A GUIDE TO

WORLD RESOURCES 2000–2001

People and Ecosystems

The Fraying Web of Life

UNITED NATIONS DEVELOPMENT PROGRAMME
UNITED NATIONS ENVIRONMENT PROGRAMME
WORLD BANK
WORLD RESOURCES INSTITUTE

Full Report Forthcoming
September 2000

WORLD RESOURCES 2000–2001

WORLD RESOURCES REPORT

Carol Rosen, Editor-in-Chief, since July 1999
Leslie Roberts, Editor-in-Chief, before July 1999
Gregory Mock, Senior Editor
Wendy Vanasselt, Associate Editor
Janet Overton, Managing Editor
Lori Han, Production Coordinator
Amy Wagener, Research Assistant
Rich Barnett, Outreach and Marketing Director

Data and Maps

Dan Tunstall, Information Director
Robin White, Data Tables Manager
Christian Ottke, Associate
Carmen Revenga, Associate
Mark Rohweder, Analyst
Siobhan Murray, Map Manager
Ken Kassem, Analyst
Yumiko Kura, Analyst
Kate Sebastian, Analyst

Pilot Analysis of Global Ecosystems

Norbert Henninger, Project Manager
Walter V. Reid, Guest Editor

Agroecosystems
Stanley Wood, Kate Sebastian, Sara Scherr

Coastal Ecosystems
Lauretta Burke, Yumiko Kura, Ken Kassem, Mark Spalding, Carmen Revenga

Forest Ecosystems
Emily Matthews, Siobhan Murray, Richard Payne, Mark Rohweder

Freshwater Systems
Carmen Revenga, Jake Brunner, Norbert Henninger, Ken Kassem, Richard Payne

Grassland Ecosystems
Robin White, Siobhan Murray, Mark Rohweder

PRINCIPAL PARTNERS

United Nations Development Programme
Roberto Lenton, Charles McNeil, Ralph Schmidt, Susan Becker, Kristen Lewis

United Nations Environment Programme
Dan Claasen, Ashbindu Singh, Anna Stabrawa, Marion Cheatle

World Bank
Robert Watson, John Dixon, Kirk Hamilton, Stefano Pagiola

SENIOR ADVISORS

Agriculture
Mary Tiffen, Drylands Research, United Kingdom

Biodiversity
Patrick Dugan, Director, Global Programme, IUCN
Calestous Juma, Kennedy School of Government, Harvard University
Thomas Lovejoy, Chief Biodiversity Advisor, World Bank
Cristian Samper, Director General, Instituto Alexander von Humboldt, Colombia
Peter Schei, International Negotiations Director, Directorate for Nature Management, Norway
Brian Walker, Wildlife and Ecology, CSIRO, Australia

Coastal/Marine
Edgardo Gomez, Marine Science Institute, University of the Philippines
Kathleen Sullivan Sealey, Department of Biology, University of Miami

Ecologists/Generalists
Serge Antoine, Comité 21, France
Munyaradzi Chenje, Director, Environment Resource Centre for Southern Africa, Zimbabwe
Madhav Gadgil, Centre for Ecological Sciences, Indian Institute of Science
Hiroyuki Ishi, Graduate School of Frontier Science, University of Tokyo
Eugene Linden, Contributor, *Time Magazine*
Pamela Matson, Geological and Environmental Sciences, Stanford University
Robert McNamara, former President, World Bank
Bedrich Moldan, Director, Environmental Centre, Charles University, Czech Republic
John Mugabe, Executive Director, African Centre for Technology Studies, Kenya
Walter V. Reid, Millennium Ecosystem Assessment Secretariat
J. Alan Brewster, Associate Dean, School of Forestry and Environmental Studies, Yale University; former Editor-in-Chief, World Resources Report

Forests
Valerie Kapos, World Conservation Monitoring Centre, United Kingdom

Grasslands
Habiba Gitay, Australian National University

Sustainable Development
Theo Panayotou, Harvard Institute for International Development

Water
Melanie L.J. Stiassny, Herbert R. and Evelyn Axelrod, Research Curator and Chair, Department of Ichthyology, American Museum of Natural History

A GUIDE TO

WORLD RESOURCES 2000–2001

People and Ecosystems

The Fraying Web of Life

UNITED NATIONS DEVELOPMENT PROGRAMME
UNITED NATIONS ENVIRONMENT PROGRAMME
WORLD BANK
WORLD RESOURCES INSTITUTE

WORLD RESOURCES INSTITUTE Washington, D.C.

A Guide to World Resources 2000–2001:
People and Ecosystems: The Fraying Web of Life

First printing April 2000

Published by World Resources Institute
10 G Street NE
Washington, DC 20002 USA

This guide summarizes the full volume, *World Resources 2000–2001: People and Ecosystems: The Fraying Web of Life,* which will be published in English in September 2000. The *World Resources* series is a collaborative product of four organizations: the United Nations Development Programme, the United Nations Environment Programme, the World Bank, and the World Resources Institute. The views expressed in this volume are those of staff from each organization and do not necessarily reflect the judgments of the organizations' boards of directors or member governments.

Ordering information for the full volume in English is provided on the last page of this guide. For further information, contact the supplier of each edition.

English hardcover edition:
Elsevier Science Ltd.
The Boulevard
Langford Lane, Kidlington
Oxford OX5 1GB, UK

English paperback edition:
World Resources Institute
10 G Street, NE
Washington, DC 20002 USA

French edition:
Editions Eska
12, rue du Quatre-Septembre
75002 Paris, France

Spanish edition:
Ecoespaña Editorial
Apto. 16.158
28080 Madrid, Spain

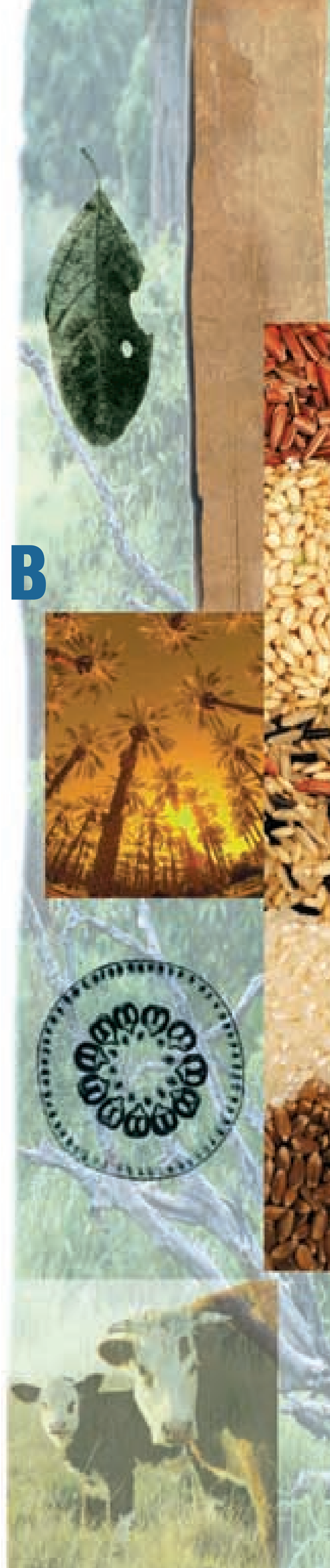
Japanese edition:
Nikkei Business Publications, Inc.
2-7-6, Hirakawacho, Chiyoda-ku
Tokyo 102-8622, Japan

Photo credits

Cover	Fall harvest in the Kathmandu Valley of Nepal: Sara Elder
Page 2	Harvesting grain, Kathmandu Valley, Nepal: Sara Elder
Page 22	Great Egret
Page 23	Fishermen, Cochin, India: Photodisc

FOREWORD

REPAIRING THE FRAYING WEB



There are times when the most difficult decision of all is to acknowledge the obvious. It is obvious that the world's national economies are based on the goods and services derived from ecosystems; it is also obvious that human life itself depends on the continuing capacity of ecosystems to provide their multitude of benefits. Yet for too long in both rich and poor nations, development priorities have focused on how much humanity can take from our ecosystems, with little attention to the impact of our actions. With this report, the United Nations Development Programme, the United Nations Environment Programme, the World Bank, and the World Resources Institute reconfirm their commitment to making the viability of the world's ecosystems a critical development priority for the 21st century.

While our dependence on ecosystems may be obvious, the task of integrating considerations of ecosystem capacity into decisions about development is difficult. It requires governments and businesses to rethink some basic assumptions about how we measure and plan economic growth. Poverty forces many people to jeopardize the ecosystems on which they depend, even when they know that they are cutting timber or extracting fish at unsustainable levels. Greed or enterprise, ignorance or inattention also leads people to disregard the natural limits that sustain ecosystems. The biggest difficulty of all, however, is that people at all levels, from the farmers at the grassroots to the policy makers in the capitals, either can't make good use of the knowledge at hand or lack basic information about the condition and long-term prospects of ecosystems. This report, and the Pilot Analysis of Global Ecosystems on which it is based, is a step toward addressing this problem.

In our unique collaboration on the World Resources Report Series, our four organizations undertook this edition in a genuine partnership to develop recommendations that would safeguard the world's ecosystems. We bring together different perspectives and decades of experience working on environment and development issues. We are motivated by the urgent need for solutions that will benefit both people and ecosystems.

At this moment, in all nations–rich and poor–people are experiencing the effects of ecosystem decline in one guise or another: water shortages in the Punjab, India; soil erosion in Tuva, Russia; fish kills off the coast of North Carolina in the United States; landslides on the deforested slopes of Honduras; fires in the disturbed forests of Borneo and Sumatra in Indonesia. The poor, who often depend directly on ecosystems for their livelihoods, suffer most when ecosystems are degraded.

At the same time, people in all parts of the world are working to find solutions: community forest conservation programs in Dhani, India; collective management of grasslands in Mongolia; agricultural transformation in Machakos, Kenya; removal of invasive tree species to protect water resources in South Africa; and restoration of the Everglades in the United States. Governments and private interests are spending billions trying to rectify ecosystem degradation or, at least, stave off the consequences–and countless billions more may be needed to restore ecosystems on a global scale.

As these examples and many others in this volume demonstrate, our knowledge of ecosystems has increased dramatically, but it has simply not kept pace with our ability to alter them. Unless we use the knowledge we've gained to sustainably develop Earth's ecosystems, we risk inflicting ever greater damage on them with dire consequences for economic development and human well-being. Thus, the urgency of this issue: shortsighted, avoidable mistakes can affect the lives of millions of people, now and in the future. We can continue blindly altering Earth's ecosystems, or we can learn to use them more sustainably.

If we choose to continue our current patterns of use, we face almost certain declines in the ability of ecosystems to yield their broad spectrum of benefits–from clean water to stable climate, fuelwood to food crops, timber to wildlife habitat. We can choose another option, however. It requires reorienting how we see ecosystems, so that we learn to view their sustainability as essential to our own. Adopting this "ecosystem approach" means we evaluate our decisions on land and resource use in terms of how they affect the capacity of ecosystems to sustain life, not only human well-being but also the health and productive potential of plants, animals, and natural systems. Maintaining this capacity becomes our passkey to human and national development, our hope to end poverty, our safeguard for biodiversity, our passage to a sustainable future.

It's hard, of course, to know what will be truly sustainable in either the physical or political environments of the future. That's why the ecosystem approach emphasizes the need for both good scientific information and sound policies and institutions. On the scientific side, an ecosystem approach should:

- Recognize the "system" in ecosystems, respecting their natural boundaries and managing them holistically rather than sectorally.
- Regularly assess the condition of ecosystems and study the processes that underlie their capacity to sustain life so that we understand the consequences of our choices.

On the political side, an ecosystem approach should:

- Demonstrate that much can be done to improve ecosystem management by developing wiser policies and more effective institutions to implement them.
- Assemble the information that allows a careful weighing of the trade-offs among various ecosystem goods and services and among environmental, political, social, and economic goals.
- Include the public in the management of ecosystems, particularly local communities, whose stake in protecting ecosystems is often greatest.

The goal of this approach is to optimize the array of goods and services ecosystems produce while preserving or increasing their capacity to produce these things in the future. *World Resources 2000–2001* advocates an ecosystem approach and recommends how we can apply it.

A critical step in taking care of our ecosystems is taking stock of their condition and their capacity to continue to provide what we need. Yet, there has never been a global assessment of the state of the world's ecosystems. This report starts to address this knowledge gap by presenting results from the Pilot Analysis of Global Ecosystems, a new study undertaken to be the foundation for more comprehensive assessment efforts.

What makes the pilot analysis valuable now, before any other assessment, is that it compares information already available on a global scale about the condition of five major classes of ecosystems: agroecosystems, coastal areas, forests, freshwater systems, and grasslands. The pilot analysis examines not only the quantity and quality of outputs but also the biological basis for production, including soil and water condition, biodiversity, and changes in land use over time. And rather than looking just at marketed products, such as food and timber, the pilot analysis evaluates the condition of a broad array of ecosystem goods and services that people rely on but don't buy in the marketplace. The bottom line is a comprehensive evaluation, based on available information, of the current condition of five major ecosystems.

It's an evaluation that clearly shows the strengths and weaknesses of the information at hand. The pilot analysis identifies significant gaps in the data and what it would take to fill those gaps. Satellite imaging and remote sensing, for example, have added to information about certain features of ecosystems, such as their extent, but on-the-ground information for such indicators as freshwater quality and river discharge is less available today than in the past.

Although some data are being created in abundance, the pilot analysis shows that we have not yet succeeded in coordinating our efforts. Scales now diverge, differing measures defy integration, and different information sources may not know of each other's relevant findings.

Our partner organizations began work on this edition of the World Resources Report with a conviction that the challenge of managing Earth's ecosystems–and the consequences of failure–will increase significantly during the 21st century. We end with a keen awareness that the scientific knowledge and political will required to meet this challenge are often lacking today. To make sound ecosystem management decisions in the 21st century, dramatic changes are needed in the way we use the knowledge and experience at hand, as well as the range of information brought to bear on resource management decisions.

A truly comprehensive and integrated assessment of global ecosystems that goes well beyond our pilot analysis is needed to meet information needs and to catalyze regional and local assessments. Planning for such a Millennium Ecosystem Assessment is already under way. In 1998, representatives from a broad range of international scientific and political bodies began to explore the merits of and to recommend the structure for such an assessment. After consulting for a year and considering the preliminary findings in this report, they concluded that a global assessment of the past, present, and future of ecosystems was feasible and urgently needed. They urged local, national, and international institutions to support the effort as stakeholders, users, and sources of expertise. If concluded successfully, the Millennium Ecosystem Assessment will generate new information, integrate current knowledge, develop methodological tools, and increase public understanding. At local, national, and regional scales it will build the capacity to obtain, analyze, and act on improved information. Our institutions are united in supporting this call for the Millennium Ecosystem Assessment.

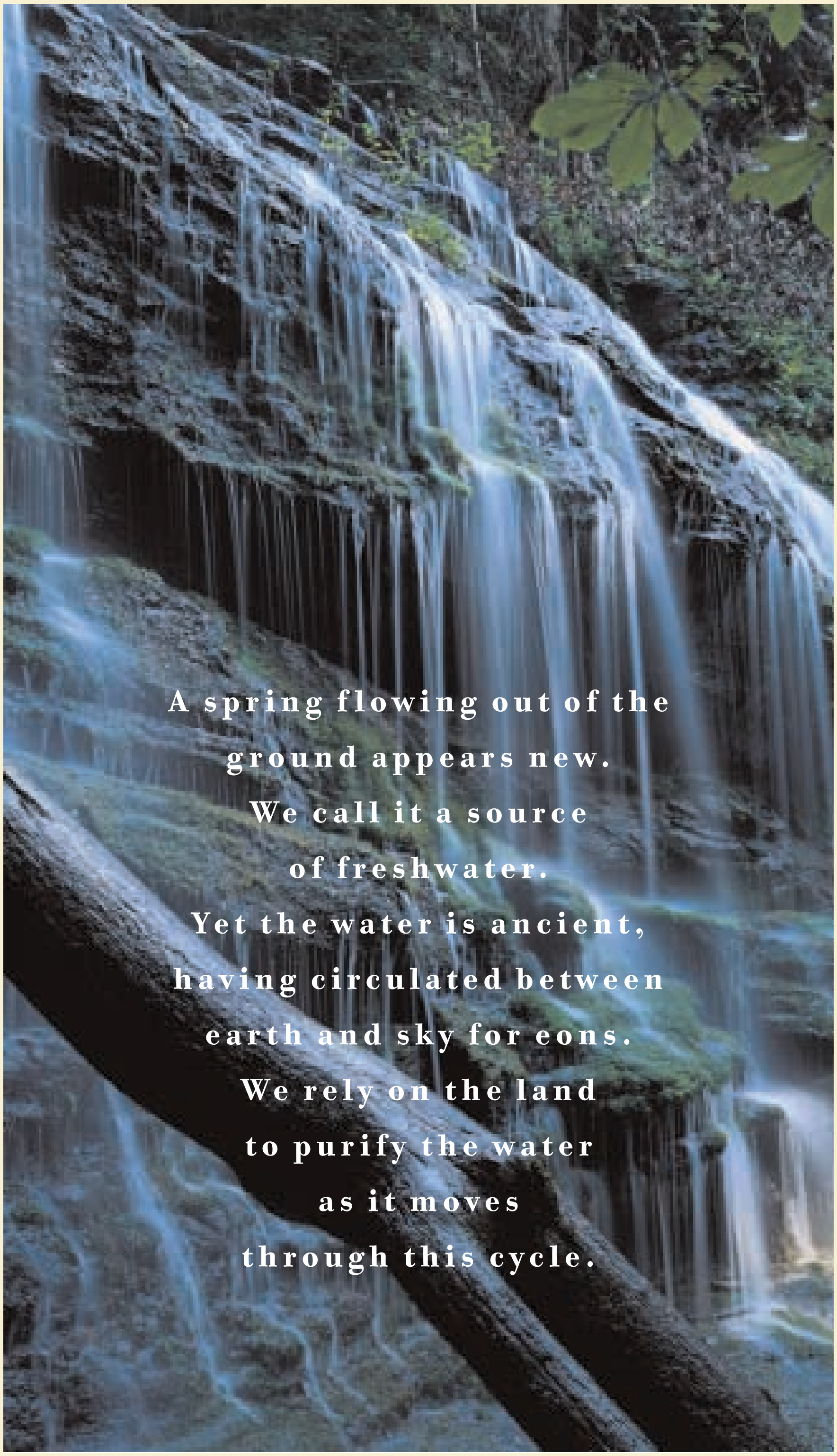
At the dawn of a new century, we have the ability to change the vital systems of this planet, for better or worse. To change them for the better, we must recognize that the well-being of people and ecosystems is interwoven and that the fabric is fraying. We need to repair it, and we have the tools at hand to do so. What better time than now?

Mark Malloch Brown
Administrator,
United Nations Development Programme

Klaus Töpfer
Executive-Director,
United Nations Environment Programme

James D. Wolfensohn
President,
World Bank

Jonathan Lash
President,
World Resources Institute



A spring flowing out of the
ground appears new.
We call it a source
of freshwater.
Yet the water is ancient,
having circulated between
earth and sky for eons.
We rely on the land
to purify the water
as it moves
through this cycle.

SUMMARY

PEOPLE AND ECOSYSTEMS

The Fraying Web of Life

Earth's ecosystems and its peoples are bound together in a grand but tenuous symbiosis. We depend on ecosystems to sustain us, but the continued health of ecosystems depends, in turn, on our care. Ecosystems are the productive engines of the planet, providing us with everything from the water we drink to the food we eat and the fiber we use for clothing, paper, or lumber. Yet nearly every measure we use to assess the health of ecosystems tells us we are drawing on them more than ever and degrading them at an accelerating pace.

How viable, then, are Earth's ecosystems? And how best can we manage ecosystems–and reduce our own impacts–so that they remain healthy and productive in the face of increasing human demands? This special millennial edition of the *World Resources Report* tries to answer these questions, focusing on ecosystems as the biological underpinning of the global economy and human well-being.

The Goals of the Report

The goals of *World Resources 2000–2001* are twofold. The first goal is to report on the condition of Earth's ecosystems at the dawn of the new millennium–a time when humans exert a dominant and growing influence on these systems. This is not an easy task because nations, even wealthy ones, do not systematically monitor the status of their ecosystems. We know a good deal about environmental conditions in many places, and we have a fair understanding of the pressures many ecosystems face. But that knowledge is not sufficient to give us a clear picture of the state of major ecosystems worldwide.

To focus attention on what is known–and what more we vitally need to know–*World Resources 2000–2001* presents the results of a first-of-its-kind Pilot Analysis of Global Ecosystems, undertaken in 1999. This analysis is unique in that it gauges the condition of ecosystems by examining the goods and services they currently produce–food, fiber, clean water, biodiversity, carbon storage, recreation, and others–and their capacity to continue producing them in the future. Although the gaps in the data limit the thoroughness of the analysis, it is as comprehensive as possible in its coverage. The results offer a sobering glimpse at how we have altered ecosystems to our purposes, increasing both benefits and vulnerability.

A second and equally important goal of *World Resources 2000–2001* is to motivate nations, local communities, and individuals to adopt an ecosystem-oriented approach to managing the environment. This means learning to recognize how our activities affect ecosystems. Furthermore, this means acting to maintain and even restore their productive capacity–their ability to deliver diverse goods and services. In practice, this requires understanding the complexity and resilience of ecosystems, and managing them along their natural boundaries, even if the boundaries extend across jurisdictional lines. Taking an ecosystem approach also demands that we reorient our usual approach from managing for a specific product such as timber or food, toward managing for the sustainability of the ecosystem as a whole.

An ecosystem approach in no way excludes people or denies the need for local, regional, and global development. In fact, the power of this approach lies in the fact that it links the needs and requirements of people to the biological capacity of ecosystems to continue to provide for the future. Without this kind of approach, there is little chance of keeping the unraveling web of life from fraying further. With it, we may begin to mend and strengthen the web.

What Are Ecosystems?

Ecosystems are communities of interacting organisms and the physical environment in which they live. Ecosystems are not just assemblages of species–they are systems combined of organic and inorganic matter and natural forces that interact and change. Ecosystems are intricately woven together by food chains and nutrient cycles; they are living sums greater than their parts. Their complexity and dynamism contribute to their productivity, but make them challenging to manage.

We are intimately familiar with ecosystems. They are the woodlands where we live, hunt, cut timber, or hike; the lakes, streams, and rivers we fish, boat, transport our goods on, and tap for water; the rangelands where we graze our cattle; the beaches where we play, and the marine waters we trawl; the farmlands we till; even the urban parks and green spaces we stroll. In effect, every centimeter of the planet is part of an ecosystem.

When talking about ecosystems, the matter of scale or size is important. A small bog, a single sand dune, or a tiny patch of forest may be viewed as an ecosystem, unique in its mix of species and microclimate–a microenvironment. On a much larger scale, an "ecosystem" may also refer to much more extensive communities–a 100 or 1,000 km^2 forest, or a major river system, each having many such microenvironments.

In this report, "ecosystem" refers to an even larger concept–*categories of ecosystems.* Coastal, forest, grassland, freshwater, and agricultural ecosystems are addressed, all on a global scale; and each may include a number of local variations. For example, forest ecosystems range from the tropical rainforests of the equatorial latitudes to the extensive boreal forests of higher latitudes–systems that are quite different in their details, but similar in basic structure and in the kinds of benefits they provide. Dividing ecosystems in this way allows us to examine them on a global scale and think in broad terms about the challenges of managing them sustainably.

However, the divisions between ecosystems are less important than the linkages between them. Grasslands give way to savannas that segue into forests. Fresh water becomes brackish as it approaches a coastal area. The systems are tightly knit into a global continuum of energy and nutrients and organisms–the biosphere in which we live.

We include in our analysis of ecosystems both "managed," such as farms, pastures, or forest plantations that have been modified to enhance the yield of certain products, and "natural," such as forests or rangeland tracts that retain much of their original structure and functioning. In reality human influence affects all the world's ecosystems to some extent–even the most isolated. Again using the example of forests, the spectrum of human influence ranges from relatively undisturbed old-growth forests, to nondestructive tapping of rubber trees, to clear-cutting, and even to single-species tree plantations consisting of only eucalypt or pine trees. Both "managed" and "natural" ecosystems are living systems capable of producing an array of benefits, and both are crucial to human survival.

Box 1

Linking Ecosystems and People

An urban professional in Tokyo reads a newspaper printed on pulped trees from North American forests. Her food and clothing come from plants and animals raised around the world—cotton and cashmere from Asia, fish from the Pacific and Indian oceans, beef from Australian and North American grasslands, fruits and vegetables from farmlands on four continents. The coffee she sips comes from tropical Central American plantations, but it is brewed with water from wells near the city.

In a Borneo village children get to school via river, poled in long boats handmade from local trees. In nearby paddies, families grow rice, their main dietary staple as well as a source of wine, and pepper, a cash crop.

The Shuar of Amazonian Ecuador find shelter in houses with thatch roofs made from the local palms. They also use palm stems for weaving baskets and containers. They grow manioc, papaya, sweet potato, and other crops derived from the rainforest, for their own subsistence and for cash. The forest is also the source of their fuelwood and medicines, as well as fish and game.

The examples above provide images of some of the essential services ecosystems provide—from the water we drink to the food we eat and the fiber we use for clothing, paper, or lumber. But just how viable are Earth's ecosystems?

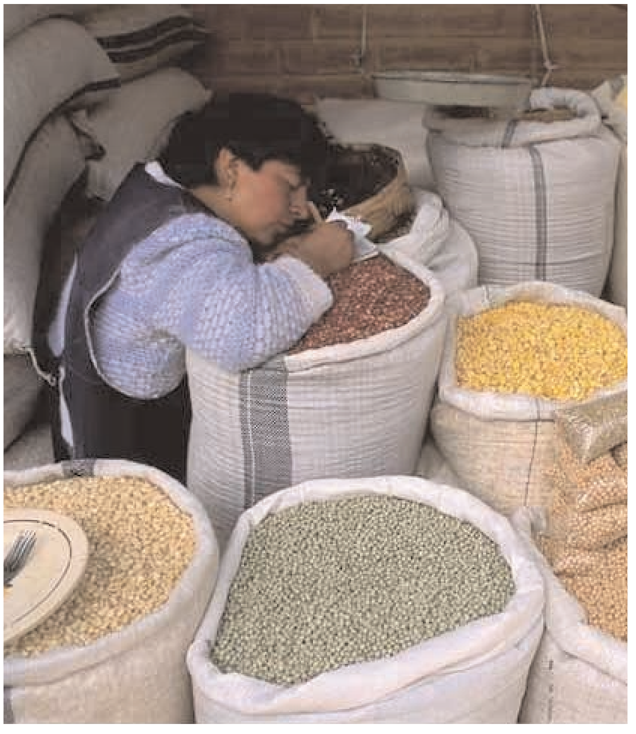
Why Care about Ecosystems?

Ecosystems sustain us. They are Earth's primary producers–solar-powered factories that yield the most basic necessities: food, fiber, water–and all at an efficiency unmatched by human technology. Ecosystems also provide essential functions–services like air and water purification, climate control, nutrient cycling, and soil production–that we can't replace at any reasonable price.

Harvesting the bounty of ecosystems roots our economies and provides us employment, particularly in low- and middle-income countries. Agriculture, forestry, and fishing are responsible for 50 percent of all jobs worldwide and 70 percent of the jobs in sub-Saharan Africa, East Asia, and the Pacific. In 25 percent of the world's nations, crops, timber, and fish still contribute more to the economy than industrial goods. Global agriculture alone produces $1.3 trillion in food and fiber each year.

Ecosystems feed our souls as well, providing places for religious expression, aesthetic enjoyment, and recreation. Every year, millions of people make pilgrimages to outdoor holy places, vacation in scenic regions, or simply pause in a park or their gardens to reflect or relax. As the manifestation of nature, ecosystems are the psychological and spiritual backdrop of our lives.

In every respect, human development and human security are closely linked to the productivity of ecosystems. Our future rests squarely on their continued viability.



Primary Goods and Services Provided by Ecosystems

Ecosystem	Goods	Services
Agroecosystems	▪ Food crops ▪ Fiber crops ▪ Crop genetic resources	▪ Maintain limited watershed functions (infiltration, flow control, partial soil protection) ▪ Provide habitat for birds, pollinators, soil organisms important to agriculture ▪ Build soil organic matter ▪ Sequester atmospheric carbon ▪ Provide employment
Forest Ecosystems	▪ Timber ▪ Fuelwood ▪ Drinking and irrigation water ▪ Fodder ▪ Nontimber products (vines,bamboos, leaves, etc.) ▪ Food (honey, mushrooms, fruit, and other edible plants; game) ▪ Genetic resources	▪ Remove air pollutants, emit oxygen ▪ Cycle nutrients ▪ Maintain array of watershed functions (infiltration, purification, flow control, soil stabilization) ▪ Maintain biodiversity ▪ Sequester atmospheric carbon ▪ Moderate weather extremes and impacts ▪ Generate soil ▪ Provide employment ▪ Provide human and wildlife habitat ▪ Contribute aesthetic beauty and provide recreation
Freshwater Systems	▪ Drinking and irrigation water ▪ Fish ▪ Hydroelectricity ▪ Genetic resources	▪ Buffer water flow (control timing and volume) ▪ Dilute and carry away wastes ▪ Cycle nutrients ▪ Maintain biodiversity ▪ Provide aquatic habitat ▪ Provide transportation corridor ▪ Provide employment ▪ Contribute aesthetic beauty and provide recreation
Grassland Ecosystems	▪ Livestock (food, game, hides, fiber) ▪ Drinking and irrigation water ▪ Genetic resources	▪ Maintain array of watershed functions (infiltration, purification, flow control, soil stabilization) ▪ Cycle nutrients ▪ Remove air pollutants, emit oxygen ▪ Maintain biodiversity ▪ Generate soil ▪ Sequester atmospheric carbon ▪ Provide human and wildlife habitat ▪ Provide employment ▪ Contribute aesthetic beauty and provide recreation
Coastal Ecosystems	▪ Fish and shellfish ▪ Fishmeal (animal feed) ▪ Seaweeds (for food and industrial use) ▪ Salt ▪ Genetic resources	▪ Moderate storm impacts (mangroves; barrier islands) ▪ Provide wildlife (marine and terrestrial) habitat ▪ Maintain biodiversity ▪ Dilute and treat wastes ▪ Provide harbors and transportation routes ▪ Provide human and wildlife habitat ▪ Provide employment ▪ Contribute aesthetic beauty and provide recreation

What Is the Problem?

The current rate of decline in the long-term productive capacity of ecosystems could have devastating implications for human development and the welfare of all species. The history of human impacts on ecosystems is a long one, and large-scale environmental disruptions have more than once factored into societal decline. Historical records from more than 4,000 years ago show that waterlogging and salt buildup in the arid soils of Sumer in ancient Mesopotamia–the product of overirrigation–gradually handicapped the kingdom's ability to feed itself and contributed to its fall.

Modern examples of the human costs of degrading ecosystems surround us as well. In Canada's maritime provinces, collapse of the cod fishery in the early 1990s from overfishing left 30,000 fishers dependent on government welfare payments and decimated the economies of 700 communities in Newfoundland alone. The residents of more than 100 of China's major cities face severe water shortages, in part because of overextraction and pollution of nearby rivers and groundwater sources. Commercial cutting of India's forests has left the traditional system of village management of local forests in shambles and brought shortages of fuelwood and building materials to millions of rural villagers. In most cases, the poor suffer most when ecosystems decline because they are usually the most directly dependent on them for survival.

The scale of human pressures on ecosystems increased enormously in the last century–and even more so in the last few decades. Since 1980, the global economy has tripled in size, and the population has grown 30 percent to 6 billion people. Consumption of everything from rice to paper to refrigerators to oil has risen in tandem–all at a cost to ecosystems. And these pressures are not likely to abate soon. Economists predict the global economy may expand by a factor of five in the next 50 years. Demographers expect the population to grow to 9 billion in the same period. Demand for rice, wheat, and maize is expected to grow 40 percent by 2020, pushing water demand for irrigation up 50 percent or more. By 2050, demand for wood could double.

These basic pressures are exacerbated by a suite of economic and political factors that influence how and what we consume and where it comes from. Too often, these factors encourage us to exploit ecosystems for short-term gain and discourage long-term stewardship. For instance, the prices we pay for food, water, or the hundreds of other ecosystem goods we purchase typically don't reflect the real cost to the environment of harvesting them. So we undervalue them and use more than we need.

Government subsidies–for water, pesticides, fishing boats, and many other things–can contribute to the damage. In arid Tunisia, for instance, farmers pay no more than a seventh of the cost of their irrigation water. Worldwide, governments spend about US$700 billion a year subsidizing environmentally unsound practices in the use of water, agriculture, energy, and transport, with almost half that amount supporting agriculture in member countries of the Organization for Economic Cooperation and Development. Other societal factors–lack of land tenure, armed conflict, and even government corruption–also add to the pressure to overexploit ecosystems.

Box 2 Trade-Offs: An Ecosystem Balance Sheet

Trade-offs among various ecosystem goods and services are common in the management of ecosystems, although rarely factored into decision making. For example, farmers can increase food production by applying fertilizer or expanding the land they have under cultivation, but these strategies harm other goods and services from the land they farm, like water quality and biodiversity.

In very few cases do resource managers or policy makers fully weigh the various trade-offs among ecosystem goods and services. Why? In some cases, lack of information is the obstacle. Typically, not much is known about the likely impact of a particular decision on nonmarketed ecosystem services such as water purification or storm protection. Or, if such information does exist, it may not include estimates of the economic costs and benefits of the trade-offs. In other cases the obstacle is institutional. A government's Ministry of Agriculture naturally focuses primarily on its mission of food production and lacks the expertise or mandate to consider impacts of its actions on water quality, carbon sequestration, or coastal fisheries, for instance.

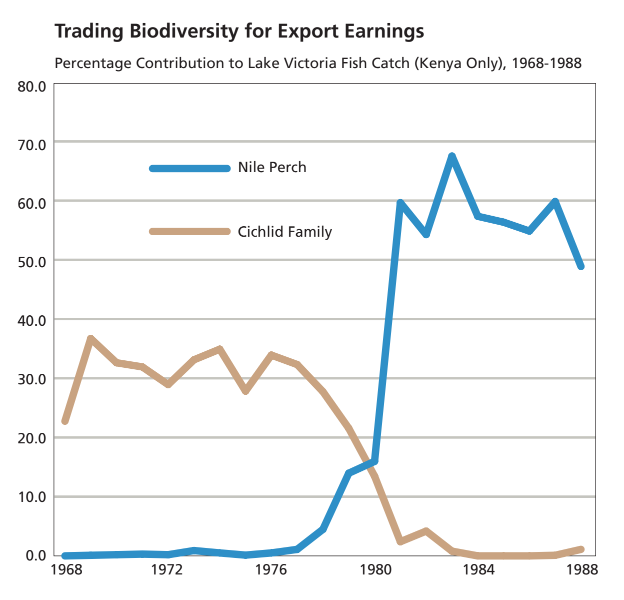
Lake Victoria

The example of Africa's Lake Victoria illustrates how profound and unpredictable trade-offs can be when management decisions are made without regard to how the ecosystem will react. Lake Victoria, bounded by Uganda, Tanzania, and Kenya, is the world's largest tropical lake and its fish are an important source of food and employment for the region's 30 million people. Before the 1970s, Lake Victoria contained more than 350 separate species of fish from the cichlid family, of which 90 percent were endemic, giving it one of the most diverse and unique assemblages of fish in the world. Today, more than half of these species are either extinct or found only in very small populations.

The collapse in the lake's biodiversity was caused primarily by the introduction of two exotic fish species, the Nile perch and Nile tilapia, which fed on and outcompeted the cichlids for food. But other pressures factored in the collapse as well. Overfishing depleted native fish stocks and provided the original impulse for introducing the Nile perch and tilapia in the early 1950s. Land-use changes in the watershed dumped pollution and silt into the lake, increasing nutrient load and causing algal blooms and low oxygen levels in deeper waters—a process called eutrophication. The result of all these pressures was a major reorganization of the lake's fishlife. Cichlids once accounted for more than 80 percent of Lake Victoria's biomass and provided much of the fish catch. By 1983, Nile perch made up almost 70 percent of the catch, with Nile tilapia and a native species of sardine making up most of the balance.

Although the introduced fishes devastated the lake's biodiversity, they did not not destroy the commercial fishery. In fact, total fish production and its economic value rose considerably. Today, the Nile perch fishery produces some 300,000 metric tons of fish, earning $280–400 million in the export market—a market that did not exist before the perch was introduced. Unfortunately, local communities that had depended on the native fish for decades did not benefit from the success of the Nile perch fishery, primarily because Nile perch and tilapia are caught with gear that local fishermen could not afford. And, because most of the Nile perch and tilapia are shipped out of the region, the local availability of fish for consumption has declined. In fact, while tons of perch find their way to diners as far away as Israel and Europe, there is evidence of protein malnutrition among the people of the lake basin.

The sustainability of the Nile perch fishery is also a major concern. Overfishing and eutrophication are major threats to



the fishery, and the stability of the entire aquatic ecosystem—so radically altered over a 20-year span—is in doubt. The ramifications of the species introductions can even be seen in the watershed surrounding Lake Victoria. Drying the perch's oily flesh to preserve it requires firewood, unlike the cichlids, which could be air-dried. This has increased pressure on the area's limited forests, increasing siltation and eutrophication, which, in turn, has further unbalanced the precarious lake ecosystem.

In sum, introducing Nile perch and tilapia to Lake Victoria traded the lake's biodiversity and an important local food source for a significant—although perhaps unsustainable—source of export earnings. When fisheries managers introduced these species, they unknowingly altered the balance of goods and services the lake produced and redistributed the economic benefits flowing from them. Knowing the full dimensions of these trade-offs, would they make the same decision today?

What Is the State of Ecosystems Today?

M*any signs point to the declining capacity of ecosystems.* One way to judge the condition or state of ecosystems is to evaluate their ability to produce the goods and services we rely on. This is the approach taken in the assessment we present here, the Pilot Analysis of Global Ecosystems (PAGE). For each of a select list of goods and services, PAGE asked: What is the quantity of the good or service being produced? And, is the capacity of the ecosystem to produce it being enhanced or diminished through time? Results for each of five major ecosystem types are summarized on pages 10–19.

ASSESSING TRADE-OFFS

The picture we get from the PAGE results is complex. Ecosystems can be in good condition for producing some goods or services but in poor condition for producing others. For example, a tree plantation may efficiently produce timber or pulp, but it is generally impoverished in terms of biodiversity, habitat value, and scenic beauty compared with a natural forest. Human management of ecosystems often involves such trade-offs–increasing one good or service, such as timber harvest, at the expense of others. Judging the overall condition of the ecosystem means assessing the capacity of the ecosystem over time to provide each of the various goods and services, and then evaluating the trade-offs among them.

We currently lack much of the baseline knowledge we need to properly determine ecosystem conditions on a global, regional, or, in many instances, even a local scale.

GOODS AND SERVICES

Food Production People have dramatically increased food production from the world's ecosystems, in part by converting large areas to highly managed agroecosystems–croplands, pastures, feedlots–that provide the bulk of the human food supply. The condition of agroecosystems from the standpoint of food production is mixed. Although crop yields are still rising, the underlying condition of agroecosystems is declining in much of the world. Soil degradation is a concern on as much as 65 percent of agricultural land. Historically, inputs of water, fertilizers, and technologies such as new seed varieties and pesticides have been able to more than offset declining ecosystem conditions worldwide (although with significant local and regional exceptions), and they may continue to do so for the foreseeable future. But how long can that kind of compensation continue? The diminishing capacities of agroecosystems will make that task ever more challenging.

The outlook for fish production–also a major source of food–is more problematic. The condition of coastal ecosystems from the standpoint of food production is only fair and becoming worse. Twenty-five percent of the world's most important marine fish stocks are depleted, overharvested, or just beginning to recover from overharvesting. Another 44 percent are being fished at their biological limit and are, therefore, vulnerable to depletion. Freshwater fisheries present a mixed picture; we are currently overexploiting most native fish stocks, but introduced species have begun to enhance the harvest in some areas. Overall, the pattern of growing dependence on aquaculture and the decline of natural fish stocks will have serious consequences for many of the world's poor who depend on subsistence fishing.

Water Quantity Dams, diversions, pumps, and other engineering works have profoundly altered the amount and location of water available for both human uses and for sustaining aquatic ecosystems. People now withdraw about half of the water readily available for use from rivers. Dams have so impeded flows that the length of time that it takes the average drop of water entering a river to reach the sea has tripled. The changes we have made to forest cover and other ecosystems such as wetlands also have altered water availability and affected the timing and intensity of floods. For example, tropical montane forests, which play key roles in regulating water quantity in the tropics, are being lost more rapidly than any other tropical forest type. Freshwater wetlands, which store water and moderate flood flows, have been reduced by as much 50 percent worldwide.

Water Quality Water quality is degraded directly through chemical or nutrient pollution, or indirectly when the capacity of ecosystems to filter water is degraded or when land-use changes increase soil erosion. Nutrient pollution from fertilizer-laden runoff is a serious problem in agricultural regions around the world; it has resulted in eutrophication and human health hazards in coastal regions, particularly in the Mediterranean, Black Sea, and northwestern Gulf of Mexico. The frequency of harmful algal blooms, linked to nutrient pollution, has increased significantly in the past two decades. We have greatly overstepped the capacity of many freshwater and coastal ecosystems to maintain healthy water quality. And although developed countries have improved water quality to some extent, within that same period, water quality in developing countries–particularly near urban and industrial areas–has degraded substantially. Declining water quality poses a particular threat to the poor who often lack ready access to potable water and are most subject to the diseases associated with polluted water.

Carbon Storage The plants and soil organisms in ecosystems remove carbon dioxide (CO_2)–the most significant greenhouse gas–from the atmosphere and store it in their tissues, helping to slow the buildup of CO_2 in the atmosphere. Unfortunately, the steps we have taken to increase production of food and other commodities from ecosystems have had a net negative impact on the capacity of ecosystems to store carbon. This is principally the result of the conversion of forests to agricultural lands; agricultural lands support less vegetation overall and therefore store less carbon. Land-use changes, such as agricultural conversion, are in fact an important source of carbon emissions, contributing more than 20 percent of global annual carbon emissions each year.

Ecosystems nonetheless still store significant carbon. Of the carbon currently stored in terrestrial systems, 38–39 percent is stored in forests and 33 percent in grasslands. Agroecosystems, which overlap grasslands somewhat, store 26–28 percent. How we manage these ecosystems–whether we promote afforestation and other carbon-storing strategies or increase the forest conversion rate–will have a significant impact on future increases or decreases in atmospheric CO_2.

Biodiversity Biodiversity yields many direct human benefits: genetic material for crop and livestock breeding; chemicals for new medicines; aesthetic beauty, wonder, and adventure that generates ecotourism revenues. More important, the diversity of species undergirds the ability of an ecosystem to provide most of its other goods and services. Reducing the biological diversity of an ecosystem may well diminish its resilience to disturbance, increase its susceptibility to disease outbreaks, and decrease productivity.

The erosion of global biodiversity over the past century is alarming. Major losses have occurred in virtually all types of ecosystems, much of it by simple loss of habitat area. Forest cover has been reduced by more than 20 percent worldwide, with some forest ecosystems, such as the dry tropical forests of Central America, virtually gone. More than 50 percent of the original mangrove area in many countries is gone; wetlands area has shrunk by about half; and grasslands have been reduced by more than 90 percent in some areas. Only tundra, arctic, and deep-sea ecosystems have emerged relatively unscathed, although human pressures are apparent even in these.

Even if ecosystems had retained their original spacial extent, many species would still be threatened by pollution, overexploitation, competition from invasive species, and habitat degradation. In terms of the health of species diversity, freshwater ecosystems are far and away the most degraded, with some 20 percent of freshwater fish species extinct, threatened, or endangered in recent decades. Forest, grassland, and coastal ecosystems all face major problems as well. The rapid rise in the incidence of diseases affecting marine organisms, the increased prevalence of algal blooms, and the significant declines in amphibian populations all attest to the severity of the threat to global biodiversity.

Recreation and Tourism The capacity of ecosystems to provide recreational and tourism opportunities was assessed only for coastal and grassland systems. It is likely that the demand for these services will grow significantly in coming years, but the condition of the service is declining in many areas because of the overall degradation of biodiversity as well as the direct impacts of urbanization, industrialization, and tourism itself on the ecosystems being visited.

THE BOTTOM LINE

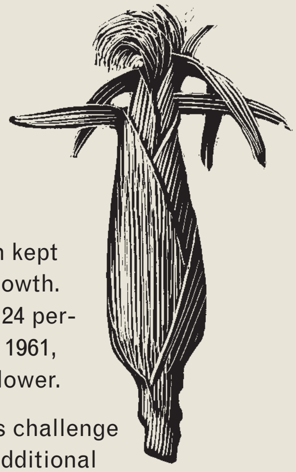
Overall, there are considerable signs that the capacity of ecosystems to continue to produce many of the goods and services we depend on is declining. PAGE results make it clear that human activities have begun to significantly alter the Earth's basic chemical cycles–the water, carbon, and nitrogen cycles–that all ecosystems depend on. Our emissions of CO_2 have brought the real threat of global climate change and, with it, potential changes in the distribution and productivity of ecosystems. Our emissions of nitrogen–in the form of fertilizer runoff and nitrogen oxides from fossil fuels and land clearing–have thrown off the balance of nutrients in many ecosystems. Our appropriation of more than half the planet's freshwater runoff has pushed aquatic ecosystems to the point of depletion. These stresses strike at the foundation of ecosystem functioning and add to the fundamental erosion of productive capacity that ecosystems face on a global scale.

One of the most important conclusions of PAGE is that we currently lack much of the baseline knowledge we need to properly determine ecosystem conditions on a global, regional, or, in many instances, even a local scale. The dimensions of this information gap are large and growing, rather than shrinking as we would expect in this age of satellite imaging and the Internet.

Filling this void means systematically assessing ecosystems at all scales, using an integrated approach. Such an approach would link the range of ecosystem goods and services with the underlying biological processes that produce them. It thus would provide a snapshot of present conditions and a gauge of residual capacity. With this kind of information, managers could develop scenarios of how ecosystems may change in the future under different types of management, thus helping to identify the best options for managing ecosystems today and in the future.

Box 3

Taking Stock of Agroecosystems



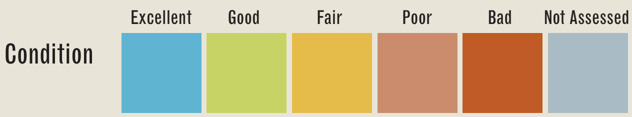
Highlights

- Food production has more than kept pace with global population growth. On average, food supplies are 24 percent higher per person than in 1961, and real prices are 40 percent lower.
- Agriculture faces an enormous challenge to meet the food needs of an additional 1.7 billion people over the next 20 years.
- Agroecosystems cover more than one-quarter of the global land area, but almost three-quarters of the land has poor soil fertility and about one-half has steep terrain, constraining production.
- While the global expansion of agricultural area has been modest in recent decades, intensification has been rapid, as irrigated area increased and fallow time decreased to produce more output per hectare.
- About two-thirds of agricultural land has been degraded in the past 50 years by erosion, salinization, compaction, nutrient depletion, biological degradation, or pollution. About 40 percent of agricultural land has been strongly or very strongly degraded.

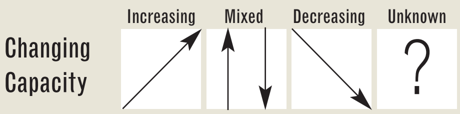
Note: This analysis of agroecosystems was undertaken in collaboration with the International Food Policy Research Institute.

Key

Condition assesses the current output and quality of the ecosystem good or service compared with output and quality of 20–30 years ago.



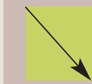
Changing Capacity assesses the underlying biological ability of the ecosystem to continue to provide the good or service.



Scores are expert judgments about each ecosystem good or service over time, without regard to changes in other ecosystems. Scores estimate the predominant global condition or capacity by balancing the relative strength and reliability of the various indicators described in the notes on data quality. When regional findings diverge, in the absence of global quality, weight is given to better-quality data, larger geographic coverage, and longer time series. Pronounced differences in global trends are scored as "mixed" if a net value cannot be determined. Serious inadequacy of current data is scored as "unknown."

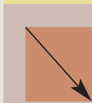
Conditions and Changing Capacity

FOOD PRODUCTION



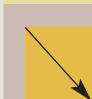
Since 1970, livestock products have tripled and crop outputs have doubled, a sign of rising incomes and living standards. Food production, which was worth US$1.3 trillion in 1997, is likely to continue to increase significantly, as demand increases. Nonetheless, soil degradation is widespread and severe enough to reduce productivity on about 16 percent of agricultural land, especially cropland in Africa and Central America and pastures in Africa. Although global inputs and new technologies may offset this decline in the foreseeable future, regional differences are likely to increase.

WATER QUALITY



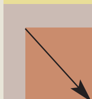
Production intensification has limited the capacity of agroecosystems to provide clean freshwater, often significantly. Both irrigated and rainfed agriculture can threaten downstream water quality by leaching fertilizers, pesticides, and manure into groundwater or surface water. Irrigated agriculture also risks degradation associated with water use, especially waterlogging and salinization, which decreases productivity. Salinization is estimated to reduce farm income worldwide by US$11 billion each year.

WATER QUANTITY



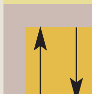
Irrigation accounts for fully 70 percent of the water withdrawn from freshwater systems for human use. Only 30–60 percent is returned for downstream use, making irrigation the largest net user of freshwater globally. Although only 17 percent of agroecosystems now depend on irrigation, that share has been growing; irrigated area increased 72 percent from 1966 to 1996. Competition with other kinds of water use, especially for drinking water and industrial use, will be stiffest in developing countries, where populations and industries are growing fastest.

BIODIVERSITY



Agricultural land, which supports far less biodiversity than natural forests, has expanded primarily at the expense of forest areas. As much as 30 percent of the potential area of temperate, subtropical, and tropical forests has been lost to agriculture through conversion. Intensification also diminishes biodiversity in agricultural areas by reducing the space allotted to hedgerows, copses, or wildlife corridors and by displacing traditional varieties of seeds with modern high-yield but uniform crops. Nonetheless, certain practices, including fallow periods and shade cropping, can encourage diversity as well as productivity.

CARBON STORAGE



In agricultural areas the amount of carbon stored in soils is nearly double that stored in the crops and pastures that the soils support. Still, the share of carbon stored in agroecosystems (about 26-28 percent of all carbon stored in terrestrial systems) is about equal to the share of land devoted to agroecosystems (28 percent of all land). Agricultural emissions of both carbon dioxide and methane are significant and increasing because of conversion to agricultural uses from forests or woody savannas, deliberate burning of crop stubble and pastures to control pests or promote fertility, and paddy rice cultivation.

Data Quality

FOOD PRODUCTION

Value, yield, input, and production data are from the Food and Agriculture Organization (FAO) national tables, 1965-97. Consistency and reliability vary across countries and years. Ecosystem analysis requires more spatially disaggregated information. Fertility constraints are spatially modeled from the soil mapping units of FAO's Soil Map of the World. Global and regional assessments of human-induced soil degradation are based primarily on expert opinion. Developing reliable, cost-effective methods for monitoring soil degradation would help to both mitigate further losses and target restoration efforts.

WATER QUALITY

No globally consistent indicators of water quality, as it relates to agriculture, exist. The quantity of nutrients—nitrogen and phosphorus—in water can be a good indicator of pollution from excess fertilizers and animal manure but are often difficult to separate from human effluent effects. Pesticides in water are specific indicators of agricultural pollution but are costly to measure. Data on suspended solids from soil erosion are also scarce and difficult to interpret.

WATER QUANTITY

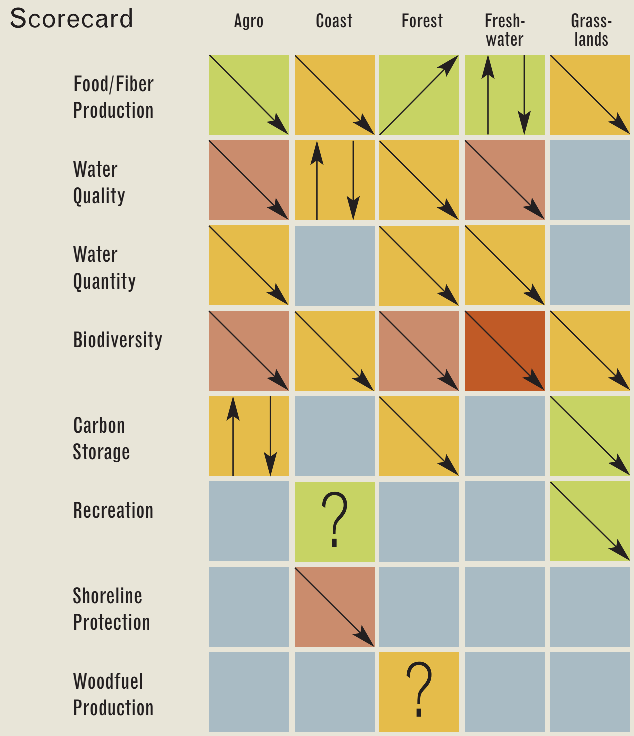
Irrigated area is assessed using the Kassel University global spatial data, which indicate the percentage and area of land equipped for irrigation but has some inconsistencies in scale, age, and reliability of source. Irrigation water use data are derived from country-specific tabular data sets on irrigated area, water availability and use, and water abstraction. Little crop-specific information is available on irrigated area and production.

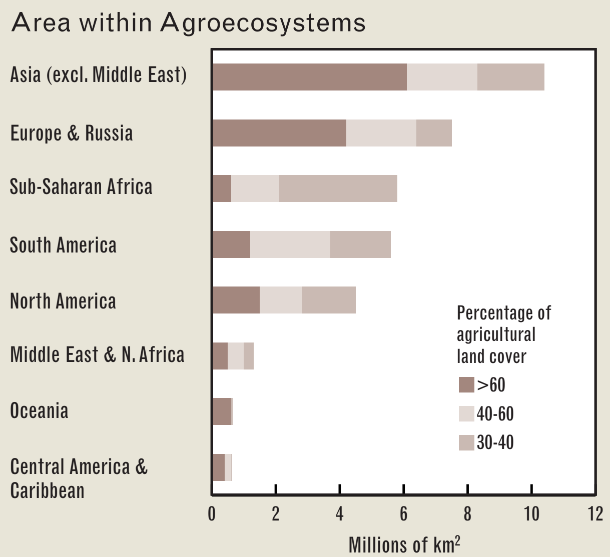
BIODIVERSITY

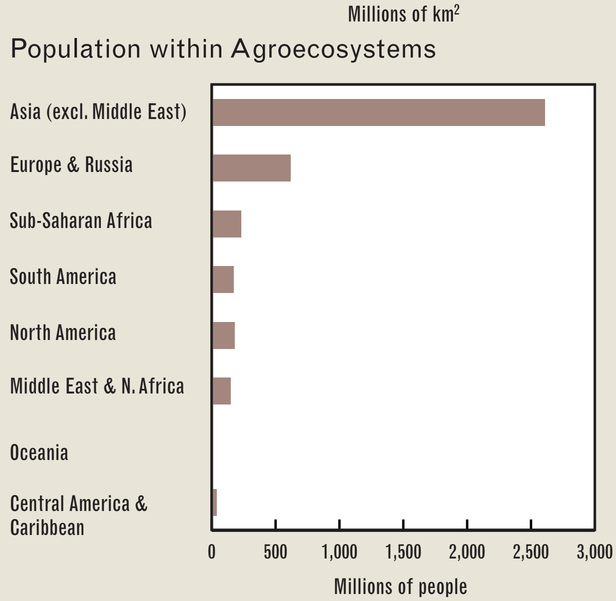
World Wildlife Fund for Nature (WWF) global spatial data describe potential natural habitats and ecoregions. These were developed from expert opinion and input maps of varying resolution and data, but the data do provide a general understanding of the spatial patterns of natural habitats. Genetic diversity data are compiled from major germplasm-holding institutions. Area adoption data for modern varieties of cereals are compiled from survey and agricultural census.

CARBON STORAGE

Storage capacity is modeled for vegetation and soils based on carbon storage capacity by land cover type at a resolution of half a degree for a single point in time. Data would be improved by better characterization of agricultural land-cover types and their vegetation content. Regionally modeled data exist for Latin America in the International Soil Reference and Information Centre's Soil and Terrain database.

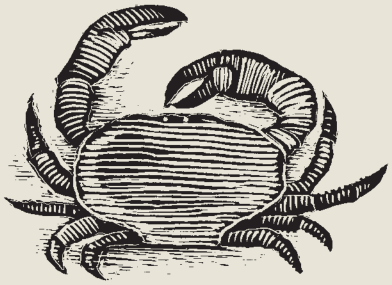






Box 4

Taking Stock of Coastal Ecosystems



Highlights

- Almost 40 percent of the world's population lives within 100 km of a coastline, an area that accounts for only about 20 percent of the land mass.
- Population increase and conversion for development, agriculture, and aquaculture are reducing mangroves, coastal wetlands, seagrass areas, and coral reefs at an alarming rate.
- Fish and shellfish provide about one-sixth of the animal protein consumed by people worldwide. A billion people, mostly in developing countries, depend on fish for their primary source of protein.
- Coastal ecosystems have already lost much of their capacity to produce fish because of overfishing, destructive trawling techniques, and destruction of nursery habitats.
- Rising pollution levels are associated with increasing use of synthetic chemicals and fertilizers.
- Global data on extent and change of key coastal habitats are inadequate. Coastal habitats are difficult to assess from satellite data because areas are small and often submerged.

Key

Condition assesses the current output and quality of the ecosystem good or service compared with output and quality of 20–30 years ago.

Condition	Excellent	Good	Fair	Poor	Bad	Not Assessed

Changing Capacity assesses the underlying biological ability of the ecosystem to continue to provide the good or service.

Changing Capacity	Increasing	Mixed	Decreasing	Unknown (?)

Scores are expert judgments about each ecosystem good or service over time, without regard to changes in other ecosystems. Scores estimate the predominant global condition or capacity by balancing the relative strength and reliability of the various indicators described in the notes on data quality. When regional findings diverge, in the absence of global quality, weight is given to better-quality data, larger geographic coverage, and longer time series. Pronounced differences in global trends are scored as "mixed" if a net value cannot be determined. Serious inadequacy of current data is scored as "unknown."

Conditions and Changing Capacity

FOOD PRODUCTION

Global marine fish production has increased sixfold since 1950, but the rate of increase annually for fish caught in the wild has slowed from 6 percent in the 1950s and 1960s to 0.6 percent in 1995–96. The catch of low-value species has risen as the harvest from higher-value species has plateaued or declined, masking some effects of overfishing. Almost 70 percent of the major fisheries are fully fished or overfished, and fishing fleets have the capacity to catch many more fish than the maximum sustainable yield. Some of the recent increase in the marine fish harvest comes from aquaculture, which has more than doubled in production since 1990.

WATER QUALITY

As the extent of mangroves, coastal wetlands, and seagrasses declines, coastal habitats are losing their pollutant-filtering capacity. Increased frequency of harmful algal blooms and hypoxia indicates that some coastal ecosystems have exceeded their ability to absorb nutrient pollutants. Although some industrial countries have improved water quality by reducing input of certain persistent organic pollutants, chemical pollutant discharges are increasing overall as agriculture intensifies and industries use new synthetic compounds. Furthermore, while large-scale marine oil spills are declining, oil discharges from land-based sources and regular shipping operations are increasing.

BIODIVERSITY

Indicators of habitat loss, disease, invasive species, and coral bleaching all show declines in biodiversity. Sedimentation and pollution from land are smothering some coastal ecosystems, and trawling is reducing diversity in some areas. Commercial species such as Atlantic cod, five species of tuna, and haddock are threatened globally, along with several species of whales, seals, and sea turtles. Invasive species are frequently reported in enclosed seas, such as the Black Sea, where the introduction of Atlantic comb jellyfish caused the collapse of fisheries.

RECREATION

?

Tourism is the fastest-growing sector of the global economy, accounting for $3.5 trillion in 1999. Some areas have been degraded by tourist trade, particularly coral reefs, but the converse effect of coastal degradation on the industry as a whole is unknown.

SHORELINE PROTECTION

Human modification of shorelines has altered currents and sediment delivery to the benefit of some beaches and detriment of others. Coastal habitats with natural buffering and adaptation capacities are being modified by development and replaced by artificial structures. Thus, the impact from storm surges has increased. Furthermore, rising sea levels, projected as a result of global warming, may threaten some coastal settlements and entire small island states.

Data Quality

FOOD PRODUCTION

Global data on fish landings are underreported in many cases or are not reported by species, which makes assessing particular stocks difficult. Data are fragmentary on how many fish are unintentionally caught and discarded, how many boats are deployed, and how much time is spent fishing, which obscures the full impact of fishing on ecosystems. Many countries fail to report data on smaller vessels and their fish landings.

WATER QUALITY

Global data on extent and change of wetlands and seagrasses are lacking, as are standardized and regularly collected data on coastal or marine pollution. Monitoring of nutrient pollution by national programs is uneven and often lacking. Current information relies heavily on anecdotal observation. Effective national programs are in place in some countries to monitor pathogens, persistent organic pollutants, and heavy metals, but data are inconsistent. No data are available on oil pollution from nonpoint sources.

BIODIVERSITY

Detailed habitat maps are available for only some areas. Loss of mangrove, coastal wetlands, and seagrasses are reported in many parts of the world, but little is documented quantitatively. Species diversity is not well inventoried, and population assessments are available only for some key species, such as whales and sea turtles. Data on invasive species are limited by difficulty in identifying them and assessing their impact. Few coral reefs have been monitored over time. Information on the ecological effects of trawling is poorly documented.

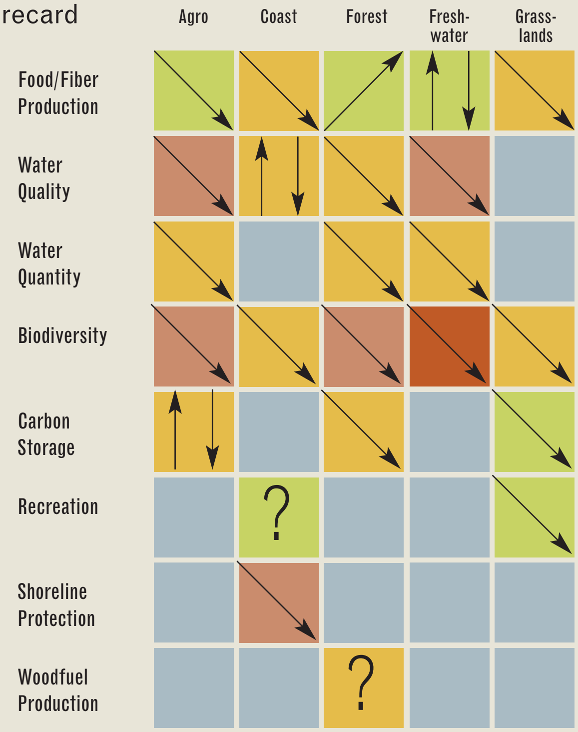
RECREATION

Typically, only national data on tourism are available, rather than data specific to coastal zones. Not all coastal countries report tourism statistics, and information on the impacts of tourism and the capacity of coastal areas to support tourism is very limited.

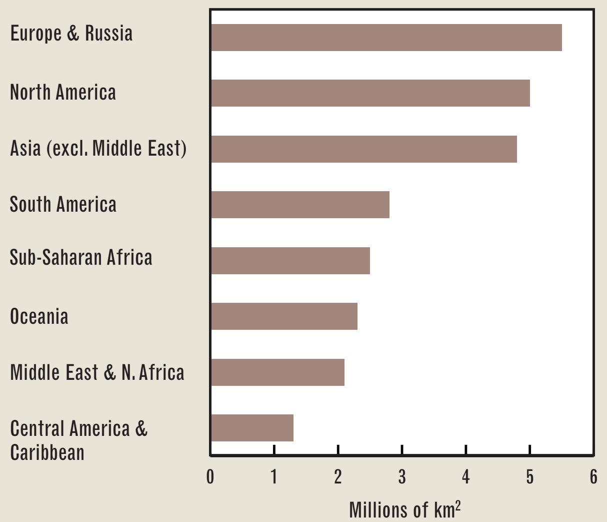
SHORELINE PROTECTION

Information on conversion of coastal habitat and shoreline erosion is inadequate. Information is lacking on long-term effects of some coastal modifications on shorelines. Predictions of sea level rise and storm effects as a result of climate change are speculative.

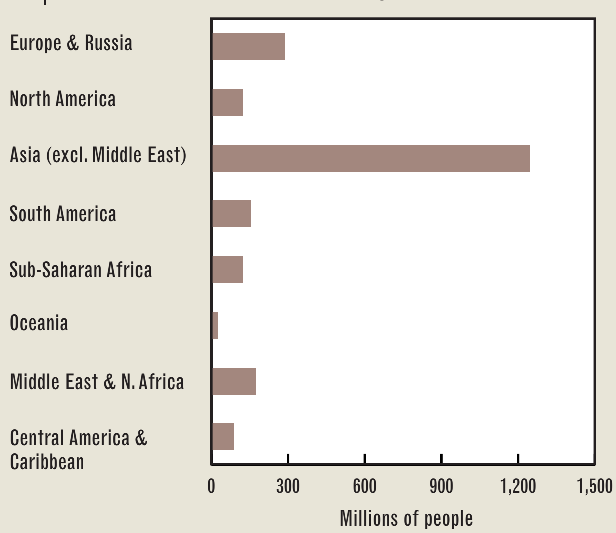
Scorecard



Area within 100 km of a Coast



Population within 100 km of a Coast



Box 5

Taking Stock of Forest Ecosystems

Highlights

- Forests cover about 25 percent of the world's land surface, excluding Greenland and Antarctica. Global forest cover has been reduced by at least 20 percent since preagricultural times, and possibly as much as 50 percent.
- Forest area has increased slightly since 1980 in industrial countries, but has declined by almost 10 percent in developing countries. Tropical deforestation probably exceeds 130,000 km^2 per year.
- Less than 40 percent of forests globally are relatively undisturbed by human action. The great majority of forests in the industrial countries, except Canada and Russia, are reported to be in "semi-natural" condition or converted to plantations.
- Many developing countries today rely on timber for export earnings. At the same time, millions of people in tropical countries still depend on forests to meet their every need.
- The greatest threats to forest extent and condition today are conversion to other forms of land use and fragmentation by agriculture, logging, and road construction. Logging and mining roads open up intact forests to pioneer settlement and to increases in hunting, poaching, fires, and exposure of flora and fauna to pest outbreaks and invasive species.

Key

Condition assesses the current output and quality of the ecosystem good or service compared with output and quality of 20–30 years ago.

	Excellent	Good	Fair	Poor	Bad	Not Assessed
Condition						

Changing Capacity assesses the underlying biological ability of the ecosystem to continue to provide the good or service.

	Increasing	Mixed	Decreasing	Unknown
Changing Capacity				?

Scores are expert judgments about each ecosystem good or service over time, without regard to changes in other ecosystems. Scores estimate the predominant global condition or capacity by balancing the relative strength and reliability of the various indicators described in the notes on data quality. When regional findings diverge, in the absence of global quality, weight is given to better-quality data, larger geographic coverage, and longer time series. Pronounced differences in global trends are scored as "mixed" if a net value cannot be determined. Serious inadequacy of current data is scored as "unknown."

Conditions and Changing Capacity

FIBER PRODUCTION

Fiber production has risen nearly 50 percent since 1960 to 1.5 billion cubic meters annually. In most industrial countries, net annual tree growth exceeds harvest rates; in many other regions, however, more trees are removed from production forests than are replaced by natural growth. Fiber scarcities are not expected in the foreseeable future. Plantations currently supply more than 20 percent of industrial wood fiber, and this contribution is expected to increase. Harvesting from natural forests will also continue, leading to younger and more uniform forests.

WATER QUALITY AND QUANTITY

Forest cover helps to maintain clean water supplies by filtering freshwater and reducing soil erosion and sedimentation. Deforestation undermines these processes. Nearly 30 percent of the world's major watersheds have lost more than three-quarters of their original forest cover. Tropical montane forests, which are important to watershed protection, are being lost faster than any other major forest type. Forests are especially vulnerable to air pollution, which acidifies vegetation, soils, and water runoff. Some countries are protecting or replanting trees on degraded hillslopes to safeguard their water supplies.

BIODIVERSITY

Forests, which harbor about two-thirds of the known terrestrial species, have the highest species diversity and endemism of any ecosystem, as well as the highest number of threatened species. Many forest-dwelling large mammals, half the large primates, and nearly 9 percent of all known tree species are at some risk of extinction. Significant pressures on forest species include conversion of forest habitat to other land uses, habitat fragmentation, logging, and competition from invasive species. If current rates of tropical deforestation continue, the number of all forest species could be reduced by 4-8 percent.

CARBON STORAGE

Forest vegetation and soils hold almost 40 percent of all carbon stored in terrestrial ecosystems. Forest regrowth in the northern hemisphere absorbs carbon dioxide from the atmosphere, currently creating a "net sink" whereby absorption rates exceed respiration rates. In the tropics, however, forest clearance and degradation are together a net source of carbon emissions. Expected growth in plantation area will absorb more carbon, but likely continuation of current deforestation rates will mean that the world's forests remain a net source of carbon dioxide emissions and a contributor to global climate change.

WOODFUEL PRODUCTION

?

Woodfuels account for about 15 percent of the primary energy supply in developing countries and provide up to 80 percent of total energy in some countries. Use is concentrated among the poor. Woodfuel collection is responsible for much local deforestation in parts of Asia, Africa, and Latin America, although two-thirds of all woodfuel may come from roadsides, community woodlots, and wood industry residues, rather than forest sources. Woodfuel consumption is not expected to decline in coming decades, despite economic growth, but poor data make it difficult to determine the global supply and demand.

Data Quality

FIBER PRODUCTION

Generally good global data on industrial roundwood production by country are published annually by the Food and Agriculture Organization (FAO) and the International Tropical Timber Organization (ITTO). Production is recorded by value and by volume in cubic meters per year. Various studies forecast future production and consumption rates. Forest inventory data, recording annual rates of tree growth, tree mortality, size and age of stands, and harvest rates, are generally available for industrial countries but are incomplete and must be estimated for many developing countries. Information on plantation extent and productivity varies widely among countries.

WATER QUALITY AND QUANTITY

Global data on current forest cover and historic loss in major watersheds have been compiled by World Resources Institute (WRI). Data on water runoff, soil erosion, and sedimentation in deforested watersheds are available mostly at regional or local levels. Evidence of the importance of forest cover in regulating water quality and quantity is based on experience in forests managed primarily for soil and water protection in the industrial countries and on studies that value forests according to the avoided costs of constructing water filtration plants. Forest degradation by air pollution in Europe is surveyed by the UN Economic Commission for Europe (UN-ECE).

BIODIVERSITY

Global data sets are few, and evidence is often anecdotal. Forests with high conservation value are identified by field observation and expert opinion. More quantitative information on threatened species is available globally for forest trees and regionally for some birds, butterflies, moths, and larger mammals. Good-quality data on restricted-range birds are available, as are data on threatened birds in the neotropics. Identification of global centers of plant diversity is based on field observation and expert opinion.

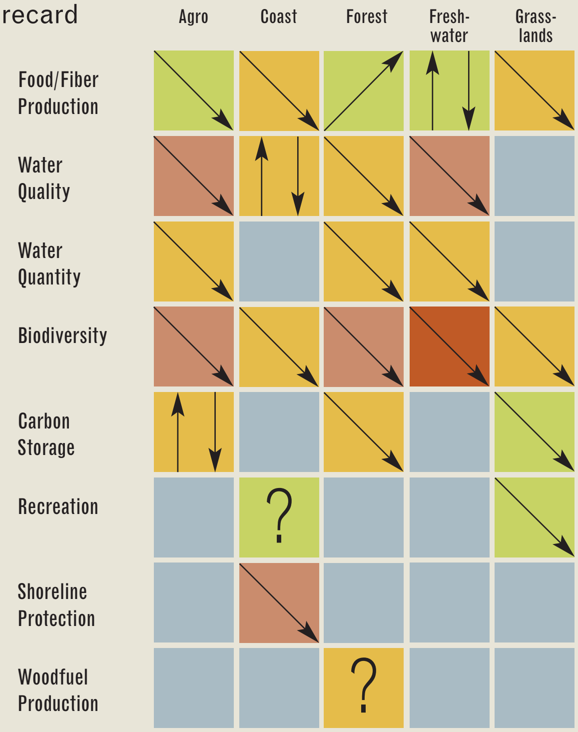
CARBON STORAGE

Methodologies for estimating the size of carbon stores in biomass and soils are developing rapidly. This study relied on the estimates of carbon stored in above- and below-ground live vegetation developed by Olson. This data set was modified by updating carbon storage estimates to accord with the land-cover map from the International Geosphere-Biosphere Programme (IGBP), delineated by global ecosystems. Estimates of soil carbon stores were based on the International Soil Reference and Information Centre—World Inventory of Soil Emission Potentials (ISRIC-WISE) Global Data Set of Derived Soil Properties.

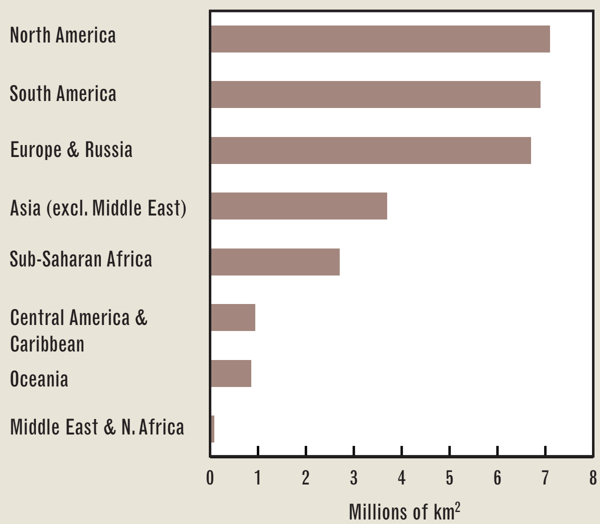
WOODFUEL PRODUCTION

The International Energy Agency (IEA) holds good recent data on wood energy production and consumption in industrial countries, where most wood energy is derived from industrial wood processing residues. Global time series data on woodfuel and charcoal production, available from FAO, are modeled or estimated from household surveys. Data on woodfuel plantations and nonforest sources of production (such as public lands) are patchy. Human dependence on woodfuel in developing countries is largely inferred from information on availability and price of other energy sources.

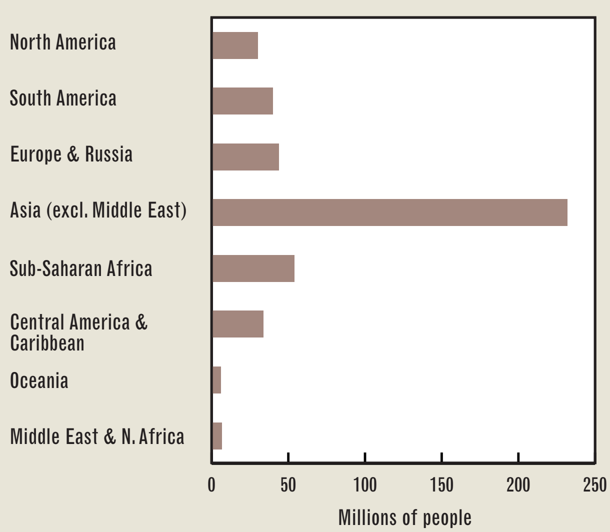
Scorecard



Area of Forest Ecosystems

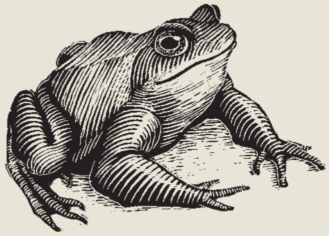


Population of Forest Ecosystems



Box 6

Taking Stock of Freshwater Systems



Highlights

- Although rivers, lakes, and wetlands contain only 0.01 percent of the world's freshwater and occupy only 1 percent of the Earth's surface, the global value of freshwater services is estimated in the trillions of U.S. dollars.
- Dams have had the greatest impact on freshwater ecosystems. Large dams have increased sevenfold since the 1950s and now impound 14 percent of the world's runoff.
- Almost 60 percent of the world's largest 237 rivers are strongly or moderately fragmented by dams, diversions, or canals.
- In 1997, 7.7 million metric tons of fish were caught from lakes, rivers, and wetlands, a production level estimated to be at or above maximum sustainable yield for these systems.
- Freshwater aquaculture contributed 17 million metric tons of fish in 1997. Since 1990, freshwater aquaculture has more than doubled its yield and now accounts for 60 percent of global aquaculture production.
- Half the world's wetlands are estimated to have been lost in the 20th century, as land was converted to agriculture and urban areas, or filled to combat diseases such as malaria.
- At least 1.5 billion people depend on groundwater as their sole source of drinking water. Overexploitation and pollution in many regions of the world are threatening groundwater supplies, but comprehensive data on the quality and quantity of this resource are not available at the global level.

Key

Condition assesses the current output and quality of the ecosystem good or service compared with output and quality of 20–30 years ago.

Condition: Excellent | Good | Fair | Poor | Bad | Not Assessed

Changing Capacity assesses the underlying biological ability of the ecosystem to continue to provide the good or service.

Changing Capacity: Increasing | Mixed | Decreasing | Unknown

Scores are expert judgments about each ecosystem good or service over time, without regard to changes in other ecosystems. Scores estimate the predominant global condition or capacity by balancing the relative strength and reliability of the various indicators described in the notes on data quality. When regional findings diverge, in the absence of global quality, weight is given to better-quality data, larger geographic coverage, and longer time series. Pronounced differences in global trends are scored as "mixed" if a net value cannot be determined. Serious inadequacy of current data is scored as "unknown."

Conditions and Changing Capacity

FOOD PRODUCTION

At the global level, inland fisheries landings have been increasing since 1984. Most of this increase has occurred in Asia, Africa, and Latin America. In North America, Europe, and the former Soviet Union, landings have declined, while in Australia and Oceania they have remained stable. The increase in landings has been maintained in many regions by stocking and by introducing nonnative fish. The greatest threat for the long-term sustainability of inland fisheries is the loss of fish habitat and the degradation of the aquatic environment.

WATER QUALITY

Even though surface water quality has improved in the United States and Western Europe in the past 20 years (at least with respect to phosphorus concentrations), worldwide conditions appear to have degraded in almost all regions with intensive agriculture and large urban or industrial areas. Algal blooms and eutrophication are being documented more frequently in most inland water systems, and water-borne diseases from fecal contamination of surface waters continue to be a major cause of mortality and morbidity in the developing world.

WATER QUANTITY

The construction of dams has helped provide drinking water for much of the world's population, increased agricultural output through irrigation, eased transport, and provided flood control and hydropower. People now withdraw about half of the readily available water in rivers. Between 1900 and 1995, withdrawals increased sixfold, more than twice the rate of population growth. Many regions of the world have ample water supplies, but currently almost 40 percent of the world's population experience serious water shortages. With growing populations, water scarcity is projected to grow dramatically in the next decades. On almost every continent, river modification has affected the natural flow of rivers to a point where many no longer reach the ocean during the dry season. This is the case for the Colorado, Huang-He (Yellow), Indus, Ganges, Nile, Syr Darya, and Amu Darya rivers.

BIODIVERSITY

The biodiversity of freshwater ecosystems is much more threatened than that of terrestrial ecosystems. Twenty percent of the world's freshwater species have become extinct, threatened, or endangered in recent decades. Physical alteration, habitat loss and degradation, water withdrawal, overexploitation, pollution, and the introduction of nonnative species all contribute to declines in freshwater species. Amphibians, fish, and wetland-dependent birds are at high risk in many regions of the world.

Data Quality

FOOD PRODUCTION

Data on inland fisheries landings are poor, especially in developing countries. Much of the catch is not reported at the species level, and much of the fish consumed locally is never reported. No data are systematically collected on the contribution to inland fisheries of fish stocking, fish introduction programs, and other enhancement programs. Historical trends in fisheries statistics are only available for a few well-studied rivers.

WATER QUALITY

Data on water quality at a global level are scarce; there are few sustained programs to monitor water quality worldwide. Information is usually limited to industrial countries or small, localized areas. Water monitoring is almost exclusively limited to chemical pollution, rather than biological monitoring, which would provide a better understanding of the systems' condition and capacity. For regions such as Europe, where some monitoring is taking place, differences in measures and approaches make the data hard to compare.

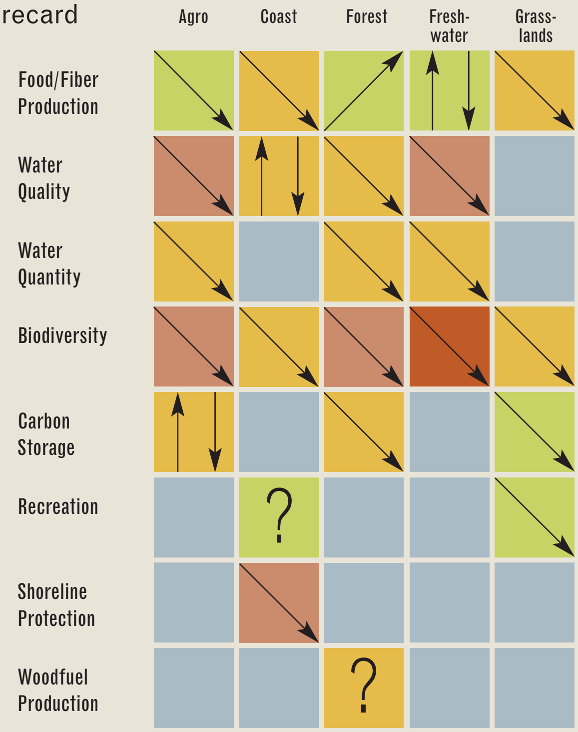
WATER QUANTITY

Statistics are poor on water use, water availability, and irrigated area on a global scale. Estimates are frequently based on a combination of modeled and observed data. National figures, which are usually reported, vary from estimates used in this study, which are done at the watershed or river catchment level.

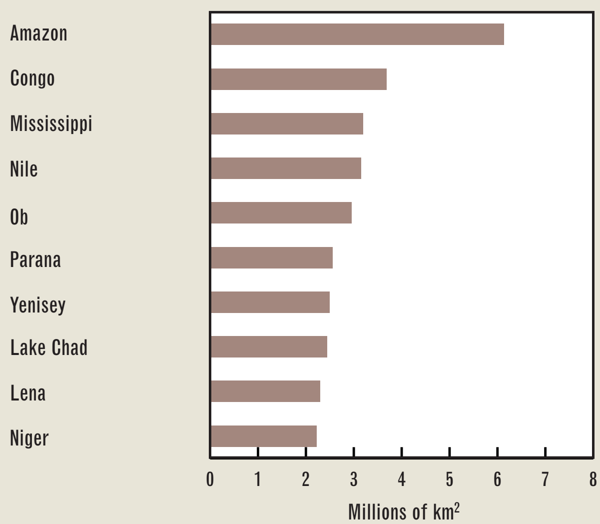
BIODIVERSITY

Direct measurements of the condition of biodiversity in freshwater systems are sparse worldwide. Basic information is lacking on freshwater species for many developing countries, as well as threat analyses for most freshwater species worldwide. This makes analyzing population trends impossible or limited to a few well-known species. Information on nonnative species is frequently anecdotal and often limited to records of the existence of a particular species, without documentation of the effects on the native flora and fauna. Spatial data on invasive species are available for a few species, mostly in North America.

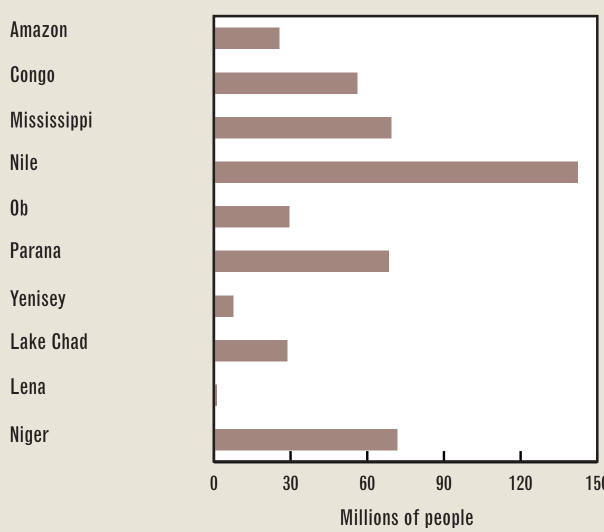
Scorecard



Area of the 10 Largest Watersheds



Population of the 10 Largest Watersheds



Box 7

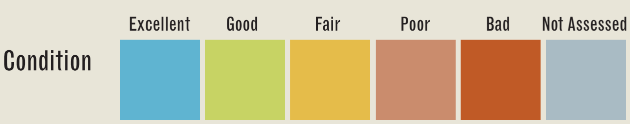
Taking Stock of Grassland Ecosystems

Highlights

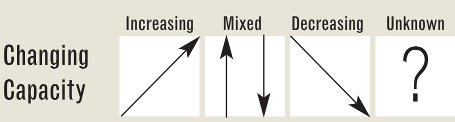
- Grasslands, which cover 40 percent of the Earth's surface, are home to almost a billion people, half of them living on susceptible drylands.
- Agriculture and urbanization are transforming grasslands. For some North American prairies, conversion is already nearly 100 percent. Road-building and human-induced fires also are changing the extent, composition, and structure of grasslands.
- All of the major foodgrains—corn, wheat, oats, rice, barley, millet, rye, and sorghum—originate in grasslands. Wild strains of grasses can provide genetic material to improve food crops and to help keep cultivated varieties resistant to disease.
- Grasslands attract tourists willing to travel long distances and pay safari fees to hunt and view grassland fauna. Grasslands boast some of the world's greatest natural phenomena: major migratory treks of large herds of wildebeest in Africa, caribou in North America, and Tibetan antelope in Asia.
- As habitat for biologically important flora and fauna, grasslands make up 15 percent of the Centers of Plant Diversity, 11 percent of Endemic Bird Areas, and 29 percent of ecoregions considered outstanding for biological distinctiveness.

Key

Condition assesses the current output and quality of the ecosystem good or service compared with output and quality of 20–30 years ago.



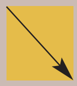
Changing Capacity assesses the underlying biological ability of the ecosystem to continue to provide the good or service.



Scores are expert judgments about each ecosystem good or service over time, without regard to changes in other ecosystems. Scores estimate the predominant global condition or capacity by balancing the relative strength and reliability of the various indicators described in the notes on data quality. When regional findings diverge, in the absence of global quality, weight is given to better-quality data, larger geographic coverage, and longer time series. Pronounced differences in global trends are scored as "mixed" if a net value cannot be determined. Serious inadequacy of current data is scored as "unknown."

Conditions and Changing Capacity

FOOD PRODUCTION

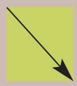


Grasslands today support some of the highest livestock densities in Africa, but much of this dry area is classified as strongly or extremely degraded. Worldwide, 55 percent of all grasslands are considered susceptible drylands, and one-fifth of those are now degraded by human activity.

BIODIVERSITY

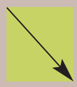
Regional data for North America document marked declines in grassland bird species and classify 10–20 percent of grassland plant species in some areas as nonnative. In other areas, such as the Serengeti in Africa, there are steady long-term population trends for large grassland herbivores.

CARBON STORAGE



Grasslands store about one-third of the global stock of carbon in terrestrial ecosystems. That amount is less than the carbon stored in forests, even though grasslands occupy twice as much area. Unlike forests, where vegetation is the primary source of carbon storage, most of the grassland carbon stocks are in the soil. Thus, the future capacity of grasslands to store carbon may decline if soils are degraded by erosion, pollution, overgrazing, or static rather than mobile grazing.

RECREATION



People worldwide rely on grasslands for hiking, hunting, fishing, and religious or cultural activities. The economic value of recreation and tourism can be high in some grasslands, especially from safari tours and hunting. Some 667 protected areas worldwide include at least 50 percent grasslands. Nonetheless, as they are modified by agriculture, unbanization, and human-induced fires, grasslands are likely to lose some capacity to sustain recreation services.

Data Quality

FOOD PRODUCTION

Soil degradation can be determined globally, but assessment often relies on expert opinion, and the scale of the data is too coarse to apply to national policies. Data on livestock density in grasslands include global and some regional coverage, but only for domestic animals. We still lack corresponding studies of vegetation, soil condition, management practices, and long-term resilience. Data on meat production are available globally, but meat produced from livestock raised in feedlots cannot be separated from meat produced from range-fed livestock.

BIODIVERSITY

Long-term trends in grassland bird populations can be assessed from comprehensive regional data for the United States and Canada. Some long-term regional data within Africa show steady levels of major herbivore populations, but geographic coverage is limited. Other regional, national, and local data for grassland species lack long-term trends. Regional and local coverage of invasive species are more descriptive than quantitative.

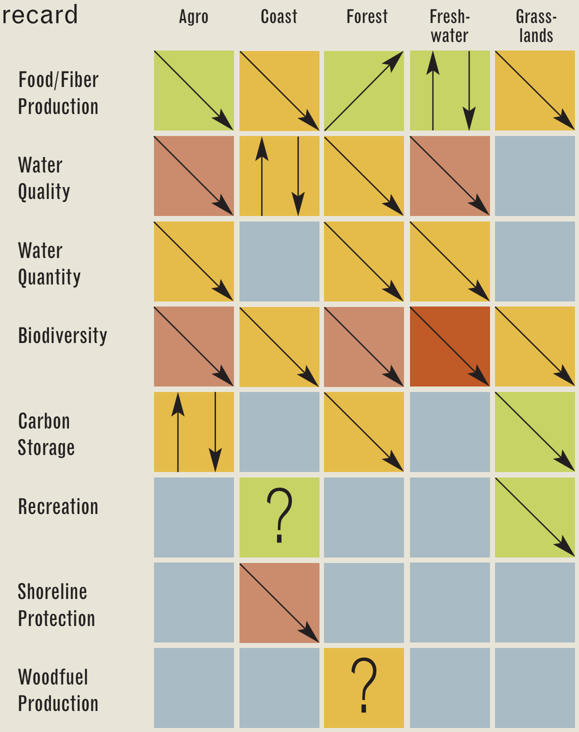
CARBON STORAGE

Methods for estimating the size of carbon stores in biomass and soils continue to evolve. This study relied on previous global estimates for above- and below-ground live vegetation, updated to fit the current land cover map by the International Geosphere-Biosphere Programme, with the addition of soil carbon storage estimates. Models are needed to incorporate carbon storage modifications based on different management practices.

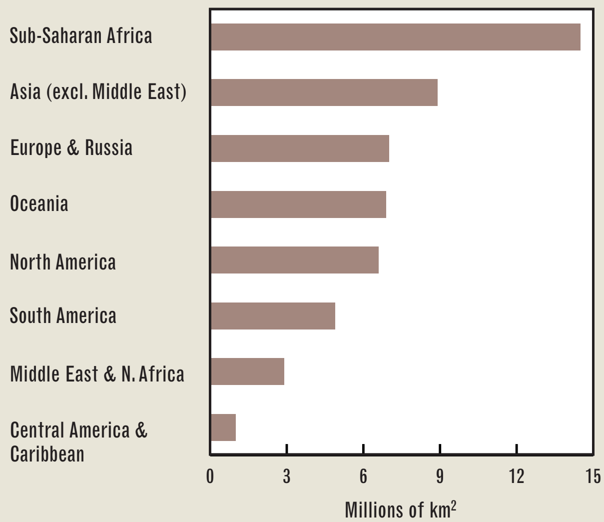
RECREATION

Regional information evaluates the exploitation of grassland wildlife but summaries are based primarily on expert opinion. Global country-level expenditures on international tourism provide estimates for all types of tourism but cannot be related specifically to grasslands. Regional data for tourism and safari hunting are good for some areas but rarely report long-term trends.

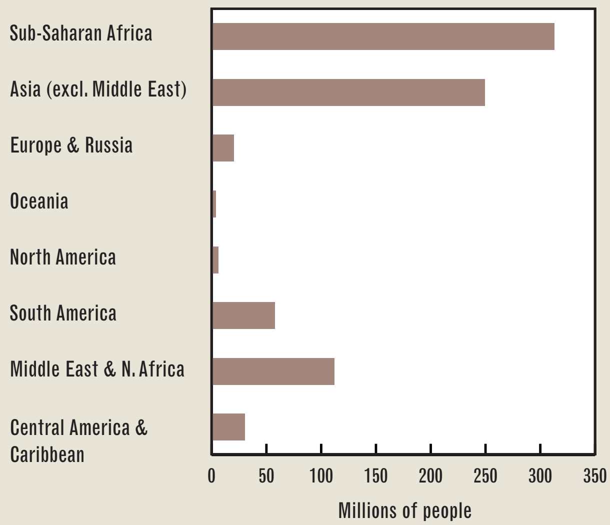
Scorecard



Area of Grassland Ecosystems



Population of Grassland Ecosystems



How Can We Sustain Ecosystems?

Sustaining the productive power of ecosystems demands a new model for managing ecosystems. Business as usual will not ensure that we continue to get what we need from ecosystems in the long run. The results from the Pilot Analysis of Global Ecosystems make it clear that the capacity of ecosystems to deliver goods and services is declining in many cases, but demand for these goods and services continues to rise.

In some areas, we have made progress in our understanding of ecosystems and how to treat them. We can point to examples all over the world where resource managers and communities are desperately trying new approaches to sustainably manage ecosystems–or pieces of them. *World Resources 2000–2001* examines many of these cases, from the Florida Everglades to the grasslands of Mongolia and from the arid watersheds of South Africa to the village forests of India. Yet these examples are only isolated instances. They fall short of the broad-scale change in thinking that we need in order to cope with current environmental degradation and projected increases in consumption.

What we require today is the worldwide adoption of an *ecosystem approach* to environmental management. In practical terms, this means evaluating every decision we make on land or resource use in terms of how it affects the essential functioning of ecosystems–and thus their productivity. Without such an approach, the prospects for attaining any measure of sustainable development drop dramatically.

What Is an Ecosystem Approach?

FUNDAMENTALS OF AN ECOSYSTEM APPROACH

An ecosystem appoach broadly evaluates how people's use of an ecosystem affects its functioning and productivity.

- *An ecosystem approach is an integrated approach.* Currently, we tend to manage ecosystems for one dominant good or service such as fish, timber, or hydropower without fully realizing the trade-offs we are making. In doing so, we may be sacrificing goods or services more valuable than those we receive—often those goods and services that are not yet valued in the marketplace such as biodiversity and flood control. An ecosystem approach considers the entire range of possible goods and services and attempts to optimize the mix of benefits for a given ecosystem and also across ecosystems. Its purpose is to make trade-offs efficient, transparent, and sustainable.

- *An ecosystem approach reorients the boundaries that traditionally have defined our management of ecosystems.* It emphasizes a systemic approach, recognizing that ecosystems function as whole entities and need to be managed as such, not in pieces. Thus it looks beyond traditional jurisdictional boundaries, since ecosystems often cross state and national lines.

- *An ecosystem approach takes the long view.* It respects ecosystem processes at the micro level, but sees them in the larger frame of landscapes and decades, working across a variety of scales and time dimensions.

- *An ecosystem approach includes people.* It integrates social and economic information with environmental information about the ecosystem. It thus explicitly links human needs to the biological capacity of ecosystems to fulfill thoses needs. Although it is attentive to ecosystem processes and biological thresholds, it acknowledges an appropriate place for human modification of ecosystems.

- *An ecosystem approach maintains the productive potential of ecosystems.* An ecosystem approach is not focused on production alone. It views production of goods and services as the natural product of a healthy ecosystem, not as an end in itself. Within this approach, management is not successful unless it preserves or increases the capacity of an ecosystem to produce the desired benefits in the future.

What we require today is the world-wide adaptation of an ecosystem approach to environmental management. This means evaluating every decision we make on land or resource use in terms of how it affects the essential functioning of ecosystems—and thus their productivity.

APPLYING AN ECOSYSTEM APPROACH

There is no universal recipe for applying the principles of an ecosystem approach, but action in several of the following areas will be required.

- *Tackle the "information gap."* Managing ecosystems effectively requires knowing how they function and what their current condition is. Having a detailed knowledge of ecosystems enables us to judge their productive capacity, to see the trade-offs we are making as we manage them, and to assess the long-term consequences of these trade-offs.

- *Engage a public dialog on trade-offs and management policies.* Knowledge of ecosystem processes and conditions is essential, but it only provides the foundation for informed policies governing resource management. Under an ecosystem approach, the goals for ecosystem management are derived through an informed public discussion of what we want and need from ecosystems, how the benefits should be distributed, and what we can tolerate in costs and trade-offs.

- *Set an explicit value on ecosystem services.* Undervaluing ecosystem services has been one of the primary factors behind many of the short-sighted management practices of the past. Thus, one essential element of an ecosystem approach is helping communities, governments, and industries assign more accurate values to ecosystem services, so that they can factor these values into their planning processes.

- *Involve local communities in managing ecosystems.* Examples from across the globe make it clear that local communities are often the most prudent ecosystem managers. Their knowledge of the ecosystem and their direct stake in its health can be important assets that improve the chances for long-term stewardship. Involving local communities in ecosystem management can also yield a more equitable distribution of the benefits and costs of ecosystem use.

- *Evaluate the potential for ecosystem restoration.* Ecosystem restoration is not a new idea, but in the last 20 years the scientific basis for restoration has greatly improved. Interest in and spending on restoration has surged. However, there is neither a good estimate of the total degradation of ecosystems globally, nor an idea of how much of this degradation can be addressed through restoration efforts.

- *Integrate urban planning into ecosystem management.* Urbanization and urban consumers are among the most significant pressures on ecosystems today. Properly managed, urban areas can reduce these pressures through economies of scale in housing, transportation, and energy use. Ignoring cities or considering them peripheral to prudent ecosystem management is counterproductive.

- *Pursue new approaches to parks and protected areas.* An ecosystem approach will require new arrangements that integrate human activities with conservation goals. Parks and protected areas must fit within an overall strategy of landscape management that includes compatible human activities. In some instances, these sites may be able to be physically linked through landscape corridors so that the original spatial character of the ecosystem can continue to function.

The Challenge for Policy Makers

Our dominance of Earth's productive systems gives us enormous responsibilities, but great opportunities as well. Human demands on ecosystems have never been higher, and yet these demands are likely to increase dramatically, especially in developing countries, as rising populations mean more and more people seeking better lives. Human understanding of ecosystems has never been greater, and yet even amid an abundance of data we are often confronted with our own ignorance about the world around us.

The challenge for the 21st century, then, is to understand the vulnerabilities and resilience of ecosystems, so that we can find ways to reconcile the demands of human development with the tolerances of nature. International institutions, national governments, local communities, research centers, businesses, and private organizations all have an opportunity to put an ecosystem approach into practice in the policies they pursue, the projects they undertake, and their own day-to-day operations. One tangible way to show support for greater understanding of our ecosystems is to endorse the Millennium Ecosystem Assessment–a new international, scientific effort to determine the capacity and condition of ecosystems globally. But even with the information already at hand, much can be done to put the ecosystem approach into practice, especially at the local level.

Adopting an ecosystem approach requires learning to see our activities through the living lens of ecosystems. Through that lens is the only clear view we have of our future.

LIVING IN ECOSYSTEMS

World Resources 2000–2001 includes case studies of five ecosystems and the people whose lives depend on them, whose actions have degraded them, and who hold the power to restore them. They showcase the trade-offs inherent in ecosystem management, the diverse influences of governments and economic policies, the value of improved information about ecosystem condition, and the vital importance of secure tenure and community participation for ecosystem health.

Up From the Roots: Regenerating India's Dhani Forest Through Community Action Twenty years ago, Dhani forest in Orissa State, India was badly degraded. Commercial harvesters had removed much of the forest canopy, cattle had grazed the forest floor heavily, and local residents had cleared slopes for crops and gathered fuelwood relentlessly. Yet today this mixed deciduous forest is reborn, thanks to a five-village effort to ensure its survival. These villages have become leaders in a trend toward community forest management that is spreading across all of India.

Regaining the High Ground: Reviving the Hillsides of Machakos, Kenya Through innovation, cultural traditions, access to new markets, and hard work, the people of Machakos District, Kenya, have turned once-eroding hillsides into productive, intensively farmed terraces. However, in light of recent economic stagnation, population growth, increasing land scarcity, and a widening income gap, the question arises: is Machakos' agricultural transformation sustainable?

Working for Water, Working for Human Welfare in South Africa Nonnative plants have invaded 10 million hectares of South Africa—the legacy of two centuries of careless introduction of these plants in commerce. These plants deprive the country of precious water, reduce biodiversity, obstruct rivers, and increase soil erosion. South Africa's response, a multiagency effort called the Working for Water Program, has hired thousands of poor, disadvantaged citizens to remove invading woody species while acquiring a living wage and new skills.

Replumbing the Everglades: Wetlands Restoration in South Florida In what may be the world's most ambitious effort to restore an ecosystem, government agencies, business interests, and environmentalists are combining forces—and some US$8 billion—to reverse a century of draining and diking in the Everglades. This vast inland marsh houses a rich assemblage of plants and wildlife and is the water source for Miami's 6 million residents and South Florida's valuable farming sector.

Sustaining the Steppe: The Future of Mongolia's Grasslands Nomadic herders have grazed large numbers of livestock on Mongolia's grassland steppe for thousands of years. Rotating their animals over vast shared pastures in complex seasonal patterns, Mongolian herders have anchored their country's economy without degrading its ecosystems. In the face of recent political and economic change, however, these sustainable practices may be disappearing. Can Mongolia balance indigenous herding traditions with the forces of urbanization, modernization, and the transition to a market economy?

World Resources 2000–2001

People and Ecosystems

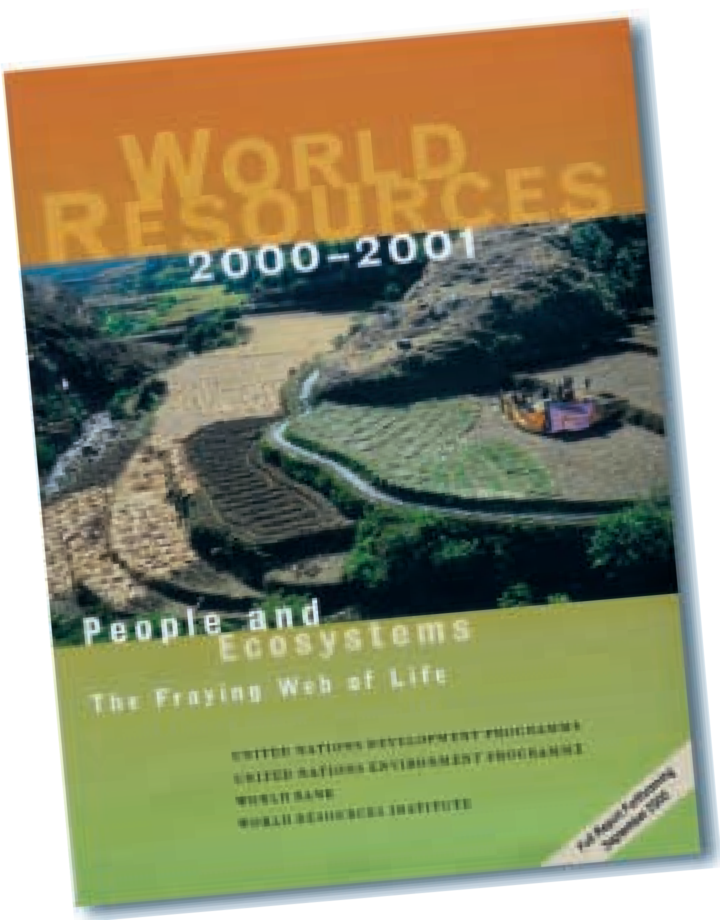
The Fraying Web of Life

Table of Contents

AN INVALUABLE REFERENCE !!

"This 'best buy' book should be available in schools, libraries and government offices so decision making can be based on accurate scientific data..."

Science Books & Films, October 1998



World Resources Report 2000-2001
People and Ecosystems: The Fraying Web of Life
U.N. Development Programme
U.N. Environment Programme
World Bank
World Resources Institute

It is time to take stock of the conditions of Earth's ecosystems and to draw lessons from our global experience in managing and protecting them. This edition focuses on five critical ecosystems that have been shaped by the interaction of physical environment, biological conditions, and human intervention. Like its eight predecessors, this edition also presents an overview of current global environmental and economic trends using hundreds of indicators in more than 150 countries.

COMING SEPTEMBER 2000

Hardcover edition
available from Elsevier Science
ISBN 0 08 0437818 / US$ 49.00
To order, visit the website at
http://www.elsevier.com/locate/worldresources
or contact one of the Regional Sales Offices below:

For customers in the Americas:
Elsevier Science
P.O. Box 882
New York, NY 10159-0882, USA
Tel: (+1) 212-633-3730
Toll-free for customers in the USA and Canada:
1-888-437-4636
Fax: (+1) 212-633-3680
E-mail: usinfo-f@elsevier.com

For customers in other locations:
Elsevier Science
Marketing Department
P.O. Box 880
1000 AW Amsterdam
The Netherlands
Tel: (+31) 20-485-3757
Fax: (+31) 20-485-3432
E-mail: nlinfo-f@elsevier.nl

Paperback edition and CD-ROM
available from World Resources Institute
and its distributor network
To order, visit the website at http://www.wristore.com
Paperback edition / ISBN 1-56973-443-7 / US$27.00
Database CD-ROM / ISBN 1-56973-444-5 / US$100.00
Toll free for customers in the USA: 1-800-822-0504
Non U.S. customers, call 1-410-516-6963

United Nations Development Programme

THE UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) is committed to the principle that development is inseparable from the quest for peace and human security and that the United Nations must be a strong force for development as well as peace. UNDP's mission is to help countries in their efforts to achieve sustainable human development by assisting them to build their capacity to design and carry out development programmes in poverty eradication, employment creation and sustainable livelihoods, the empowerment of women, the protection and regeneration of the environment–giving first priority to poverty eradication.

UNDP, at the request of governments and in support of its areas of focus, assists in building capacity for good governance, popular participation, private and public sector development and growth with equity, stressing that national plans and priorities constitute the only viable frame of reference for the national programming of operational activities for development within the United Nations system.

UNDP strives to be an effective development partner for the United Nations relief agencies, working to sustain livelihoods while they seek to sustain lives. It acts to help countries to prepare for, avoid, and manage complex emergencies and disasters.

Visit the UNDP website
http://www.undp.org/info/discover/mission.html

United Nations Environment Programme

THE UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP) was established as the environmental conscience of the United Nations. UNEP has created a basis for comprehensive consideration and coordinated action within the UN on problems of the human environment. UNEP's mission is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing, and enabling nations and people to improve their quality of life without compromising that of future generations.

One of the most important functions of UNEP is the promotion of environmental science and information. UNEP has always recognized that the environment is a system of interacting relationships that extends through all sectors of activity. To manage these relationships requires an integrated approach. UNEP's uniqueness lies in its advocacy of environmental concerns within the international system. UNEP nurtures partnerships with other UN bodies possessing complementary skills and delivery capabilities and enhances the participation of the private sector, scientific community, NGOs, youth, women, and sports organizations in achieving sustainable development.

UNEP derives its strength and influence from the authority inherent in its mission–environmental management. UNEP has and will continue to play a pivotal role in caring for the environment for the future.

Visit the UNEP website
http://www.unep.org/unep/about.htm

World Bank Group

FOUNDED IN 1944, THE WORLD BANK GROUP consists of five closely associated institutions: the International Bank for Reconstruction and Development (IBRD); International Development Association (IDA), International Finance Corporation (IFC); Multilateral Investment Guarantee Agency (MIGA); and the International Centre for Settlement of Investment Disputes (ICSID).

The World Bank is the world's largest source of development assistance, providing nearly $30 billion in loans annually to its client countries. The Bank uses its financial resources, its highly trained staff, and its extensive knowledge base to individually help each developing country onto a path of stable, sustainable, and equitable growth. The main focus is on helping the poorest people and the poorest countries, but for all its clients the Bank emphasizes the need for: • Investing in people, particularly through basic health and education • Protecting the environment • Supporting and encouraging private business development • Strengthening the ability of the governments to deliver quality services, efficiently and transparently • Promoting reforms to create a stable macroeconomic environment, conducive to investment and long-term planning • Focusing on social development, inclusion, governance, and institution-building as key elements of poverty reduction.

Visit the World Bank website
http://www.worldbank.org/html/extdr/about/

World Resources Institute

THE WORLD RESOURCES INSTITUTE provides information, ideas, and solutions to global environmental problems. Our mission is to move human society to live in ways that protect Earth's environment for current and future generations.

Our program meets global challenges by using knowledge to catalyze public and private action • to reverse damage to ecosystems • to expand participation in environmental decisions • to avert dangerous climate change • to increase prosperity while improving the environment.

For hundreds of years, enterprises have expanded and national economies have grown by using more resources, burning more energy, creating more waste. That economic growth has improved human well-being dramatically by providing more goods and services, by creating more opportunities for trade and employment, and by underwriting more investments in technology and education. But the historical process of growth has also degraded biological resources, depleted energy supplies, and polluted the water, the land, and the air. WRI believes the remedy to environmental problems lies not in reducing growth, but in breaking the connection between expanded prosperity and depleted resources. We are working with governments, businesses, and civil society to find new ways to use resources more efficiently and to take advantage of new technologies and new markets.

Visit the World Resources Institute website
http://www.wri.org/

World Resources 2000–2001

The dawn of a new millennium is an appropriate time to take stock of the condition of the Earth's ecosystems and to draw lessons from our global experience with managing and protecting them. This millennial edition of *World Resources* focuses on five critical ecosystems that have been shaped by the interaction of physical environment, biological conditions, and human intervention: croplands, forests, coastal zones, freshwater systems, and grasslands.

These ecosystems produce a wide variety of goods and services, some of which have not been recognized or valued but all of which sustain human life. The report provides examples of goods and services, such as water purification or pollination, which occur naturally in a healthy ecosystem, but have to be replicated or supplemented if the natural capacity declines. The first step to good management, the report proposes, is to acknowledge the value of these goods and services and the tradeoffs that we often make among them.

The second step is to base decisions on current information about the capacity of ecosystems to continue to provide goods and services. Such information, however, has never before been collected comprehensively. To demonstrate the feasibility of a full-scale Millennium Assessment of Global Ecosystems, the report provides bottom-line judgments based on a survey of current evidence for each ecosystem on food or fiber production, water quantity and quality, biodiversity, carbon sequestration, and recreation.

The final step to good management advocated in the report is an "ecosystem approach" that explicitly recognizes the interaction and tradeoffs among these goods and services, as well as the political and social context in which environmental decisions are made. Through five detailed case studies and many additional examples, the report demonstrates that people in all parts of the world, rich and poor, have the capacity to improve the way they manage ecosystems.

Like the eight previous editions of *World Resources*, the millennial edition also presents an overview of current global environmental trends in population, human well-being, food and water security, consumption and waste, energy use, and climate change. Comprehensive current data and time series for hundreds of indicators in more than 150 countries make the *World Resources* data tables an invaluable reference for environmental research and decision making.

World Resources 2000–2001 was produced by the World Resources Institute in collaboration with the United Nations Development Programme, the United Nations Environment Programme, and the World Bank.

undp

UNEP

THE WORLD BANK

WRI

9 781569 734452 00000

ISBN 1-56973-445-3