

Global Scenarios: Background Review for the Millennium Ecosystem Assessment

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ABSTRACT

The long-range outlook for the world's ecosystems depends on the course taken by global development in the coming decades. Current global trends and ecological dynamics are consistent with very different outcomes, defined by alternative assumptions about the technological, economic, demographic, geopolitical, and social aspects of development and the ways in which institutions, personal and public values, and natural systems may be expected to respond to historically novel stressors. Recent advances in scenario analysis have addressed the dual methodological challenge of exploring these uncertainties in an organized way and determining what would be needed to make the transition to sustainability. This paper reviews global scenario research, setting current efforts in a historical context. It focuses on seven recent studies that are comprehensive, regionally disaggregated, and narratively rich—and thus of greatest relevance to the Millennium Ecosystem Assessment (MA). It summarizes their social visions and the

level of quantitative detail used in these exercises. Taken together, this suite of global scenario studies provides a useful platform for the MA by offering insight into the complex factors that drive ecosystem change, estimating the magnitude of regional pressures on ecosystems, sounding the alert on critical uncertainties that could undermine sustainable development, and understanding the importance of institutions and values. But these studies are only a point of departure. The integration of changing ecosystem conditions into global development scenarios, as both effects and causes, is at the cutting edge of scenario analysis. The paper concludes by identifying directions for this research program and suggesting ways that the MA can contribute to this effort.

Key words: ecosystems; scenarios; sustainability; global futures; Millennium Ecosystem Assessment; global modeling; social visions.

INTRODUCTION

As global systems grow ever more interconnected, the fate of the Earth's ecosystems becomes increasingly coupled to global development patterns. The factors that directly affect ecosystem conditions—land change, resource exploitation, pollution, hydrology, and climate change—are

conditioned by far-flung global influences—patterns of production and consumption, the character of economic globalization, cultural distinctions, international governance, geopolitical conflict, migration, and global warming. It is essential, therefore, to situate the analysis of the long-range prospects for ecosystems in the context of global development.

A useful point of departure is the suite of recently conducted global scenarios studies that are described in this paper. Although the treatment of ecosystems in these exercises has been minimal, they nonetheless suggest new ways of formulating

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integrated conceptual frameworks, developing alternative global visions, and quantifying economic, social, technological, and environmental drivers. This rapidly evolving corpus of work is an important resource that can support the task of developing more comprehensive visions of the futures and, in particular, help us to elaborate the implications of ecosystems.

The quest for sustainable development has moved the task of making projections about the future to the center of policy and scientific agendas. Animated by the core concern of passing on an unimpooverished world to future generations, sustainability studies confront a number of challenging questions. How might the trajectory of global development evolve over the coming decades? Are we currently on a sustainable path? What surprises and critical uncertainties could deflect the global system in novel directions? How might environmental, social, and economic processes interact, feed back on each other, and amplify change? What actions, policies and value changes can best ensure a sustainable future?

New methods are needed to address these critical questions about the future in an organized and integrated fashion. Predictive modeling is well suited to the simulation of well-understood and deterministic systems (Peterson and others 2003). But it is insufficient for the study of the long-range future of highly complex socio-ecological systems, which are inherently uncertain, exhibit novel phenomena, and are subject to human choices that are not yet made. Such systems are capable of branching into fundamentally different pathways, all of which would be consistent with current conditions, trends, and driving forces of change. As an alternative to prediction, scenario analysis has emerged as a key methodology for exploring alternative futures, identifying critical uncertainties, and guiding action.

Scenarios draw from the human imagination as well as science to provide an account of the flow of events leading to vision of the future. In essence, scenarios are plausible stories about how the future might unfold from existing patterns, new factors, and alternative human choices. The stories can be told in the languages of both words and numbers. Indeed, the great strength of scenario research lies in its blending of the richness, texture, and imaginative qualities of narrative with the structure, replicability, and rigor offered by modeling. The narrative gives voice to the qualitative factors that shape development, such as values, behaviors, and institutions, while modeling offers empirically based insights into the subset of socio-economic

and biophysical factors that are amenable to quantification.

Scenario analysis has its roots in the strategic planning exercises and war games devised in the early years of the cold war (Kahn and Wiener 1967). But the direct antecedents of contemporary scenario research are the future studies of the 1970s. This first wave of global scenarios included ambitious mathematical simulation models (Meadows and others 1972; Mesarovic and Pestel 1974; Herrera and others 1976), speculative futurology (Kahn and others 1976), and foresight exercises for corporate managers (Wack 1985; Schwartz 1991). A new round of studies in the 1990s included pure narrative (Burrows and others 1991; Milbrath 1989), optimistic projections (CPB 1992), pessimistic visions (Kaplan 1994), surprising futures (Svedin and Aniansson 1987; Toth and others 1989), and the countless model-based climate change scenarios summarized in the most recent assessment report of the Intergovernmental Panel on Climate Change (IPCC 2001).

The early practitioners of global scenario assessment paved the way by showing the power—and limits—of both deterministic modeling and descriptive analysis. In an attempt to transcend these limits by blending narrative and quantification, recent studies have been grounded in improved global data sets and a fuller understanding of the dynamics of the planetary system, while also reflecting the potential for surprise and structural bifurcation inherent to complex socioecological systems. The challenge for the Millennium Ecosystem Assessment (MA) is to enhance these global scenarios, which have been deficient in ecosystem analysis, by incorporating the bidirectional effects that development choices can exert on ecosystems and that ecosystem change can exert on development (Cummings and others 2005).

RECENT SCENARIO STUDIES

Which of this wealth of scenario studies might provide useful resources for this effort? We can narrow the candidates considerably by identifying the needs of global ecosystem assessment and focusing on these exercises that address them. First, the multiple drivers of ecosystem change and the long chains of causation require that relevant scenarios provide *integration* across social, economic, and environmental dimensions. Second, scenarios should include *quantification* of key variables linked to ecosystem conditions. Third, they should span a *long time horizon*, at least several decades. Fourth, they should be global in scope, but offer *regional*

disaggregation, because the analysis of ecosystem change will be conducted at various spatial scales. Finally, they should explore *multiple futures* that span a broad range of plausible global visions over the coming decades.

These criteria exclude hundreds of economic and demographic projections, sectoral and thematic scenarios, and regional and national scenarios (Raskin 2000). We are led to seven major recent scenario studies (Table 1).

Global Scenario Group

Convened in 1995 by the Stockholm Environment Institute, the Global Scenario Group (GSG) is an international and interdisciplinary body that has developed an array of integrated global and regional scenarios (Raskin and others 1998, 2002; Gallopin and others 1997). The narratives of the GSG scenario are quantified with the use of the PoleStar System, a flexible adaptable tool for synthesizing global data sets, organizing sectoral linkages, and introducing assumptions (Raskin and others, 1999). This work has been relied on in numerous international assessments, including several reviewed here: the United Nations Environmental Programme's (UNEP) *Global Environmental Outlook*, the organization for Economic Cooperation and Developments (OECD) *Environmental Outlook*, and the *World Water Vision*.

Global Environment Outlook

The United Nations Environment Programme's third Global Environment Outlook (GEO 3) placed greater emphasis on integrated global and regional scenarios than earlier versions (UNEP 2002). The scenarios were developed through a lengthy collaborative process that began with four of the GSG's scenarios, which were then elaborated through a series of regional and global meetings (Raskin and Kemp-Benedict 2002). The aim of the process was to refine the narratives and give them regional texture. Although little new quantitative analysis was conducted, PoleStar simulations were further disaggregated into 23 subregions, and IMAGE runs for the International Panel on Climate Change's (IPCC) Special Report on Emissions Scenarios (SRES) were updated (see below).

Special Report on Emissions Scenarios

The SRES report (Nakićenović and others 2000) was a significant advance over prior IPCC scenarios. The SRES covers the main driving forces of human-in-

duced climate change and their implications for energy-related and land-use emissions. Four basic scenarios are provided, along with numerous variants on the basic set. Six modeling groups estimated greenhouse gas emissions for the scenarios, and an open process solicited participation and feedback.

IMAGE

The scope of the individual models used in the SRES is broader than the limited set of climate-relevant outputs in the final SRES report. One of the modeling groups, the Dutch National Institute for Public Health and the Environment (RIVM), has continued to use their IMAGE model to update and expand the SRES findings (RIVM 2001; Alcamo and others 1998). RIVM's extension of the quantification to various nonclimate issues warrants a separate entry here. As with other integrated assessment models, the objective of IMAGE is to explore the long-term consequences of global environmental change. Post-SRES IMAGE runs have provided input to the GEO-3 processes.

World Business Council on Sustainable Development

The World Business Council on Sustainable Development (WBCSD) has constructed a set of three scenarios to engage the business community in the debate on sustainable development (WBCSD 1997). The focus here is on the scenario narratives, which span a broad spectrum of possible futures. For each of the narratives, the report presents a series of challenges to business and lessons to be drawn. The scenarios were developed in an open process involving representatives from 35 organizations.

World Water Vision

The World Water Vision (WWV) project was conducted by the World Water Council to increase awareness of an impending global water crisis (WWV 2000; Cosgrove and Rijsberman 2000). The WWV presents three global scenarios that focus on issues of water supply and demand, conflict over water resources, and water requirements for nature. The council recognized that the scenarios could illuminate water sutures and provide useful guidance to policy makers only if their scope extended beyond issues specific to water to include lifestyle choices, technology, demographics, and economics. The implications for water sufficiency and quality were explored quantitatively in background studies.

Table 1. Selected Scenario Studies

Study	Horizon	Regions	Focus	Scenario structure
GSG	2050	11	Environment, poverty reduction, human values	<p><i>1. Conventional Worlds:</i> Gradual convergence in incomes and culture toward dominant market model</p> <p><i>a. Market Forces:</i> Market-driven globalization, trade liberalization, institutional modernization</p> <p><i>b. Policy Reform:</i> Strong policy focus on meeting sustainability goals through technology</p> <p><i>2. Barbarization:</i> Social and environmental problems overwhelm market and policy response</p> <p><i>a. Breakdown:</i> Unbridled conflict, institutional disintegration, and economic collapse</p> <p><i>b. Fortress World:</i> Authoritarian rule with elites in "fortresses," poverty and repression outside</p> <p><i>3. Great Transitions:</i> Fundamental changes in values, lifestyles, and institutions</p> <p><i>a. Eco-communalism:</i> Local focus and a bioregional perspective</p> <p><i>b. New Sustainability Paradigm:</i> New form of globalization that changes the character of industrial society</p> <p><i>Markets First, Policy First, Security First, Sustainability First</i> (correspond, respectively, to 1a, 1b, 2b, and 3b above)</p> <p><i>A1:</i> Rapid market-driven growth, with convergence in incomes and culture; rapid technological change</p> <p><i>A2:</i> Self-reliance and preservation of local identities; fragmented development</p> <p><i>B1:</i> Similar to <i>A1</i>, but emphasizes global solutions to sustainability, relying heavily on technology</p> <p><i>B2:</i> Local technological and policy solutions to economic, social, and environmental sustainability</p> <p><i>IMAGE 2.2:</i> SRES structure, with quantification extended to nonclimate issues</p> <p><i>FROG!:</i> Market-driven growth, economic globalization, and rapid technological change</p> <p><i>GEOpolicy:</i> Top-down approach to sustainability, with emphasis on technology</p> <p><i>Jazz:</i> Bottom-up approach to sustainability, ad hoc alliances, innovation</p> <p><i>Business-as-Usual:</i> Current water policies continue, high inequity</p> <p><i>Technology, Economics, and the Private Sector:</i> Market-based mechanisms; better technology</p> <p><i>Values and Lifestyles:</i> Less water-intensive activities; ecological preservation</p> <p><i>Reference</i> with policy variants (e.g., subsidy removal, ecotaxes)</p>
GEO-3	2032	6	Environment	
SRES	2100	4	Climate change	
IMAGE	2100	17	Environment	
WBCSD	2050	NA	Business and sustainability	
WWV	2025	18	Freshwater crisis	
OECD	2020	10	Environment in OECD countries	

GSG, Global Scenario Group; GEO-3, Global Environment Outlook, third version; SRES, Special Report on Emissions Scenarios; WBCSD, World Business Council on Sustainable Development; WWV, World Water Vision; OECD, Organisation for Economic Cooperation and Development

Table 2. Overview of Variables Reported in Scenario Simulations

	GSG	SRES	IMAGE
Demographics			
Population	×	×	×
Distribution	Urban/rural		Age and sex
Poverty	×		
Economics			
GDP	×	×	×
Sectors	×	×	×
Income distribution/poverty	×		
Agriculture and forestry			
Diets	×	×	×
Yields	×	×	×
Livestock practices	×	×	×
Inputs	×		
Timber production	×	×	×
Fish production	×		
Cropland degradation	×	×	×
Water			
Withdrawals	×		
Resources	×		
Stress	×		
Energy			
Requirements by fuel	×	×	×
Production	×	×	×
Land use			
Built environment	×		Gridded
Cropland	×	×	Gridded
Grazing/grassland	×	×	Gridded
Forest	×	×	Gridded
Plantation	×	×	Gridded
Pollution/waste			
Air	GHGs, SO _x	GHGs, SO _x	GHGs, SO _x
Water	×		
Toxics	×		
Solid waste	×		

GSG, Global Scenario Group; SRES, Special Report of Emissions Scenarios; DP, grossdomestic product; SO, sulfur oxides.

Organization for Economic Cooperation and Development

In its Environmental Outlook, the Organization for Economic Cooperation and Development (OECD) developed a baseline scenario based on development projections to 2020, complemented by several policy variants (OECD 2001). The Outlook examined the drivers of environmental change, the specific sectors that put the greatest pressure on the environment, and the resulting environmental impacts. Although its main focus is the critical environmental concerns facing OECD countries, the study is global in scope. Global economic patterns were modeled using the OECD's JOBS model. These drivers were then used as inputs into the

PoleStar System to assess potential environmental impacts in the scenarios.

Two of the studies—GSG and SRES,—stand out as presenting both a broad range of alternative visions and a wide set of quantitative indicators. Table 2 summarizes the kinds of data provided by these studies, along with those developed from SRES enhancements using the IMAGE model. The outputs include drivers of environmental change, resource requirements, and environmental stressors.

NARRATIVE SKETCHES

At first glance, there appears to be great variation across the studies in the way frameworks are

Table 3. Cross-study Mapping of Scenarios into Archetypal Social Visions

GSG	GEO-3	SRES/IMAGE	WBCSD	WWV	OECD
Conventional worlds					
Market forces	Markets first	A1	FROG!	B-a-u	Reference
Policy reform	Policy first	B1	GEOpolity	Technology and economics	Policy variants
Barbarization					
Breakdown		A2			
Fortress world	Security first				
Great Transitions					
Eco-communalism		B2			
New sustainability paradigm	Sustainability first		Jazz	Lifestyles and values	

GSG, Global Scenario Group; GEO-3, Global Environment Outlook, Third report; SRES, Special Report on Emissions Scenarios, WBCSD, World Business Council on Sustainable Development; WWV, World Water Vision; OECD, Organisation for Economic Cooperation and Development.

structured (Table 1). But despite their apparent diversity, each of the scenarios is rooted in a set of common archetypal visions of the future. Each envisions, in turn, a world that evolve gradually, shaped by dominant driving forces; a world that is influenced by a strong policy push for sustainability; a world that succumbs to fragmentation, environmental collapse, and institutional failure; and a world where new human values and new approaches to development emerge. The correspondences among the scenarios across the studies are shown in Table 3. Thumbnail sketches of the GSG SRES, and WBCSD scenarios are presented below.

Global Scenario Group

The GSG scenarios are organized into three classes with two variants for each class; for a total of six scenarios. Each class—*Conventional Worlds*, *Barbarization* and *Great Transitions*—reflects a fundamentally different social vision, while the variants explore a range of possibilities within each class.

Conventional Worlds envisions a future that is shaped by increasing economic interdependence, the spread of dominant cultural values, and the gradual convergence of developing regions with the evolving socioeconomic relationships characteristic of modern industrial societies. In the *Market Forces* variant, powerful global actors advance the priority of economic growth and the so-called Washington Consensus policy agenda of liberalization, privatization, and modernization. *Market Forces* relies centrally on the self-correcting logic of competitive markets to address global challenges. In the *Policy Reform* variant, widespread concern over environmental deterioration, social conflict, and economic instability leads to a marshalling of the political will to implement comprehensive government action aimed at redirecting and con-

straining the global economy to achieve a broad set of social and environmental goals.

Barbarization scenarios envision the grim possibility that the social, economic, and moral underpinnings of civilization will deteriorate. Cultural polarization, geopolitical conflict, environmental degradation, and economic instability reinforce and amplify each other, leading to a general global crisis. The coping capacity of markets is overwhelmed, while the political will necessary for policy reform fails to emerge. The *Breakdown* variant describes a downward spiral toward unbridled conflict, institutional disintegration, and economic collapse. The *Fortress World* features an authoritarian response to the threat of breakdown: from protected enclaves, elites control an impoverished majority and manage critical natural resources.

Great Transitions scenarios explore futures in which the global sustainability challenge catalyzes fundamental changes in socioeconomic arrangements and human values. They depict a transition to a society that places high value on the preservation of nature, improved human well-being through qualitative development and material sufficiency for all, and a strong sense of social solidarity. In contrast to the global homogeneity envisioned by *Conventional Worlds* scenarios, *Great Transitions* recognizes multiple pathways to modernity, where regions pursue diverse development strategies by building on unique cultural, ecological, and institutional attributes. In the context of equitable and plural global development, population stabilization, less material-intensive lifestyles in rich- countries, and massive deployment of green technologies radically diminish the long-range stress on nature. The *Eco-communalism* variant of *Great Transitions* presents a highly localist vision of face-to-face democracy, small technology, and economic autarky. The *New Sustainability Par-*

adigm, the scenario highlighted by the GSG (Raskin and others 2002), would seek to change the character of urban, industrial civilization rather than replace it and to build a more humane global civilization rather than retreat into localism.

Special Report on Emissions Scenarios

The SRES lie in four quadrants defined by two axes: whether the world is integrated or fragmented, and whether sustainability is a priority or not. In the SRES notation “A” and “B” signify low and high commitment to sustainable development, respectively; and “1” and “2” signify regional integration or fragmentation, respectively. Thus, A1 is an integrated unsustainable world, A2 is a fragmented unsustainable world, B1 is an integrated sustainable world, and B2 is a fragmented sustainable world.

A1 represents a globalizing world of extremely rapid economic growth, stabilizing populations, rapid technological change, and convergence among regions, with a substantial reduction in income differences. The scenario branches into three subdivisions that assume different technological developments in the energy sector—fossil fuel, intensive, a sharp increase in nonfossil energy sources, and a balance across all sources.

A2 is a very heterogeneous world. Rather than converging toward a single model of industrial development, regions and nations emphasize self-reliance and the preservation of local identities. Because local fertility patterns converge very slowly toward rich-country practices, global population continues to grow throughout the 21st century. Economic development maintains its local character, integration into the global economy is limited, average incomes diverge between regions, and technological change is relatively slow and regionally diverse.

B1 is a regionally convergent world where global population peaks in midcentury and declines thereafter, as in A1. A rapid shift in economic structure toward the service and information sectors, coupled with the introduction of clean and resource-efficient technologies, leads to a sharp reduction in material intensity (material input per economic output). Global governance mechanisms evolve and countries remain committed to international assistance programs. Global solutions are sought to improve economic, social, and environmental sustainability, as well as social equity. However, as in all SRES, there are no new climate initiatives.

B2 is a world where regions and nations pursue plural models of development. But unlike A2,

economic, social, and environmental sustainability are high priorities. Diverse local solutions and policies are implemented to achieve these goals. Global population continues to increase but at a lower rate than A2. Economic growth is at intermediate levels. Technological change is more rapid than A2 and less rapid and more diverse than B1 and A1. As in B1, development strategies prioritize environmental protection and social equity, but global governance is weak and the focus is on local and regional initiatives. Vision.

WORLD BUSINESS COUNCIL ON SUSTAINABLE DEVELOPMENT

The *FROG!* scenario of the WBCSD begins as a business-as-usual world where economic growth is the major concern everywhere. Some developing nations leapfrog to advanced technology, enjoying rapid economic development. Action on sustainable development is weak. Improvement in local air quality, solid waste management, and environmental education leads to a perception that conditions are improving. Due to economic and population growth, greenhouse gases rise, but this problem goes largely unnoticed and people disagree about its significance. However, by 2050, there is evidence of severe global warming. The reliance on technology has not delivered environmental or social health. Globalization and urbanization have increased inequity and unrest, threatening the basic survival of both the human and environmental ecosystems.

The *GEOpolity* scenario begins with a succession of signals in the first 2 decades of the 21st century that an environmental and social crisis is looming. The emphasis on economic growth is increasingly viewed as dangerously narrow. A new global consensus welcomes technocratic solutions, sanctions, and more direct control of the market to ensure environmental preservation and social cohesion. Because neither governments nor businesses are effective in providing leadership, people demand new global institutions—such as the Global Ecosystem Organization (GEO)—to enforce standards and measures, even if doing so requires economic sacrifice. Governments become rejuvenated as focal points of civil society, taking the lead in shifting the structure of the economy toward the goal of sustainable development.

Jazz is an innovative world of ad hoc alliances of diverse stakeholders, experimentation, adaptation, and a dynamic global market. Information technology enables the entry of new economic actors as

participants in the burgeoning global market, which is supported by sound legal systems. Government activity is largely confined to the local level, as ad hoc global governance institutions address specific problems. Although public access to information is required, green behaviors are not, as new environmental and social standards are achieved largely out of self-interest. High corporate transparency enables the public to become aware of transgressions and to act quickly against companies or countries that violate standards. Companies have a self-interest in avoiding disputes and in being seen as environmentally and socially responsible. Nongovernmental organizations, governments, concerned consumers, and businesses are partners in finding ways to incorporate environmental and social values into market mechanisms.

TOWARD ECOSYSTEM SCENARIOS

The development of scenario analysis is a response to the current imperative to explore the long-range possibilities of complex socioecological systems and to provide policy guidance on the consequences of alternative actions and choices. Global scenario methods have evolved rapidly in recent years to include a progressively wider range of issues and themes, greater spatial disaggregation, and more seamless blending of qualitative and quantitative descriptions. Continual progress can be anticipated. These are still early days in forging the conceptual and methodological foundations for an emerging sustainability science (Swart and others 2004).

However, to date, global scenarios have not focused directly and systematically on the role of ecosystem conditions and management in shaping scenarios and guiding policy decisions. This task falls naturally to the MA. In this effort, existing global scenarios provide a useful point of departure. They provide archetypal storylines that can be enriched with an ecosystem perspective and the quantification of the key variables—demographics, economic activity, land change, climate change, and so on—relevant for ecosystems scenarios.

As the MA sets about developing ecosystem-centered scenarios, these preliminary exercises can provide useful insights. For example, they tend to show that indirect institutional and cultural developments will be as important to ecosystem conditions as direct technological and management choices. Moreover, all of them suggest that a future in which a “market forces” vision of global economic growth prevails, the consumer society is taken as the model for successful development, and globalization

is corporate-driven would be a perilous proposition. The risk is that social polarization, persistent poverty, and environmental degradation would undercut the basis for social cohesion, ecosystem resilience, and, ironically, economic growth itself. The scenarios suggest that a “policy reform” response could make great strides in principle, toward reducing the many stresses on socioecological systems by promoting the dissemination of nature-sparing technologies and practices, fostering a transition to the use of renewable resources, and alleviating poverty. But although this strategy is feasible in the sense that the required technology and policy instruments are available to reconcile economic growth with social and environmental remediation, it is problematic in practice, requiring a sustained and widespread political will for a comprehensive policy program that is not in evidence. Most of the studies conclude that a more fundamental global transition is the preferred path for ensuring an ecologically sound and humane global future in the 21st century. This new sustainability paradigm draws attention to institutional innovation, such as multiscale, adaptive, and democratic governance processes, and the constructive engagement of stakeholders and civil society in balancing economic, social, and environmental concerns. It underscores the need for the revision of human values to include an emphasis on materially sufficient and qualitatively rich lifestyles, a strong sense of human solidarity from local to global levels, and an ecological sensibility.

Enriching the ecosystem aspects of global scenarios will be an important item on the research agenda in the coming years. Achieving this goal will require, in parallel, improved methods for quantitative simulations and the enhancement of scenario narratives. One long-term goal that would enhance quantification is the creation of modules for the simulation of ecosystem goods and services that could then be imbedded into global assessment frameworks. Although the implementation of such an integrated approach is beyond its scope, the MA can help catalyze this process by providing a clear conceptual framework, synthesizing relevant databases, and identifying appropriate indicators of ecosystem conditions, goods, and services.

A parallel challenge is the refinement of scenario narratives to more richly reflect ecosystem descriptors, impacts, and feedbacks. The message across global scenario exercises is that assumptions about institutional design and human values are critical for the resilience of human and natural systems. Will the future be driven by growth-first economic policies? by government-led efforts to constrain economies in favor of a broad range of

environmental and social goals? or by new governance arrangements and a more enlightened set of human values and priorities? What decision-making systems and underlying human values can minimize the risk of dangerous and abrupt surprises in environmental and social systems? What policies and actions can promote the technological and cultural adjustments that would foster sustainability?

The scenarios presented here underscore the perils of global pathways that enable diverse stressors—cultural polarization, geopolitical fissures, environmental degradation, persistent poverty, and economic instability—to reinforce and amplify each other. At the same time, they offer hope by also presenting visions that feature greater equity, plural regional development strategies, and innovative cross-scale governance systems that build adaptive capacity for coping with an era of complex and accelerating change. The addition of a strong ecological perspective would enrich not only our understanding of the future of ecosystems, but more generally the prospects for a sustainable and desirable global civilization.

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