PREPUBLICATION DRAFT

Living Beyond Our Means




Natural Assets and Human Well-being

Statement from the Board

MILLENNIUM ECOSYSTEM ASSESSMENT

Millennium Ecosystem Assessment Board

Co-chairs

Robert Watson
Chief Scientist and Senior Advisor, ESSD, The World Bank

A.H. Zakri
Director, Institute of Advanced Studies, United Nations University

Institutional Representatives

Salvatore Arico
Programme Officer, Division of Ecological Science, United Nations Educational, Scientific and Cultural Organization

Peter Bridgewater
Secretary General, Ramsar Convention on Wetlands

Hama Arba Diallo
Executive Secretary, United Nations Convention to Combat Desertification

Adel El-Beltagy
Director General, International Center for Agricultural Research in the Dry Areas

Max Finlayson
Chair, Science and Technical Review Panel, Ramsar Convention on Wetlands

Colin Galbraith
Chair, Scientific Council, Convention on Migratory Species

Erica Harms
Senior Program Officer for Biodiversity, United Nations Foundation

Robert Hepworth
Acting Executive Secretary, Convention on Migratory Species

Olav Kjørven
Director, Sustainable Energy and Environment Division, United Nations Development Programme

Kerstin Leitner
Assistant Director-General, Sustainable Development and Healthy Environments, World Health Organization

Alfred Oteng-Yeboah
Chair, Subsidiary Body on Scientific, Technical and Technological Advice, Convention on Biological Diversity

Christian Prip
Chair, Subsidiary Body on Scientific, Technical and Technological Advice, Convention on Biological Diversity

Mario Ramos
Biodiversity Program Manager, Global Environment Facility

Thomas Rosswall
Director, International Council for Science - ICSU

Achim Steiner
Director General, IUCN -World Conservation Union

Halldor Thorgeirsson
Coordinator, Methods, Inventories and Science Program, United Nations Framework Convention on Climate Change

Klaus Töpfer
Executive Director, United Nations Environment Programme

Jeff Tschirley
Chief, Environmental Service, Research, and Training Division, Food and Agriculture Organization of the United Nations

Riccardo Valentini
Chair, Committee on Science and Technology, United Nations Convention to Combat Desertification

Hamdallah Zedan
Executive Secretary, Convention on Biological Diversity

At-large Members

Fernando Almeida
Executive President, Business Council for Sustainable Development, Brazil

Phoebe Barnard
Global Invasive Species Programme, National Botanical Institute, South Africa

Gordana Beltram
Undersecretary, Ministry of the Environment and Spatial Planning, Slovenia

Delmar Blasco
Former Secretary General, Ramsar Convention on Wetlands, Spain

Antony Burgmans
Chairman, Unilever N.V., The Netherlands

Esther Camac
Executive Director, Asociación Ixä Ca Vaá de Desarrollo e Información Indigena, Costa Rica

Angela Cropper
President, The Cropper Foundation, Trinidad and Tobago

Partha Dasgupta
Professor, Faculty of Economics and Politics, University of Cambridge, UK

José María Figueres
Managing Director, Center for Global Agenda, World Economic Forum, Switzerland

Fred Fortier
Indigenous Peoples' Biodiversity Information Network, Canada

Mohamed H.A. Hassan
Executive Director, Third World Academy of Sciences, Italy

Jonathan Lash
President, World Resources Institute, USA

Wangari Maathai
Vice Minister for Environment, Kenya

Paul Maro
Professor, Department of Geography, University of Dar es Salaam, Tanzania

Harold Mooney
Professor, Department of Biological Sciences, Stanford University, USA

Marina Motovilova
Professor, Faculty of Geography, M.V. Lomonosov Moscow State University, Russia

M.K. Prasad
Environment Centre of the Kerala Sastra Sahitya Parishad, India

Walter V. Reid
Director, Millennium Ecosystem Assessment (*ex officio*), Malaysia

Henry Schacht
Past Chairman of the Board, Lucent Technologies, USA

Peter Johan Schei
Director, Fridtjof Nansen Institute, Norway

Ismail Serageldin
President, Bibliotheca Alexandrina, Egypt

David Suzuki
Chair, David Suzuki Foundation, Canada

M.S. Swaminathan
Chairman, MS Swaminathan Research Foundation, India

José GalíziaTundisi
President, International Institute of Ecology, Brazil

Axel Wenblad
Vice President Environmental Affairs, Skanska AB, Sweden

Xu Guanhua
Minister, Ministry of Science and Technology, China

Muhammad Yunus
Managing Director, Grameen Bank, Bangladesh

Preface

The Millennium Ecosystem Assessment (MA) was called for by United Nations Secretary-General Kofi Annan in 2000 in a report to the General Assembly entitled We the Peoples: The Role of the United Nations in the 21st Century. *Initiated in 2001, the objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for actions needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being.*

The MA has involved the work of more than 1,360 experts worldwide. Their findings on the condition and trends of ecosystems, scenarios for the future, possible responses, and assessments at a sub-global level are set out in technical chapters grouped around these four main themes. In addition, a General Synthesis Report draws on these detailed studies to answer a series of core questions posed at the start of the MA. The practical needs of specific groups of users, including the business community, are addressed in other synthesis reports.

Each part of the assessment has been scrutinized by governments, independent scientists and other experts to ensure the robustness of its findings.

This statement is from the Board governing the MA process, whose membership includes representatives from U.N. organizations, governments through a number of international conventions, nongovernmental organizations, academia, business, and indigenous peoples. (For a full list of Board members, see the inside front cover.)

It is not intended as a comprehensive summary of the findings of the MA, but rather as an interpretation of the key messages to emerge from it. Written for a non-specialist readership, it is nevertheless consistent with the more detailed documents of the assessment and can be read in conjunction with them.

We believe that the wide range of global interests combining to issue this statement, together with the rigorous study on which it is based, should add power and urgency to the conclusions it sets out.

—The Board of the Millennium Ecosystem Assessment

Key Messages

- Everyone in the world depends on nature and ecosystem services to provide the conditions for a decent, healthy, and secure life.
- Humans have made unprecedented changes to ecosystems in recent decades to meet growing demands for food, fresh water, fiber, and energy.
- These changes have helped to improve the lives of billions, but at the same time they weakened nature's ability to deliver other key services such as purification of air and water, protection from disasters, and the provision of medicines.
- Among the outstanding problems identified by this assessment are the dire state of many of the world's fish stocks; the intense vulnerability of the 2 billion people living in dry regions to the loss of ecosystem services, including water supply; and the growing threat to ecosystems from climate change and nutrient pollution.
- Human activities have taken the planet to the edge of a massive wave of species extinctions, further threatening our own well-being.
- The loss of services derived from ecosystems is a significant barrier to the achievement of the Millennium Development Goals to reduce poverty, hunger, and disease.
- The pressures on ecosystems will increase globally in coming decades unless human attitudes and actions change.
- Measures to conserve natural resources are more likely to succeed if local communities are given ownership of them, share the benefits, and are involved in decisions.
- Even today's technology and knowledge can reduce considerably the human impact on ecosystems. They are unlikely to be deployed fully, however, until ecosystem services cease to be perceived as free and limitless, and their full value is taken into account.
- Better protection of natural assets will require coordinated efforts across all sections of governments, businesses, and international institutions. The productivity of ecosystems depends on policy choices on investment, trade, subsidy, taxation, and regulation, among others.

RUNNING DOWN THE ACCOUNT

The bottom line

At the heart of this assessment is a stark warning. Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted.

The provision of food, fresh water, energy, and materials to a growing population has come at considerable cost to the complex systems of plants, animals, and biological processes that make the planet habitable.

As human demands increase in coming decades, these systems will face even greater pressures—and the risk of further weakening the natural infrastructure on which all societies depend.

Protecting and improving our future well-being requires wiser and less destructive use of natural assets. This in turn involves major changes in the way we make and implement decisions.

We must learn to recognize the true value of nature—both in an economic sense and in the richness it provides to our lives in ways much more difficult to put numbers on.

Above all, protection of these assets can no longer be seen as an optional extra, to be considered once more pressing concerns such as wealth creation or national security have been dealt with.

This assessment shows that healthy ecosystems are central to the aspirations of humankind.

Natural provisions

In the streets of a crowded city, in the aisles of a giant supermarket, or on the floor of a gleaming electronics factory, the biological state of Earth's rivers, forests, and mountains may seem a remote concern.

Yet despite the breakneck pace of technological change many of us have seen in our lifetimes, we each depend far more than we may realize on the web of life of which we are a part.

The food and fresh water that keep us alive, the wood that gives us shelter and furniture, even the climate and the air we breathe: all are products of the living systems of the planet.

As forests and savanna 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, the recent changes made to natural systems have helped not just to feed a rapidly growing human population, but to improve the lives of billions.

In the midst of this unprecedented period of spending Earth's natural bounty, however, it is time to check the accounts. That is what this assessment has done, and it is a sobering statement with much more red than black on the balance sheet.

Spending the capital

Nearly two thirds of the services provided by nature to humankind are found to be in decline worldwide. In effect, the benefits reaped from our engineering of the planet have been achieved by running down natural capital assets.

In many cases, it is literally a matter of 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.The cost is already being felt, but often by people far away from those enjoying the benefits of natural services. Shrimp on the dinner plates of Europeans may well have started life in a South Asian pond built in place of mangrove swamps—weakening a natural barrier to the sea and making coastal communities more vulnerable.

Unless we acknowledge the debt and prevent it from growing, we place in jeopardy the dreams of citizens everywhere to rid the world of hunger, extreme poverty, and avoidable disease—as well as increasing the risk of sudden changes to the planet's life-support systems from which even the wealthiest may not be shielded.

We also move into a world in which the variety of life becomes ever more limited. The simpler, more uniform landscapes created by human activity have put thousands of species under threat of extinction, affecting both the resilience of natural services and less tangible spiritual or cultural values.

Yet this need not be a counsel of despair. The natural balance sheet we bequeath to future generations depends on choices made at every level and in every corner of the planet—from the head of a village in Bangladesh to a corporation board in a New York skyscraper; from international gatherings of finance ministers to consumers in a Brazilian furniture store.

THE SERVICES OF NATURE

Essential to our lives

As human societies become more and more complex and technologically advanced, it is easy to gain the impression that we no longer depend on natural systems.

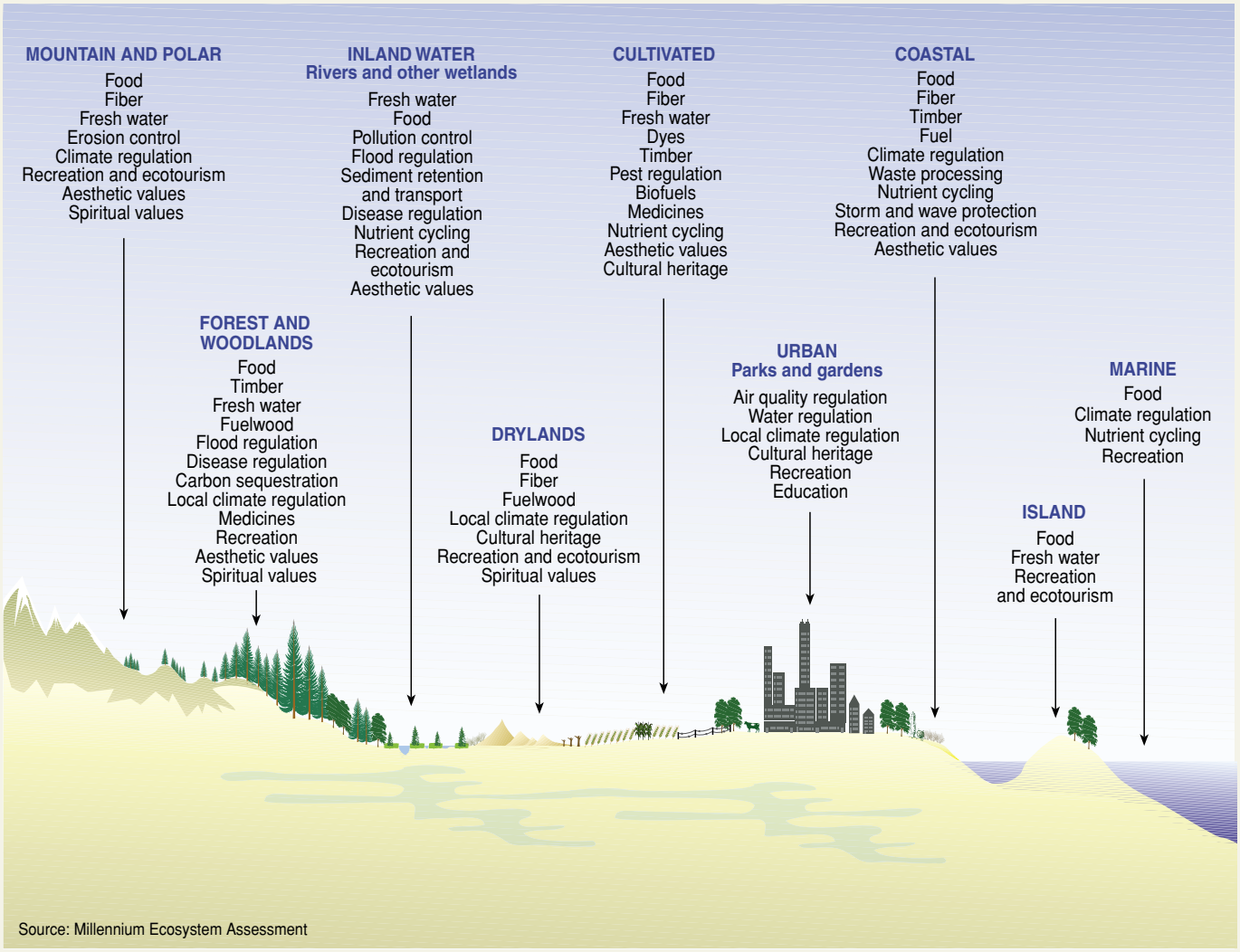
A steadily increasing proportion of the population lives in cities, in environments dominated by human-built structures and machines. Nature may appear to be something to be enjoyed at the weekend if we get the chance, nice to have but hardly at the forefront of our daily concerns.

Even in rural areas, the conservation of natural spaces is often seen as a luxury that has little to do with the well-being of local people—a swamp, for example, might be viewed as wasted land, whose only value is in the crops that could be planted if it were to be drained.

These are dangerous illusions that ignore the vast benefits of nature to the lives of the 6 billion people on the planet. We may have distanced ourselves from nature, but we rely completely on the services it delivers.

Ecosystems and Some Services They Provide

Different combinations of services are provided to human populations from the various types of ecosystem represented here. Their ability to deliver the services depends on complex biological, chemical, and physical interactions, which are in turn affected by human activities.



Source: Millennium Ecosystem Assessment

Providing the basics

At the most basic level, the food we eat is a service of nature. This is most obviously true when it is obtained by harvesting wild species such as ocean fish: the healthy functioning of the food chain of the seas is an asset of vast economic value.

Even food grown in what appear to be the most unnatural conditions, however, is still a product of the biological processes of nature. Whether it is in the genetic material from which seeds or livestock are bred (or, with biotechnology, altered), the soils in which crops are grown, or the water that makes the land fertile: human nourishment depends on a natural infrastructure underlying the skills and technology of farmers around the world.

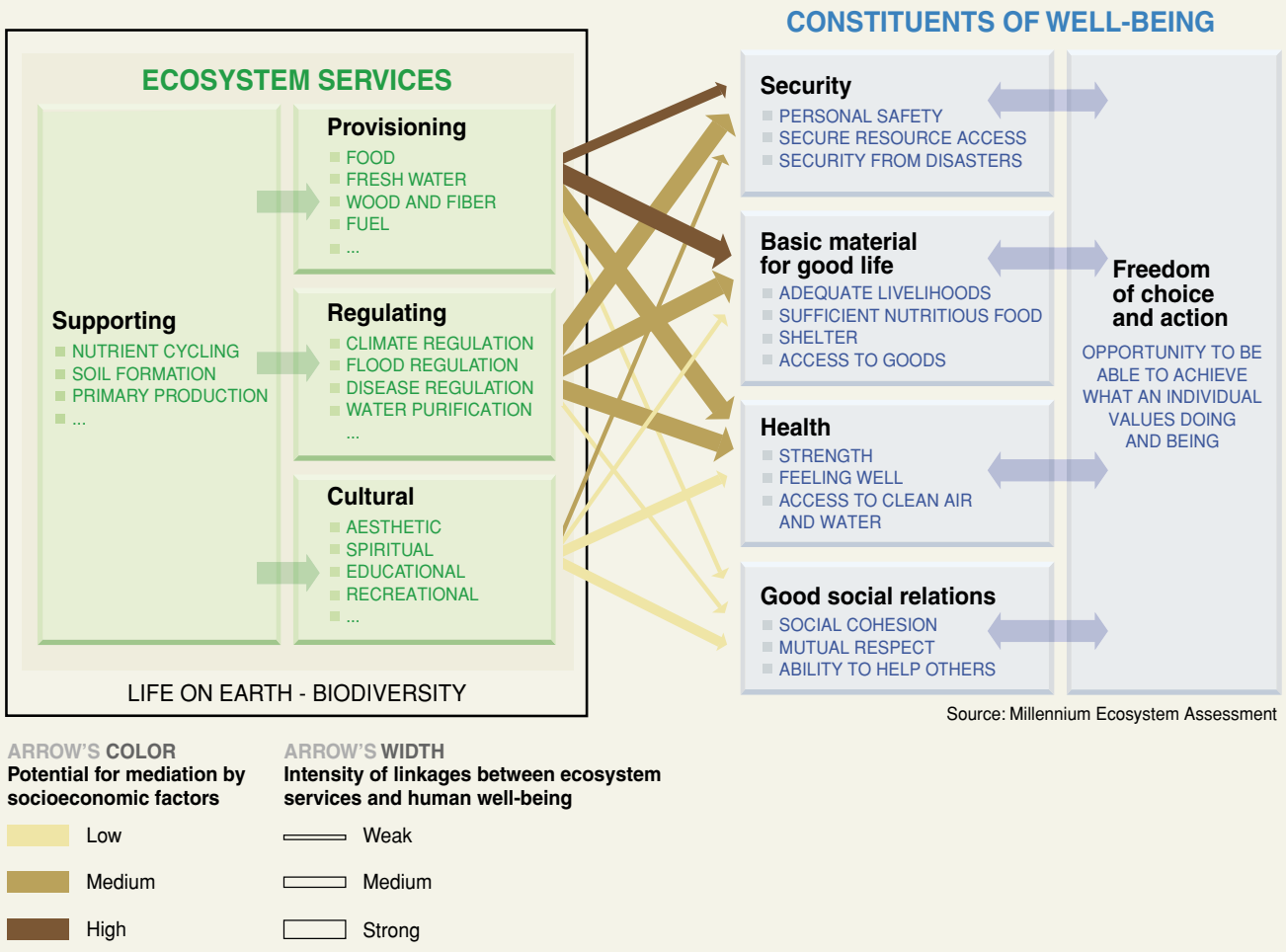
Apart from its role in food production, fresh water is of course another of the basics of life. For all the ingenious channeling techniques developed since the earliest civilizations, we still rely on natural systems to regulate the flow of water through the river basins of the world.

Even with the invention of many synthetic materials, other products of nature are still used in huge quantities in every society—trees bring us wood and paper, the fashion industry needs plant and animal fibers, and medicines derived from nature are in ever-greater demand.

Regulating Earth—nature as life support

While the value of most of these products can be fairly easily calculated, many other services of nature do not appear on conventional balance sheets, but they are equally essential for the survival of modern economies. Their true worth is often appreciated only when they are lost.

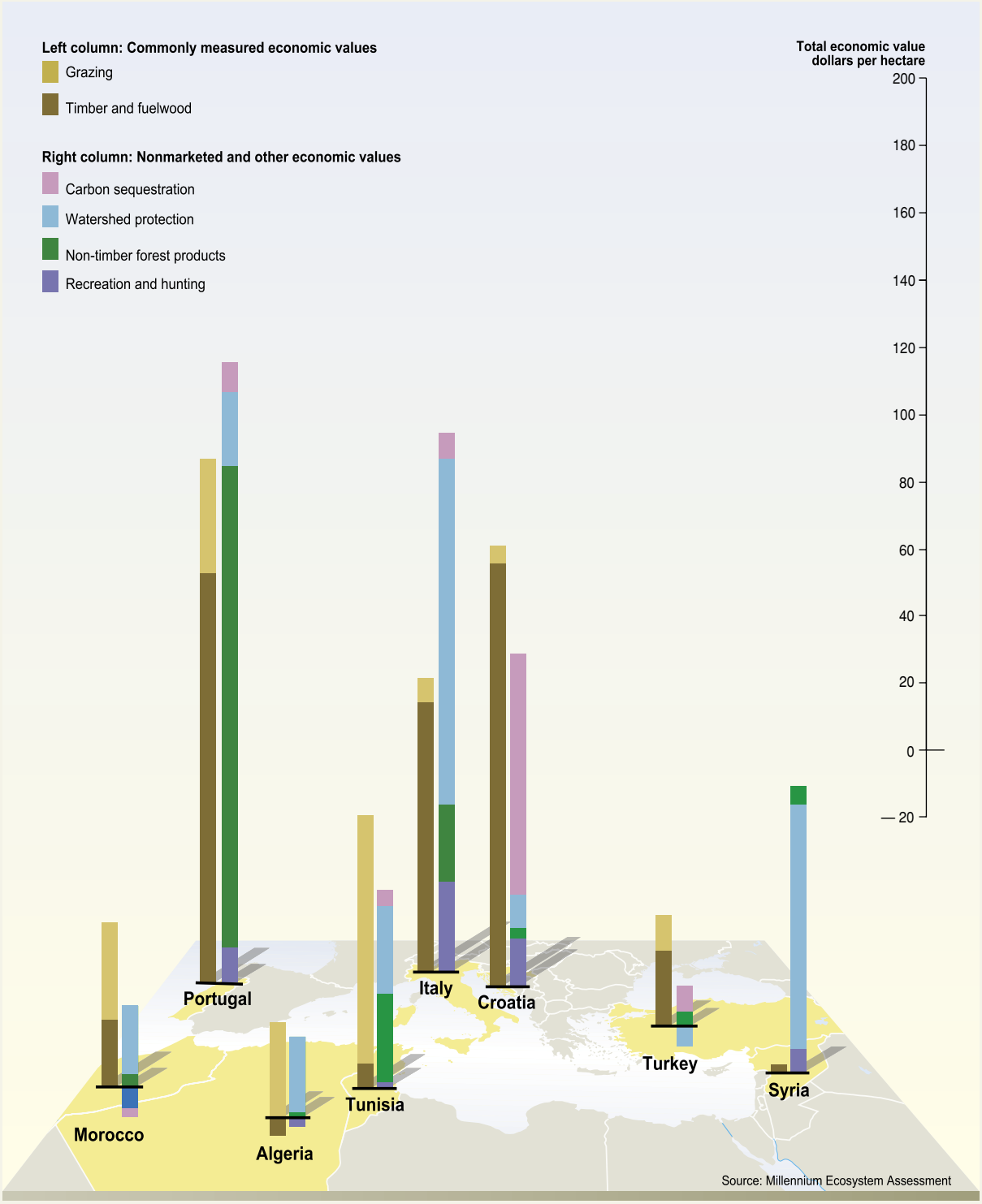
Linkages between Ecosystem Services and Human Well-being



Source: Millennium Ecosystem Assessment

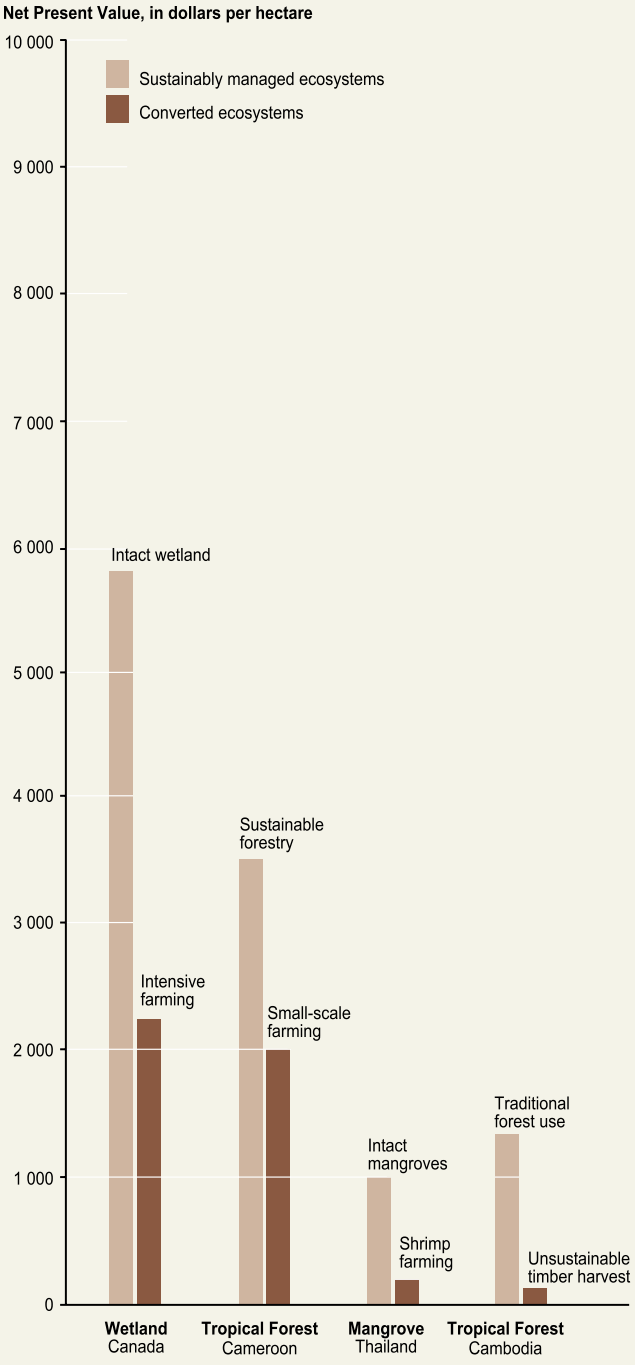
Annual Flow of Benefits from Forests in Selected Countries

The value of a forest is often measured only by the timber and fuel provided by its trees. In these countries, however, that is generally less than one third of the total economic value. This higher figure includes services such as control of the climate through absorption (sequestration) of carbon dioxide, protection of freshwater sources (watersheds), and recreation. Because many of these services are not bought and sold in markets, they are frequently lost or degraded even though their value to human societies is high.



Economic Benefits Under Alternate Management Practices

In each case, the net benefits from the more sustainably managed ecosystem are greater than those from the converted ecosystem when measurements include both marketed and nonmarketed services, even though the private (market) benefits would be greater from the converted ecosystem.



Source: Millennium Ecosystem Assessment

Returning to that apparently worthless swamp, for example, wetlands perform a wide range of functions of great value to people—from acting as a natural pollution filter and preventing floods by storing water during heavy rains to supporting wildlife and recreation.

Forests help regulate air quality, the flow of water, and the climate itself. Although their relationship with the atmosphere is more complex than the common description as "lungs of the earth," forests store large quantities of carbon that would add to the greenhouse effect if released into the air.

Natural systems provide protection from a range of catastrophic events that can devastate human communities—vegetation helps prevent soil erosion and reduce the likelihood of landslides, while coral reefs and mangrove forests act as barriers against coastal storms and even tidal waves.

Interference with living systems can also promote the sudden emergence of human diseases and crop pests, causing great suffering and economic damage.

In attempting to assess the importance of nature to our lives, we should not lose sight of the value placed on the variety of life on Earth for its own sake: this is even more difficult to put a price on, but nonetheless of deep concern to people of all cultures.

Whether it is the uplifting sound of birdsong in a city park, the reverence for local species in many indigenous belief systems, or the wonder of a child watching wildlife in a zoo or even on television, appreciation of the natural world is an important part of what makes us human.

Even if our material needs could be met with a much narrower range of species and landscapes, many people would regard this loss as a significant threat to their overall well-being.

PRESSURES AND CHANGES

The historical context

The development of human societies has been a story of changing the natural systems of the planet to sustain ever-more sophisticated and comfortable ways of living—and ever-greater numbers of people.

In early civilizations, the transition to complex social and political structures was often closely linked to major projects engineering those systems for human advantage, such as clearing forests to make way for agriculture and diverting rivers to irrigate crops.

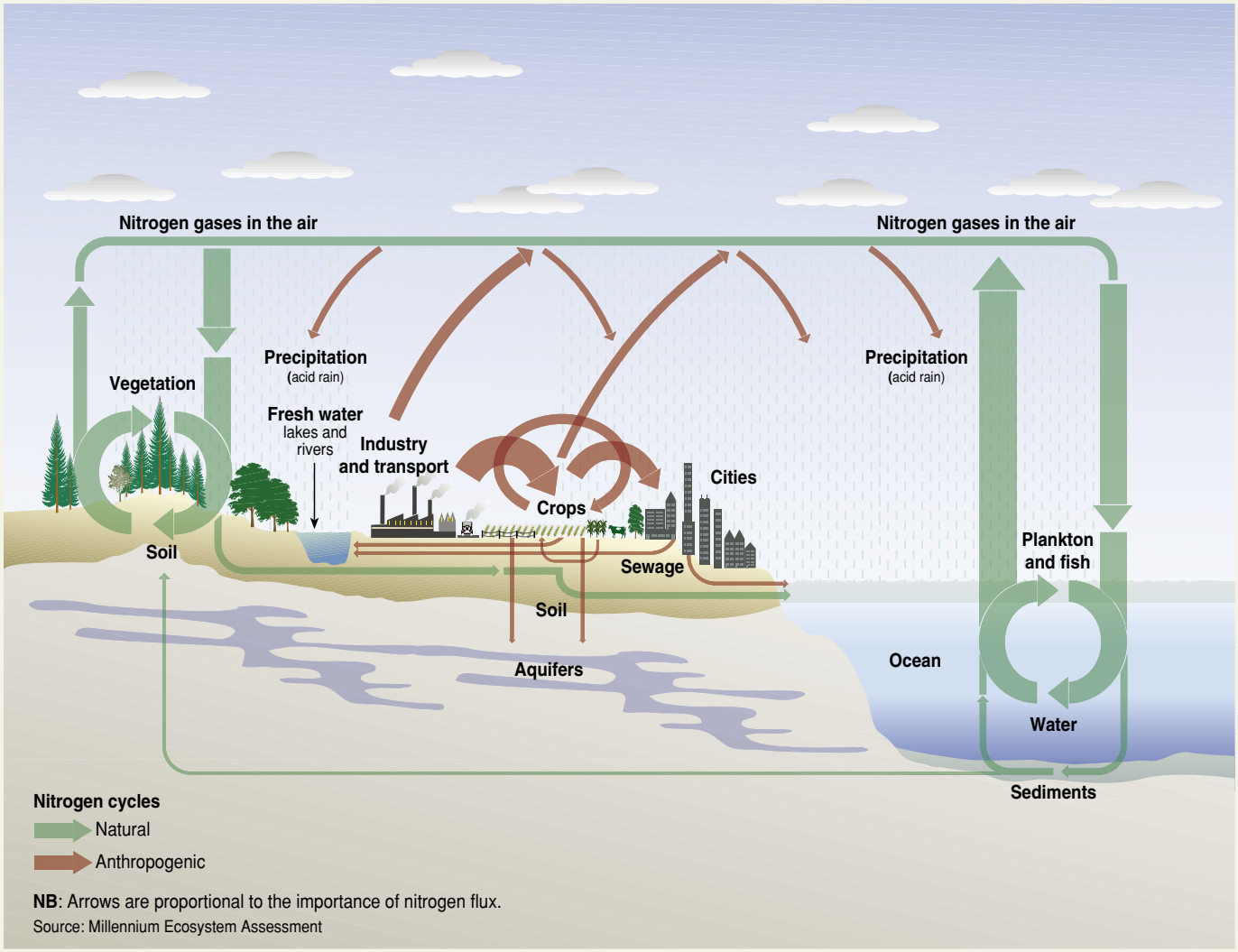
Over the millennia, areas of wilderness were adapted across the planet to enable settled communities to enjoy a secure supply of food, water, energy, and materials. Demand for luxuries in one part of the world could influence natural systems thousands of miles away—for instance, the European taste for sugar and the red textile dye produced from brazilwood changed forever the Atlantic Forest of South America.

With the onset of industrialization, the pace of these changes accelerated as new technology and medical advances made possible the sustenance and survival of rapidly growing urban populations.

Yet throughout human history, no period has experienced interference with the biological machinery of the planet on the scale witnessed in the second half of the twentieth century.

The Nitrogen Cycle.

Human activities, including farming and industry, have greatly increased the cycle of nitrogen through soils, water courses, and the atmosphere. By accumulating more nitrogen in a form that can be taken up by plants, the balance of ecosystems can be seriously upset.



NB: Arrows are proportional to the importance of nitrogen flux.

Source: Millennium Ecosystem Assessment

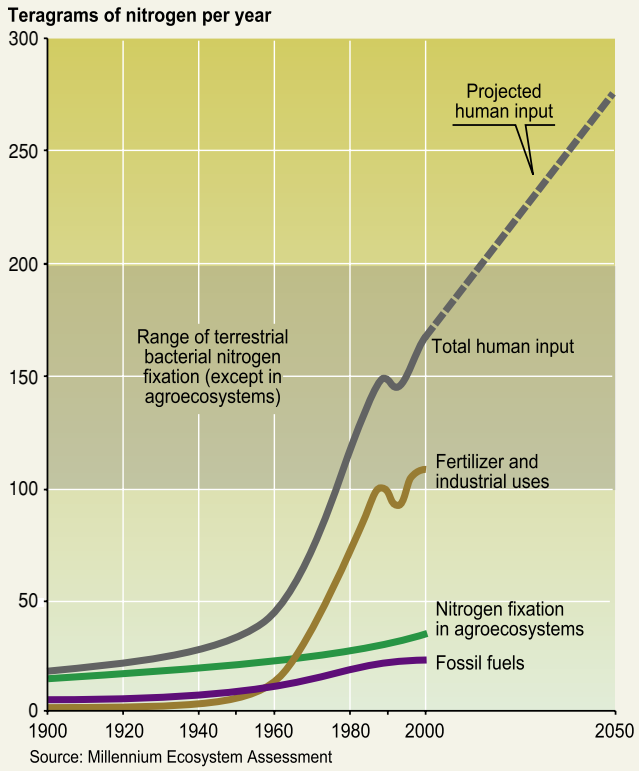
Re-engineering the planet

Since 1945, more land such as forest, savanna, and natural grassland has been converted for the growing of crops than in the eighteenth and nineteenth centuries combined. Nearly a quarter of the land surface of Earth is now cultivated.

Accompanying this change has been a huge increase in the application of manufactured nitrogen and phosphorus fertilizers. These nutrients are targeted at crops, but in effect they have also fertilized nature as they are washed into streams, rivers, and eventually the oceans. In many places this has led to excess growth of plants such as algae that in turn deprive the water of oxygen and kill other forms of aquatic life.

The amount of water taken from rivers and lakes to irrigate fields, to meet the needs of industry, and to supply households has doubled since 1960. The quantity impounded behind dams has quadrupled in the same period, and artificial reservoirs now hold much more water than free-flowing rivers do.

Global Trends in the Creation of Reactive Nitrogen (That Available to Living Organisms) by Human Activities, with a Projection to 2050



Source: Millennium Ecosystem Assessment

As a result, the flow of some rivers has been substantially reduced. At times the Yellow River in China, the Nile in Africa, and the Colorado in North America do not even reach the ocean. Rivers now transport much less of the sediments that bring food supplies to estuaries and help support vibrant populations of shellfish, fish, and birds. In some areas, however, soil erosion produces an oversupply of sediment, which can cause considerable damage to the local ecology.

The development of coastlines for tourism and activities such as shrimp farming has also dramatically altered the meeting point of land and ocean. In just two decades, it is estimated that people have removed more than a third of the world's mangroves—the dense forests growing in the tidal mud of many tropical regions.

It will probably never be known how many lives were lost in the Indian Ocean tsunami due to the loss of mangroves and damage to coral reefs, but it has been widely accepted that areas with less damage to the natural coastline were better protected from the force of the tidal wave.

The unchanging appearance of the ocean itself belies a major shift in the systems of life hidden beneath the waves, due mostly to the human appetite for fish and the increasing technological efficiency of the fishing industry.

The full consequences of this pressure are still poorly understood, but a recent study estimated that 90% of the total weight of large predators of the ocean such as tuna, swordfish, and sharks has disappeared in modern times.

Moving species

Another major change might be termed the globalization of nature. As people become increasingly mobile, plants and animals have been transported to parts of the world where they never previously existed, entering the local web of life and sometimes altering it profoundly.

Often this has been deliberate, such as the introduction of domestic livestock or crop species —the unique wildlife of some of the Galapagos Islands, for example, has been severely affected by the arrival of goats.

In many cases, however, it has been an accidental impact of the accelerating human links across the planet. Ocean-going freight ships carry large numbers of sea creatures in their ballast tanks, which are flushed out at their destination as they load up their holds.

This has led to some remarkable exchanges of species. The Baltic Sea, for instance, contains 100 creatures from outside the region, a third of which are native to the North American Great Lakes. And a third of the 170 alien species in those lakes are native to the Baltic.

Such changes are more than just a question of the purity of nature. A species introduced from outside can dramatically change the local system and the services it provides—for example, the arrival of the American comb jellyfish in the Black Sea led to the destruction of 26 commercially valuable stocks of fish.

Changing the climate

The change with the greatest potential to alter the natural infrastructure of Earth is the chemical experiment humans have been conducting on the atmosphere for the past century and a half.

The dominance of coal, oil, and natural gas as our sources of energy has released large quantities of carbon previously locked in underground rock layers and has increased the amount of carbon dioxide gas in the air by about a third.

It is now well established that this has changed global weather systems by trapping more of the Sun's heat within the atmosphere, and that these changes will accelerate as the concentration of carbon dioxide continues to grow.

Nature has always adapted to changes in climate, but this shift is likely to pose unprecedented challenges to its resilience for two main reasons.

First, the anticipated speed of climate change is greater than anything seen for at least 10,000 years, making it far more difficult for species to move to more suitable areas or adapt to the new conditions by evolving new survival mechanisms. Coral reefs, for example, have already become barren in some areas through relatively modest increases in sea temperatures, combined with other pressures such as nutrient pollution and overfishing.

Just as important, the options available to plants and animals have been greatly narrowed by the massive changes humans have made to

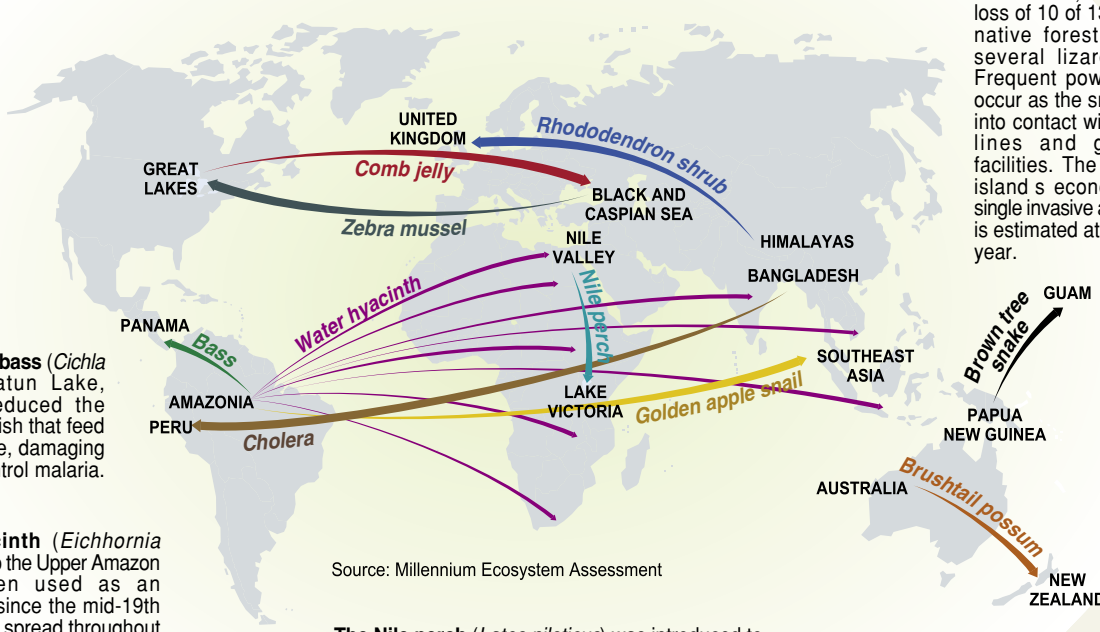
Invasive Species around the World

The Zebra mussel (*Dreissena polymorpha*) native to the Caspian and Black Seas arrived in Lake St. Clair in the ballast water of a transatlantic freighter in 1988, and within 10 years spread to all of the five neighboring Great Lakes. The mussels form massive colonies and clog underwater structures such as power station outlets, and have greatly reduced the population of native mussels. The economic cost of this introduction has been estimated by the US Fish and Wildlife Services at about $5 billion.

The North American comb jelly (*Mnemiopsis leidyi*) was carried in ballast water to the Black Sea in the early 1980s. A voracious feeder on zooplankton and fish larvae, it has changed the entire ecosystem and contributed to the collapse of more than two dozen major fisheries. The jelly has also invaded the Azov, Marmara, and Aegean Seas and most recently arrived in the Caspian via oil tankers.

The rhododendron shrub (*Rhododendron ponticum*) was introduced to Great Britain from Asia as an ornamental garden plant in the 19th century. It spread to woodlands, where it inhibits regeneration of trees both by casting a dense shade and by forming a layer of undergrowth.

The brown tree snake (*Boiga irregularis*) transferred from Papua New Guinea to Guam in plane wheel-wells, leading to the loss of 10 of 13 species of native forest birds and several lizard species. Frequent power outages occur as the snakes come into contact with electrical lines and generation facilities. The cost to the island s economy of this single invasive alien species is estimated at $5˚million a year.



Source: Millennium Ecosystem Assessment

The introduction of **bass** (*Cichla ocellaris*) to Gatun Lake, Panama, has reduced the numbers of other fish that feed on mosquito larvae, damaging local efforts to control malaria.

The water hyacinth (*Eichhornia crassipes*), native to the Upper Amazon Basin, has been used as an ornamental plant since the mid-19th century. By 1900 it spread throughout the tropics. It clogs waterways and infrastructure, reduces light and oxygen, and causes severe damage to fisheries and navigation.

A form of **cholera** (*Vibrio cholerae*) previously reported only in Bangladesh apparently arrived via ballast water in Peru in 1991, killing more than 10,000 people over the following three years.

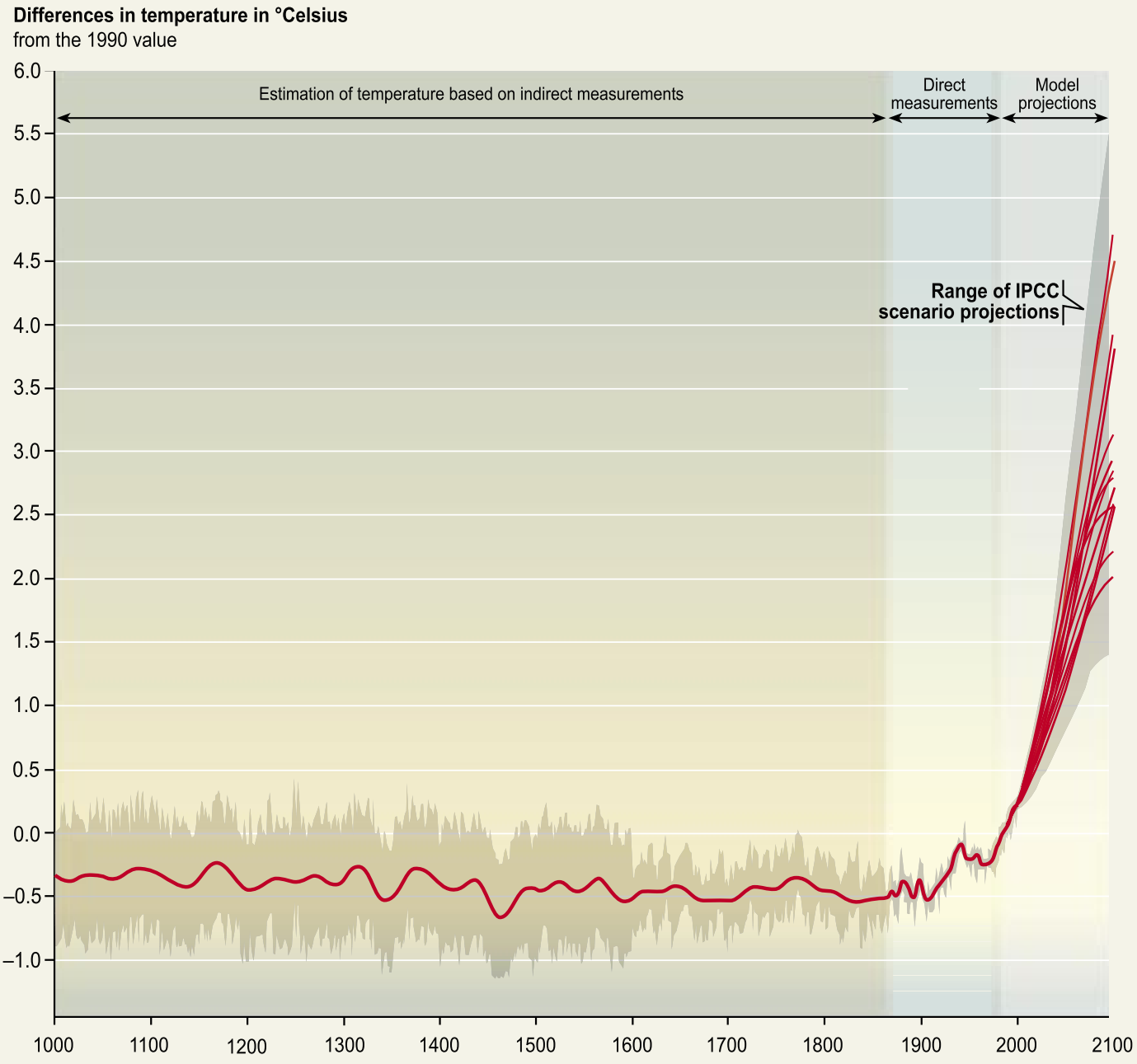
The Nile perch (*Lates niloticus*) was introduced to Lake Victoria in 1954 to improve fishing and has contributed to the extinction of more than 200 local species, which were relied on by local fishers.

The golden apple snail (*Pomacea canaliculata*), native to the Amazon, was introduced as a food source to Southeast Asia and is now a major rice pest in Indonesia, Thailand, Cambodia, Hong Kong, southern China, Japan, Taiwan, and the Philippines.

The brushtail possum (*Trichosurus vulpecula*) was introduced from Australia to New Zealand and nearby islands, with devastating impacts on forest systems. The marsupial damages native forests by selective feeding on foliage and fruits. It also preys on bird nests and carries bovine tuberculosis.

Historic and Projected Variations of Earth's Surface Temperature

Estimated global temperature averages for the past 1,000 years, with projections to 2100 depending on various plausible scenarios for future human behavior.



Source: Intergovernmental Panel on Climate Change 2001

Water withdrawal and impoundment

- Water withdrawals from rivers and lakes for irrigation, household, and industrial use doubled in the last 40 years.
- Humans now use between 40% and 50% of the fresh water running off land to which the majority of the population has access.
- In some regions, such as the Middle East and North Africa, humans use 120% of renewable supplies (due to the reliance on groundwater that is not recharged).
- Between 1960 and 2000, reservoir storage capacity quadrupled and, as a result, the amount of water stored behind large dams is estimated to be three to six times the amount held by natural river channels (this excludes natural lakes).

CREDIT: ICARDA01

Conversion and degradation

- More land was converted to cropland since 1945 than in the eighteenth and nineteenth centuries combined, and now approximately one quarter (24%) of Earth's terrestrial surface has been transformed to cultivated systems.
- Since about 1980, approximately 35% of mangroves have been lost, while 20% of the world's coral reefs have been destroyed and a further 20% bad-

CREDIT: RON GILING/PETER ARNOLD, INC.

Nutrient use and levels

- Human activities now produce more biologically usable nitrogen than is produced by all natural processes combined, and more than half of all the manufactured nitrogen fertilizer (first produced in 1913) ever used on the planet has been applied since 1985.
- The flow of nitrogen to the oceans has doubled since 1860.
- The use of phosphorus fertilizers and the rate of phosphorus accumulation in agricultural soils both increased nearly threefold between 1960 and 1990. Although the rate has declined somewhat since then, phosphorus can remain in soils for decades before entering the wider environment.

Fisheries

- At least one quarter of marine fish stocks are overharvested.
- The quantity of fish caught by humans increased until the 1980s but is now declining because of the shortage of stocks.
- In some sea areas, the total weight of fish available to be captured is less than a hundredth of that caught before the onset of industrial fishing.
- Inland fisheries, especially important for providing high-quality diets for the poor, have also declined due to overfishing, changes to habitats, and withdrawal of fresh water.

the landscape. Many species are in effect locked into islands of nature surrounded by urban or intensively farmed regions, shutting off "escape routes" and making them highly vulnerable to climate change.

Reducing diversity

An outcome of all these changes has been to reduce significantly the variety of species that can be found in many individual areas, and on the planet as a whole.

Converting rainforest into cropland, river banks into reservoirs, or marshes into parking lots will not end all natural processes, but it will tend to produce a less diverse landscape excluding many of the species previously occupying the space.

We cannot be precise about the overall scale of the change, since it is estimated that science has only identified some 10% of the species on Earth.

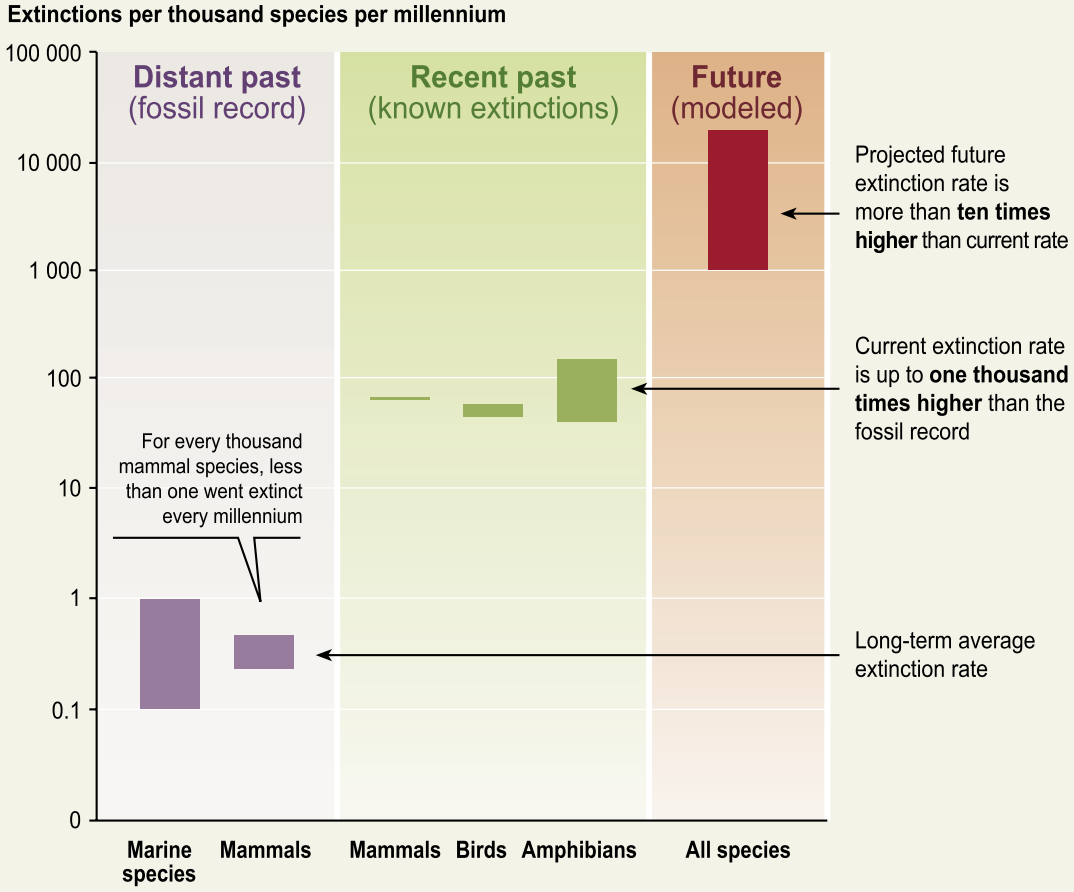
However, we can say that the majority of species across a range of different categories such as amphibians, farmland birds, and Caribbean corals are declining in abundance or in the area occupied by their populations.

Some 12% of birds, 25% of mammals, and at least 32% of amphibians are threatened with extinction over the next century.

Although actual disappearance of a recognized species is quite rare in terms of human time scales, it is estimated that people may have increased the rate of global extinctions by as much as 1,000 times the "natural" rate typical of Earth's long-term history.

Species Extinction Rates

Comparisons with the rate at which species have disappeared from the planet over a long period of Earth's history indicate that humans have already increased extinction levels dramatically. Projections suggest this rate will take another big leap due to changes over the next 50 years. The bars represent the range of estimates in each case.



Source: Millennium Ecosystem Assessment

THE BALANCE SHEET—THE STATE OF NATURE'S SERVICES

In credit—food production

The Millennium Ecosystem Assessment is the first attempt by the scientific community to describe and evaluate on a global scale the full range of services people derive from nature.

In all, it has been able to provide a health check on 24 of those services—others were identified, but the information was not available to make a sensible judgment on their status.

Only 4 of the services were found to be increasing their ability to benefit human populations, while 15 were in decline. Five more were found to be in a stable state overall, but in trouble in some parts of the world.

On the credit side, three of the improving services reflect the worldwide efforts to keep food supply ahead of the increase in population—total food production increased by about two-and-a-half times while the number of people in the world doubled from 3 billion to 6 billion between 1960 and 2000.

So the landscapes of the planet were able in recent decades to yield far more crops and meat through a combination of turning more land over to agriculture and harvesting more grain or fattening more animals on each hectare.

Another way of providing food has also seen a dramatic increase in recent years—the farming of fish or shellfish, from salmon cages in the sea lochs of Scotland to shrimp farms in Thailand or carp ponds in China. This now accounts for nearly a third of all fish and shellfish production on the planet.

In debit—running short of stock

Some of the clearest evidence of the pressure we are putting on nature comes in services such as wild fish and fresh water. People have always relied on Earth's systems to replace what we take of these items. In effect, they have been treated as free gifts, with their supply limited only by the technology and effort needed to capture more for our use.

In both cases, the signs are flashing red, with strong indications in many areas that we have gone past the point where nature can replenish the stock.

For ocean fish, that evidence comes simply from the fact that fishing vessels are catching less in their nets, despite—and, in a sense, because of—their improved technology. Worldwide fish landings peaked in the 1980s and are now declining, even though demand has never been greater and will continue to rise according to all the "plausible futures" investigated during this assessment.

In many sea areas, the weight of fish available to be harvested is calculated to be less than one tenth or even one one-hundredth of what it was before the introduction of industrial fishing. The decline of stocks is depriving many poor communities of valuable sources of protein.

CREDIT: FAO PHOTO BY T. JANSSEN

This is not helped by arrangements such as the European Union's practice of paying West African countries for access to their territorial waters, leaving small-scale traditional vessels to compete for dwindling stocks with giant super-trawlers—themselves often built using subsidies from European taxpayers.

For fresh water, there is no worldwide shortage—even after doubling our consumption we use roughly 10% of the water that flows from source to sea. But the supply is very unevenly distributed across the world and over time. The pattern of use in some areas simply cannot continue into the long term.

Up to a quarter of the water supplied to human communities is being used in larger quantities than local river systems can provide. To make up the shortfall, supplies either have to be transferred from other regions through major engineering works or "mined" from underground sources that are not replaced.

In either case, current water consumption is only able to continue by shifting the problem to distant communities and natural systems—or to future generations.

Global Status of Ecosystem Services Evaluated in the MA

An upwards arrow indicates that the condition of the service globally has been enhanced and a downwards arrow that it has been degraded. Definitions of "enhanced" and "degraded" for the three categories of ecosystem services shown in the table are provided in the note below. Supporting services, such as soil formation and photosynthesis, are not included here as they are not used directly by people.

Service	Sub-category	Status	Notes
Provisioning Services			
Food	crops	▲	substantial production increase
	livestock	▲	substantial production increase
	capture fisheries	▼	declining production due to overharvest
	aquaculture	▲	substantial production increase
	wild foods	▼	declining production
Fiber	timber	+/–	forest loss in some regions, growth in others
	cotton, hemp, silk	+/–	declining production of some fibers, growth in others
	wood fuel	▼	declining production
Genetic resources		▼	lost through extinction and crop genetic resource loss
Biochemicals, natural medicines, pharmaceuticals		▼	lost through extinction, overharvest
Water	fresh water	▼	unsustainable use for drinking, industry, and irrigation; amount of hydro energy unchanged, but dams increase ability to use that energy
Regulating Services			
Air quality regulation		▼	decline in ability of atmosphere to cleanse itself has declined
Climate regulation	global	▲	net source of carbon sequestration since mid-century
	regional and local	▼	preponderance of negative impacts
Water regulation		+/–	varies depending on ecosystem change and location
Erosion regulation		▼	increased soil degradation
Water purification and waste treatment		▼	declining water quality
Disease regulation		+/–	varies depending on ecosystem change
Pest regulation		▼	natural control degraded through pesticide use
Pollination		▼[a]	apparent global decline in abundance of pollinators
Natural hazard regulation		▼	loss of natural buffers (wetlands, mangroves)
Cultural Services			
Spiritual and religious values		▼	rapid decline in sacred groves and species
Aesthetic values		▼	decline in quantity and quality of natural lands
Recreation and ecotourism		+/–	more areas accessible but many degraded

Note: For provisioning services, we define enhancement to mean increased production of the service through changes in area over which the service is provided (e.g., spread of agriculture) or increased production per unit area. We judge the production to be degraded if the current use exceeds sustainable levels. For regulating services, enhancement refers to a change in the service that leads to greater benefits for people (e.g., the service of disease regulation could be improved by eradication of a vector known to transmit a disease to people). Degradation of regulating services means a reduction in the benefits obtained from the service, either through a change in the service (e.g., mangrove loss reducing the storm protection benefits of an ecosystem) or through human pressures on the service exceeding its limits (e.g., excessive pollution exceeding the capability of ecosystems to maintain water quality). For cultural services, degradation refers to a change in the ecosystem features that decreases the cultural (recreational, aesthetic, spiritual, etc.) benefits provided by the ecosystem.

[a] Indicates *low to medium certainty*. All other trends are *medium to high certainty*.

In debit—the fabric of life

The assessment also found deterioration of a wide range of natural services essential to the functioning of human societies.

The loss of wetlands combined with increased pollution has reduced the ability of natural systems to cleanse water supplies, with major implications for human health and fisheries.

Ecosystems are losing their ability to maintain a stable local climate—for example, loss of plant cover and deforestation can lead to less rainfall in tropical regions.

There are signs that damage to natural systems has reduced the number of insects and birds available to carry the pollen needed for flowering plants to reproduce, with serious implications for many crops.

The protection provided to people by natural systems against extreme events is in decline. For instance, there have been significantly more floods in recent years, not just due to heavier rainfall, but also through landscape changes such as deforestation and the draining of marshes—removing natural storage areas and forcing more water through the narrow channels into which rivers are often now confined.

Shocks and surprises

If natural systems were well understood and behaved in a predictable way, it might be possible to calculate what would be a "safe" amount of pressure to inflict on them without endangering the basic services they provide to humankind.

Unfortunately, however, the living machinery of Earth has a tendency to move from gradual to catastrophic change with little warning. Such is the complexity of the relationships between plants, animals, and microorganisms that these "tipping points" cannot be forecast by existing science.

Abrupt changes can have devastating impacts on human communities. The buildup of nitrogen and phosphorus in lakes, estuaries, and enclosed seas, for example, can continue for years before suddenly triggering an explosive growth of algae.

Climate change also has the potential to tip natural systems quickly over the edge. Some models suggest that global warming could turn the Amazon from lush forest to dry savanna, with devastating impacts including further instability of the regional and global climate.

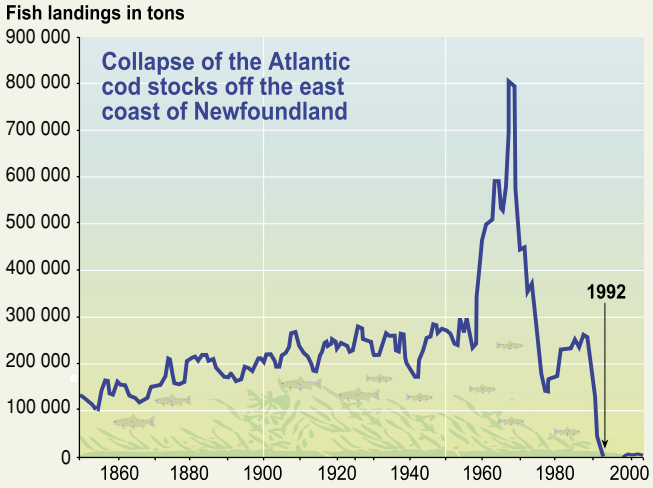
Once such trigger points are reached, it can be difficult or impossible for natural systems to return to their former state: more than a decade after the sudden collapse of cod stocks on the Grand Banks off Canada, for example, there are few signs of the fish returning even though the main fishery has been closed for 13 years.

Even if these changes cannot be predicted, the scientists involved in this assessment conclude that our current behavior makes it likely that more will occur in future. We are lowering the resilience of natural systems by simultaneously reducing the variety of species and placing them under unprecedented pressures.

Investing in the health of natural assets could therefore be seen as a form of prudent insurance against abrupt changes and the risk to human well-being that they pose.

Marine Fisheries

The dramatic collapse of cod stocks off Newfoundland illustrates how quickly the services of an ecosystem can disappear when its resources are overexploited.



Source: Millennium Ecosystem Assessment

NATURAL ASSETS AND HUMAN DEVELOPMENT

Nature and poverty

The arrival of the new millennium has brought a new recognition of the need for international efforts to improve the lives of the large portion of humanity who have been excluded from the growing global prosperity of recent decades.

Facts and Figures on Poverty and Ecosystem Services

Despite the progress achieved in increasing the production and use of some ecosystem services, levels of poverty remain high, inequities are growing, and many people still do not have a sufficient supply of or access to ecosystem services.

- In 2001, just over 1 billion people survived on less than $1 per day of income, with roughly 70% of them in rural areas where they are highly dependent on agriculture, grazing, and hunting for subsistence.
- Inequality in income and other measures of human well-being has increased over the past decade. A child born in sub-Saharan Africa is 20 times more likely to die before age five than a child born in an industrial country, and this disparity is higher than it was a decade ago. During the 1990s, 21 countries experienced declines in their rankings in the Human Development Index, an aggregate measure of economic well-being, health, and education; 14 of them were in sub-Saharan Africa.
- Despite the growth in per capita food production in the past four decades, an estimated 852 million people were undernourished in 2000–02, up 37 million from 1997–99. South Asia and sub-Saharan Africa—the regions with the largest numbers of undernourished people—are also the areas where growth in per capita food production has been the slowest. Most notably, food production per person has declined in sub-Saharan Africa.
- Some 1.1 billion people still lack access to an improved water supply, and more than 2.6 billion lack access to improved sanitation. Water scarcity affects roughly 1–2 billion people worldwide. Since 1960, the ratio of water use to accessible supply has grown by 20% per decade.

CREDIT: PETER ARNOLD

Governments worldwide have committed themselves to a range of targets, the Millennium Development Goals, aimed at reducing the number of people who lack the basic ingredients for a decent life, such as adequate food, clean water, and freedom from avoidable diseases.

A striking part of this assessment is that the people lacking these minimum standards of human well-being are generally those most vulnerable to the deterioration of natural systems.

Addressing the threat to the planet's natural assets therefore must be seen as part of the fight against poverty.

To put it the other way around, development policies aimed at reducing poverty that ignore the impact of our current behavior on the natural environment may well be doomed to failure.

Hunger and thirst

More than 2 billion people live in the dry regions of the world, and they suffer more than any other parts of the population from problems such as malnutrition, infant mortality, and diseases related to contaminated or insufficient water.

Areas such as sub-Saharan Africa are among those where natural services are most threatened by human impacts. Bucking the trend of the rest of the world, the amount of food produced for each person living in this region has actually been going down.

The prospects for drier areas are of particular concern as water supplies are largely being drawn from sources such as the "mining" of groundwater, not sufficiently recharged by rivers or rain, and they are therefore not sustainable in the long term. At the same time, population in these regions is rising rapidly.

Poverty and degradation of nature can combine into a downward spiral—poor communities are often left with fewer options to conserve their natural resources, leading to further deterioration of the land and even greater poverty. The problem of degradation of drylands, a process known as desertification, is acknowledged as a cause as well as a consequence of poverty. Poor farming practices can lead to serious soil erosion and lack of moisture, making survival from the land even more difficult.

Some win, others lose

In many cases, it is the poor who suffer the loss of services caused directly by the pressure put on natural systems to bring benefits to other communities, often in different parts of the world.

The benefits of dams, for example, are mainly enjoyed by the cities to which they provide electricity and water, while the rural poor can lose access to land and fishing, and even suffer increased diseases such as schistosomiasis carried by snails that thrive in artificial reservoirs.

CREDIT: NASA/GODDARD SPACE FLIGHT CENTER SCIENTIFIC VISUALIZATION STUDIO

Satellite Image Showing Deforestation in the Border Area between Haiti and the Dominican Republic

The deforestation of Haiti (left) is in stark contrast to the lush forest that thrives in the Dominican Republic (right) in this satellite image. Deforestation can be linked to poverty, as people are forced to chop down trees for firewood or to extend agricultural production. The resulting bare land is left vulnerable to floods and landslides and can leave communities with reduced options for conservation of the natural resource base. The differences in land use that can be seen here depend greatly on existing policy and institutional conditions that influence the decisions of local land users.

Large-scale deforestation in areas such as Indonesia and the Amazon is driven partly by demand for timber, paper, and agricultural products far from the forested area, yet it is indigenous people who feel most keenly the disappearance of the wide range of natural services that the forest provides.

The negative impacts of climate change will fall disproportionately on the poorest parts of the world—for instance by exacerbating drought and reducing food production in the drier regions—but the buildup of greenhouse gases has come overwhelmingly from richer populations as they consume more energy to fuel their higher living standards.

Natural decline hits us all

Yet wealthy parts of the world cannot shield themselves entirely from these impacts, even if they are usually better able to find alternatives to natural services or to displace the damage to other regions and future generations.

The consequences of overfishing, for example, harm the economy of coastal communities as fleets are cut back and can consume large sums of public money in welfare or promotion of alternative employment, as in the Canadian province of Newfoundland or the northeast of Scotland.

Even though richer countries have generally reduced local pollution of the air and water through cleaner technologies, the consequences of nutrient buildup will be felt for many years to come—phosphorus, for example, can remain in the soil for decades before eroding into water courses and damaging wildlife.

While wealthier economies can more easily afford engineered alternatives to natural services, such as artificial flood defenses to compensate for the changes made to river banks and wetlands, the cost of such measures can place a heavy burden on public expenditure. Investment in measures to conserve the original function of these natural spaces is generally a far cheaper and highly effective option.

Loss of natural services in poor regions affects people with far fewer alternatives to protect their livelihoods. This can also put high financial and political strains onto the international community, either through increased disaster relief, the need to intervene in regional conflicts, or the migration of refugees.

OPTIONS FOR THE FUTURE

Possible scenarios

The Millennium Ecosystem Assessment devised four scenarios to investigate the likely direction of change to natural systems and human well-being over the next 50 years—depending on the priorities adopted by human societies.

They were not intended as predictions, but rather as "plausible futures" reflecting different approaches to international cooperation and to the care of natural systems.

Certain trends relevant to the pressures on natural systems emerge from all scenarios. For example, the global population is projected to rise to 8–10 billion by the middle of the century, with the biggest growth concentrated among poor urban populations of the Middle East, sub-Saharan Africa, and South Asia.

The conversion of land to agricultural uses continues to be the main factor influencing change in biological diversity, but in some regions other factors become increasingly important in coming decades—the buildup of nitrogen in rivers and coastal waters, for example, rises sharply in developing countries, especially in Asia, with serious consequences for human health, fisheries, and habitats such as coral reefs.

Under the four scenarios, climate change also has a bigger influence on the services provided by natural systems—heightening the risk of species extinctions, for example, increasing the incidence of both drought and floods, and making hydroelectric power less reliable.

The scenarios diverge when it comes to the overall state of natural services, with the most serious declines occurring in "futures" where conservation takes low priority and where governments tend to favor their own national or regional security over global cooperation. In the scenarios where natural assets see improvements across entire categories, however, the world has taken action on a scale well beyond anything under way at present—for instance, investments in cleaner technology, proactive conservation policies, education, and measures to reduce the gap between rich and poor.

Seeking a better way

An important part of this assessment is to report on possible solutions to the stresses building up in the planet's natural infrastructure. Rather than a vain attempt to find a single panacea for all problems, this has been a methodical look at the kind of actions that have been found to work and at some of the underlying barriers that need to be removed before those stresses can be reduced.

Three important messages emerge from this exploration. First, protection of nature's services is unlikely to be a priority so long as they are perceived to be free and limitless by those using them—effective policies will be those that require natural costs to be taken into account for all economic decisions.

What Can We Do about It? Some Key Steps Available to Reduce the Degradation of Ecosystem Services

Change the economic background to decision-making

- Make sure the value of all ecosystem services, not just those bought and sold in the market, are taken into account when making decisions.
- Remove subsidies to agriculture, fisheries, and energy that cause harm to people and the environment.
- Introduce payments to landowners in return for managing their lands in ways that protect ecosystem services, such as water quality and carbon storage, that are of value to society.
- Establish market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way.

Improve policy, planning, and management

- Integrate decision-making between different departments and sectors, as well as international institutions, to ensure that policies are focused on protection of ecosystems.
- Include sound management of ecosystem services in all regional planning decisions and in the poverty reduction strategies being prepared by many developing countries.
- Empower marginalized groups to influence decisions affecting ecosystem services, and recognize in law local communities' ownership of natural resources.
- Establish additional protected areas, particularly in marine systems, and provide greater financial and management support to those that already exist.
- Use all relevant forms of knowledge and information about ecosystems in decision-making, including the knowledge of local and indigenous groups.

Influence individual behavior

- Provide public education on why and how to reduce consumption of threatened ecosystem services.
- Establish reliable certification systems to give people the choice to buy sustainably harvested products.
- Give people access to information about ecosystems and decisions affecting their services.

Develop and use environment-friendly technology

- Invest in agricultural science and technology aimed at increasing food production with minimal harmful trade-offs.
- Restore degraded ecosystems.
- Promote technologies to increase energy efficiency and reduce greenhouse gas emissions.

Second, local communities are far more likely to act in ways that conserve natural resources if they have real influence in the decisions on how they are used—and if they end up with a fairer share of the benefits.

Finally, natural assets will receive far better protection if their importance is recognized in the central decision-making of governments and businesses, rather than leaving policies associated with ecosystems to relatively weak environment departments.

Getting more from less

If the consumption of natural capital had grown as quickly as the global economy, Earth's systems would be in a very much worse state than they are at present. In fact, important improvements in efficiency have been introduced, such as less energy-intensive products and processes or farming techniques that use less water and create less pollution.

Unfortunately, these efficiencies are outweighed by the fact that more people are consuming ever-greater quantities of goods and services, so the total toll on natural systems continues to grow. This is not a matter of rising population alone, but also of lifestyle changes among those enjoying greater prosperity.

These changes are extending rapidly beyond the fully industrialized world. In fast-growing countries such as China, India, and Brazil, an increasing number of citizens have aspirations to possess more than just the basics of life.

This has major implications for future exploitation of natural systems, as the extra demand for ecosystem services could weaken them still further—for example, increased meat consumption will create even more pressure to clear forests for pasture or to grow crops such as soybeans to feed livestock.

So future policies must aim to satisfy human needs while exacting a far smaller cost on natural systems. Without this radical change, they will eventually become incapable of meeting our demands.

Taking nature's value into account

An important part of this must be to correct the historic bias that has existed against natural services when it comes to weighing the costs and benefits of particular economic choices—whether for individuals, businesses, or governments.

In most societies, a large number of natural services are treated either as free or with no reflection in their price of the real cost of using them. For instance, relatively few consumers with piped water supply are charged according to how much they use.

Equally, the only "market value" of a forest is often in the price that can be obtained for its wood, even though the standing forest may be worth much more for its contribution to water control, climate regulation, and tourism. In a major study reviewed in this assessment, the timber and fuel from Mediterranean forests were found to account for less than a third of the total economic value of the whole natural system.

This distortion is compounded by measures of economic wealth that fail to "count" natural capital—a significant number of countries judged to be growing in wealth according to conventional indicators actually became poorer in 2001 when loss of natural resources was factored in.

Policies that acknowledge the true cost of obtaining natural services can steer consumers or businesses into more-efficient behavior. For example, water charges that reflect the actual environmental impact of an individual user will tend to make people think more carefully before opening the tap. A tax on excessive fertilizer applications or on pesticides may encourage farmers to put fewer nutrients and chemicals into the soil.

State subsidies have often directly encouraged degradation of natural systems, especially in agriculture, where farmers have benefited financially from putting unnecessary pressure on the land, stripping out valuable features such as wetlands or field borders important to wildlife. In Europe, a start has been made in shifting these incentives away from producing ever-greater quantities of food and toward methods that bring wider benefits to society, such as a more vibrant and diverse rural environment.

Although still a rare technique, attempts are increasingly being made to recognize the specific services nature provides by paying landowners to provide them. In Costa Rica, for instance, conservation of forests is partly ensured through payments reflecting their importance in regulating water supply, stabilizing the climate, and harboring the diverse wildlife that brings in ecotourism and provides potential opportunities for genetic research.

While some functions of nature will always struggle to be reflected in markets, new opportunities are emerging to put a price on services previously assumed to be free. For example, the Kyoto Protocol that recently entered into force is creating a multibillion-dollar market in greenhouse gas emission credits, in effect rationing the right to pollute and creating new incentives for cleaner technology and potentially for forest conservation. Similar allowance-trading schemes are being looked at for the use of nutrients in farming in the United States.

Business leadership

For businesses, finding ways of reducing the impact of their activities on nature can bring important long-term benefits, such as cutting down on materials or services that could become more expensive as they get scarcer or targeted by government regulation.

Major new opportunities exist for companies prepared to pioneer less wasteful technologies or practices that preempt trends in public policy—for example, minimizing water and energy use or recycling waste materials can position a business well for the future demands of society.

Consumer preferences for products obtained responsibly from natural systems can also reward companies that are discriminating in the supply of their goods. In part this will reduce the risk of damage to the reputation of the company if credible claims are made about the negative impact of its activities throughout the supply chain. But it can also provide a positive competitive advantage through consumer labels such as those on organic foods and the Forest Stewardship Council mark that denotes timber from sustainably managed forests.

Yet business as a whole also has an interest in rebuilding the stock of natural capital, as its continued deterioration will affect commercial activity in countless ways—the insurance industry, for instance, is facing unprecedented payouts for floods, wildfires, and climate-related disasters, all connected to human interference with natural systems.

CREDIT: CHUCK SAVALL

Local involvement and ownership

Major progress has been made in designating and managing particular areas of the world as priority zones for the conservation of nature, but these can often end up as "paper parks" with insufficient tools, funds, or political will to enforce genuine protection of wildlife or other services.

Experience has shown that these efforts tend to be much more effective when local people are given a genuine stake in the benefits from conservation. If profits from ecotourism or the harvesting of forest products are shared fairly with local communities, for example, people are less likely to turn to wildlife poaching or to farming methods that destroy the natural fabric of the area.

Various techniques being used increasingly in some parts of the world allow local people to make productive use of land while keeping favorable conditions for nature. One example is agroforestry, in which trees and crops are grown together, providing buffer zones between more strictly protected conservation areas and open farmland.

Greater involvement of indigenous communities in decision-making can also tap traditional knowledge about the working of natural systems to help design more effective ways of protecting them.

Nature at the center

Better conservation policies may be of limited value, however, unless governments, businesses, and communities take natural systems into account in a wide range of other decisions.

This requires big changes in the way many institutions work, for instance by recognizing the influence that taxation and investment can have to either protect or damage ecosystems through different incentives.

Aid programs for developing countries seldom give priority to protection or restoration of natural services. Recipient governments, donor nations, and lending institutions could do far more to direct funds at supporting those services in a way that would bring long-term benefits.

International negotiations on issues such as trade rules can have far-reaching impacts on the pressure put on natural systems. If their ambitions to increase overall prosperity are to be realized, they need to be coordinated much more closely with other conventions and treaties aimed at protecting the natural environment.

Meaningful steps to address climate change also underpin all other measures. The uncontrolled warming of the atmosphere will jeopardize many of the benefits provided to people by nature. Equally, further neglect of natural systems will accelerate that warming.

One of the key barriers to more-effective behavior to protect natural assets is ignorance about the services they deliver. The approach taken by the Millennium Ecosystem Assessment, already being used in a number of studies at a local and regional scale, could provide a useful tool to enable decision-makers to understand far better the full consequences of their actions.

The overriding conclusion of this assessment is that it lies within the power of human societies to ease the strains we are putting on the natural services of the planet, while continuing to use them to bring better living standards to all.

Achieving this, however, will require radical changes in the way nature is treated at every level of decision-making. Resilience and abundance can no longer be confused with indestructibility and infinite supply.

The warning signs are there for all of us to see. The future lies in our hands.

Millennium Ecosystem Assessment

Secretariat Support Organizations
The United Nations Environment Programme (UNEP) coordinates the Millennium Ecosystem Assessment Secretariat, which is based at the following partner institutions:
Food and Agriculture Organization of the United Nations, Italy
Institute of Economic Growth, India
International Maize and Wheat Improvement Center (CIMMYT), Mexico (*until 2004*)
Meridian Institute, USA
National Institute of Public Health and the Environment (RIVM), Netherlands (*until mid-2004*)
Scientific Committee on Problems of the Environment (SCOPE), France
UNEP-World Conservation Monitoring Centre, UK
University of Pretoria, South Africa
University of Wisconsin, USA
World Resources Institute (WRI), USA
WorldFish Center, Malaysia

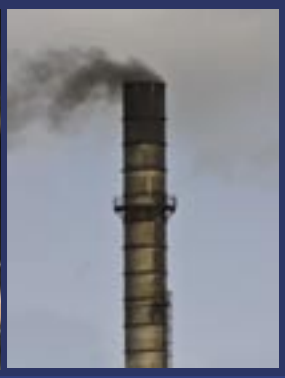
The Board of the Millennium Ecosystem Assessment extends its deepest gratitude to Tim Hirsch who so aptly and eloquently described and summarized the main findings of the assessment on our behalf.

Maps and graphics: Emmanuelle Bournay and Phillippe Rekacewicz, UNEP/GRID-Adrenal, Norway
The production of maps and graphics was made possible by the generous support of Ministry of Foreign Affairs of Norway and UNEP/GRID-Arendal.

Photos: Front cover, from left to right:
- Julio Etchart, The World Bank
- Paiwei Wei, Istock Photo
- Gene Alexander, US Department of Agriculture Natural Resources Conservation Service Photo Library
- Ole Jensen, IStock Photo

Back cover, from left to right:
- Jon Maidens
- Jordan Ayan, Istock Photo
- Edwin Huffman, The World Bank
- I. de Borhegyi, FAO Photo






CBD

CMS

GEF

ICSU
International Council for Science

IUCN
The World Conservation Union

Ramsar
CONVENTION ON WETLANDS

UNITED NATIONS FOUNDATION

UNDP

UNEP

UNESCO

March 2005