decision makers can visualize some ecosystem benefits, such as increased shoreline protection from the restoration of a mangrove or wetland (see Box 2.2). Such tools are often only suitable for rough assessments and visualization; they are useful for raising awareness of an issue, but often with wide ranges of uncertainty, which should be considered in the use of results.

7. Build capacity to implement ecosystem service assessments and valuations worldwide through an "Ecosystem Service Corps."

In many parts of the world technical capacity for ecosystem modeling and valuation is limited. A network of experts in ecosystem service assessments and valuations could work via medium-term assignments directly with local groups to assemble data, implement models, and interpret and communicate results. This "Ecosystem Service Corps" would help build capacity to both generate and use ecosystem service values, as well as raise awareness of the utility of the ecosystem services framework. Corps members would range from graduate students and people early in their careers seeking real world experience, to late-careers or semi-retired professionals. Depending on the country, context, and local/national capacity, the corps members might be from within the country or international. Where possible, corps programs would be closely linked with local universities. In all cases, corps members would be paired with local organizations, building community capacity through a partnership approach, and would implement assessments that are cocreated and co-owned with local stakeholders. An ecosystem service corps could help with initial ecosystem service assessments, build capacity to implement and use future assessments through technical and policy training, and provide a network for continued support. It could also facilitate data sharing across agencies and institutions, identify data needs, and provide links to global and regional data sources and resources. This would also support the information needs of natural capital accounts (see Getting Started section below.)

8. Communicate—clearly, honestly, and with the right people.

Frequently, ecosystem service experts produce and share information that they feel makes obvious what the rational and economically sensible course of action might be. But, as noted above, converting information into action remains problematic for a variety of reasons. Communication may be too complex, technical, or confused by caveats about uncertainties, or lack explicit links to policy and finance reform. These problems can be overcome, and communication of ecosystem service analysis results can be made more effective by:

- Focusing on the **most important findings**
- **Visualizing the results** by using maps, graphics, and possibly video to convey findings
- Identifying **local examples** of how healthy ecosystems contribute to human well-being, as well as where environmental degradation has led to a loss of ecosystem services
- Complementing model outputs with **clearly documented (measured/monitored) examples**; examples should move beyond communicating relationships that are anecdotal or modeled, to communicating relationships that are measured and apparent (see section 6 on Communicating Resilience)
- Communicating the **links** between natural ecosystems and **human health**
- **Storytelling** about the benefits of healthy ecosystems and the consequences of their loss, often using ecosystem assessment, tradeoff analysis, and valuation.

Stakeholder engagement helps ground the ecosystem service assessment: it ensures that local priorities and values inform the design of the assessment and fosters buy-in and ownership of the results. It also aids stakeholders in understanding the sources and extent of uncertainty, which helps to guide appropriate use of results.

BOX 2.2

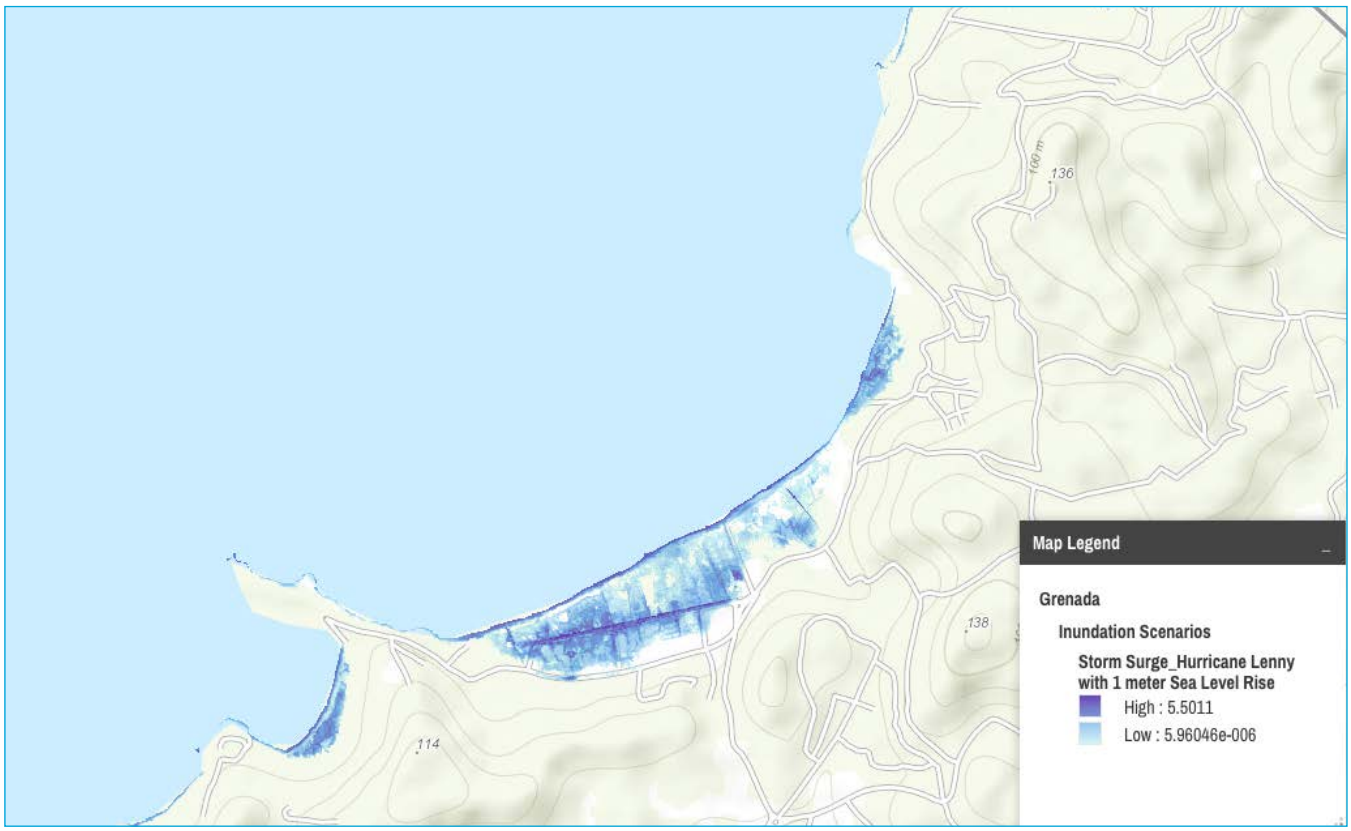
VISUALIZING COASTAL VULNERABILITY

The Coastal Resilience website (www.coastalresilience.org/) offers detailed maps of locations around the United States, Caribbean, and Latin America. The maps show topography, land use, population density, economics, and storm history, to visualize the physical, social, and economic vulnerability to coastal inundation for an area.

The map below visualizes a projection of coastal inundation in southwestern Grenada, in the eastern Caribbean. The scenario depicted combines the storm surge of Hurricane Lenny (1999) with a sea level rise of 1 meter. Map layers such as population demographics or critical infrastructure can be turned on or off to explore vulnerability.

Such online tools provide an easy means of visualizing some risks under future climate change. When this tool is extended to include "what if" scenarios of change in land cover, for example, it will be possible to evaluate the benefits of natural infrastructure.

Map 1. Inundation projection for Grenada (Hurricane Lenny plus 1m SLR)



Notes: For a comparison of ecosystem service assessment tools, see:

- Center for Ocean Solutions. 2011. Decision Guide: Selecting Decision Support Tools for Marine Spatial Planning. Stanford, California: The Woods Institute for the Environment, Stanford University. Available at: <http://themaritimealliance.org/pdf/cos_msp_guide_selecting_tools.pdf>.
- Table 7 in R. Waite et al. 2014. *Coastal Capital: Ecosystem Valuation for Decision Making in the Caribbean*. Washington, DC: World Resources Institute. Available at: <http://www.wri.org/coastal-capital>.

GETTING STARTED

The ecosystem service corps would be modeled after SCORE (www.score.org), a nonprofit association dedicated to helping small businesses get off the ground, grow, and achieve their goals through education and mentorship. SCORE was established in 1964 and is supported by the U.S. Small Business Administration. The name originally stood for Service Corps of Retired Executives. With a network of over 11,000 volunteers, SCORE is able to deliver services at no charge or at very low cost. It provides volunteer mentors who share experience, as well as technical support online (webinars) and via voice, video calls, and e-mail. SCORE has over 320 local chapters that match entrepreneurs with local mentors. Although the topic of ecosystem services is fairly different from business development, and the ecosystem service corps would have both international and domestic volunteers, SCORE is a useful model of a volunteer network providing technical expertise and mentoring (see www.score.org/about-score).

The ecosystem service corps would begin with a small central operation and pilots in two to four countries. The central operation would provide training, serve as a clearing house for modeling tools, and link members to assignments. It would initially be staffed by a small group of professionals with expertise in ecosystem service assessments and valuations. Applications in pilot countries would rely on junior corps members (graduate students and people early in career), who would often be local members. Central operation professionals, who would often be associated with universities or research centers, would support and guide the junior corps members. Corps members would be paired with local counterparts (government or NGO staff) and would provide training on assembling data, implementing models, and interpreting and communicating results. This would build local capacity, enabling more demand-driven ecosystem service assessments, where local and national governments propose the questions they would like to examine using an ecosystem services framework. Over time, the ecosystem service corps would build up a network of volunteers offering continued support. Flexibility, constant learning, and adaptive, responsive engagement would be the corps' operating principles.

Host locations and sustainable sources of funding are critical to the corps becoming a reality. Possible hosts for the corps include the UN Environment Programme and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). IPBES was established in 2012 as an independent intergovernmental body open to all member countries of the United Nations. The members are committed to building IPBES as the leading intergovernmental body for assessing the state of the planet's biodiversity, its ecosystems, and the essential services they provide to society. IPBES aims to strengthen capacity for the effective use of science in decision making at all levels.

IPBES is working to build technical capacity for the effective use of science in decision making related to biodiversity and ecosystem services. Initiating and hosting an ecosystem service corps would advance IPBES's goals of building capacity to scale up targeted ecosystem service risk and tradeoff analysis, and fostering the sharing and use of data to improve the accuracy, relevance, and influence of ecosystem service assessment and valuation.

The corps would require funding both for a pilot phase as well as to sustain the program over the long term. International aid agencies and bilateral funders interested in poverty alleviation, resilience building, and ecosystem services are likely sources of support for the pilot phase. Long-term funding would require a sustainable source, such as a routine contribution from members of the Natural Capital Coalition or signatories to the Natural Capital Declaration, or a fixed percentage of grants from multinational institutions that focus on ecosystem services.

While the ecosystem service corps will help develop influential information, we also need a targeted and sustained communication effort to promote uptake and raise awareness of ecosystem service benefits. A major communication campaign—communicating the importance of ecosystem services, the risks inherent in losing them, and solutions to sustain them—is at the core of broad uptake of ecosystem service information and consequent investment. Especially in the wake of natural disasters, which often focus sudden attention on lost ecosystem services, a sustained communication campaign can ensure that ecosystem service values remain in the consciousness of decision makers (see section 6 on communicating ecosystem resilience).

3. SCALING UP INVESTMENTS IN NATURAL INFRASTRUCTURE FOR WATER RESOURCES PROTECTION AND COASTAL DEFENSE

TODD GARTNER, JAMES MULLIGAN, LAURETTA BURKE, DAVID MEYERS, JUSTIN KETZLER, AND SYLVIA TOGNETTI

VISION FOR 2025

By 2025, governments and businesses worldwide team up to protect water resources and natural coastal defenses by investing in conserving and restoring forests, wetlands, floodplains, and coastal ecosystems. Investments in this "natural infrastructure," alongside or in lieu of traditional built infrastructure, is recognized as the most cost-effective way to alleviate water-related economic growth constraints and meet urban water needs, as well as protect cities and coastal areas from increasingly severe storms and flooding. Natural infrastructure is increasingly integrated into public and private investment decision making.

BARRIERS AND OPPORTUNITIES

Faced with growing water-related challenges, cities, planning agencies, utilities, and private businesses default to the built infrastructure solutions that they understand and trust. However, built infrastructure often fails to address the root cause of water and coastal defense challenges, which are linked to ecosystem degradation. For example, decision makers may turn to advanced filtration facilities to manage degrading drinking water; costly dredging activities in waterways, ports, and reservoirs to manage increasing sedimentation; and groins and seawalls to compensate for lost natural barriers to storm inundations. In many cases, investment in these built infrastructure components is essential for safeguarding human health and well-being, and may complement natural infrastructure. However, in a number of cases, built investments are more costly and less resilient to extreme events (especially in the face of climate change), and thus less efficient than natural infrastructure alternatives.[34]

In 2012, Hurricane Sandy revealed some of the benefits that natural infrastructure provides. In the wake of the storm, New York City's forested watershed provided clean, gravity-fed water with no interruption in service.[35] Very few people lost potable water.[36] In contrast, New Jersey's damaged pumps, filtration plants, and contaminated intakes left much of New Jersey without potable water for weeks after the storm, and a $2.6 billion tab for water infrastructure, including $342 million for recovery, $553 million for repairs, and $1.7 billion to build resiliency into the systems.[37]

The barriers impeding a broad shift toward natural infrastructure solutions are multifaceted:

- **Decision makers may not understand the benefits of natural infrastructure.** In many cases, decision makers at key institutions and their constituents might not be aware of, or might lack information or tools to evaluate, the multiple benefits of natural infrastructure. In other cases, an organization's primary mission and statutory authority may not promote or even permit consideration of these benefits. These knowledge gaps are difficult to resolve in the face of institutional inertia, silos, and resistance to change. For example, land use plans often fail to consider implications for water resources because land use and water sector plans are typically formulated by separate agencies with different missions and constituencies.

- **Technical capacity as well as evidence may be insufficient.** Even where the full value of natural infrastructure is recognized, water management and coastal planning institutions may lack the technical capacity and resources to identify,

Faced with this combined scientific and valuation uncertainty, many institutions continue to default to more "precise" built solutions, even when these solutions result in greater costs and fewer benefits.

evaluate, cost, and design natural infrastructure options. This challenge is compounded by the inherent uncertainty associated with quantifying the ecological and economic benefits of natural infrastructure; these benefits are highly dependent on the local context, which may rapidly change. Examples include the level of coastal defense provided by mangroves under specific storm scenarios or the degree of water filtration provided by forests in a specific watershed. Faced with this combined scientific and valuation uncertainty, many institutions continue to default to more "precise" built solutions, even when these solutions result in greater costs and fewer benefits.

- **Natural infrastructure projects require extensive coordination (and hence greater effort) with partners beyond the utility.** Built solutions often can be completed "within the four walls" of a water utility, whereas natural infrastructure solutions must often be pursued in collaboration with typically dispersed landowners, sometimes without clear land ownership, as well as among different political jurisdictions.
- **Financing for natural infrastructure projects may be hard to secure.** The challenges outlined above have inhibited (but not precluded) the application of traditional finance mechanisms for natural infrastructure. Vested interests in large engineering solutions may also present a challenge. Furthermore, natural infrastructure cannot be financed as a capital improvement project because, under existing standards for public sector financial reporting, it cannot be counted as an asset. (However, the increased costs associated with the loss of natural infrastructure are a mounting liability and are driving the development of innovative approaches to financing, such as restoration bonds, discussed in section 5.)

SOLUTION

Investments in natural infrastructure can be achieved at a meaningful scale if decision makers in key institutions have the understanding, capacity, tools, and incentives needed to act, as well as effective institutions and adequate resources. This begins with building awareness of the benefits of natural and natural-built hybrid solutions, and the scale of the global investment opportunity. Raising awareness broadly means leveraging national and international associations, regulatory authorities, and civil society groups to reach a broader audience and to lend natural infrastructure credibility from trusted sources of expertise. It also means engaging beyond municipal drinking water, stormwater, and wastewater utilities and disaster management agencies. For natural infrastructure solutions to have a significant impact at a landscape or watershed scale, they need to be implemented over large areas. This will require collaboration and potentially investment from other water beneficiaries, such as hydropower companies, irrigation districts, flood management agencies, insurance companies, manufacturers, port authorities, waterway shipping companies, and others in the public and private sectors. Crucially, expanding awareness means influencing the financiers of water and coastal infrastructure (e.g., development and private banks) with a strong base of evidence about the economic and social benefits.

To increase the use of natural and hybrid solutions for coastal protection, we need to better evaluate, document, and communicate the wave attenuation and flood mitigation benefits of coastal wetlands, mangroves, and oyster and coral reefs. The economic benefits of protecting these coastal ecosystems are very context-specific, and current biophysical models have wide uncertainty ranges. The biophysical relationships will become clearer as science progresses in the coming years, but in the meantime, we can communicate what we already know about the benefits provided by healthy coastal ecosystems. Moreover, uncertainty related to biophysi-

BOX 3.1

COASTAL PROTECTION IN NEW YORK CITY

New York City's shoreline has been radically altered over the past 350 years to accommodate growing populations and maritime commerce. It has been dramatically reshaped, hardened, extended, and deepened, with landfill, seawalls, and piers replacing wetlands and other soft, natural habitat. New York harbor has lost 80 percent of its historic tidal wetlands and virtually all of its 200,000+ acres of oyster reefs.

In late October 2012, Hurricane Sandy, the second most damaging storm in U.S. history, revealed the inadequacies of current coastal defense around New York harbor and raised awareness of the protective potential of many natural coastal habitats. The storm was particularly damaging because of the confluence of a tropical hurricane (moving up the coast), a blocking ridge of high pressure over Greenland, and high spring tides.[a] Storm tide approached 14 feet in the New York City region and shorelines proved ill-equipped. Damage in New York City and on Long Island was major. The storm surge overwhelmed beaches, bulkheads, and seawalls—flooding homes, subways, tunnels, and other infrastructure.

Sandy also revealed stretches of resilient natural infrastructure, with intact sand dunes and wetlands protecting communities and lessening damage in many areas. Communities located behind restored sand dunes (such as in Point Lookout, Lido Beach, Atlantic Beach, Coney Island and Plumb Beach) appear to have experienced less damage than those without protective dunes. A restoration project in Queens, New York has reconstructed 148 acres of salt marsh islands in Jamaica Bay, which provided storm buffering for communities and infrastructure in and around the bay—both by reducing wave energy and slowing current.[b]

The combination of heightened awareness of the benefits of natural, coastal infrastructure, coupled with a shift away from maritime commerce and intensive commercial use of the shoreline presents New York City with an opportunity to reenvision and redesign a resilient shoreline, offering better protection from storms as well as ecological and recreational benefits for residents.

In the wake of Sandy, the "NYS 2100 Commission" and "PlaNYC" have strongly recommended expanded investment in natural infrastructure and in hybrid combinations (of both natural and traditional built infrastructure) to protect New York's shoreline.[c,d] The recommendations include investing in restoration of sand dunes, tidal wetlands, oyster reefs, and in "living shorelines"—each having economic, environmental, and risk-reduction benefits. Tidal wetlands, for example, offer the benefits of reducing wave energy by one-half within the first three meters of marsh width, and, given sufficient sediment deposition, can accrete to keep up with sea level rise.[e] Natural infrastructure is more adaptive than built infrastructure, and from an economic perspective, has lower maintenance and management costs.[f]

The restoration of salt marsh in Jamaica Bay and restoration of dunes along many barrier islands are examples of investment in natural infrastructure that increase resilience and bring ecological and recreational benefits. But much more is needed, and much more is possible. Rising Currents–Projects for New York's Waterfront¸ presents project ideas developed by teams of artists, architects, and designers focused on preparing New York Bay's shoreline for future climate conditions.[g] Innovative ideas include development of oyster aquaculture in Brooklyn, with combined benefits of improving water quality (an oyster filters about two gallons per hour), coastal protection (provided by transplanted oysters building a reef), community-based development in this commercial enterprise, and ultimately, shellfish production.[h] A more resilient living shoreline is possible.

Notes: a. Halverson, J., and T. Rabenhorst. 2013. "Hurricane Sandy: The Science and Impacts of a Superstorm." Weatherwise. Available at: <http://www.weatherwise.org/Archives/Back%20Issues/2013/March-April%202013/hurricane-sandy-full.html>.
b. New York State Sea Level Rise Task Force. 2010. New York State Sea Level Rise Task Force: Report to the Legislature. Available at: <www.dec.ny.gov/docs/administration_pdf/slrtffinalrep.pdf>.
c. NYS 2100 Commission. 2013. "Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure." Available at: <www.governor.ny.gov/assets/documents/NYS2100.pdf>.
d. PlaNYC. 2011. A Greener, Greater New York. New York: City of New York. Available at:< http://s-media.nyc.gov/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf >.
e. NYS 2100 Commission 2013. (note c). f. Gartner, T., J. Mulligan, R. Schmidt, and J. Gunn. 2013. Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States. Washington, DC: World Resources Institute. (pg. 21.) Available at: <http://www.wri.org/publication/natural-infrastructure>.
g. Bergdoll, B. 2012. Rising Currents: Projects for New York's Waterfront. New York: The Museum of Modern Art.
h. Ross, M. 2012. "Bringing the Oysters Back to New York Harbor." Grist. Available at: <http://grist.org/food/bringing-the-oysters-back-to-new-york-harbor>

cal relationships can be addressed and communicated through scenario development and sensitivity analysis and other statistical approaches. [38]

In the freshwater context, pilot efforts and analyses of the benefits and cost-effectiveness of natural infrastructure are raising awareness in key institutions and among engineers and financiers—not just ecologists and hydrologists. Several large development banks and aid agencies are developing programs and planning investments in natural infrastructure, and public-private partnerships are forming to investigate opportunities on the ground. Natural infrastructure is becoming a common theme in industry conferences worldwide (see www.watershedconnect.com/projects/ for examples). Natural infrastructure is even gaining traction in areas that are water-scarce and prone to drought, as seen in agroforestry efforts throughout sub-Saharan Africa.[39] With momentum slowly growing, support for and replication of these efforts over the next five years could bring natural infrastructure to a critical tipping point as a mainstream strategy for freshwater management.

We propose a three-step roadmap for raising awareness and radically expanding investment in natural infrastructure:

1. More Success Stories, Better Measures, Smarter Communication

The first step is to better document and disseminate the ecological and economic as well as social benefits of natural infrastructure. There are success stories from around the world, including source water protection investments in the United States, several water funds in Latin America, pilot efforts in Africa and Asia, and a new database that documents the performance of natural coastal defense projects (see Box 3.2 for an example of a water fund in Brazil).[40, 41, 42] As a critical mass of these success stories develops, key institutions will be able to find parallels that match the physical, ecological, social, or economic context of their watershed or coastal area. To have the greatest impact, these success stories should be not only anecdotal and modeled, but also *measured and documented*. This will require measurement of baseline/pre-intervention biophysical conditions and robust monitoring of outcomes over time. Presently, measuring and monitoring are sometimes foregone because of resource limitations, but the institutional capacity to perform these tasks should be developed as a vital component of natural infrastructure initiatives.

In addition to success stories, robust tools for context-specific quantification and comparison of the benefits of natural, built, and hybrid solutions will, in many cases, enable faster adoption of the natural infrastructure evaluation approach. Several tools are already available and continually improving. These include the Natural Capital Project's InVEST (www.naturalcapitalproject.org/InVEST.html) and several more traditional watershed models, such as:

- the Soil and Water Assessment Tool (http://swat.tamu.edu/)
- the Hydrological Simulation Program-FORTRAN (http://www2.epa.gov/exposure-assessment-models/hspf)
- the Generalized Watershed Loading Function (www.avgwlf.psu.edu/)

In addition, new technologies have made it possible to develop better tools for monitoring landscape changes, such as those made available through Global Forest Watch,[43] which unites satellite technology, open data, and crowdsourcing to guarantee access to timely and reliable information about forests. These technologies are complemented by economic analysis tools, such as the World Resources Institute's Green-Grey Analysis, which provides decision makers with a methodology to compare the benefits and risks of natural (green) infrastructure approaches alongside or instead of built (grey) infrastructure approaches.[44]

2. Demonstrate the Scale of Opportunity

Step two is to demonstrate the scale of the opportunity through spatial analysis and risk assessment. This step is critical for demonstrating where, for example, freshwater risk and ecosystem restoration opportunities overlap, or where low-lying coastal areas and coral reef protection or restoration opportunities overlap. This analysis will help prioritize where natural infrastructure investments are most applicable and highlight specific opportunities. Moreover, it will emphasize the importance of the approach to key institutions with interests and influence that span across watersheds and cities, such as international industry associations, development and private banks, international aid agencies, and national governments.

BOX 3.2

WATER FUNDS IN BRAZIL

With a population of 20 million people, the Greater São Paulo Metropolitan Region is Brazil's largest and most important financial area, but it is facing a critical water shortage and unprecedented drought. About half of São Paulo's water is supplied by the Cantareira water supply system, which was reported to be at 3.3 percent of capacity as of late October 2014.[a] This water supply draws from the heavily deforested Piracicaba-Capivari-Jundiaí (PCJ) watershed, from which almost 70 percent of the native vegetation has been cleared, including forests in hydrologically sensitive areas such as riparian zones and steep slopes.[b] The resulting soil erosion and sedimentation negatively impact the quality, quantity, and timing of the freshwater supply. Moreover, polluted tributaries and reservoirs in the PCJ watershed ultimately affect the Cantareira system, increasing water treatment costs and reducing the lifespan of reservoirs.

In response to this degradation, the Brazilian Water Agency (ANA), The Nature Conservancy (TNC), the São Paulo State Environmental Agency (SMA-SP), and the Extrema Municipality implemented the Water Producer Program (WPP) in the PCJ watershed in 2006. The WPP compensates landowners for preserving forests in hydrologically critical areas, advises on best practices, and supports restoration projects. In the PCJ watershed, landowners are paid $38 per acre (~$95 per hectare) per year for conserving forests. This program is financed by the Extrema municipal budget as well as rates paid by water users. The WPP initiative is part of a larger PCJ water fund, which in turn is part of the Latin American Water Funds Partnership (made up of TNC, the FEMSA Foundation, the Inter-American Development Bank, and the Global Environment Facility).

As of 2013, approximately 340 hectares of critical wetlands and riparian zones have been restored, and more than 1,160 hectares have been protected under the Water Fund. Building off of this early success, TNC has proposed protection and restoration of at least 14,300 hectares of hydrologically sensitive land, which is necessary to significantly improve water quality and quantity. According to TNC projections, protection of 14,300 hectares would reduce sedimentation by 50 percent, increase the longevity of the Cantareira reservoir system, and save $2.5 million/year.[c]

New types of arrangements for managing water resources are becoming increasingly critical in the face of growing populations and increased water insecurity in the context of a changing climate. The PCJ water fund is demonstrating the quantifiable economic benefits of the natural infrastructure approach toward meeting these challenges. It has also enhanced cooperation between upstream and downstream rural and urban communities, as urban water users recognize reduced risk and costs associated with their drinking water supply, while rural communities receive incentives and payments that supplement their income. In addition, the water fund has made it possible to bridge the gaps between civil society and government entities. Accordingly, water funds and similar approaches are being replicated throughout Latin America and other regions.

Notes: a. See: < http://www.businessweek.com/news/2014-10-21/sao-paulo-warned-to-brace-for-more-dramatic-water-shortages>.
b. Guimarães, J. 2013. "Application of InVEST`s Sedimentation Retention model for restoration benefits forecast at Cantareira Water Supply System." The Nature Conservancy. Available at: <http://ncp-dev.stanford.edu/~dataportal/natcap/NatCap%20Publications/Invest_Sediment_Retention_Cantareira.pdf>.
c. The Nature Conservancy. 2012. "Water Funds Business Case: Conservation as a Source of Comparative Advantage." Available at: <http://www.watershedconnect.com/documents/files/water_funds_business_case.pdf>.

3. Work toward Institutionalization at Key Leverage Points

Concurrently with step two, proponents of the natural infrastructure approach must move beyond raising awareness toward embedding the natural infrastructure approach in key institutions with global reach and influence. Proponents should also engage with national processes and institutions, and support the development of new capacities at all levels. This can be done, for example, by influencing International Finance Corporation Performance Standards or lending practices at development banks. It can also be accomplished through the preparation of guidance documents for resource management agencies, multinational corporations, and international industry associations.[45] Partnerships between NGOs and these audiences can help expand understanding of the approach, identify and evaluate specific opportunities, develop better finance mechanisms, and guide pilot development and implementation. These

partnerships can also be used to share critical lessons-learned with a broader community of practitioners and to mobilize a network of "champions" to replicate success stories in their own watersheds and coastal areas. Partnership networks can also rally public and private institutions around matching commitments to the approach.

GETTING STARTED

A cohort of NGOs and international organizations—including WRI, The Nature Conservancy (TNC), the International Water Association, the World Wildlife Fund, Forest Trends, the United Nations Environment Programme, and the International Union for Conservation of Nature—are already making progress raising awareness and encouraging investment in natural infrastructure for freshwater. Similar efforts to document and scale up the benefits of natural infrastructure for coastal defense are under way, led by TNC, the Natural Capital Project, WRI, the WAVES partnership, and others.[46] Recent storms underscore the need for coastal protection, lending new urgency to these efforts (see Box 3.1 on coastal protection in New York City).

For natural infrastructure approaches to take hold on a larger scale, advocacy efforts should coalesce around a unified four-part agenda:

- Capture the attention of the international bodies that set investor standards (such as the Equator Principles and IFC Performance Standards), development banks, and financing institutions.
- Convene global conferences that raise awareness and share best practices.
- Influence engineering and urban planning programs to expand their training and continuing education curricula to include natural capital.
- Increase awareness of natural infrastructure approaches among landowners and managers through extension offices, training, and peer-to-peer communications.

This agenda includes educating investors in both the public and private sectors.

Natural infrastructure is more adaptive than built infrastructure, and from an economic perspective, has lower maintenance and management costs.

4. SCALING UP CORPORATE INVESTMENTS IN ECOSYSTEMS TO SECURE VITAL RAW MATERIALS FOR THE FOOD AND BEVERAGE SECTOR

SUZANNE OZMENT, JANET RANGANATHAN, AND PAUL REIG

VISION FOR 2025

By 2025, leading companies in the food and beverage sector are proactively managing ecosystem services business risks in ways that reverse ecosystem degradation. As a result, companies improve food and water security, primarily through the adoption of three approaches:

- Conducting routine ecosystem service dependence and impact assessments on corporate operations and supply chains
- Establishing public corporate-wide goals and plans to manage ecosystem risks and capitalize on opportunities
- Investing in large-scale watershed and landscape management and restoration efforts through partnerships with suppliers, other companies, local stakeholders, and relevant national and local governments

This pathway focuses on the food and beverage sector, given its high dependence on ecosystem services and its significant contribution to the direct drivers of ecosystem degradation. However, the proposed approach can be applied to other sectors that depend on and impact ecosystems.

BARRIERS AND OPPORTUNITIES

Demand for land, food, and water is accelerating, driven by an increasing population and growing global middle class. This, in turn, is driving overexploitation, loss, and degradation of ecosystems. Ecosystem service loss and degradation is compounded by climate change. For example, Brazil's 2014 drought caused the global price of coffee to spike by 50 percent due to concerns about low yields, forced more than 20 million people to ration water, stymied beverage production, and inhibited river transport of agricultural products.[47] Experts assert that the drought was caused by climate change and Amazon deforestation, which have severely degraded regional climate regulation and water storage ecosystem services.[48] The unpredictable provision of water and raw agricultural materials under changing climatic and ecological conditions can incite price volatility, disrupt supply chains, and increase costs.

Nearly all companies depend on or impact ecosystem services somewhere in their value chain. The tourist industry benefits from the recreational services provided by nature. Hydroelectric companies depend on a regular supply of water. And the insurance industry benefits from the natural hazard protection services of coral reefs and wetlands to protect coastal property. The food and beverage sector is especially dependent on healthy ecosystems for the services they provide. The beverage industry depends on a regular supply of freshwater, while the food sector depends on freshwater, pollination, pest control, and erosion control services to support food production.

Despite this high dependence on healthy ecosystems, businesses in the food and beverage sector do not always make the connection between healthy ecosystems, climate change impacts, and their bottom line. This is because ecosystem risks threatening the food sector are primarily one step removed from the companies' own operations, buried in disparate global agriculture supply chains or upstream watersheds. In addition, corporate environmental management systems and environmental

due diligence tools primarily focus on environmental impacts such as pollution and natural resource consumption, overlooking the fact that environment is a two-way street. Companies impact the environment, but changes to the environment also impact companies, creating risks and opportunities from their dependence on ecosystems and the services they provide.[49]

While a few companies have set goals for biodiversity and ecosystem conservation, such initiatives have had limited impact in halting and reversing ecosystem degradation. Certifications and procurement policies can help reduce environmentally detrimental practices, but are typically not designed to address risks that require interventions at the landscape level rather than at the farm level.[50] While there has been a proliferation of ecosystem service assessment and management tools to help companies assess ecosystem service risks, their use has mostly been limited to one-off demonstration projects,[51] with an emphasis on reducing environmental impacts, such as deforestation.

SOLUTION

We propose a three-fold approach for food and beverage companies to scale up investments in natural capital:

TABLE 4.1

SAMPLE OF ECOSYSTEM SERVICE BUSINESS RISK ASSESSMENT TOOLS

Name	Primary Focus	Approach
Corporate Ecosystem Service Review (ESR)[a]	What ecosystem services does my company depend on and impact, and how can the associated risks and opportunities be incorporated into business strategy?	Qualitative assessment guidelines
The Guide to Corporate Ecosystem Valuation (CEV)[b]	How can I carry out ecosystem valuation in a business context, using a step-by-step process?	Quantitative and economic assessment guidelines
InVEST[c]	What is the spatial distribution and value of ecosystem services on a site?	Quantitative and economic model
Aqueduct[d]	How and where are water risks emerging worldwide?	Quantitative indicators and interactive mapping platform
Trucost "Natural Capital at Risk"[e]	Ranks the Top 100 business environmental externalities worldwide, by region, sector, and type of impact, based on estimated external cost.	Screening list of top 100 geographic regions most impacted by business

Notes: a. www.wri.org/ecosystems/esr>.
b. World Business Council for Sustainable Development (WBSCD). 2011. Guide to Corporate Ecosystem Valuation. Geneva: World Business Council for Sustainable Development.
c. The Natural Capital Project. 2007. "Integrated Valuation of Environmental Services and Tradeoffs." The Natural Capital Project. Available at:<http://www.naturalcapitalproject.org/InVEST.html>.
d. WRI. 2013. "Aqueduct." World Resources Institute. Available at:< http://www.wri.org/our-work/project/aqueduct>.
e. Trucost. 2013. Natural Capital at Risk: The Top 100 Externalities of Business. London: Trucost.

1. Identify ecosystem service risks and opportunities

There are a number of tools that help companies and investors identify the risks and opportunities associated with their dependence and impacts on ecosystem services (see Table 4.1). Applying these tools is a good first step for a company to incorporate ecosystem service considerations into its decisions. Companies can incorporate these tools in existing management systems, such as goal setting, procurement, site management, project planning, or environmental management systems.[52] Similarly, investors can encourage their clients in the food and beverage sector to assess ecosystem service-related risks by applying lending conditions requiring ecosystem service risk assessments and disclosure of the results. The International Finance Corporation and signatories to the Equator Principles have already adopted such requirements. Furthermore, forty-one financial institutions representing an excess of US$6.4 trillion in total assets have signed The Natural Capital Declaration, which commits to integrating ecosystem service considerations into lending requirements.[53]

2. Set public targets to manage ecosystem service risks and opportunities

Companies should develop and disclose objectives and targets for increased stewardship of ecosystems and the services they provide. These objectives should align with the company's core business strategies and policies. While objectives are time-bound goals, targets are detailed performance requirements that need to be met in order to achieve the objectives. Public disclosure of these objectives and targets ensures transparency and accountability to external stakeholders.

Net-positive objectives might seem "above the call of duty" and challenging to achieve, but in fact, these targets can create significant benefits for communities and companies alike. Companies in non-food and beverage sectors have already started adopting net-positive goals in order to secure a sustainable supply of raw materials, as well as to burnish their brands. For example, to meet its net-positive environmental goals, Kingfisher, Europe's largest home improvement store, set targets to source 100 percent sustainable timber products by 2020 and to reforest more land than is deforested to feed its supply chain.

To date, to the best of our knowledge no food and beverage company has set goals of having net-positive impacts on ecosystems. Some of the most ambitious goals set within these sectors include:

- Corporate members of the Consumer Goods Forum (CGF) have pledged to work toward "zero net deforestation" by 2020 within their palm oil, soya, beef, paper, and board supply chains. This means CGF companies will avoid deforestation linked to commodities in their supply chains, and help restore forests commensurate with the amount that is lost. These companies are currently devising time-bound action plans to achieve this goal.
- By 2017, AB InBev aims to engage in watershed protection measures at 100 percent of their facilities located in key areas in Argentina, Bolivia, Brazil, China, Mexico, Peru, and the United States, in partnership with local stakeholders.[54]
- Walmart has set a goal of 100 percent sustainably sourced palm oil for all Walmart private brand products globally and zero-deforestation beef by the end of 2015.[55]
- Coca-Cola has pledged to improve water efficiency by 25 percent and safely return to communities and nature an amount of water equal to what it used in its finished beverages and their production by the 2020. The company is working in eleven key regions across five continents to help ensure healthy and resilient freshwater sources.[56] They have made progress on this target by systematically implementing "Source Water Vulnerability Assessments," which gauge risks to the watersheds where they operate and determine suitable corporate responses to those risks.

The emergence of ambitious corporate goals and targets to reduce ecosystem service risks will help measure progress toward the vision of this initiative and to prioritize efforts. To actualize these goals, it is critical for companies to engage suppliers, local communities, and other stakeholders to coordinate actions that achieve lasting positive impact. Approaches to getting started on driving collective action are discussed in the following section.

3. Co-invest in large-scale watershed and landscape management efforts

Two types of approaches can support large-scale watershed and landscape management of ecosystems: verti-

cal integration of supply chains and horizontal integration of ecosystem service users within a landscape.

Vertically integrate ecosystem service stewardship in supply chains

Ecosystem service dependence and the associated business risks are especially significant in agricultural supply chains of food and beverage manufacturers.[57] For example, realizing that most of the water footprint in a bottle of Coca-Cola takes place during the agricultural production of sweeteners,[58] the Coca-Cola Company is implementing its Sustainable Agriculture Guiding Principles and is expanding its collaboration with WWF and other organizations to deeply engage its value chain in natural resource protection.[59]

Vertical integration refers to the degree of control a company has over its suppliers to help secure a reliable, high-quality supply of raw materials. This management principle applies to securing a supply of vital ecosystem services (see Box 4.1). To minimize business risks and secure access to essential ecosystem services, companies should work collectively and coinvest with industry and government to encourage and support suppliers to source and produce raw materials in ways that protect, restore, and sustain natural capital. To do so, companies will need to engage key producers, traders, distributors, and other intermediary suppliers of raw materials and increase traceability in the supply chain. Specifically, companies can provide technical assistance, share the cost of implementing new practices and technologies, and support research to develop new approaches that can help suppliers halt and reverse ecosystem degradation.

Horizontally integrate ecosystem service users regionally

Natural resources are shared, creating competition among users to access ecosystem services. This can lead to overconsumption of some ecosystem services and degradation of others. Because of this, the actions of other actors as well as changes in natural conditions in the watershed can create ecosystem service risks that are outside the direct control of a company. To address these risks, companies need to coordinate landscape interventions with multiple stakeholders in order to secure and protect ecosystem services over time (see section 3 on Natural Infrastructure.) Likewise, companies should develop an understanding of how the actions of others in the landscape affect key ecosystem services important to their business.

Horizontal integration refers to when a company increases coordination with other actors at the same level, in order to reduce competition or because cost advantages increase with scale. Such an approach can apply to managing ecosystem services within a landscape or

BOX 4.1

VERTICALLY INTEGRATING ECOSYSTEM SERVICE MANAGEMENT IN WALMART-BRAZIL'S BEEF SUPPLY CHAIN

Agricultural activities threaten the very ecosystem services that food and beverage companies depend on. For example, 80 percent of Amazon deforestation is attributed to conversion of forest for beef production. This deforestation has changed the region's climate and has undermined the viability of some farms and ranches in the region, jeopardizing beef supply to companies like Walmart.[a]

To help its suppliers halt natural ecosystem loss and ensure the delivery of raw materials in the future, Walmart-Brazil is working with suppliers to develop a new model of responsible beef production that contributes to the preservation of the Amazon River basin without reducing beef supply and productivity.[b] Consistent with these efforts, the company will align with other programs that are creating the incentives necessary to scale up sustainable beef production in Brazil, such as the Brazilian Roundtable on Sustainable Livestock and the Global Roundtable for Sustainable Beef. Walmart has committed to not buy any beef from deforested areas in the Amazon River basin in its global operations by 2015, and has adjusted standard purchasing procedures to reflect this goal.[c]

Notes: a. Senna, M., et al. 2009. "Vegetation-atmosphere-soil nutrient feedbacks in the Amazon for different deforestation scenarios." *Journal of Geophysical Research*, vol. 114, and Schneider, R., and C. Diewald. 2008. "Update Assessment and Country Analysis on Section 118/119 of the Foreign Assistance Act: Tropical Forestry and Biodiversity Conservation in Brazil." Washington, DC: U.S. Agency for International Development.
b. Ozment, S. 2013. *The Corporate Ecosystem Services Review Case Study: Walmart Brazil.* Washington, DC: World Resources Institute.
c. Walmart. 2010. "Walmart unveils sustainable agriculture goals." Walmart press release. Available at: <http://news.walmart.com/news-archive/2010/10/14/walmart-unveils-global-sustainable-agriculture-goals>.

watershed (see Box 4.2). Companies should work with important stakeholders that influence and use common ecosystems within a region to agree on performance indicators, assess risks, set targets, and take collective action to improve the health of ecosystems and the long-term availability of the services they provide.

GETTING STARTED

Actualizing the three-fold approach to scaling up corporate investments in ecosystem services necessitates a significant transformation of business sustainability efforts worldwide. Today, most companies regarded as leaders in ecosystem service stewardship are still conducting qualitative assessments of ecosystem services and engaging in isolated stewardship activities. Few companies, if any, have fully integrated ecosystem service considerations into core business decisions and strategies.

How do we move from a world of isolated, small-scale corporate efforts to protect ecosystems, toward a world where corporate investments in ecosystems to secure vital raw materials and reduce ecosystem service risks are considered business as usual? As a first step, companies can assess their dependence and impacts on ecosystem services, identifying key ecosystem services for each main geography and value chain where the company has operations or investments. They can leverage existing assessment tools (Table 4.1) and programs—such as the Natural Capital Hub, The Natural Capital Coalition, Natural Capital Leaders Platforms, Brazilian Business and Ecosystem Services Partnership, and other corporate partnerships—to receive technical support from sustainability organizations and learn from other companies. It is important to note that assessment alone does not necessarily result in on-the-ground improvements in management of ecosystem services—companies must also set targets and advance on-the-ground projects in priority regions and supply chains to secure raw materials through ecosystem management.

Industry associations and investors can influence or support companies' sustainability initiatives, and therefore have a role to play in setting the conditions for companies to succeed at reducing business risks due to ecosystem change. For example, NGOs with corporate memberships—such as Ceres, Consumer Goods Forum, WWF, World Business Council for Sustainable Development, or Business for Social Responsibility—can actively encourage their members to use ecosystem service risk assessments.[60] Table 4.2 identifies the first steps that companies, investors, and commodity-specific associations and industry groups can take to make progress toward the vision.

While the solution described here focuses on the provision of tools to convince companies to assess and set goals that take into account ecosystem value, companies can also take advantage of approaches suggested in other pathways included in this brief. These include the use of restoration bonds to finance landscape-level restoration efforts (see section 5). In addition, a sustained communications campaign focused on ecosystem values can help ensure ecosystems are on the corporate agenda.

BOX 4.2

HORIZONTALLY INTEGRATING ECOSYSTEM SERVICE MANAGEMENT IN UNILEVER'S TEA PRODUCTION AREAS

Unilever Tea Kenya (UTK) relies on regular rainfall throughout the year to produce a high-quality tea. In 2000, the company became aware of impending water scarcity at its plantations in the Mau Forest, when the cumulative impacts of unrestricted overlogging for firewood and clearing of land for farms began to affect rainfall patterns and water availability within the forest. Since the ecosystem change threatening water supply occurred across a large landscape, UTK's only option to reverse this trend was to engage those who were degrading forests and the ecosystem services that forests provide. It set out to encourage the reforestation of the region around its plantations. To support this effort, UTK established a large program to grow indigenous seedlings and donate them to the surrounding farmers and communities for planting. Since 2001, 850,000 trees have been planted to help protect regional water supplies.[a]

Notes: a. Unilever. 2009. "Unilever Tea Kenya Limited Avifaunal Assessment Report." London: Unilever Global.

TABLE 4.2

CALL TO ACTION FOR COMPANIES AND INVESTORS

Actor	Call to action	Example
Companies	Companies must first assess their dependence and impacts on ecosystem services, and identify key at-risk commodities, production plants, and geographies on which the business relies. Understanding these baseline conditions for priority areas will provide the foundation for managing and scaling up ecosystem service investments to reduce business risks and increase natural resource stewardship.	AB InBev has set a 2017 goal to engage in watershed protection measures at 100% of their facilities located in priority areas in Argentina, Bolivia, Brazil, China, Mexico, Peru, and the United States, in partnership with local stakeholders.
Investors	Investors in the food and beverage sector call for greater use and public disclosure of ecosystem service risk assessments and development strategies across their portfolio of investments. Investors can also support the creation of green bonds and impact funds (see section 5) to encourage increased investment in natural infrastructure, aiming to generate environmental, social, and financial returns.	The Livelihoods Fund, a pioneering carbon asset investment fund worth roughly US$46 million, finances projects in reforestation, sustainable farming to enhance soil fertility, the water cycle, and biodiversity to encourage effective and sustainable production methods.[a] Livelihood's corporate partners then guarantee a market for sustainable products produced through Livelihood's projects, ensuring project sustainability.
Commodity-specific associations & industry groups	Commodity-specific associations and industry groups should help coordinate large-scale horizontally integrated restoration efforts in countries where multiple member companies have an interest. Industry groups can also play a key role in broadly sharing good practices and information on the financial advantages of private investments in natural capital. Industry groups can also monitor and report aggregate hectares under improved management, dollars invested, and dollars saved through avoided costs to provide information on their industry sector's progress toward halting and reversing ecosystem degradation.	Twelve of the world's largest chocolate companies are partnering with the national governments of Côte d'Ivoire and Ghana, where the majority of the world's cocoa is grown, to form CocoaAction, a collective action effort to reach 300,000 cocoa farmers across the region to help address ecosystem degradation and align sustainability initiatives.[b]

Notes: a. The Livelihoods Fund Website. Available at: <http://www.livelihoods.eu/about-us/>.
b. Best, Dean. "AFRICA: Industry in new cocoa sustainability pledge." May 22, 2014. Available at: <http://www.just-food.com/news/industry-in-new-cocoa-sustainability-pledge_id126869.aspx>.

Progress toward the vision can be measured based on the plans, commitments, and investments companies make over the next ten years. The payoff to companies promises to be significant: enhanced corporate reputation, improved business resilience, secure supply chains, and more sustainable communities, watersheds, landscapes, and seascapes.

5. RESTORATION BONDS: A CATALYST TO RESTORE ECOSYSTEM SERVICES IN AGRICULTURAL LANDSCAPES

ROBERT WINTERBOTTOM, DAVID MEYERS, RICARDO BAYON, LUC GNACADJA

VISION FOR 2025

Through "restoration bonds", by 2025 millions of smallholder farmers have received the financial and technical support needed to shift from nonsustainable agricultural practices that contributed to land degradation, to improved practices that protect, sustain, and restore ecosystem services in agricultural landscapes. These farmers have adjusted their farming practices to enhance the flow of clean water and to improve flood control, soil fertility, and other ecosystem services as an integral part of the sustainable production of food and other goods. Governments and financial institutions recognize the value of investing in smallholder farmers to enhance the flow of ecosystem services while simultaneously reclaiming degraded land, lowering greenhouse gas emissions from agriculture, and sustainably boosting crop production. Large amounts of capital are being mobilized to scale up the adoption of improved land and water management practices that are good for people, the planet, and profits.

Innovative financing approaches have grown from a few pilot applications to a key tool for providing farmers low-cost access to technical knowledge and capital. Governments have established market conditions that support smallholders investing in the adoption of improved farming practices and adopting new modes of more sustainable crop production by eliminating subsidies for nonsustainable agricultural practices. Governments have also encouraged the emergence of markets for ecosystem services and facilitated access to new types of financing known as "restoration bonds" through the adoption of policy, institutional, and regulatory reforms that recognize the value of ecosystems and increase the flow of revenues tied to the protection, management, and restoration of ecosystem services on farms.

BARRIERS AND OPPORTUNITIES

With projected population growth and anticipated shifts in diets, the world will need to produce nearly 70 percent more food calories in 2050 than in 2006.[61] Yet, nearly two-thirds of the world's agricultural land is already degraded to some degree.[62] Agriculture and associated deforestation and other land use changes are the source of 24 percent of global GHG emissions.[63] Agriculture also accounts for 70 percent of all freshwater withdrawals.[64] Across many agricultural landscapes, extensive areas have been degraded by loss of vegetative cover, high rates of rainfall runoff and soil erosion, as well as nonsustainable modes of cropping and livestock production. There is an urgent need to both address the drivers of degradation and enable the adoption of more sustainable farming practices.

Given the scale of existing demands on natural resources and impacts on ecosystems, it is imperative that future strategies to meet the growing demand for food eliminate and even reverse agriculture's negative impacts on the planet. This requires that agriculture be transformed from a primary driver of ecosystem degradation and climate change to a force for reducing rural poverty and securing the livelihoods of rural communities while restoring the long-term productivity of land and the underlying health of agroecosystems.

What does land degradation look like? Soil organic matter and nutrients have been depleted, and the misuse of pesticides, herbicides, and other chemicals and mechanized cultivation have in many cases undermined the resilience of agroecosystems. Land degradation has adversely impacted growth in crop yields (particularly in sub-Saharan Africa), and the aggregate negative

impacts of agriculture on land and water resources have grown, along with the greenhouse gas (GHG) emissions associated with food production.[65]

The widespread emphasis on short-term gains in crop yields has overshadowed concerns about long-term, cumulative impacts on soil fertility, water quality, and the loss of other ecosystem services provided by healthy agroecosystems. Many farmers recognize these problems but are constrained in their ability to implement solutions. Developing innovative approaches to mobilize financing needed by smallholder farmers to reverse the degradation of cropland is critically important.

Four primary barriers discourage many smallholder farmers, particularly in developing countries, from shifting to more sustainable practices that restore and maintain the underlying ecosystem services and productivity of agricultural landscapes:

1. Lack of knowledge and technical support on sustainable land and water management practices, which help farmers to adapt to climate change.

Farmers may face difficulties obtaining assistance with soil testing and implementing integrated soil fertility management practices. They may not have access to guidance on regeneration methods and appropriate species for restoring agroforestry systems. Technical support to facilitate farmer adoption of rainwater harvesting, efficient drip irrigation systems, or integrated pest management may be limited or unavailable.

2. Limited access to equipment and other inputs.

Farmers may lack access to the labor-saving equipment or other inputs that enable the adoption of improved practices. Funds are needed to purchase specialized equipment for no-till farming along with relatively small amounts of herbicides needed for short-term use to facilitate the transition from conventional plowing to conservation agriculture, and equipment and supplies needed for efficient water management or for value-added processing of agroforestry products may not be available.

3. Risk aversion: existing investment vehicles and commercial banks may be reluctant to provide capital.

The gaps in information needed to make the business case for adopting these measures may inhibit investment in these practices. The complexity of investing in smallholder farmers in developing and emerging economies may also discourage investment. Even when farmers are persuaded of the benefits of shifting their production approaches, they may be reluctant or constrained in their ability to use conventional bank loans.

4. Shortcomings in government policies and lack of favorable enabling conditions for innovative financing of restoration.

National governments often fail to account for the socioeconomic costs of land degradation, and do not capitalize on restoration opportunities because the economic benefits and returns on restoration investments have not been well-quantified. Government policies and regulations may also contribute to the problem by providing perverse incentives that degrade agroecosystems and by creating barriers to the adoption of sustainable and improved farming practices. Forestry regulations and land tenure systems in many countries discourage farmers from regenerating and managing trees on farms as part of more resilient and diversified farming systems that incorporate agroforestry practices.[66] In some countries, high rates of subsidy for mineral fertilizers discourage innovative and alternative methods to replenish and maintain soil fertility and contribute to long-term problems of soil degradation.[67]

SOLUTION

The idea for "restoration bonds" emerged from a search for approaches that could address the root causes of land degradation and help smallholder farmers overcome the primary barriers to the adoption of more sustainable farming practices. Restoration bonds build on the experience gained to date with innovative financing instruments such as "green bonds", which link the issuance of a bond to environmentally friendly investments. Markets for green bonds are reportedly booming; in 2012 some $3 billion of green bonds were sold, and the market is projected to account for $50 billion in investment by the end of 2014.[68]

Governments or financial institutions could issue restoration bonds to serve three objectives:

By providing smallholders access to financial and technical support, restoration bonds would reward both farmers and investors with long-term returns generated by the increased farm productivity and flow of ecosystem services associated with improved farming practices.

1. **Provide a financial return** for investors that accounts for major risks to both investors and farmers.
2. **Contribute to environmental sustainability objectives** by restoring ecosystem services and increasing resilience of agricultural production by smallholder farmers in the face of climate change.
3. **Support social and economic goals** by providing a means for farmers to shift toward more secure and sustainable livelihoods and higher incomes.

Restoration bonds would encourage the financial support that smallholders may need to adopt sustainable land management practices and organize payment for ecosystem services across agricultural landscapes (see Box 5.1). By providing smallholders access to financial and technical support, restoration bonds would reward both farmers and investors with long-term returns generated by the increased farm productivity and flow of ecosystem services associated with improved farming practices. Farmers would benefit from cost savings in farm operations as inefficiencies in the use of water, nutrients, and other inputs were reduced and as reliance on expensive inputs declined following the adoption of more sustainable practices. Farmers would also benefit from the adoption of improved land and water management practices that halted and reversed land degradation and increased the productivity of the farming system. As the flow of valued ecosystem services across agricultural landscapes is restored and increased, farmers could benefit from the sale of marketable ecosystem services, such as added carbon storage (in soils and in trees in agroforestry systems), and secured water supplies (as erosion and runoff are controlled and infiltration and storage in groundwater are increased). And in return, farmers could share a portion of these increased revenues with the investors that financed the bonds and with the institutions providing technical support.

Restoration bonds could play a key role in reducing several critical barriers that smallholder farmers face in adopting sustainable land and water management practices. These include the lack of knowledge and technical support for sustainable practices, and limited access to finance and other inputs.

How would restoration bonds work?

- A restoration bond broker would approach private sector investors interested in restoring degraded agricultural landscapes. The broker and investors would discuss the anticipated returns and other benefits from investing in the shift toward more sustainable agricultural practices and the restoration of ecosystem services across agricultural landscapes. A well-regarded foundation would insure the first generation of pilot bonds, until the bonds established a track record that attracts investors. Financial services companies, development assistance agencies, governments, or NGOs would issue bonds for a specified amount with an estimated return that would be favorable to investors (this will be determined by an analysis of the opportunity and risks). To reduce and manage risks for the farmer and the investor associated with climate change and other factors, insurance would be provided as part of the restoration bond package.
- The financing would then be made available to farmers who want to shift to more sustainable practices, and who have applied for the bond, been approved, and have agreed to the repayment terms. The capital mobilized through the bond would then be used to access both financial and technical support for participating farmers to adopt agreed-upon improved practices in a targeted landscape.

- Management of the farmer qualification criteria, application process, review and approval of plans for improved practices, and issuance and repayment procedures on the ground would be the responsibility of either an NGO, a microfinance institution specialized in sustainable farming, a large cooperative or farmer association, or a for-profit farmers company.

Through collaboration with the investors and facilitators of restoration bonds, farmers and extension services would have access to **decision-support tools** and other support for restoration bonds, to help demonstrate the feasibility and value of the improved practices. Such tools and support include:

- **Landscape analysis and farming system diagnostic tools** to identify key drivers or contributors of land degradation and loss of ecosystem services associated with current farming systems. Tools can also identify alternative, cost-effective practices that could help farmers to boost long-term productivity while generating other benefits. The resulting information would set the stage for the adoption of both regional landscape and farming systems plans to transition to more sustainable, ecosystem-friendly agricultural practices.
- **Consultation and technical support** to innovative farmers to identify specific opportunities that could be supported by restoration bonds. Support should also focus on developing plans for shifting production systems to more sustainable practices while enabling farmers to repay investors in the restoration bonds.
- **Financial planning tools** to evaluate year-by-year the expenses and returns of a restoration bond. Financial planning tools can also help track the longer term returns on the farm-level investments.
- **Increased cooperation, transparency, and data sharing** linked to investments in restoration bonds to enable investors to monitor the environmental impact of their investments. Monitored impacts might include increases in long-term productivity of agroecosystems and the flow of ecosystem services, and improvements in farmer income and profitability. Data sharing will help farmers to make more informed decisions and improve the return on investments; it will also enable the growth of "green" stock exchanges and other marketplaces where investors can connect with opportunities to invest in ecosystem restoration activities that boost the overall productivity of agricultural landscapes.
- Assessing the potential **linkages to existing certification processes** related to the sustainable intensification of agriculture could help streamline and reinforce the process of vetting smallholder applicants for restoration bonds.
- Review and diagnosis of policy and institutional context (in a given country) to help **identify barriers and needed reforms to improve enabling conditions** for scaling up the use of restoration bonds. As the feasibility of restoration bonds is demonstrated and the economic case is made, this additional analysis will investigate country-level policy and institutional barriers and consider how they can be overcome.

GETTING STARTED

As a first step, a group interested in testing the idea of restoration bonds would review experiences with green bonds for energy-related initiatives. The restoration bonds innovators could also learn from the experiences of social impact bonds, development impact bonds, and similar "pay for performance" social financing innovations.[69] Significant attention has been devoted in recent years to new approaches in development finance aimed at fostering innovative collaboration and generating positive impacts at scale. The development of restoration bonds can certainly capitalize on these reflections. During the review of these experiences, it will be important to consider how to ensure that the restoration bonds are accessible to smallholder farmers. Barriers to smallholder participation in pilot activities should be addressed, and steps taken to reduce the risk that only larger enterprises may take advantage of restoration bonds.

A second step is to identify potential investors such as agriculture and rural development banks, and banks, asset managers, and others known for promoting socially responsible and progressive investments. In parallel, this group could review examples of farmers from different

BOX 5.1

THE MOUNT KENYA EAST PILOT PROGRAM

The Mount Kenya East Pilot Program piloted a program in five subcatchments of the Tana River basin to provide access to green water credit by farmers and rural communities. The program improved the livelihoods of small-scale farmers depending on rain-fed agriculture by enabling investments through water resource user associations in erosion control, soil and water conservation, irrigation, and improved infrastructure for water resources management. In addition to benefits for the farmers and strengthening community organizations, the program achieved landscape-level benefits through investments in restoration of degraded forest lands and improvements in the provision of ecosystem services to downstream areas. Green Water Credits were arranged using public and commercial financing and payments from large downstream water users.

Source: Kenya case study in E. Gray, N. Henninger, C. Reij, and R. Winterbottom. 2014. Integrated Landscape Management for Enhancing Resilience in Africa Drylands: Review and Assessment. Background paper for the Economics of Dryland Resilience in sub-Saharan Africa. Prepared by the World Resources Institute for the World Bank.

regions that have already transitioned to more sustainable agricultural practices, and assess the role of increased access to financing and technical support.

Having completed these first steps, the group could then work with interested investors to target regions and develop and pilot the restoration bond concept. Local NGOs, farmer associations, and other organizations familiar with the challenges faced by smallholder farmers and committed to working with farmers in these regions would be identified and engaged to facilitate a shift toward more sustainable farming practices. Because extension services that respond to the needs of smallholder women farmers are particularly weak or lacking, emphasis would be placed on working with smallholder women farmers to plan and organize a pilot activity to test the feasibility of the restoration bond concept.

As knowledge is gained from reviewing the experience of promising examples and through consultations with interested parties, the group would identify specific investments needed, estimate costs, calculate potential returns, and summarize the anticipated results and benefits. With this information in hand, the group could then make the case to investors, farmers, and other stakeholders who could contribute to the success of restoration bonds.

Other interested groups with connections to financial service companies and investors could help identify investors interested in providing capital for restoration bonds. The group would then work with intermediary organizations to connect the interested local communities and the pioneering investors.

6. FROM SHOCK TO ACTION: ECOSYSTEM AND COMMUNITY RESILIENCE MADE VISIBLE THROUGH COMMUNICATION

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VISION FOR 2025

By 2025, a fact-based, coordinated, and sustained communication effort, embedded in a dynamic social exchange, heightens public understanding of the role of ecosystem services in preventing and mitigating natural disasters. Increased awareness of ecosystems' contributions to climate regulation, flood control, soil stabilization, and food system resiliency prompts demand for better management and protection. Prepared, well-informed, and coordinated communications networks use natural disasters and other shocks to highlight the links between resilience and healthy ecosystems. These networks dynamically engage and empower the public, mobilize scientific support, and provide business and governments with trusted information. As a strategy to build community resilience, the goal is to encourage rapid, transparent, and informed decisions—often made under intense pressure and timelines—that safeguard ecosystems.

BARRIERS AND OPPORTUNITIES

To avoid repeating its past mistakes, society needs shared and trusted information, as well as communication that can turn that information into solutions that yield desired outcomes. The value of ecosystems is taken for granted until an ecosystem shock—a flood, drought, superstorm, storm surge, mudslide, or other catastrophes—destroys health, life, property, environment, and/or economic stability.

Ecosystem shocks generate understandably bad news, often about tragic events. This news—reported by professional and social media—often fails to properly analyze cause and effect. Before, during, and after a system shock, there are processes for emergency aid, rehabilitation, and recovery across agencies. However, there are few if any processes for gathering and disseminating critical information that:

- Sets the context and big-picture framing for the situation in the near-term.
- Is persistent in messaging about the cause of the shock or about the relevancy and value of ecosystems for reducing future risk to natural disasters.

In some cases, the media needs additional training in order to understand the science associated with natural disasters and report on them in a broader context. With proper training and reliable information, media can be potent avenues of information on proactive action for minimizing, or sometimes preventing, natural disasters by maintaining ecosystems and taking care of the environment. Messaging can be transformative in affecting the public's behavior. In the Philippines, for example, Rappler.com provides news feeds related to disasters and mitigating actions, validates the status of disasters through crowd sourcing, and provides a platform for information exchange.

SOLUTION

The will to recognize the value of ecosystems and halt their degradation is generated by continued efforts to accumulate, synthesize, and communicate knowledge. Often, these efforts are catalyzed by "transcending moments" that create movements, build participation, accumulate facts, and focus our attention (see Box 6.1 for an example from Super Typhoon Haiyan).

Ecosystems' natural resiliency can be made visible through a communications approach that is immediate yet maintains a long-term, disciplined message and history. The effort puts

the "now" of an ecosystem shock into context, identifies emergent networks of influencers, and quickly responds to windows of opportunity to tell compelling stories of resiliency. It makes the most of the moment when the world is watching and seeking answers by reframing the challenge into an action-oriented path to a better future. This communication approach is iterative, refining strategies based on lessons from the last event to prepare for the next one.

Communicating the natural resilience of ecosystems is achieved through an adaptive and cumulative communication process that unfolds over three timeframes: immediate (during the crisis), near-term (during recovery), and long-term (as part of future risk reduction and mitigation plans). The components of an effective communication strategy vary in line with these timeframes.

Immediate communication.

During a crisis, ensuring people's well-being and minimizing damage to property is the top priority. However, crises also offer the opportunity to communicate at a time of heightened awareness to a given location and disaster issue. An immediate communication strategy should focus on:

- Conveying real-time data and narratives about the event, as well as information that puts the event into a broader context
- Coordinating networks for capturing and disseminating information
- Preparing shared messaging about the importance of ecosystems, targeted to regional, national, and international audiences
- Engaging compelling local experts who can interpret the immediate situation and next steps
- Activating professional networks that can help determine the relevant ecosystems, the factors that contributed to the event, and appropriate short- and long-term actions to reduce further risk
- Collaborating with aid agencies (where applicable) to capture and share data and stories.

Near-term communication.

Once the immediate danger has passed and attention begins shifting toward recovery, or as an emergent risk prompted by changes in ecosystems comes to the fore, near-term communication efforts should focus on:

- Identifying key stories of resiliency—or lack thereof—and the consequences
- Capturing and sharing stories that help identify factors that contributed to the event and to people's resilience
- Reviewing experiences to learn what could have been done better to lessen damage and future risk
- Analyzing the situation by looking backward and forward to identify and address potential barriers to action such as competing priorities; short-term thinking and policies; opportunistic, status quo, or static responses; transparency and corruption; and vested and branded interests.

Long-term communication.

After recovery, the long-term goal of communication is to enhance understanding of ecosystems' value from political, economic, and environmental perspectives. Coordination with the research community and government transparency advocates is also essential: success will require economic analysis, engaged local and national constituencies, and a concerted plan to overcome vested interests. It will also require political leaders ready to make long-term decisions. For long-term communications to influence plans and actions, each of these elements should be in place. Long-term efforts should focus on:

- Creating a cumulative process that includes lessons learned, reliable information, trusted stories, and data that can inform longer-term responses.
- Sustaining the effort through continuity in reporting; tracking and elevating stories; promoting dialogue on responses to ecosystem shocks; and long-term messaging on the issue and highlighted stories.
- Targeting key audiences for longer-term messaging. Local governments, policy makers, investors, business leaders, and community leaders need information and examples to talk about and highlight the value of ecosystems for reducing disaster risk.

BOX 6.1

MEDIA AS A POTENT INSTRUMENT DURING SUPER TYPHOON "HAIYAN"

On November 8, 2013, Super Typhoon Haiyan—one of the strongest storms in history—struck the central Philippines. With winds up to 275 km per hour and storm surges of 4 to 6 meters, Haiyan killed 6,300 people, damaged 200,000 homes, and felled millions of trees.[a]

Haiyan's extraordinary size attracted real-time coverage in local and international media. Through cable television, Filipinos and the world witnessed first-hand accounts of its catastrophic impacts. In his statement from the palace in the aftermath of the storm, President Benigno Aquino III noted that the "media gave this tragedy a very human face and moved others to action".

The extensive coverage of Haiyan brought immediate results. Within days, media reports triggered an avalanche of support from thirty-three countries. Media criticisms of delayed government action pushed the government to publish a consolidated rehabilitation report on November 13, 2013, in the Official Gazette. Social media helped locate missing people and connect families. But while the devastation of Haiyan was well-reported, little attention was paid to extracting lessons that could lessen impacts from similar natural disasters in the future—until two-and-a-half months later.

On January 23, 2014, the Oscar Lopez Center on Climate Change Adaptation and Natural Hazard Management and the Office of the Presidential Assistant for Rehabilitation and Recovery gathered some 300 scientists and disaster risk reduction practitioners as well as the UNDP Disaster Team. The aim of the gathering was to review the calamity through a new lens. The scientists underscored the importance of maintaining healthy ecosystems in vulnerable island countries like the Philippines and noted that the regulatory services provided by ecosystems can protect communities during natural disasters. The participants agreed on the need to integrate ecosystems into disaster risk management.

In addition to protecting ecosystems to prevent catastrophic losses due to natural disasters, an ecosystems-based framework for the rehabilitation of damaged areas was also crafted as a result of the gathering. This became the basis for the environmental projects sponsored by the seventeen private companies that volunteered to assist the Yolanda corridor. Today, Energy Development Corporation, a renewable energy company devastated by Haiyan, has learned its lesson. It has completed an ecosystem services analysis of all its geothermal sites and is going one step further by developing a plan on how to protect its assets from cyclones using natural infrastructure, or "bioshields."

Notes. a. Office of the Presidential Assistant for Rehabilitation and Recovery. 2014. "Yolanda Comprehensive Rehabilitation and Recovery Plan—Improving Lives Building Communities." Commemoration of Yolanda calamity on Nov. 18, 2014 at Resorts World Hotel, Manila, Philippines.

GETTING STARTED

This effort should be led by a trusted, impartial organization that can convene diverse communities, gather relevant data and stories, and extract policy implications. The organization must be demonstrably capable of effectively implementing a communications process.

We do not identify a candidate here, but instead note the functions such an organization would play:

- Review cases of ecosystem shocks and how the news media, social networks, and technical experts managed communications (or not)
- Study the captured and lost opportunities to communicate the importance of ecosystems, their relevancy/context within the disaster
- Prepare an empirical, disciplined response process based on immediate, near-term, and long-term approaches
- Convene key media and stakeholders to map existing networks of communicators that can be tapped
- Prepare sample key talking points for ecosystem shocks
- Organize and implement a full-day, real-world scenario session with key media, scientists, NGOs, and stakeholder representatives, for real dialogue.

As external shocks continue to stress ecosystems worldwide, sustained communication that makes resilience more visible becomes more important. This process can build constituencies, leverage communications and knowledge networks and resources, and encourage unified, geographically oriented action. In

addition, this process can create communities around geographies, shared interests, and connections. It can elevate urgency, relevancy, and empathy, and develop shared messages and terminology.[70] A successful process led by a trusted organization will develop a network of informed, respected voices that can effectively communicate ecosystem and community resiliency in the face of increased ecosystem shocks.

CONCLUSION / THE WAY FORWARD

Healthy ecosystems are integral to healthy economies, businesses, and communities. The relationship between ecosystems and human well-being is growing ever more critical as demands for ecosystem services intensify with an expanding global population. Over 60 percent (15 of 24) of ecosystem services examined during the Millennium Ecosystem Assessment are being degraded or used unsustainably, meaning that their capacity to provide us with benefits is decreasing. Overlaid on this backdrop of decline, our fraying natural life support system now faces the onslaught of climate change. While ecosystems have adapted before in response to climate shifts, their resilience now is already compromised by existing and growing human pressure.

Society can no longer take ecosystems and their benefits for granted. Businesses, governments, communities, farmers, and the myriad of others that depend on ecosystems need to incorporate ecosystem value in their decisions. The six pathways presented in this paper aim to help mainstream ecosystem services in decision making.

While efforts in the past to value ecosystem services have failed to gain broad traction, this time promises to be different. The scale and speed of ecosystem degradation and collapse has heightened awareness of business, government, and the public to their dependence on ecosystems. Advances in information and communication technologies make it easier to assess, model, and communicate information on ecosystem conditions and trends. And the resulting information can be displayed on open, internet-based, interactive virtual globes, and broadly communicated for all to use.

The pathways we propose here will not be blazed through uncharted territory. Each pathway builds on pockets of progress already made, including the availability of practical tools for businesses and governments, new accounting guidelines for ecosystems in national economic accounts, and innovative financing mechanisms to provide bridging loans to farmers undertaking ecosystem restoration. They offer a multi-pronged approach, targeting decisions at multiple scales: global (corporate food supply chains, a corps of ecosystem service analysts, and a network of communicators); national (national economic accounts); local (community and farm-level restoration); and at the watershed scale (natural infrastructure investments).

Although described as pathways, the six initiatives are not intended to be standalone journeys. Rather, they are intended as complementary reinforcing approaches to spawning a global movement on valuing ecosystems. The network of communicators can spread the word on successes with natural infrastructure and farmer-led restoration efforts. Incorporating ecosystem values into national accounts can inform policies that reward community and corporate-level ecosystem stewardship. And the ecosystem corps can build the information base to inform public and private decisions on ecosystem management.

We hope the six pathways will inspire action by others. Everyone, including the public sector, NGOs, and philanthropic communities, can play a role. Nature's assets are, after all, what all life depends on. The time has come to change how people see and value ecosystems and in doing so move beyond protecting nature from development to investing in nature for development.

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ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being.

Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision
We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT
We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT
We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT
We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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