



# Millennium Ecosystem Assessment

**A Toolkit for Understanding and Action**

*Protecting Nature's Services. Protecting Ourselves.*



Island Press is a nonprofit publisher with the mission to stimulate, shape, and communicate the ideas that are essential for solving environmental problems. [www.islandpress.org](http://www.islandpress.org)

The Millennium Ecosystem Assessment, published in 2006, is an international work program designed to meet the needs of decisionmakers and the public for scientific information concerning the consequences of ecosystem change for human well-being and options for responding to those changes. [www.maweb.org](http://www.maweb.org)

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## This Toolkit Provides:

- An overview of the Millennium Ecosystem Assessment and its key findings
- Examples of how people around the world are using the principles of the Millennium Ecosystem Assessment to protect natural systems
- Resources to help you bring the lessons of the Millennium Ecosystem Assessment home to your community and organization

## What is the Millennium Ecosystem Assessment?

Human beings are wholly dependent on nature. Our health, prosperity, and security are all connected to the planet's natural systems — or what scientists call “ecosystems.” Healthy ecosystems supply us with food, fresh water, clean air, and a stable climate. They protect us from disease and disaster, and allow us to make choices about our way of life.

How healthy are the planet's ecosystems? Will they be able to provide for the needs of current and future generations? And what can we do about it? The Millennium Ecosystem Assessment (MA) was launched to answer these questions. In 2000, the United Nations brought together a consortium of governments, non-profit groups, international agencies, universities, and businesses to conduct a global assessment of the Earth's ecosystems and the services they provide. The result, a seven-volume report published in 2006, is:

- **Comprehensive:** The MA was conducted by 1,360 experts in 95 countries. Those experts synthesized information from scientific literature and peer-reviewed datasets and models, and drew on the knowledge of local communities. The experts then evaluated, synthesized, and interpreted the data.
- **Integrated:** In recent decades, there has been an explosion of research on ecosystem health at a variety of scales — forest, watershed, national, regional, and global. The MA, for the first time, weaves those studies together to present an integrated, holistic view of the planet's ecosystems and their implications for human well-being.
- **Authoritative:** Each part of the assessment has been scrutinized by independent scientists, governments, and experts to ensure the accuracy of its findings.
- **Inclusive:** Unlike many previous environmental assessments, the MA draws on the experience and knowledge of indigenous people, marginalized communities, and citizens of the developing world.
- **People-centered:** The MA does not view nature as separate from human systems — rather, it underlines the urgency of finding a new relationship between the two. The MA shows how ecosystems are critical to human well-being — to our health, our prosperity, our security, and to our social and cultural identity.



## The Bottom Line

The MA contains a stark warning. While living standards have generally improved over the past two centuries, human activity is putting such strain on nature that we are undermining the Earth's capacity to support current and future generations. We are living beyond our means: recent gains in quality of life have come at considerable cost to the natural systems on which we all depend. If we act now, we can avoid irreversible damage to ecosystems and human well-being. But this will require a sea-change in the way we think about and use natural resources.

The MA can help us make that change. It offers a pragmatic new framework for solving environmental problems, and a host of proven strategies to protect the environment while raising living standards. These include education, the spread of new technologies, and economic incentives for environmental protection. Fundamentally, the MA asks us to recognize that we can no longer treat nature's bounty as free and limitless; instead, we must value natural systems and their irreplaceable contributions to human well-being.

## Who is Using the Millennium Ecosystem Assessment?

- **Financial institutions** are using the MA. Organizations like Smith Barney / Citigroup and Goldman Sachs use MA criteria to guide and inform investment decisions.
- **Governments** are using the MA's framework to develop new regulations and markets to protect ecosystem services. The MA's policy impact has been greatest in the Caribbean, South Africa, China, Sweden, Norway, U.K., France, and other countries in the European Union.
- **Organizations** are using the MA by developing programs, policies, and structures to protect ecosystem services. Around the world, nongovernmental organizations are using the MA framework to protect and restore ecosystems.
- **Multilateral institutions** are using the MA. All of the UN agencies involved in the MA process (UNEP, UNDP, FAO, WHO, and UNESCO) have incorporated the MA findings and process into their activities.
- **Universities** are using the MA to drive their curricula, research, and community engagement work. MA materials are being used extensively in university courses and curricula. Universities are developing new research agendas and relationships with their communities and states, and are working with new partners to map out future scenarios and trends.





### Key Findings: Living Beyond Our Means

- All people depend on nature and ecosystem services to provide the conditions for a decent, healthy, and secure life.
- In the last half-century, people have made unprecedented changes to the planet's ecosystems — largely to meet rising demands for food, fresh water, fiber, and energy.
- These changes have improved the lives of many of the world's people, but they have also come at the expense of others, by weakening nature's ability to deliver key services, such as clean air and water and protection from floods, disease, and other disasters. These losses disproportionately affect the poor.
- We are living beyond our means: some 60 percent of the ecosystem services examined in the Millennium Ecosystem Assessment — including fisheries and fresh water — are being degraded or used in ways that cannot be sustained.
- Pressures on ecosystems will grow significantly worse during the first half of this century, unless human attitudes and actions change.
- There is growing evidence that many ecosystems could reach the “tipping point,” at which sudden and irreversible changes have grave implications for human well-being. Examples include the emergence of deadly diseases, the creation of “dead zones” in coastal waters, the collapse of fisheries, and shifts in regional climate.
- We have the technology and knowledge we need to make changes that will protect ecosystems and human well-being.
- To make those necessary changes, we must stop thinking of nature's services as free and limitless. It is time to take nature's full value into account.





## Ecosystems and Human Well-Being

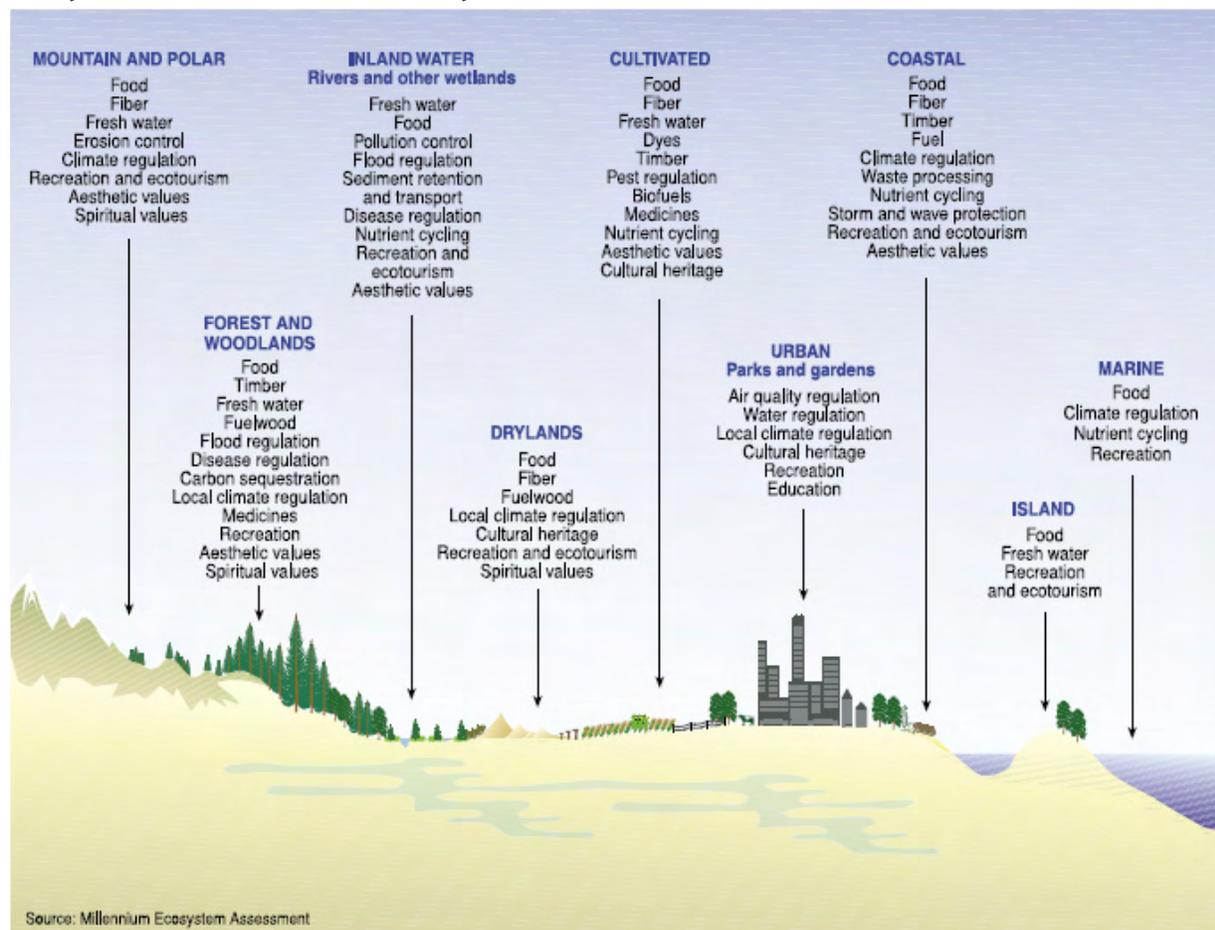
### *Nature's life-support systems*

All people are dependent on the services of nature, or ecosystem services. Whether you are a subsistence farmer or a high-tech executive, you rely on natural systems to provide the food you eat, the water you drink, and the air you breathe. And, despite the invention of many synthetic materials, nature still provides the stuff of life: trees bring us wood and paper, clothing is made from plant and animal fiber, and many life-saving medicines are derived from plants.

Less visible but equally important are the complex natural systems that filter our air and water, regulate the climate, and protect us from disease and natural disasters. Forests, for example, help maintain air and water quality, reduce landslides and floods, and play a key role in stabilizing climate. Coral reefs and mangroves act as natural barriers against hurricanes and tidal surges. And chemical processes — made possible by regular cycles of water, carbon, nitrogen, and phosphorous — underlie ecosystem health and render the planet habitable.

The ecosystems on which we depend are not static; change is constant in nature. For millennia, the Earth has been transformed by advance of glaciers, volcanic eruptions, and the clash of continents. But today, human beings are the most powerful force of environmental change. In the last 50 years, people have modified ecosystems more rapidly and extensively than in any comparable period of human history.

### Ecosystems and Some Services They Provide





Those changes were made largely to meet soaring demands for food, fresh water, fiber, and fuel as the human population doubled between 1960 and 2000, and consumption per person soared along with urbanization and wealth in many parts of the world. As forests made way for farms, as rivers were diverted to irrigate fields, and as new technology enabled fishing vessels to haul ever-greater harvests from the oceans, humans reshaped natural systems in order to provide for our growing needs.

By reshaping ecosystems, we have improved the lives of billions. Human well-being, on average across and within many societies, has improved substantially over the past two centuries. More people are better nourished than ever before. People live longer, and incomes have risen. But the changes we have made to natural systems are not without costs. These costs are disproportionately borne by those who are poor and marginalized.



### *Earth's accounts: in the red*

The MA offers the first comprehensive assessment of the planet's ecosystems. It is, in effect, an audit of the Earth's accounts, and there is much more red than black on the balance sheet. About 60 percent of the ecosystem services examined in the MA — including fisheries and fresh water — are being degraded or used in ways that cannot be sustained. In many cases, we are literally living on borrowed time. By using up supplies of fresh groundwater faster than they can be recharged, for example, we are depleting assets at the expense of our children.

Frequently, what appears to be a net gain shows up as a debit somewhere else. A huge increase in the application of nitrogen and phosphorous fertilizers has brought record crop yields, but those nutrients wash into streams, rivers, and eventually the ocean, where they cause algal blooms that deplete oxygen and kill other forms of aquatic life — at great cost to the world's fisheries. And intensive livestock production has made inexpensive protein available to millions, but it has also created an ideal environment for the emergence of new diseases like SARS and bird flu, and even has implications for water quality, forest preservation, and the climate.

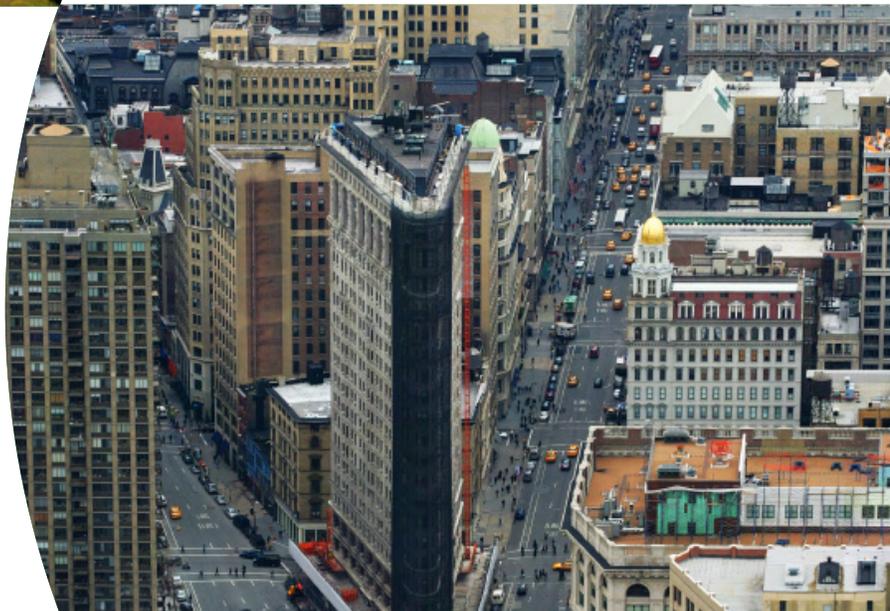


As we reshape ecosystems to meet human needs, we have extinguished much of their vibrant diversity. Biodiversity — the variability among living organisms — is an important feature of healthy ecosystems because it increases their flexibility and resilience. Resilience is the capacity of ecosystems to respond to and cope with changing conditions, and still continue to provide valued services. But over the past centuries humans have increased the extinction rate by as much as 1,000 times the “natural” rate typical of Earth’s long history. Human activities also introduce “alien” or non-native species, which can displace native species, disrupting the delicate balance of natural systems. As a result of these changes, the natural world has become more uniform and less resilient.



Perhaps the most profound change we are making is to the Earth’s climate. The burning of fossil fuels for energy has released large quantities of carbon previously locked underground and increased the amount of carbon dioxide in the atmosphere by about a third. This “greenhouse effect” influences global weather systems by trapping more of the sun’s heat within the atmosphere, and those changes are expected to accelerate as the concentration of carbon dioxide continues to grow. The precise effects of this unprecedented change cannot be known, but scientists expect a range of potentially catastrophic events: rising sea levels and intensified storms, floods, and droughts.

The cost of ecosystem change is already being felt, but often by people far away from those enjoying the benefits of natural services. When Californians fuel their cars with gasoline, the environmental price is paid thousands of miles away in Ecuador, where oil extraction leaves a deadly wake of fouled rivers and sickened children. Forests in China and Southeast Asia are decimated to provide chopsticks for Japanese fast-food restaurants. And huge swaths of the Brazilian Amazon, which regulates the supply of fresh water to much of South America, are logged and planted with soy for export to Asian markets.



Unless we acknowledge our ecological debt and keep it from growing, we will consign our children to lives that are less prosperous and less secure than our own. We will leave them a world in which the magnificent diversity of life is vastly diminished. And we risk sudden and catastrophic changes to the vital life-support systems on which we all depend.



### *Valuing nature's services*

To prevent irreversible damage to natural systems, we must make sweeping changes in the way we use — and think about — natural resources. Fortunately, we have the knowledge and the technology we need to make those changes. But change of the required magnitude is unlikely to happen as long as nature's services are perceived as free and limitless. The first order of business, then, is to value nature's services — to understand their contribution to human well-being, and then to design policies and practices that allocate these costs in an equitable way.

In the pages that follow, you will find a framework to value and protect nature's services in your community.

### The Millennium Ecosystem Assessment Can Help You Solve Problems

The MA is one of the largest studies of the Earth's natural systems ever undertaken. It draws on the work of thousands of scientists and experts around the world and investigates some of the most complex issues we face. But the MA presents more than a set of findings about the state of our world. The MA is premised on a simple and powerful framework for understanding and meeting environmental challenges, and that framework can help policymakers, advocates, business leaders, journalists, organizations, and communities, whether you are concerned about a single watershed, forest, species, or the world's oceans and climate.

### The MA Framework

**People first.** The MA framework is a people-centered approach. Human well-being is its central focus. While the MA recognizes that the natural world — biodiversity and ecosystems — has intrinsic value, its assessment focuses on maximizing human well-being now and over time.

**Humans are part of ecosystems.** The MA shows that a dynamic interaction exists between people and ecosystems. The human condition drives change in ecosystems and changes in ecosystems cause changes in human well-being. At the same time, many other factors independent of the environment change the human condition, and many natural forces influence ecosystems.

**Get the size right.** To understand interactions between people and ecosystems and encourage change we must examine them in the proper scale. Focus your efforts on a scale that encompasses the natural processes associated with the problem being considered and includes the governments, businesses, and others that can affect change at that scale. Your ecosystem could be a watershed, an intact wilderness, or a migratory route. The factors that drive change might be found in a single farm, village, or fishing fleet, or they might be found spread over a province, a continent, or the world.

**Cooperation and knowledge.** Effective incorporation of different types of knowledge in an assessment can both improve the findings and help to increase their adoption by stakeholders who can bring important knowledge about the place and the context.

**Know the players.** The usefulness of an assessment can be enhanced by identifying and seeking to address its structural biases. Any assessment empowers some stakeholders at the expense of others by virtue of the selection of issues and of what knowledge is incorporated.



## Understanding Nature's Services

### *What is an ecosystem?*

An ecosystem is an ever-changing complex of living things interacting with the non-living environment. Human beings are integral parts of ecosystems; our actions shape ecosystems and our well-being is tied to them. For example, a forest ecosystem is more than just trees — it's the trees, the soil, the water, the rain, and everything that allows people to harvest its timber, communities to receive clean water from its filtering process, and countries to increase economic activity through eco-tourism. Ecosystems can vary enormously: a city block, farmland, a forest, and an ocean basin can all be ecosystems.

### *What are ecosystem services?*

Ecosystem services are the benefits people obtain from ecosystems.

For example, healthy ecosystems provide:

- **The Stuff of Life** — food, fresh water, timber, and fiber for clothing.
- **Protection** from extreme weather, floods, fire, and disease.
- **Regulation** of the Earth's climate.
- **Filtration** of wastes and pollutants.
- **Regeneration** of clean air, water, and soil.
- **Inspiration**, recreation and spiritual sustenance, and support for a way of life..

### *How are human beings changing the planet's ecosystems?*

In the last half-century, humans have reshaped ecosystems as never before. For example:

**Land:** Between 1950 and 1980, more land was converted to cropland than in the eighteenth and first half of the nineteenth centuries combined. Nearly a quarter of the land surface of Earth is now cultivated.





**Freshwater:** Water withdrawals from rivers and lakes for irrigation, household and industrial use doubled in the last 40 years. Increased water use has, for example, reduced the flow of the Colorado and other major rivers, so that they do not always flow to the sea.

**Pollution:** As the use of synthetic fertilizers has grown, humans have doubled the amount of nitrogen in the environment. Nitrogen in our air and water cause asthma and respiratory disease, blue-baby syndrome, cancer, and other chronic diseases.

**Climate:** Human-induced climate change is expected to raise the planet's mean surface temperature by two and a half to 10 degrees Fahrenheit, and sea levels will rise between three and a half to 35 inches in the next century.

**Fisheries:** At least one quarter of marine fish stocks are overexploited or significantly depleted. In many sea areas, the total weight of fish available to be caught has declined by 90 percent since the onset of industrial fishing.

**The diversity of life:** Humans are currently responsible for the sixth major extinction event in the history of the Earth, and the greatest since the dinosaurs disappeared, 65 million years ago.

### *How do these changes affect human well-being?*

**Health:** Human health is intimately tied to natural systems. For millions of the world's poorest people, healthy ecosystems are a matter of survival: starvation looms when a fishery fails; cholera spreads when waste-filtering wetlands are lost. Even in wealthier industrialized countries, degraded ecosystems take a devastating toll on human health. Air and water pollution are linked to an explosion of asthma and other respiratory problems, and an increased risk of cancer and heart disease. And epidemics rage when natural systems are disrupted. For example, the emergence of Lyme disease in the U.S. has been linked to habitat loss and diminished diversity of species. Global warming is expanding the geographic range of mosquitoes, ticks, mice, and other disease carriers, bringing pathogens to new areas. As a result, it is believed to have contributed to a rise of infectious disease worldwide.

**Economy:** Our economies are built on the products of healthy ecosystems: crops, fish, timber, and other commodities. When ecosystems fail, the economic damage is plain to see. For example, when North Atlantic cod stocks crashed after decades of overfishing, the cost included tens of thousands of jobs and more than \$2 billion paid out in income support and retraining. Now the largest commercial and recreational fishery in the U.S. — the Gulf of Mexico — is threatened. Because of runoff from nitrogen and phosphorous fertilizers, an oxygen-depleted "dead zone" as large as New Jersey forms in the Gulf each year. Although nature's services don't usually appear on balance sheets, their economic value is critical. For example, wetlands help filter wastes and reduce floods; forests provide fresh water and regulate the climate. When these natural resources are gone, their services are expensive — or even impossible — to reproduce.

**Security:** Our personal and national security rests on a foundation of goods and services provided by nature: food, fresh water, and protection from disease and disaster. When that foundation crumbles — as the Gulf hurricanes of 2005 so vividly illustrated — social order suffers as well. The MA warns that there is an increased likelihood of many such disasters — floods, wildfires,



intense storms — unless we take immediate steps both to protect natural systems and to reduce our vulnerability through appropriate development patterns. Depleted resources can also catalyze wars and other manmade conflagrations. In the Middle East, where freshwater supplies are depleted more rapidly than nature can regenerate them, water scarcity magnifies the conflicts that have made the region a political tinderbox. On the other hand, there is evidence that negotiations over water can also be a catalyst for peace in regions of previous conflict. Threats from ecosystem change are greatest in resource-poor countries, but their byproducts — political instability, refugee migrations, and disease — easily cross borders in our ever-more globalized world.

## Understanding Value

The MA framework recognizes that it can be very difficult to identify and value ecosystem services and how that, in turn, complicates understanding their role in human well-being and policy making. While it can be difficult, the MA encourages us to understand the many values an ecosystem can provide and describes approaches by which we can begin to understand the value a community of any size places on an ecosystem. Understanding the full range of values should create better informed policy.

In some cases the value of an ecosystem service may be derived in part by assessing existing markets for food and fiber products in the marketplace. For example, we might know the monetary value of a fishery if it is commercially harvested, providing us with one measure of its worth. In many other cases there may be no direct market for services, although they may have enormous value and we may pay to secure them. This might include, for example, clean water. Its value might be understood by examining both how much people in a community are willing to pay or work for access to clean water through different sources and also the damage a loss of clean water might do to a community's health. Some ecosystem services must be evaluated through their relationship to other services. For example, a fish species that has no food value may be essential to the health of another species upon which a community may be heavily dependent as a





source of protein. And services may have intrinsic value rooted in social understandings and beliefs. Communities set aside wilderness areas and many of their potential services because they value a “nonconsumptive” use such as recreation or preservation. The MA recognizes that value may change over time as services become scarce or threatened, or as a result of social learning and new knowledge. For example, biodiversity might not be valued until years from now when medicines are derived from species yet to be discovered or researched. This creates an unknown opportunity cost to extinction. Or the value of a healthy watershed may grow dramatically as the size of a community grows.

### *Know your trade-offs*

The MA acknowledges the difficult trade-offs we must consider to maximize human well-being. An ecosystem is a finite resource. When we exploit an ecosystem service we invariably lose some other potential service. For example, when we turn grassland into ranch land, we gain essential food but we may lose habitat and biodiversity. This creates a trade-off between services and the constituents that might benefit from them.

We also make trade-offs over time. Exploiting an ecosystem today may increase our material well-being and alleviate poverty, but it may also prove unsustainable. That is, to solve today’s pressing problems, society is often tempted to deplete tomorrow’s ecological resource base. This can jeopardize future well-being and, in some cases, even survival. It is essential to understand how changes to ecosystems today will affect their ability to provide essential services tomorrow. The MA created scenarios of what the future may hold depending on how we manage ecosystems today, and each case offered different outcomes for human well-being. This same approach could apply on a smaller scale.

### *Look for synergies*

Just as an ecosystem assessment can reveal trade-offs among which communities must choose, so too it can reveal synergies to enhance human well-being for the majority of constituents now and into the future. The MA assessed several policies for their effectiveness at solving problems and maximizing human well-being in such areas as freshwater, biodiversity, food, forest products, and climate change. While no policy is a sure path to success, the MA found many that have shown themselves to be effective and promising. These include policies such as protected areas and the integration of biodiversity concerns into regional planning decisions. And they go beyond traditional regulatory approaches to the use of market-based economic incentives to protect ecosystem services. Other response options include: the use of legal mechanisms to change the “rules of the game”; changing social norms, values, and attitudes through communication and education about the consequences of management practices; research and development of new technologies for ecosystem management; and public and consumer action.

## **Bringing Home the Lessons of the Millennium Ecosystem Assessment**

### *Taking nature’s value into account*

Humans protect what they value most. For too long, we have failed to value and protect the services of nature — perhaps because we view them as free and limitless. But today, the limits of nature are in sight. It is time to fully value nature and its essential services to humankind.



The MA offers a framework for understanding and valuing ecosystem services. Around the world, people are using that framework to help protect the environment. They are demonstrating explicit connections between ecosystem services and human well-being, and quantifying their value in monetary terms where possible. Then, armed with hard data on the worth of a forest, a wetland, or a watershed, they are working to design policies and practices that reflect the full value of nature and its services. Here are some examples:

### *Preserving the cloud forest*

**Location:** Guatemala

**Strategies:** Public education, payment for ecosystem services

High above the arid scrubland of Guatemala's Motagua Valley rise the misty peaks of the Sierra de las Minas — a steep mountain range that contains the largest unbroken cloud forest in central America. The epiphyte-draped rainforests of the Sierras shelter countless rare plants — including hundreds of species of orchids — and the last holdouts of the Mayans' revered "bird of paradise," the quetzal. Most importantly, a half million Guatemalans depend on the streams and rivers flowing down from the mountains for drinking water, irrigation, and hydroelectric power. But that life-giving water is threatened. Small farmers, displaced by agribusiness in the central valleys, are moving farther up the mountain slopes, replacing forests with fields. Water flow from the mountains has fallen by 40 percent during the last decade and is of degraded quality. Clearly, Guatemalans have a stake in conserving the high-elevation forests of the Sierras. To protect this critical resource, the Guatemalan legislature established a Biosphere Reserve in the mountains and appointed Fundación de los Defensores de la Naturaleza — a local NGO — to manage it. The Fundación works in partnership with many other groups, including the U.S.-based Nature Conservancy, Universidad del Valle de Guatemala, and the humanitarian group CARE to purchase sensitive land, conduct research, and educate local farmers on sustainable land use. Recently, The Fundación teamed up with World Wildlife Fund





Guatemala to create a “water fund” that will support conservation efforts. Through this innovative plan, companies and communities that depend on the Sierras’ water make voluntary contributions to finance the forest protection measures being taken by those living upstream.<sup>1</sup>



### *Determining the worth of a coral reef*

**Location:** Trinidad/Tobago, St Lucia, and Belize

**Strategies:** Analysis of value of ecosystem services

The warm turquoise waters of the Caribbean are home to magnificent coral reefs, which nurture schools of fish and provide essential protection from storms. They also draw legions of tourists, whose collective impact threatens to destroy the very resources they come to enjoy. The fate of these resources rests in the hands of national governments, whose development policies could doom the reefs — or save them. That is why the World Resources Institute, a Washington, DC-based NGO, is working with governments of three countries in the Caribbean (Trinidad/Tobago, St Lucia, and Belize) to develop and pilot-test a tool that will quantify the value of ecosystem services from healthy reefs for shoreline protection, fishing, and tourism. The tool will help governments make better coastal management decisions and bolster

incentives for improved coastal resource management by showing — in clear fiscal terms — the costs of poor management. The information will be gathered at a national level, but standardized to encourage broader, regional level thinking and action on the value of coral reefs.<sup>2</sup>

### *Saving a watershed by working with neighbors upstream*

**Location:** India

**Strategy:** Incentive-based mechanism

When the wells ran dry in Suan, a village in India’s far north, residents looked upstream. There, in the town of Bhodi, overgrazing and deforestation were threatening the quality — and quantity — of water supplies throughout the area. So the Suan villagers made a deal with their neighbors upstream. With support from government, the Suan villagers offered their labor to help replant the slopes of the upper watershed, and the residents of Bhodi agreed to curb grazing and



improve soil conservation. Although they were initially skeptical and reluctant to lose prime grazing land, the people of Bhodi were rewarded with an increased supply of fodder and fuel wood. And villagers in Suan have noticed an improvement in the flow of water as well as reduced soil erosion.<sup>3</sup>

### *Helping corporations assess the business risks and opportunities of ecosystem change*

**Location:** Global

**Strategy:** Business risk assessment tool

Today's globe-spanning multinational corporations have as much power to protect – or destroy – the environment as any national government. But few corporations understand the ways in which ecosystem change can affect their bottom line. To address that gap, the World Business Council for Sustainable Development, the World Resources Institute, and the Meridian Institute are convening a business leadership group on ecosystem services. The consortium will develop, test, and publish a corporate ecosystem services review methodology. This will enable businesses to evaluate their dependence and impact on ecosystem services, and their vulnerability to ecosystem service degradation. It will also help them identify the resulting business risks and opportunities. The ultimate goal is to help corporations reduce their impacts on ecosystems and promote more sustainable use of ecosystem services.<sup>4</sup>

### *Making the links between poverty and ecosystem services*

**Location:** Kenya and Uganda

**Strategy:** Ecosystem service mapping tool

In the sub-Saharan African countries of Kenya and Uganda, most people live in crushing poverty. In both countries, life expectancy is just 47 years, and the gross domestic product is less than \$1,500 per person. Clearly, economic development is a crucial humanitarian objective for Kenyans and Ugandans. But few policymakers understand the linkages between poverty and ecosystem services. To make that link explicit — and encourage policymakers to protect vital resources — the World Resources Institute is working closely with African partners to map poverty and ecosystem services at the watershed level in Kenya and Uganda. Maps created for the Upper Tanu River basin in Kenya highlight the strong association between poverty and damaged ecosystems. WRI is engaging national and international decisionmakers in the initiative to ensure that the results inform the implementation of national and regional development strategies.<sup>5</sup>

### *Making biodiversity pay for local communities*

**Location:** India

**Strategy:** Benefit-sharing model for biodiversity protection

The world's tropical forests contain a genetic treasure trove with great potential to benefit human health. These biologically diverse forests teem with species that may hold the key to curing AIDS, cancer, and heart disease. Already, a quarter of our medicines are derived from plant sources. But we are losing species more quickly than we can study their medicinal potential. One solution is to make biodiversity pay — to ensure that local communities have a financial stake in protecting their forests' riches. That is what happened in India's Kerala State, where the



Kani tribe is receiving revenue from a new drug they helped identify. It began on a field expedition of ethnobotanists, when scientists noticed that the Kani men accompanying the team frequently ate fruits that kept them energetic and agile. When asked about the source of the fruits, the Kani were initially reluctant to reveal the information. The team assured the tribes' members that information would not be misused and that, if any marketable drugs were developed, the benefits accrued would be equally shared with the tribe. The Kani introduced the scientists to the fruit, "Arogyapacha," which is now the basis for a popular herbal remedy. The fruit's key compounds are also under study for use as a pharmacological stimulant. The Kani tribe is sharing the licensing fee and royalties for the drug with a local botanical garden. And cultivation of "Arogyapacha," a shade-loving plant that must be grown in the understory of mature forests, provides a sustainable livelihood for the tribespeople.<sup>6</sup>



### *A new partnership to restore degraded wetlands*

**Location:** United States

**Strategy:** Public/private partnership, ecosystem restoration

The San Francisco Bay is best known for the vibrant urban life that rings its shores, but the Bay area is also among California's most important ecosystems. The Bay's salt marshes and other wetlands provide a nursery for many commercially important species of fish, and serve as a key link in the Pacific Flyway — offering shelter and sustenance to millions of migrating waterfowl each year. The wetlands also supply crucial ecosystem services, including flood prevention and filtration of pollutants and sediments from the rivers pouring into the Bay. Unfortunately, some 80 percent of these wetlands have been lost to development. But now, thanks to an innovative public-private partnership, more than 15,000 acres of prime wetland will be restored to their original condition. Funding for the project has been provided by the federal government, private foundations — the William and Flora Hewlett Foundation, the David and Lucile Packard



Foundation, the Gordon and Betty Moore Foundation, and the Richard and Rhoda Goldman Fund — and state water and park bonds approved by voters. The restoration is well under way, with efforts to eradicate invasive alien species and reduce the salinity of abandoned commercial salt ponds. Ultimately, the project will improve the water quality of the Bay, bolster endangered species, and provide clear economic benefits from fishing and recreation.<sup>7</sup>

### *Legislative commission on global environment*

**Location:** Washington, DC

**Strategy:** Collaboration and oversight, guidance to policy and decisionmakers

Environmentalists are advised to “think globally, act locally.” But it’s easy to lose sight of the big picture while immersed in local concerns. Yet many of the key environmental issues of our time — climate change, the health of the oceans — are global in scope. That’s why Senator Paul Sarbanes (D-MD) recently introduced legislation that would create an “Earth Legacy Commission” — a bipartisan, independent commission that would develop policy recommendations for responding to the findings of the MA and advise the U.S. government on global environmental security. If enacted, the commission would examine the state of scientific understanding and current efforts to protect the global environment, assess the impact of continued global environmental deterioration on U.S. interests, and make recommendations for a coordinated, comprehensive, long-range national policy to promote global environmental security.<sup>8</sup>

### *Researching the connections between ecosystems and human well-being*

**Location:** Minnesota

**Strategy:** Research and education

As John Muir once remarked, “When we try to pick out anything by itself, we find it hitched to everything else in the universe.” For better or worse, the health of our planet’s environment is “hitched” to human economic, political, and cultural systems. To better understand those connections — and to craft a sustainable future — the University of Minnesota has launched the Ecosystem Science and Sustainability Initiative. The Initiative is designed to explore how ecosystems and socio-economic systems can work hand-in-hand for the long-term, net benefit of all. The Initiative includes three components: interdisciplinary research, an undergraduate program in sustainability studies, and interactive workshops for journalists and teachers. The Initiative places a high value on scenario planning in its research, coursework, and fundamental approaches to learning. For example, one project of the Initiative involves developing plausible scenarios of Minnesota’s environment in 2050, and then using the scenarios to develop options and strategies for policy change. The Initiative also focuses on placing market value on benefits that natural systems afford to human well-being, in order to further integrate economics and the environment.<sup>9</sup>

### *A national commitment to conservation*

**Location:** Costa Rica

**Strategies:** Payment for ecosystem services, coordinated by national government on a large scale

With only 0.01 percent of the Earth’s landmass, Costa Rica is believed to host some five percent of the planet’s biodiversity. And Costa Rica stands out in another way: as a leader in valuing and protecting its unique natural resources. A half century ago, Costa Rica abolished its army, freeing up 15 percent of its GNP for development and social programs — including environmental protection. And in the 1980s, the country was the first to carry out a “debt for nature”



swap, which has subsequently attracted tens of millions of dollars for conservation of its forests. Today, Costa Rica is a pioneer in recognizing the vital importance of ecosystem services. Its Environmental Services Program encourages landowners to protect or sustainably manage the forests they own and to reforest land that has already been shorn of trees. This is accomplished through direct payments to landowners, which are funded through a nationwide tax on fossil fuels, international donations, and fees for the forests' environmental services. The country has collected additional funding through the sale of "carbon bonds" to foreign countries and utility companies, which guarantee that Costa Rica will protect an agreed-upon number of acres of carbon dioxide-absorbing forests. These measures have enabled Costa Rica to effectively reverse deforestation, while generating much-needed revenue for this developing country. Costa Rica's secret? Visionary leadership at the federal level.<sup>10</sup>

### *Shrinking "dead zones"*

**Location:** United States

**Strategy:** Cap and trade system

Around the globe, nutrient pollution from agricultural fertilizers is a major threat to water quality. Fertilizers wash into streams, rivers, bays and — ultimately — oceans, causing algal blooms and oxygen depleted "dead zones." Perhaps the most dramatic example is the recurrent dead zone in the Gulf of Mexico, which is as large as the state of New Jersey. But nutrient pollution poses a significant regulatory challenge. While "point" sources of pollution, such as sewage treatment plants or fossil fuel based power plants, are relatively easy to identify and regulate, nutrient waste comes mostly from a vast number of scattered "non-point" sources, such as farms and yards. Now, inspired by the U.S. government's successful effort to control acid rain through a "cap-and-trade" system, the World Resources Institute has launched NutrientNet, a trading tool that seeks to limit nutrient pollution from thousands of non-point sources. Here's how it works: first, a "cap" is set on the total amount of pollution allowed. This can be either a statutory limit or a voluntary goal. Then, polluters in that region find ways to meet the goal. If they exceed the goal, they can sell "pollution credits" to others; if they fall short, they must buy credits. NutrientNet provides a user-friendly e-marketplace to estimate and trade nutrient reduction credits on-line. It also allows industrial facilities and farmers to estimate the cost and amount of nutrient reduction credits they are able to achieve. NutrientNet has been used to support Pennsylvania's water quality trading program and Michigan's Kalamazoo watershed pilot trading program. WRI's goal for the future is to establish a multi-state nutrient trading program for the Chesapeake Bay.<sup>11</sup>





### *Using financial markets to create and reward good change*

**Location:** Global

**Strategy:** Investment in strategic projects and markets

Bruce Kahn, with SmithBarney/Citigroup, believes that empowering organizations to use their investments in new and different ways can create large change. Kahn, a financial advisor, consults with individuals, endowments, and foundations on the ecological impact of investments. During this process, Kahn feels it important and wise to incorporate advice on green investment, which is partially exemplified by using the principles of the Millennium Ecosystem Assessment. Kahn finds particular value in the MA in its assessment of natural capital and flux trends. By determining if systems a company is dependant upon are in a state of deficit or surplus, Kahn helps his clients project future outcomes – both in terms of natural capital and also in decisions to invest or divest. By encouraging clients to take the vision and findings of the MA into account, Kahn is helping to foster a better balance between the natural world and human well-being, and also is developing a broader, stronger, and more responsible portfolio for his client's present, and future.

### *Promoting land conservation through demonstrated economic benefit*

**Location:** Global

**Strategy:** Demonstrate use of economic benefits assessments

In today's world, the dollar is often the bottom line. Conservation groups have recognized the importance of being able to make the economic argument, but have sometimes struggled to create tools for this purpose. Defenders of Wildlife has sought to do just that in a new report, "Assessing the Wealth of Nature: Using Economic Studies to Promote Land Conservation Instead of Sprawl." The report shows that conservationists can fight sprawl and promote land conservation by demonstrating the economic value that comes from natural lands. The report inventories economic benefits assessments, illustrates how they were used in local land use planning, and provides a starting place for conservationists interested in conducting their own assessments.

### **Lessons Learned**

To protect the ecosystems on which we all depend, we must make sweeping changes in the way we think about and manage natural resources. The MA asks us to think holistically about natural resources, to evaluate the varied services they offer, and to acknowledge that intelligent resource management involves trade-offs. For example, protecting a forest may cost revenue from logging and other extractive industries, but those losses can be offset by improved ecosystem services such as flood control, and improved water quality. The MA also asks us to appreciate and protect less tangible ecosystem services, such as the aesthetic and spiritual value of nature.

The MA offers a wealth of strategies to help communities and decisionmakers grapple with these issues. Below is a summary of lessons learned from the MA's assessment of successful strategies to protect ecosystem services.



### *Institutions and governance*

- **Include ecosystem protection in all decisionmaking.** Typically, policies on trade and development have far-reaching effects on the environment, but are not under the control of agencies charged with environmental protection. The MA recommends integrating ecosystem management goals in all relevant policymaking.
- **Improve coordination among multilateral environmental agreements and other international institutions.** International agreements are indispensable for addressing environmental problems that span national boundaries — like biodiversity and climate change. But those agreements are often narrowly focused, and their efforts are not well coordinated. Moreover, there is too little coordination between multilateral environmental agreements and far more powerful international economic and trade institutions.
- **Make government and the private sector more transparent and accountable.** Ecosystems fare better when all stakeholders are informed about, and involved in, environmental decision-making.
- **Get the scale right.** Ecosystem management is often too centralized — for example, run by a national agency that is out of touch with local concerns — or too decentralized — managed by local governments who fail to see the bigger picture. The problem is exacerbated by ecosystems that sprawl across political boundaries. In several regions, new institutions have been created to manage border-crossing ecosystems, including the Danube River, Lake Victoria, the Mekong River, and the Amazon.
- **Protect the whole ecosystem, not just its parts.** In most countries, separate agencies are in charge of different aspects of ecosystems — agriculture, water, forests, fish, and wildlife — and different drivers of change — energy, transportation development, and trade. A key challenge is to develop more holistic strategies that incorporate all of these concerns, such as integrated management of coastal zones or river basins, or national sustainable development strategies.

### *Economics and incentives*

- **Eliminate subsidies for unsustainable resource use.** Wealthy countries, in particular, offer huge subsidies for agriculture, fishing, and resource extraction. Those subsidies reward the wholesale exploitation of resources and mute market signals that could encourage more sustainable practices. Removing those subsidies — and requiring the users of ecosystem services to pay for what they use — could go a long way toward preserving ecosystem health.





- **Harness the power of markets.** A wide range of market-based approaches are being used with great success to protect ecosystems. These include: taxes or user fees for the use of ecosystem services; creation of markets for ecosystems that have always been treated as “free,” such as water; paying landowners and others to protect ecosystems; and mechanisms that give consumers more information and power, such as certification of sustainable products.

### *Social and behavioral changes*

- **Reduce consumption of unsustainably managed ecosystem services.** Our patterns of consumption are influenced by many factors, including price, availability, and culture. But even within current social and economic structures, consumers have untapped power. Sparked by public awareness campaigns, consumer demand can change corporate practices. Examples include the “dolphin-safe” tuna campaign and the growing popularity of organic foods.
- **Communication and education.** Both the public and decisionmakers can benefit from education about ecosystems and human well-being. Also, education more generally provides a myriad of social benefits that can, among other things, reduce environmental degradation.
- **Empower the disempowered.** Women, youth, and indigenous people are often disproportionately affected by ecosystem degradation, yet may lack the political power to make themselves heard. Mobilizing these groups could invigorate new constituencies for environmental protection.

### *Technological responses*

- **Promote technologies that increase crop yields without increasing pollution and land degradation.** As the human population grows from 6.5 to 9 billion in the next half-century, agriculture will continue to be a major cause of environmental damage. Sustainable farming practices already exist; the challenge for the coming decades will be to bring those practices to a broader scale.
- **Restore degraded ecosystems.** Efforts are underway to restore a broad range of ecosystems, including wetlands, forests, grasslands, estuaries, and coral reefs. While these restored systems seldom fully replace the original systems, they can effectively meet needs for particular ecosystem services.
- **Promote technologies to increase energy efficiency and reduce greenhouse gas emissions.** Here, too, a range of promising technologies already exist; the challenge is to create institutions and policies that can help diffuse these technologies in the world marketplace.

## Conclusion

The challenges before us are without precedent in human history. But solutions do exist. The MA points the way — with strategies that reflect the increasing value of nature and recognize its irreplaceable contributions to human well-being. In the preceding pages, you’ve seen those strategies used at many different scales — from rural villages to national governments and multinational corporations.

You, too, can use the MA in your work. Whether you are a teacher, a community organizer, a scientist, an engineer, or a state legislator, you can view your work through the prism of ecosystem services and human well-being. Understand the value of ecosystem services to your family, your community, your watershed, your nation. Help others understand that value. And work for policies, practices, and laws that will preserve ecosystems for current and future generations. The future is in our hands.



## Resources

### Millennium Ecosystem Assessment

The MA website contains downloadable versions of the Assessment reports, and links to other relevant news and resources:

[www.maweb.org](http://www.maweb.org)

### Other websites

[www.naturalcapitalproject.org](http://www.naturalcapitalproject.org)

[www.ecosystemvaluation.org](http://www.ecosystemvaluation.org)

[www.ecosystemmarketplace.com](http://www.ecosystemmarketplace.com)

[www.lwa.gov.au](http://www.lwa.gov.au)

[www.ecosystems-services-project.org](http://www.ecosystems-services-project.org)

### For Further Reading

- Walter Reid et al., Millennium Ecosystem Assessment (Washington, DC: Island Press, 2005)
- Gretchen Daily, Nature's Services: Societal Dependence on Natural Ecosystems (Washington, DC: Island Press, 1997)
- The Heinz Center, The State of the Nation's Ecosystems (Washington, DC: 2002)
- World Resources 2005: The Wealth of the Poor — Managing Ecosystems to Fight Poverty (Washington, DC: World Resources Institute, 2005). Online at: <http://multimedia.wri.org/worldresources2005.cfm>

## Footnotes

<sup>1</sup> Smithsonian Institution: <http://www.nmnh.si.edu/botany/projects/cpd/ma/ma14.htm>

Swiss Re: <http://www.swissre.com/INTERNET/pwswpspr.nsf/fmBookMarkFrameSet?ReadForm&BM=../vwAllbyIDKeyLu/mdis-5xkdf5?OpenDocument>

<sup>2</sup> Janet Ranganathan, "What is the World Resources Institute doing to address the Millennium Ecosystem Assessment findings?" (Washington, DC 2006)

<sup>3</sup> Winrock International/International Institute for Environment and Development: <http://www.environmental-incentives.org/projects.htm>

<sup>4</sup> Ranganathan, *ibid.*

<sup>5</sup> Ranganathan, *ibid.*



<sup>6</sup> Convention on Biological Diversity:

<http://www.biodiv.org/doc/case-studies/abs/cs-abs-tbgri-in-en.pdf>

<sup>7</sup> Resources Legacy Fund: [http://www.resourceslegacyfund.org/programs/prg\\_baylands.html](http://www.resourceslegacyfund.org/programs/prg_baylands.html)

San Francisco Chronicle: <http://www.sfgate.com/cgi-bin/article.cgi?f=/chronicle/archive/2002/05/29/MN190127.DTL>

<sup>8</sup> U.S. Congressional Record: [www.earthlegacy.org/Sarbanes\\_CongRecord\\_GlobalResources%20introduction.pdf](http://www.earthlegacy.org/Sarbanes_CongRecord_GlobalResources%20introduction.pdf)

<sup>9</sup> [www.sustainability.umn.edu/research/index.html](http://www.sustainability.umn.edu/research/index.html)

<sup>10</sup> The Nature Conservancy:

<http://www.nature.org/wherewework/centralamerica/costarica/>

Rainforest Alliance:

<http://www.rainforest-alliance.org/neotropics/eco-exchange/2001/mar01-1.html>

<sup>11</sup> Ranganathan, *ibid.*



### Thank you ...

Thank you to our scientific reviewer, Ms. Sylvia S. Tognetti.

Sylvia S. Tognetti is an Environmental Science and Policy Consultant who has several publications regarding the development of payment and other institutional arrangements to create incentives to protect ecosystem services, and was a contributor to the Millennium Ecosystem Assessment report on Policy Response Options, for which she served as a lead author.

### A Special Note

In spring 2007, the World Resources Institute will release a guide on ecosystem services, titled *Integrating Ecosystem Services into Economic and Development Decisions: A Guide for the Perplexed*. The purpose of the guide is to encourage and help public sector decisionmakers incorporate information on ecosystem services, the benefits provided by nature, in their policies and actions. The guide will outline why and how to use information on ecosystem services, drawing on examples from a variety of economic and development decisions.

The guide will be designed to support a number of applications, including: facilitating the integration of ecosystem service considerations in economic and development strategies; providing additional information to supplement environmental impact assessments of large infrastructure projects; and helping ecosystem-focused initiatives make relevant links to the attainment of social, economic, and development goals.

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