SPECIAL FEATURE: INTRODUCTION

Natural capital and ecosystem services informing decisions: From promise to practice

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The central challenge of the 21st century is to develop economic, social, and governance systems capable of ending poverty and achieving sustainable levels of population and consumption while securing the life-support systems underpinning current and future human well-being. Essential to meeting this challenge is the incorporation of natural capital and the ecosystem services it provides into decision-making. We explore progress and crucial gaps at this frontier, reflecting upon the 10 y since the Millennium Ecosystem Assessment. We focus on three key dimensions of progress and ongoing challenges: raising awareness of the interdependence of ecosystems and human well-being, advancing the fundamental interdisciplinary science of ecosystem services, and implementing this science in decisions to restore natural capital and use it sustainably. Awareness of human dependence on nature is at an all-time high, the science of ecosystem services is rapidly advancing, and talk of natural capital is now common from governments to corporate boardrooms. However, successful implementation is still in early stages. We explore why ecosystem service information has yet to fundamentally change decision-making and suggest a path forward that emphasizes: (*i*) developing solid evidence linking decisions to impacts on natural capital and ecosystem services, and then to human well-being; (*ii*) working closely with leaders in government, business, and civil society to develop the knowledge, tools, and practices necessary to integrate natural capital and ecosystem services into everyday decision-making; and (*iii*) reforming institutions to change policy and practices to better align private short-term goals with societal long-term goals.

sustainable development | resilience | human well-being | decision making | beneficiary

Since the start of the Industrial Revolution, a massive expansion of economic activity has transformed the planet. From 1820 to 2003, world gross domestic product (GDP) increased nearly 60-fold in real terms (1). This expansion dramatically increased the average standard of living even as human population rose sixfold; but, economic expansion has come with large costs. Global environmental changes and further population expansion (possibly reaching 10 billion people by 2100) threaten to undermine future prosperity (2–7). Improving living standards for the approximately two billion people living in dire poverty, achieving a sustainable population size, and securing the life-support systems that underpin human well-being and life on the planet is the central development challenge of the 21st century.

Our current global economic, political, and social systems are not well suited to meeting this challenge. There is a fundamental asymmetry at the heart of economic systems that rewards short-term production and consumption of marketed commodities at the expense of stewardship of natural capital necessary for human well-being in the long term. With a majority of people now living in urban areas (expected to be two-thirds of

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the global population by 2050) (8), this asymmetry may be accentuated further as connections to nature become less evident, though no less important. Correcting this asymmetry will require transforming the use of natural capital through better understanding the role that natural capital plays in sustaining human well-being, integrating this information into decision and policy contexts, and changing institutions, policies, and incentives to reward long-term stewardship (6, 9–12). Conservation and economic development have been considered in separate spheres for too long. Sustainable development in the 21st century requires explicit recognition that social and economic development are part of—and dependent upon—a stable and resilient biosphere.

A decade ago, the Millennium Ecosystem Assessment (MA) drew attention to the importance of natural capital and ecosystem services in supporting human well-being (2). It also amassed powerful evidence that human actions were leading to declines in a majority of ecosystem services. The intent of the MA was to catalyze efforts to reverse these declines. Currently, hundreds of such efforts are underway, engaging individuals, communities, businesses, nongovernmental organizations, governments, and international organizations (13). After defining central concepts, we explore progress in the 10 y since the MA, we highlight critical knowledge gaps and impediments preventing fuller incorporation of natural capital and ecosystem services into decision-making, and we suggest a path to accelerate progress toward sustainable development.

Defining Natural Capital, Ecosystem Services, and Other Key Terms

"Natural capital" refers to the living and nonliving components of ecosystems—other than people and what they manufacture—that contribute to the generation of goods and services of value for people. Capital assets take many forms, including manufactured capital (buildings and machines), human capital (knowledge, skills, experience, and health), social capital (relationships and institutions), and financial capital (monetary wealth), as well as natural capital. Multiple forms of capital interact to generate goods and services. For example, fish harvesting depends on the availability of fish stocks (natural capital), which depend on high-quality habitat (natural capital), but harvesting also depends on fishing vessels (manufactured capital, backed by financial capital), the skills and experience of fishers (human capital), and fisheries governance (social capital).

Ecosystems sustain and fulfill human life through "ecosystem services." Forested riparian buffers hold soil in place and improve water quality for people downstream; aquatic habitats support populations of fish caught for food; mangroves stabilize shorelines and decrease damage to people and property from storms; forests and oceans store carbon that helps regulate climate; lakes and mountains provide aesthetic views, opportunities for recreation, and spiritual inspiration. Ecosystem services are the conditions and processes of ecosystems that generate—or help generate—benefits for people. These benefits result from the interactions among plants, animals, and microbes in the ecosystem, as well as biotic, abiotic, and human-engineered components of social-ecological systems. Ecosystem services are produced along the full spectrum of heavily managed ecosystems (e.g., agroecosystems) to ecosystems with low human imprint. Ecosystem services can be final (produce benefits directly, such as seafood) or intermediate (underpinning final services; e.g., the generation of habitats that support fish populations) (14).

The pace of research on ecosystem services has increased greatly in the last decade (15, 16). Rapid innovation and proliferation of approaches have been productive, but have resulted in inconsistent and confusing use of terms [17; see also Polasky et al. (18) in this issue]. For example, the terms "environmental services" and "ecosystem services" are used by different authors, but the intended meaning is similar. We use "ecosystem services" for three pragmatic reasons: it is consistent with the considerable body of literature emerging from the MA, the word "ecosystem" connotes the integration of both biotic and abiotic components, and many people equate environmental services with waste and recycling services provided by local government.

Understanding who affects the generation of ecosystem services (called providers or suppliers) and who benefits from ecosystem services (beneficiaries or consumers) allows assessments of the costs and benefits from a given policy, including the distributional consequences across affected parties. Institutions, such as property and access rights, together with the nature of the services in question, frame the policy context and influence the set of incentives for the private and public use and provision of ecosystem services. Understanding the institutional landscape and incentive structures can inform effective management and governance. For example, carefully designed policies, such as payments for ecosystem services (PES), can motivate potential ecosystem service suppliers by using payments for action, access, or maintenance of a service. Similarly, rights-based fishery management can incentivize fishers to be better stewards of the ecosystems that produce the fish they catch (19).

Concerns about how ecosystems will respond to climate change and other gradual or abrupt changes have led to greater efforts to understand their resilience from local to planetary scales (20–22). Natural capital with enhanced resilience has a greater ability to persist and adapt in the face of change, to continue to provide ecosystem services, and to adapt and transform in beneficial ways (23). This capacity of social-ecological systems to sustain natural capital and ecosystem services in the face of disturbance and ongoing changes is more likely to support development pathways in changing environments where uncertainty and surprise prevail (24, 25). Robust solutions that generate desired outcomes for people and nature under a wide range of potential futures can be enhanced by adopting a more integrated dynamic systems approach to understanding complex social-ecological systems [21, 26–28; see also Reyers et al. (29) in this issue]. Such thinking fosters more wide-ranging contemplation of potential future outcomes and places an emphasis on adaptive governance [e.g., Schultz et al. (30) in this issue].

Taking Stock: Progress and Remaining Challenges

There has been remarkable progress in elevating these concepts over the past decade. Influential actors in public and private sectors now routinely talk about the importance of natural capital and ecosystem services, scientific research has advanced significantly, and new institutions are emerging (31–33). However, tangible changes in the operation of businesses and governments have not been dramatic, especially compared with the scale and urgency of the issue. Fundamental asymmetries in economic systems leading to undervaluing stewardship of natural capital remain largely unchanged. In this section we consider: (*i*) increasing awareness of the interdependence of nature and people; (*ii*) advancing interdisciplinary science of the value of natural capital and ecosystem services, the effects of governance and behavior, and impacts of policy or management interventions; and (*iii*) incorporating natural capital and ecosystem services into policy and management.

Increasing Awareness of the Interdependence of Nature and People. Several efforts have enhanced broader general understanding of the fundamental linkage between ecosystems and human well-being (5, 12, 34, 35) and a number of examples state the importance of incorporating the value of nature in public and private arenas [e.g., refs. 36–39 and Kareiva et al. (40) and Schaefer et al. in this issue (41)]. In many cases, interest from decision-makers has created demand for information that has outstripped the supply from science [42; see also Polasky et al. in this issue (18)].

However, awareness of the interdependence of nature and people is not yet sufficiently widespread. Despite promising developments, such as the World Economic Forum's identification of environmental issues among the top 10 global risks for business (43), environmental issues still often rank low in public concerns (44). Most business and economic practices ignore natural capital (45). A major limitation of the current framing of natural capital is its perceived isolation from other forms of capital and the mainstream of economic and social activity. This isolation relegates considerations of natural capital and ecosystem services to ministries of the environment rather than finance, agriculture, and industry; to corporate sustainability departments rather than boardrooms; and to the rural poor populations rather than to the urban populations driving resource use.

Placing natural capital and ecosystem services into a broader decision-making context (Fig. 1) is necessary to effect large-scale transformations in policies, practices, and investments. Such considerations are not only relevant to natural resource and conservation decisions, but also for health, agriculture, energy, water security, infrastructure, urban development, finance, and national security: arenas that extend well beyond classic conservation. Helping sectoral leaders understand these connections is critical. Societal decisions in these contexts would often be different if natural capital and ecosystem services considerations were incorporated [46; see also Arkema et al. (47) and Li et al. (48) in this issue].

Advancing Science. Advancing science and creating accessible tools for analysis and decision support can identify critical natural capital, quantify and map ecosystem service values, highlight spatial, temporal, and social differences in ecosystem service production and delivery of services to beneficiaries, and explore trade-offs. In this section we explore four key themes describing scientific progress and challenges: the provision and resilience of ecosystem services, the value of natural capital and ecosystem services, governance, and the impacts of policy and management.

Understanding the provision and resilience of ecosystem services. New knowledge, metrics, data, and tools have made it easier to assess and account for nature's benefits to people and provide tangible ways to identify and weigh trade-offs resulting from different possible decisions. Progress has been made in quantifying, mapping, and exploring relationships among multiple ecosystem services and biodiversity (26, 49, 50); predicting changes in land use, climate, and other drivers of ecosystem change (51); and spatial modeling of how changes in ecosystems are likely to lead to changes in the flow of ecosystem services [31, 33, 46, 52–54; see also Arkema et al. (47) and Chaplin-Kramer et al. (55) in this issue].

Less progress has been made in understanding complex, adaptive system dynamics, including feedbacks and the potential for climate change and other major disruptions to affect natural capital and the future provision of ecosystem services (56–58). Recent progress in the area of complex systems and resilience of ecosystem services (21, 59) uses both natural and social science to understand how environmental and social shocks disrupt systems, and in turn how those systems respond in ways that either undermine or maintain sustainability. Combining approaches to understanding resilience with ecosystem service modeling will assist evaluation and design of alternative management interventions so that ecosystem services are more secure in an uncertain future (29).

Understanding the value of ecosystem services and natural capital.

Ecosystem service valuation. The value of ecosystem services is not always clear to decision-makers or the public. Monetary valuation of ecosystem services is sometimes helpful. Market and nonmarket valuation methods from economics are used to estimate ecosystem service values [e.g., Bateman et al. (60) in this issue]. Numerous studies report values for a range of services across many locations (61) but these first-generation studies generally are insufficient for robust extrapolation to other locations (58, 62).

Where monetary valuation is highly contested or lacks robustness, or where monetary value metrics are not relevant to decisions, it is often preferable to report outcomes in biophysical terms or directly in terms of impacts on human health or livelihoods (63–65). Although recent work has begun to describe the varied ways in which natural systems affect human health and well-being [66, 67; see also Bauch et al. (68) in this issue], the paucity of models and tools for exploring

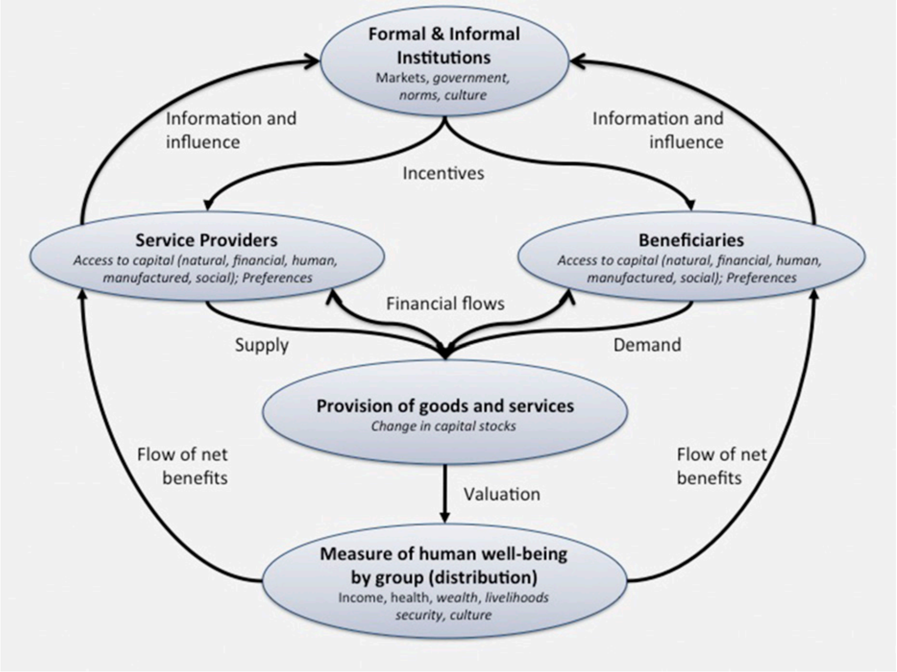

Fig. 1. A framework for including natural capital in the broader context of formal and informal decision-making institutions along with other forms of capital: financial, human, manufactured, and social. Formal and informal institutions influence decisions by both service providers and beneficiaries. Access to various forms of capital ("capabilities") (115) and preferences affect the decisions of service suppliers and beneficiaries. The joint actions of service providers and beneficiaries determine the flow of goods and services (including ecosystem services). These change various capital stocks (including natural capital) and affect the well-being of different groups in society. Closing the loop from institutions to decisions to human well-being, and back to the top to inform institutional design and decision-making, has the potential to improve policy and management in ways that lead to improvements in human well-being. Components in italics indicate factors that change on relatively long timescales.

regulating and cultural services and connecting them to human health and well-being metrics is a critical research gap.

Natural capital accounting. Maintaining natural capital is essential for future flows of ecosystem services. Focusing only on trends in the provision of services is insufficient. Current provision of ecosystem services can be increased temporarily by reducing natural capital, such as by harvesting more fish at the expense of depleting stocks. Natural capital accounts are an important additional tool for informing sustainable development (69). Such accounts highlight areas of developing "natural capital deficit" (42) that may require policy intervention.

A number of accounting frameworks for natural capital have been developed, including "inclusive wealth," which attempts to value all forms of capital assets: human, manufactured, social, and natural capital (10, 70). Increasing inclusive wealth means that future generations are endowed with a larger "productive base," capable of providing more goods and services to support human well-being. Inclusive wealth can be used as a gauge of sustainability, although accurate measurement of the value of capital assets is challenging (70).

Including future as well as present values raises questions of how to properly aggregate values over time. Economists typically argue that future values should be discounted. However, the appropriateness of discounting in cases affecting natural capital with potentially profound influences on future generations is controversial and entails ethical as well as economic considerations. Debates on discounting in the context of climate change policy highlight the importance and lack of agreement on how society should aggregate benefits and costs over time (71, 72).

Understanding governance: Social norms, policy, incentives, and behavior. Natural capital is degraded and ecosystem services are underprovided in large part because of a failure of markets and other institutions to provide proper incentives to conserve and value them (11). Reform of policies and institutions can help correct the fundamental asymmetry that rewards production of marketed commodities but fails to reward ecosystem service provision. Incentives to maintain or enhance natural capital and increase provision of ecosystem services can be provided in a variety of ways, including PES, environmental taxes, cap-and-trade schemes, environmental laws and regulations, product certification, and encouraging social norms for stewardship.

Social-ecological systems are complex, characterized by multiple interacting processes with nonlinear and stochastic dynamics (73). Multiple scales (local to international) and forms of governance (e.g., social norms and policy rules) often overlap and intersect (74) and typically differ from the biophysical scales at which ecosystem services are generated. Policy design for governance of social-ecological systems should reflect the underlying complexity of such systems (75) and should account for the complex spatial patterns of ecosystem service supply and the spatial patterns that link supply with beneficiaries [76; see also Bateman et al. (60) in this issue].

The integration of behavioral economics, psychology, and resilience theory offers potential for more effective policy design. Behavioral economics and social psychology provide insights into how people make decisions and can lead to better policy and management interventions (77–79). A growing body of literature has analyzed approaches for adaptive management, comanagement, and governance (25, 30, 80). A better understanding of human motivations, preferences, and cultural norms surrounding nature and its benefits is a prerequisite for changes in human–nature interactions. Anthropology, behavioral economics, psychology, sociology, and other social sciences are directly relevant.

Understanding impacts of policy and management. Assessing the impacts of policies and decisions on the sustainable use of natural capital and the provision of ecosystem services is essential for testing assumptions, and enabling on-going learning and adaptive management. Some advances have been made in evaluating the impact of protected areas [81–83; see also Bateman et al. (60) and Ferraro et al. (84) in this issue] and PES programs on biophysical and social outcomes (85; see also Li et al. (48) in this issue]. Impact evaluation of conservation actions on aspects of human well-being is significantly behind other fields (e.g., education and health impact evaluation) and remains a critical area for further work (86).

Evaluating impacts requires monitoring of relevant biophysical and socioeconomic measures. Most current monitoring data are inadequate. The obvious solution is more comprehensive or more relevant data collection, but this is costly. Analysts must often try to make clever use of whatever data exist.

Assessing policy impacts is complicated by confounding factors, complex feedbacks, and potentially long lags between action and impacts. Accurately assessing impacts of a program requires comparison of conditions postimplementation and a counterfactual of conditions had the program not been instituted (84, 86). Because it is often difficult to design experiments at landscape scales, careful control both of the factors going into selection of areas for program implementation and for potential confounding factors is needed for relatively unbiased estimates of program impact (86).

Attribution of impacts from a policy intervention often involves trying to trace through a complex chain of causation. Understanding complex causal links is often incomplete and likely to remain so with emerging novel climate and ecosystem conditions. Complexity regarding causation of impacts can complicate implementation of policies such as PES, with disputes likely over who should pay for services, how much, and who should bear the risks of underprovision. Shared understanding of social-ecological dynamics can reduce, but is unlikely to eliminate, disputes [e.g., Schultz et al. (30) in this issue].

For many recently instituted interventions, it is simply too early to see significant impacts. For example, habitat destruction (or restoration) can lead to eventual biodiversity loss (or increase) but the effect may take decades to centuries (87). However, program evaluation—even if interim and incomplete—offers immense value for the design and ongoing improvement of effective policies [e.g., Li et al. (48) and Ferraro et al. (84) this issue].

Incorporating Natural Capital and Ecosystem Services into Policy and Management. National governments, international organizations, businesses, and nongovernmental organizations have begun to incorporate natural capital and ecosystem service information into policy and management, but it is not yet standard practice.

China has ambitious plans to harmonize economic development with nature to become the "ecological civilization of the 21st Century" (88). Following severe droughts in 1997 and massive flooding in 1998, China instituted the world's largest PES program, the Sloping Land Conversion Program, enrolling 120 million households to convert cropland into forest and grassland (approximately 9 million ha) and afforest barren land (approximately 12 million ha). Progress on biophysical objectives is being achieved (89) but progress on social objectives of poverty alleviation and sustainable livelihoods is mixed (90). China is now establishing a network of "Ecosystem Function Conservation Areas" to focus conservation in areas with high return-on-investment for public benefit (91). Ecosystem Function Conservation Areas now span approximately 35% of the country and are expected to expand to 45% in 2015 (88). China also announced plans to track natural capital and ecosystem services through a new metric, "gross ecosystem product," to be reported alongside GDP (92).

Costa Rica pioneered PES at a national scale (93) and transformed itself from having the world's highest deforestation rate to one of the few countries with net reforestation. The program increased forest cover on farmland under PES contracts from 11% to 17% over 8 y (85), notable given the ongoing loss of tree cover on farmland globally. The program also conserved and regenerated forest on other lands to provide watershed services, biodiversity, and carbon sequestration (93). It is difficult, however, to fully disentangle the effects of PES from other policy measures and broader economic trends (93).

Other countries are moving ahead as well. In South Africa, ecosystem service planning is linked with development planning to inform decisions in water management and allocation processes, poverty alleviation (94), disaster management (29), and land-use planning (95, 96). Belize incorporated the value of ecosystem services in coastal zone management to identify the preferred balance of tourism, fisheries, and coastal protection goals for the country (47). The United Kingdom conducted a national-scale assessment of status and trends of ecosystems, services, and impacts (34). The United Kingdom then set up a Natural Capital Committee (42) that reports to the UK Government Economic Affairs Committee, not the UK Environment Department. The Gulbenkian Foundation in Portugal has created the Marine Ecosystem Services Partnership to share ecosystem service information. In Sweden, ecosystem services are incorporated into urban planning and green area management (97). In the United States, federal agencies have begun to incorporate ecosystem service information into decision-making and natural resource damage assessment (39). A White House interagency committee is exploring further steps and recent legislation directs consideration of ecosystem services in decision-making (41).

Across Latin America there is movement to use payments to secure water for cities. Since 2006, more than 40 water funds, systems of payments from downstream water consumers to upstream communities to alter land management and improve water quality and quantity (32), have been established or are under development. Standardized approaches for targeting investments, designing finance and governance systems, and ongoing monitoring are being developed and shared (98, 99).

New policies provide incentives to the private sector. In fisheries, rights-based management limits overall harvest, stops the "race to fish," reduces unwanted by-catch, and improves efficiency (19, 100). Cap-and-trade for carbon emissions, taxes on activities with negative impacts on ecosystems, PES, and certification schemes that provide consumers with information are all ways to realign incentives in the private sector to protect and enhance natural capital and provide ecosystem services. Some corporate CEOs have committed to including the value of nature into business practices [101–103; see also Kareiva et al. (40) in this issue].

Ruckelshaus et al. (63) summarized over 20 examples of ecosystem service approaches in both private and public spheres to inform decisions in spatial planning, ecosystem restoration, PES, climate adaptation planning, corporate risk management, development planning, and permitting of infrastructure projects.

The World Bank's Wealth Accounting and Valuation of Ecosystem Services initiative (69) is working to expand national economic accounts to include the value of ecosystem services and natural capital. The InterAmerican Development Bank, through its Biodiversity and Ecosystem Services Program, aims to integrate ecosystem services into infrastructure investments. For all loans, the International Finance Corporation requires assessment of ecosystem service impacts in its environmental impact assessments (18). Similarly, the United Nations has advanced the accounting of ecosystem services and natural capital. The Statistics Division has created experimental ecosystem accounts as part of the revision of the System of Environmental and Economic Accounts. The Inclusive Wealth Report provides information for 140 countries on changes in natural capital over the past 20 y (104). However, significant data gaps remain. Most nonmarket values are not included in these efforts. Evidence that such information is being used in policy is also needed. GDP, by comparison, is regularly calculated, reported, and cited for almost all countries.

Despite this progress, incorporation of natural capital and ecosystem service information into diverse decisions remains the exception, not the rule. In the next section, we suggest a strategy for building on progress to bolster real-world implementation.

A Path Forward: Accelerating Progress Toward Sustainable Development

A strategy for future success includes: (*i*) developing solid evidence linking decisions to impacts on natural capital and ecosystem services, and then to human well-being; (*ii*) working closely with leaders in governments, businesses, and civil society to develop and make accessible the knowledge, tools, and practices necessary to integrate natural capital and ecosystem services into everyday decision-making; and (*iii*) reforming policies and institutions and building capacity to better align private short-term goals with societal long-term goals.

A growing number of cases suggest that incorporating natural capital and ecosystem service information into decisions is practical and can lead to decisions that secure a broader set of desired outcomes (e.g., refs. 29, 41, 47, and 48). Making better decisions requires solid evidence that demonstrates how incorporating natural capital and ecosystem service understanding can lead to outcomes that improve human well-being in the short and long term. This evidence will necessarily combine biophysical, economic, and social data. Most compelling will be a robust portfolio of well-documented studies that include both successes and failures, allowing the next generation of policy design to learn from past efforts.

Conducting ecosystem service science linked to specific decision contexts will provide invaluable learning opportunities. Some examples of promising decision contexts include: securing water for cities, national and coastal development planning, fishery management and ocean conservation, corporate supply chains, and infrastructure investment (Table 1). Refining and replicating these approaches to bring them into the mainstream can spur innovation and action that may drive deep, systemic change for sustainability.

Engaging with leaders will help move from vision to action. True engagement requires codeveloping knowledge and understanding and cocreating tools that address real-world challenges (105–107). Such engagement within decision-making processes improves the salience, credibility, and legitimacy of the science (108) and its uptake (63, 109). Furthermore, leaders can encourage greater uptake of ecosystem service information by improving accessibility of science and data. A platform that reduces the time and cost associated with sharing useable biophysical and social data could greatly enhance transparency and trust needed among parties striving to balance multiple development and environmental objectives.

Perhaps the most difficult challenge in the path of success is removing the fundamental asymmetry at the heart of economic systems, which rewards production of marketed commodities but not the provision of nonmarketed ecosystem services or the sustainable use of natural capital that supports these services. As mentioned above, numerous policy

Table 1. Some promising opportunities to effect large-scale transformative change in the near future

Opportunity	Geography/possible key actors	Context	Specific questions	What is at stake?	Scalability
Securing water for cities	Africa, Latin America; Water Funds Platforms (including city water companies, local governments, development banks)	Prioritize investments in watersheds for ensuring access to clean water and associated benefits, by identifying areas most important to conserve or restore and how changes will enhance or secure water-related ecosystem services	(*i*) To maintain/improve water purification and regulation, where in the watershed is most important to restore or protect? (*ii*) Which activities will promote the most cost-effective outcomes for desired benefits?	The 30 funds established or in development worldwide approach ∼$1 billion in spending; targeted investments can produce three to six times more efficient outcomes	The number of water funds in operation has more than doubled in the past 5 y, another doubling is expected in the next decade
National development plans	China; Chinese government	Inform zoning of ecosystem function conservation areas to ensure most vital natural capital assets are secured and livelihoods are improved; focus on securing local surface water and water from W. China for Beijing as well as Hainan Island pilot	(*i*) What areas should be zoned for conservation to most cost-effectively secure key natural capital assets and improve livelihoods? (*ii*) What magnitude of investment is needed? (*iii*) How might eco-compensation policies be designed?	Essential to national and economic security (environmental degradation equivalent to 9% of China's gross national income)	Scalable throughout China and as an example for other nations
National development plans	South Africa; South African government	Invest in conserving Strategic Water Source Areas in South Africa for urban and agricultural water security	How and where should large national investments from South Africa's National Infrastructure Plan be directed?	Strategic Water Source areas are 8% of land area, securing 50% of national water supply	Replicable in other regions
Corporate supply chains with agricultural products	Global; International corporations (e.g., Unilever, Coca-cola)	Incorporate ecosystem services into sourcing, product development, or certification strategies by selecting the most sustainable regions/materials or adopting ecosystem service standards for agricultural practices	(*i*) What are the relative impacts and dependencies for different sourcing locations or material ingredients? (*ii*) Where should suppliers apply best management practices for optimal ecosystem outcomes at lowest production costs?	Top multinational corporations have larger GDPs than most nations, and demand significant portions of global agricultural product (e.g., Unilever purchases up to 12% of black tea globally)	The standards and approaches adopted by corporate leaders can be scaled throughout other companies in their sectors
Sustainable infrastructure investments	Latin America; Inter-American Development Bank (IDB)	Quantify and value impacts and dependencies of roads on ecosystem services; integrate into cost benefit analysis for road siting and investment and mitigation decisions to ensure compliance with in-country offset regulation and IDB standards	(*i*) Which projects should be prioritized across the portfolio (based on dependence and impacts)? (*ii*) Within a project, how and where should development be designed to minimize impacts, and how does the environment affect infrastructure security?	IDB spending $5B/y on infrastructure lending ($1.67B on transportation, 79% of that on roads)	Scalable across IDB and to other multilaterals. Building capacity within IDB and with consultants
National and international fishery reforms	National governments and international regional fishery management organizations	Reform management to incentivize sustainable fisheries and protection of habitat and biodiversity	(*i*) Which fisheries are most appropriate for rights-based approaches that can incentivize sustainable fisheries and habitat/biodiversity protection? (*ii*) How can use of high seas be sustainable?	Food and economic security for the billions of people who depend upon seafood for protein and poverty alleviation without eroding the resilience of ocean ecosystems in the face of continued exploitation, climate change, and ocean acidification	Scalable across nations

approaches exist to correct this market failure (PES, environmental taxes, cap-and-trade schemes, environmental regulations, product certification). Implementing these policy approaches requires the other two conditions for success: evidence on outcomes under alternative strategies, and engaged and committed leadership that will reform institutions and implement governance.

The eight Millennium Development Goals established by the United Nations in 2000 were one mechanism through which the international community hoped to encourage integration of well-being, poverty alleviation, and environmental objectives. In 2005, the MA concluded that policy interventions to improve human well-being through development rarely considered sustainable use of natural capital and had achieved only mixed success (2). Achievement of the Millennium Development Goals has been hampered by poor integration between environmental and other targets, among other issues (110–112). The United Nation's new Sustainable Development Goals (SDGs) better integrate the three pillars of sustainable development (social, economic, and environmental) but the true test will be in implementation. Actionable, easy-to-communicate goals, targets, and indicators that include connections between nature and human well-being are needed. As demonstrated by the papers in this Special Feature, the data, methods, technology, and body of evidence on the value of natural capital and ecosystem services have advanced rapidly over the past decade and are ripe for inclusion in the implementation of the SDGs and the country plans to follow. Many important building blocks are in place for achieving sustainable development by active stewardship of natural capital alongside human, manufactured, built, financial, and social capital.

The UN Secretary General's High-level Panel on Global Sustainability argues that "by making transparent both the cost of action and the cost of inaction, political processes can summon both the arguments and the political will necessary to act for a sustainable future. . .to eradicate poverty, reduce inequality and make growth inclusive, and production and consumption more sustainable, while combating climate change and respecting a range of other planetary boundaries" (113). Similarly, the World Business Council for Sustainable Development in its *Vision 2050* document defined their goal as "not just living on the planet, but living well and within the limits of the planet. . .. This guiding star is an attempt to help leaders across governments, businesses and civil society avoid repeating mistakes of the past—making decisions in isolation that result in unintended consequences for people, the environment and planet Earth" (38). This vision has recently been translated to an Action 2020 agenda, defining guardrails for businesses to be able to thrive within a safe operating space on Earth; a similar framework has been proposed to guide the United Nation's SDGs (114). Progress since the MA—in increasing awareness, advancing science, and beginning the long and difficult road to implementation—suggests that we can indeed go beyond promise to inspire and empower leaders to include natural capital and ecosystem services in their decisions. As human populations grow, and grow increasingly disconnected from nature, sustainability requires no less.

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