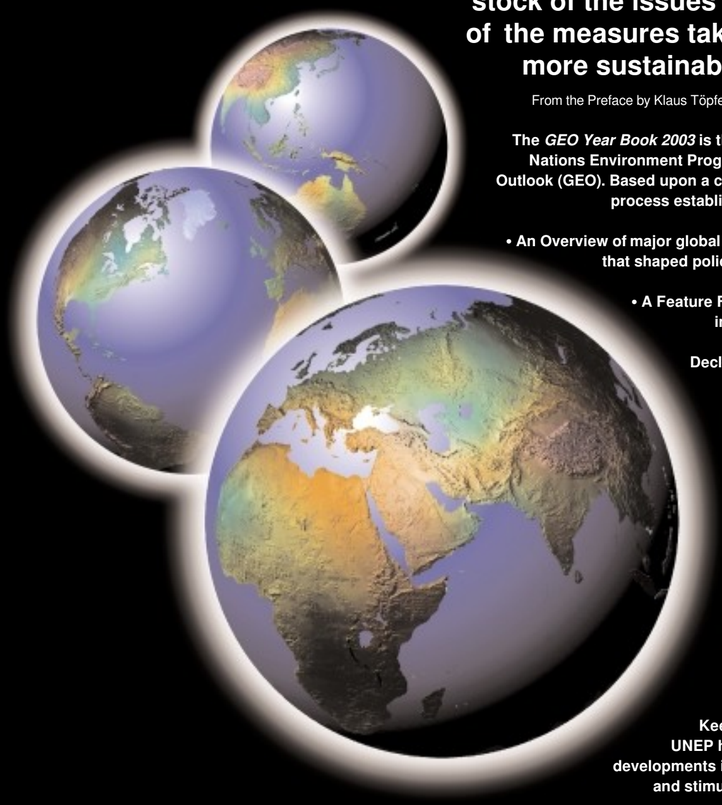

"It is our duty individually and collectively to take stock of the issues and developments of 2003 and of the measures taken during the year to achieve a more sustainable future for the environment."

From the Preface by Klaus Töpfer, Executive Director, United Nations Environment Programme

The *GEO Year Book 2003* is the first in an annual series associated with the United Nations Environment Programme (UNEP) flagship report, Global Environment Outlook (GEO). Based upon a collaborative/comprehensive tracking and stocktaking process established with partners, the *GEO Year Book 2003* includes:

• An Overview of major global and regional environmental issues and developments that shaped policy decisions and actions during the course of the year

• A Feature Focus on Water and its critical role in realizing various internationally-agreed development goals and targets, including those contained in the UN Millennium Declaration and in the Plan of Implementation agreed at the World Summit on Sustainable Development

• Emerging Challenges – New Findings presenting scientific progress made in 2003 that may assist society in recognizing and better understanding emerging environmental issues and help decision makers in designing adequate responses

• GEO Indicators highlighting some of the key global and regional environmental issues and trends that have been identified in GEO reports. The selected set of trend indicators will provide a consistent and harmonized oversight of major environmental changes on an annual basis

Keeping abreast of environmental issues as they unfold, UNEP has encapsulated the most significant of these recent developments in this readable and reliable volume – to inform, guide and stimulate further action for the health of our environment

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GLOBAL ENVIRONMENT OUTLOOK YEAR BOOK 2003

GEO YEAR BOOK 2003

UNEP **United Nations Environment Programme**

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GEO YEAR BOOK 2003

UNEP

Contents

Preface

UNEP began 2003 with the 22nd session of the Governing Council/Global Ministerial Environment Forum (GC/GMEF). By the end of that important week, a total of 24 decisions had been adopted. One of them is GC/22/1/IB which requests the preparation of an annual Global Environment Outlook (GEO) statement to highlight significant environmental events and achievements during the year and raise awareness of emerging issues from scientific research and other sources.

The *GEO Year Book* is UNEP's response to this GC/GMEF decision. It is based on comprehensive tracking – at global and regional level – of issues and developments as they unfolded during the year, and collaboration between UNEP and many partners at both levels. The *Year Book* also becomes the latest addition to the set of products developed within UNEP's GEO process for integrated environmental assessment. Like them, it aims to bridge the gap between science and policy, and make environmental information easily accessible to policy-makers and other readers.

Designing a new product is like being faced with a blank canvas. The options for filling it are numerous, but space is limited and choices have to be made. Decisions on the focus of the *Year Book*, and what it should or should not include, were a major part of the process which shaped this first report in the annual GEO series. We have used our best judgment to reach a formula that will provide a timely overview of environmental change, highlight progress, contribute to the knowledge base for decision-making, stimulate debate, and be visually informative and attractive all at the same time.

One of the overall objectives of the *GEO Year Book*, which will be published annually between major GEO reports, is to present, in a clear and timely manner, an analytical overview of issues and developments which, for better or worse, have most influenced the environment during the year and may continue to be major factors in the years ahead. While some of the issues and developments made headline news during the course of the year, and galvanized action, others hardly registered on the radar. But that does not mean that they were, or are, less important. All the issues – no matter how local, regional or global – have a bearing on how the environment can either enhance human security or increase human vulnerability.

The issues and developments of the year are presented at both global and regional levels in the Overview section. Some of the issues, such as climate change impacts, loss of biodiversity, and environment and security, are manifested both globally and regionally, demanding action at many levels. The short analyses are reinforced with boxes highlighting specific examples of policy developments and instruments.

An example of one of the major policy developments at regional level is the increasing attention being given by African governments to phasing out leaded vehicle fuel. Progress in 2003 is encouraging.

Also in the Overview section is a short analysis of key issues of critical importance to Small Island Developing States (SIDS) – countries of special significance for the international meeting in Mauritius in August 2004 to review the Barbados+10 Plan of Action. The SIDS section focuses on the major challenges which these countries face rather than specifically on developments in 2003.

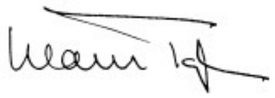
The *GEO Year Book 2003* includes a Feature Focus on Water that highlights the important role that water plays in realizing various internationally-agreed development goals, including those contained in the Millennium Declaration which arose out of the UN Millennium Summit of Heads of State and Government convened in 2000. Water is a crucial component of ecosystems. Its quantity and quality have a fundamental role in defining the range of organisms that can live in a given ecosystem and the ability of water-related goods and services to sustain human life and well-being. It is clearly recognized that, without concerted action, about a third of the world's population is likely to suffer from chronic water shortages within a few decades. We must, therefore, work to ensure that different water stakeholders understand and appreciate that

freshwater resources are precious, sensitive and finite. Water is not only critical in terms of the environment and human security but also provides key sustainable development opportunities. With 2003 designated as the International Year of Freshwater, and water issues receiving attention throughout the year through activities such as the Third World Water Forum, it is only fitting that the *GEO Year Book 2003* reinforces the need to keep water high on the international agenda. This vital resource is also on the agenda of the forthcoming 12th session of the Commission on Sustainable Development (CSD 12). The *Year Book* is designed to provide an input to the CSD 12 and other deliberations at different levels, including UNEP's own governing bodies.

The section on Emerging Challenges – New Findings describes some of the latest available knowledge that may assist society in recognizing and better understanding ongoing and emerging environmental compexities and help decision-makers in designing appropriate responses. Our ability to identify and respond to environmental challenges is closely related to our scientific understanding of the phenomena. The *GEO Year Book 2003* focuses on science research findings related to the nitrogen cycle and marine fisheries. The science behind these issues is broadening and has significant implications on how we mange them. Nevertheless, their extent, magnitude and impacts vary significantly, for example, while problems related to nitrogen occur all over the world there is too much in some places, and too little to meet human needs in others. Local and regional perspectives are, therefore, important to advancing our understanding of the nature of these issues and their impact in various places, and appropriate interventions which can be put in place.

The *Year Book* uses GEO Indicators to highlight trends in some of the major global and regional environmental issues which have been addressed in previous GEO reports. While the availability of reliable, up-to-date global data sets still limits the choice of indicators, the core set selected for this report aims to give a consistent and harmonized overview of major environmental changes on an annual basis and thereby facilitate tracking of major environmental issues over the years.

It is our duty individually and collectively to take stock of the issues and developments of 2003 and of the measures taken during the year to achieve a more sustainable future for the environment. Ultimately we rely on you, as the reader, to assess whether your needs are being met. It is our intention that the *GEO Year Book 2003* and subsequent issues in this annual series will be a constant reminder that good long-term planning for a sustainable future begins with what is happening around us today and every year. Your feedback on this *Year Book*, and suggestions for future editions, are most welcome.

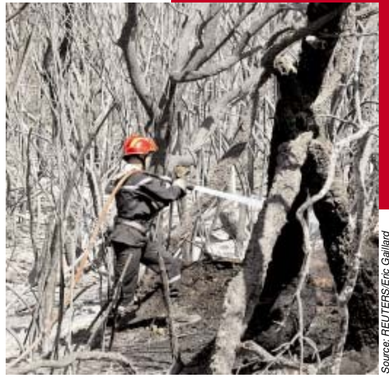


Klaus Töpfer
United Nations Under-Secretary General
and Executive Director,
United Nations Environment Programme

Source: REUTERS/Alexei Kalmykov

Source: REUTERS/Rick Wilking

2003 Overview



Source: REUTERS/Eric Gaillard

GLOBAL ● AFRICA ● ASIA AND THE PACIFIC ● EUROPE
LATIN AMERICA AND THE CARIBBEAN ● NORTH AMERICA
WEST ASIA ● POLAR ● SMALL ISLAND DEVELOPING STATES

Global

While armed conflict, anti-war demonstrations and the bombing of the United Nations building in Iraq provided some of the lasting images of 2003, a number of environmental milestones also made their mark. At the global level, climate change, international environmental governance and the debate on genetically modified organisms continued to dominate much of the environmental discourse

The Cartagena Protocol on Biosafety came into force on 11 September – exactly a year after the World Summit on Sustainable Development (WSSD) adopted the Plan of Implementation. This was a toast to the success of international cooperation in a world too often badly affected by discord. Multilateral negotiations and meetings in 2003 strengthened the framework for international environmental governance at global and regional levels.

There were achievements, but there were also challenges, many of which were similar across different regions of the world. Some of the common issues at the regional level included; extreme weather events, including drought and floods; water resources management; protected area and biodiversity management; and environmental impacts of armed conflict. The environmental issues and challenges highlighted in the following global and regional sections are only a significant representative sample of many faced in 2003 at different spatial levels. They are not mutually exclusive, but key strands in the complex web of life. Setbacks and controversy joined progress as regular items on the agenda of international cooperation.

EXTREME WEATHER EVENTS

Regional overviews show that a variety of extreme weather events across the globe, supported by new research, added further weight to the concerns expressed by the Intergovernmental Panel on Climate Change (IPCC) and many others that climate change is already having an impact on the environment.

According to the United States National Oceanic and Atmospheric Administration (NOM), 2003 was the third warmest year on record. Average temperatures for the year were above average by as much as 1.7° C for large parts of Asia, Europe, and the western United States. Warmer-than-average temperatures were also recorded in much of South America, Australia, Canada and parts of Africa. However, widespread areas of cooler-than-average temperatures were experienced in the eastern United States, western Asia, and coastal areas of Australia (NOM 2003).

In September, scientists from the United States and Canada announced that the largest ice-shelf in the Arctic had broken up. The Ward Hunt Ice-shelf (see also Polar section), to the north of Canada's Ellesmere Island, split into two main parts, with other large blocks of ice also pulling away from the main sections

1979

2003

Figure 1: Dramatic changes in Arctic sea ice since 1979. The loss of Arctic sea ice may be caused by warming Arctic temperatures that result from greenhouse gas build-up in the atmosphere.

Source: NASA/Goddard Space Flight Center Scientific Visualization Studio

2003

INTERNATIONAL YEAR OF FRESHWATER

January

UN global population projections for 2050 have dropped by 400 million people from the 9.3 billion that was estimated two years ago. The new figure of 8.9 billion reflects the impact of the HIV/AIDS epidemic and reduction in the number of projected births

February

A panel of Eminent Persons on United Nations-Civil Society Relations holds its first meeting to look into the modes of participation in UN processes of non-governmental organizations, as well as of other non-governmental actors such as the private sector and parliamentarians

The 22nd Session of the UNEP Governing Council/Global Ministerial Environment Forum (GC/GMEF) held in Nairobi, Kenya

Preparations start in Paris for the UN Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report on global warming

World Trade Organization (WTO) grants the Secretariats of six multilateral environmental agreements (MEAs) provisional observer status at meetings of the WTO Committee on Trade and Environment. This decision extends to UNEP as well as the Basel Convention, Convention on International Trade in Endangered Species of Flora and Fauna (CITES), Convention on Biological Diversity (CBD), the Montreal Protocol, International Tropical Timber Organization (ITTO), and United Nations Framework Convention on Climate Change (UNFCCC)

NGOs in Chile ask the government to present a proposal to UNESCO to declare part of Chilean Patagonia a Heritage of Humanity, to prevent polluting industries from being built in the region

The Abu Dhabi Declaration on Environment and Energy ratified by the Arab Ministers for Energy and Environmental Affairs

(Mueller and others 2003). The news only added to the growing number of reports in recent years of melting in the Polar Regions. For example, trends of perennial sea ice in the Arctic declining at a rate of nine per cent per decade, which were found from studies conducted in 2002, persisted in 2003. Researchers suspect that the loss of Arctic sea ice may be caused by changing atmospheric pressure patterns over the Arctic that move sea ice around, and by warming Arctic temperatures that result from greenhouse gas buildup in the atmosphere. The two images (Figure 1) show a comparison of Arctic sea ice extent in 1979 and 2003.

There were also reports of glaciers shrinking at a rapid rate in Nepal as well as in Bolivia, while the Patagonian glaciers in Chile and Argentina were found in October 2003 to be melting so fast that they were actually contributing to sea level rise (Combs and others 2003). And in the Antarctic, it was discovered that the Pine Island Glacier, one of the continent's biggest, had lost 31 km^3 of ice since 1992, and could be lost to the ocean in a few hundred years if present rates of thinning continue (BAS 2003).

While not all cases of extreme weather events can be attributed to climate change, there was certainly an abundance of such phenomena in 2003. A record summer heatwave affected Europe. The all-time maximum temperature record in the United Kingdom was broken on 10 August, when the mercury reached 38.1° C at Gravesend in Kent. France had its warmest summer on record, with a heatwave that the National Institute of Health and Medical Research blamed for 14 802 deaths in the country (Boyer and others 2003). Temperatures also soared across southern

Asia in late May and June. During a 20-day heatwave, maximum temperatures climbed to 45–50° C, and more than 1 500 deaths occurred in India (NOAA 2003).

In China, widespread flooding left four million people homeless after torrential rains hit the country's eastern provinces in July. And there was no let up in reports of extreme weather as 2003 drew to an end, with major floods reported in southeastern France and southern Brazil, while a freak thunderstorm struck Melbourne, Australia, all within the space of a few days.

Costs of disasters

In December, Munich Re, a major re-insurance firm, reported that natural disasters were set to cause a record US$60 billion of damage in 2003, with most of the losses coming from weather-related catastrophes (Munich Re 2003). The biggest insured losses were reported in the United States, where the tornadoes that hit the Midwest in April and May cost insurers more than US$3 billion. A company representative warned that, "as extreme weather becomes more or less the norm by the middle of the century, the extensive losses suffered in the past year provided "a glimpse into the future". The company predicted that the global economic loss due to extreme weather events would reach US$300 billion annually by 2050 (Munich Re 2003).

Tornado damage in Oklahoma City, May 9, 2003. A record season of tornadoes hit North America, with an unprecedented 300 'twisters' striking the US in a single week in May.

Source: REUTERS/John Sommers

BIOSAFETY AND TRADE

At the centre of a highly emotional scientific, social and political debate about the pros and cons of modern biotechnology in 2003, the Cartagena Protocol on Biosafety (Box 1), negotiated under the auspices of the Convention on Biological Diversity and adopted by its Conference of the Parties on 29 January 2000, entered into force on 11 September 2003.

March

Over 24 000 people from around the world attend the 3rd World Water Forum, held in Kyoto, Osaka and Shiga, Japan

The UN Economic Commission for Europe (UNECE) launches a new compliance mechanism aimed at underpinning public participation in environmental decision-making under the Aarhus Convention

US Senate rejects provision to allow for oil and gas drilling in the Arctic National Wildlife Refuge in Alaska

Water Sciences and Technology Association (NGO) holds the Sixth Gulf Water Conference in Riyadh, Saudi Arabia, under the theme "water in the Gulf Cooperation Council. Towards Sustainable Development". The conference emphasizes Integrated Water Resources Management (IWRM)

War in Iraq begins

April

Arctic Council releases report documenting unacceptable levels of human-made environmental toxins in the Inuit population of Greenland

The Fourth Ministerial Conference on the Protection of Forests in Europe meets in Vienna, Austria and adopts the Vienna Living Forest Summit Declaration "European Forests-Common Benefits, Shared Responsibilities"

The World Bank approves implementation of a project financed with a US$5 million grant from the Global Environment Facility (GEF) to help islands and coastal nations in the Caribbean adapt to climate change

Trade debate heats up

Although it is the only international instrument that deals exclusively with LMOs (also commonly known as genetically modified organisms (GMOs)), the Cartagena Protocol runs in parallel with a number of international instruments and standard-setting processes that address different aspects of biosafety. These include the International Plant Protection Convention, the Codex Alimentarius Commission and several World Trade Organization (WTO) agreements, such as the Sanitary and Phytosanitary Measures and Technical Barriers to Trade Agreements. All these various international agreements are intended to guide implementation at the national or regional level and also be mutually complementary. However, improving coordination and avoiding potential conflicts remains a challenge (Box 2).

Box 1: The Cartagena Protocol

The Protocol aims to protect biological diversity from the potential risks of living modified organisms (LMOs), with specific focus on transboundary movements, and taking also into account risks to human health. It makes reference to the precautionary approach contained in Principle 15 of the Rio Declaration, and establishes an advance informed agreement procedure for ensuring that countries are provided with prior written notification and information necessary to make informed decisions before agreeing to the first import of LMOs that are to be intentionally introduced into the environment. It also establishes a Biosafety Clearing-House to facilitate the exchange of information and experiences on LMOs, and to assist countries in implementation.

Source: CBD 2003

Differing domestic agendas

The European legislative framework now includes rules regarding the deliberate release of GMOs into the environment (Directive 2001/18). Two regulations entered into force in November 2003, one on genetically-modified food and feed (Regulation 1829/2003) and one on traceability and labeling (Regulation 1830/2003). A number of applications for product authorizations are currently in the pipeline, and it is unclear whether completion of the legislative framework will affect the voting attitude of the European Union members which have supported the moratorium. By the end of December 2003, the EU had failed to agree on lifting its five-year-old moratorium on new genetically modified foods.

In contrast to the EU, the US has not developed separate biotechnology regulations, but rather has opted for regulating GMOs through existing product legislation. There are no mandatory risk assessment requirements for GMOs, although the proposed Premarket Notice Concerning Bioengineered Foods will require companies to submit information on safety considerations before marketing genetically-modified foods (Cochran 2003). The US Food and Drug Administration has also issued voluntary draft guidelines for the labeling of genetically modified foods.

These contrasting regulatory policies stem from, and indicate, the divergent risk management approaches as well as social

Box 2: GMOs generate international controversy

The request by the US, Canada and Argentina for a WTO panel against the EU concerning Measures Affecting the Approval and Marketing of Biotech Products (WT/DS291/23, 19 August 2003) can be regarded as an illustration of the potential conflict between these diverse approaches to biosafety. In this case, the three states allege that the EU de facto moratorium on the approval of LMOs or GMOs poses an unjustifiable trade barrier in violation of the WTO Agreements. The EU moratorium has been in place since June 1999, when the Danish, Greek, French, Italian and Luxembourg delegations, later joined by Austria, submitted a declaration urging the need for rules on labelling and traceability of GMOs and GMO-derived products stating that, until the adoption of such rules, in accordance with the preventive and precautionary approaches, they would take steps to have any new authorizations suspended. The European Commission described the request for the WTO panel as "legally unwarranted, economically unfounded and politically unhelpful," arguing that the EU measures are justified under international law, citing the recently adopted Codex Alimentarius principles for risk analysis of genetically-modified foods and the precautionary approach provided for in the Cartagena Protocol. Civil society groups also attacked the decision to commence a trade dispute, accusing the countries concerned of trying to force genetically-modified foods onto European consumers.

Source: ICTSD 2003

May

Parties to the UNECE Aarhus Convention adopt a protocol on Pollutant Release and Transfer Registers, the first such legally binding international instrument on the issue

War in Iraq declared over

Environment Ministers and senior officials from 51 countries in the UNECE region meet in Kyiv, Ukraine for the Fifth Pan-European Ministerial Conference "Environment for Europe (EfE)"

22 European countries sign new Protocol on Civil Liability and Damage Caused by Transboundary Effects of Industrial Accidents on Transboundary Waters to the Conventions on Transboundary Effects of Industrial Accidents and on Protection and Use of Transboundary Waters and International Lakes

35 European countries and the EU sign new Protocol on Strategic Environmental Assessment to the Espoo Convention

The Framework Convention on the Protection and Sustainable Development of the Carpathians adopted and signed by ministers from Central and Eastern Europe

A programme is inaugurated to administer and conserve the Guarani Aquifer, South America's largest underground freshwater reservoir, which covers 1.2 million km² across Argentina, Brazil, Paraguay and Uruguay

The Third Session of the UN Forum on Forests (UNFF-3) meets in Geneva, Switzerland. Delegates address progress in the implementation of the Intergovernmental Panel on Forests/ Intergovernmental Forum on Forests proposals for action related to: economic aspects of forests; forest health and productivity; and maintaining forest cover to meet present and future needs

contexts in different parts of the world.
In Europe negative public opinion, particularly regarding inclusion of genetically modified products in food, a number of active environmental and consumer groups, a series of food crises with long-term effects turning food safety into a key policy objective in the EU, and the introduction of the precautionary approach in legal texts are at the heart of a major societal and policy debate, and therefore mark European regulatory developments. In the US, the largest producer of genetically modified products in food in the world, a strictly scientific risk assessment process, the consideration of biotechnology as a key contribution to economic growth, the successful influence of regulatory developments by the biotechnology companies, and a more tolerant or, up-to-now, largely unconcerned public have induced a framework that is more flexible. It consists mainly of voluntary requirements, allowing the market approval of various genetically modified food products.

Unresolved issues

While the international regulatory framework is still under development and many issues remain unresolved, including the relationship of the Cartagena Protocol to the WTO Agreements, the scientific basis of the policy debate is also far from clear. This is illustrated by the results published in 2003 of the first long-term farm-scale evaluation of three herbicide-tolerant crops – maize, sugar beet and spring oilseed rape – carried out in the UK, and the subsequent unease of the Agriculture and Environment Biotechnology Commission, the UK's chief policy advisor on genetically modified food and crops (The Royal Society 2003). The evaluation showed that conventional varieties of the above crops are contaminated with genetically-modified traits at a much faster rate than previously expected. It also showed that genetically modified beet and oilseed rape fields had fewer weed seeds, birds and butterflies than conventional ones, while genetically modified maize was an exception and brought more weed seeds, birds and butterflies.

INTERNATIONAL ENVIRONMENTAL AGENDA

In the post-WSSD world, the sustainable development agenda has successfully integrated the WSSD targets and the internationally agreed development goals, including those contained in the Millennium Declaration of 2000, into the substantive work of all the relevant multilateral environmental agreements that held meetings in 2003. The link between poverty reduction and environment has also been increasingly recognized, as evidenced by the constant calls for environmental issues to be framed in a human-centred development context and integrated with national poverty reduction strategies.

On the heels of the Millennium Declaration and the WSSD, the 2003 International Year of Freshwater helped keep water on the global agenda (see Feature Focus) and led to increased cooperation on related issues, including at the Third World Water Forum in Japan in March, and the G-8 Summit in Evian, France in June. The Global Environment Facility's announcement that it plans to increase funding for water projects over the next four years further reflects an important commitment to sustaining the planet's water resources and ecosystems. The Commission on Sustainable Development (CSD), at its 11th session in 2003, agreed that freshwater, sanitation and human settlements would be its major themes of focus in 2004–05. This ensures that water will remain in the forefront of the sustainable development agenda for the next two years.

Forest issues, particularly illegal logging, also received a good deal of international attention during the year (see Box 3). On the broader issue of the status of the planet's terrestrial ecosystems, scientific findings weighed in with the release of a study indicating the apparent greening of the biosphere (Box 4). Moving to the atmosphere, issues related to the implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer were again on the agenda, with the phase-out of methyl bromide proving to be a challenge to resolve (Box 5).

Regarding climate change, more governments than ever seem convinced of the importance of multilaterally-agreed solutions to this global problem. By the end of 2003, 188 countries had ratified the United Nations Framework Convention on Climate Change (UNFCCC), while 120 had ratified the Kyoto Protocol (UNFCCC 2003).

However, as 2003 drew to a close, the Kyoto Protocol had still not gathered sufficient support to enter into force as a legally binding international treaty. To do so, it must be ratified by industrialized countries and former

June

The G8 Summit in Evian, France, gives priority to issues aimed at promoting global economic growth, enhancing sustainable development and improving security

The African Ministerial Conference on the Environment (AMCEN) adopts the New Partnership for Africa's Development (NEPAD) Environment Action Plan in Maputo. Civil society organizations also adopt the plan

New figures for deforestation in Amazonia are the highest in six years

Serious floods in Mexico, including tropical storm Death and damage in Venezuela because of the heavy rains, floods and landslides following a long period of drought, lack of water and brush fires

Russian and French Presidents issue declaration on cooperation in Arctic research, and express importance of indigenous peoples' roles in sustainable development and environmental protection

Wild forest fires spread from southern Turkey into the Syrian pine forests, causing heavy damage

The tenth International Coral Reef Symposium in Okinawa, Japan, focuses on stability and degradation of coral reef ecosystems

The United Nations Foundation and the International Coral Reef Action Network (ICRAN) launch the Coral Reef Fund, aimed at protecting and managing more than 284 000 sq km damaged or threatened coral reefs worldwide

Eastern bloc nations (known under the Convention as Annex I countries) responsible for at least 55 per cent of total anthropogenic carbon dioxide emissions for the year 1990. With many of the major developed countries having already ratified, and the US having rejected the treaty in 2001, the focus is now on what the Russian Federation will do. Its ratification would be sufficient to trigger the Protocol's entry into force. However, at year's end, the Russian Government had yet to make a final decision.

Box 3: Forest policy developments

The issue of illegal logging dominated debate on international forest policy in 2003, highlighting much wider issues such as appropriate forest governance, effective law enforcement, sustainable trade, and ethical investment.

In May 2003, the European Union published its Action Plan on Forest Law Enforcement, Governance and Trade. This outlines proposals for voluntary licensing to ensure that only legally verified timber could be imported into the EU, procurement policies that discriminate against illegal timber, encouragement of responsible financing and support for private sector-led trade initiatives. However, NGOs have criticized the action plan as lacking the necessary legislation to make it effective, but deliberations are ongoing.

Regional Forest Law Enforcement and Governance (FLEG) processes have been running in tandem with the EU initiative. In the Asia Pacific region, for example, the East Asia FLEG, which was launched in 2001, met in January 2003 in Bali, Indonesia, delivering tough messages but less in the way of concrete action plans. Many of the governments involved have additionally signed up to other regional initiatives. Indonesia, home to the most extensive tropical forest cover in Asia, is the key member, with Japan, of the new Asia Forest Partnership (AFP). Indonesia also entered in 2003 into bilateral agreements on illegal logging and timber trade with China, South Korea and Laos.

In Africa, the first ministerial meeting of the FLEG process was held in Yaoundé, Cameroon, at which a ministerial declaration was endorsed by 27 African governments to promote good governance and strengthen forest law enforcement capacity through a number of joint actions. Momentum is also coming from the Congo Basin Forest Partnership, which was launched in January 2003. It will support multi-purpose community-based forest management, combat poaching and illegal logging, and improve management of protected areas. It has a starting budget of US$53 million from the US government. A number of countries in Western and Southern Africa have also started up a Forest Governance Learning Group aimed at sharing learning on key challenges for equitable and practicable forest policy.

The FLEG processes around the world have also opened space for action and calls for accountability by civil society. In Latin America, for example, where an official FLEG process is in the pipeline, a consortium of over 500 NGOs agreed in October 2003 to urge the Brazilian government to drop infrastructural plans in Amazonia which could worsen deforestation.

Source: CIFOR 2003

The ninth Conference of the Parties to the UNFCCC, in Milan in December, concluded with experts applauding a deal on the use of carbon sinks in the Kyoto Protocol's Clean Development Mechanism (CDM). This initiative is designed to help industrialized countries meet their emissions targets in a cost-effective way while helping developing countries to meet sustainable development targets. With this issue resolved, most of the details of how the Kyoto Protocol could function in practice have now been agreed.

New agreements in force

The year heralded the entry into force of several be Multilateral Environmental Agreements (MEAs), including key regional environmental agreements. The Framework Convention for the Protection of the Marine Environment of the Caspian Sea, and the Agreement on Transboundary Haze Pollution of the Association of Southeast Asian Nations, are both designed to address priority issues in the respective regions. The 50th instrument of ratification required for the Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) to enter into force was also deposited at the end of 2003. Other examples are given in the timeline below.

There was also progress in the area of soft law in 2003. The Vth World Parks Congress, held in Durban, South Africa, in September, demonstrated increased commitment among countries to the establishment of parks and protected areas. A report released by UNEP-World Conservation Monitoring Centre and

July

Delegates from over 30 countries and 22 multilateral organizations attend the Earth Observation Summit hosted by the United States State Department in Washington, D.C., US

The Revised African Convention on the Conservation of Nature and Natural Resources is endorsed by the Assembly of the African Union (AU)

AU leaders adopt the NEPAD Environment Action Plan

The Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) identifies more than 50 companies that have illegally deforested more than 10 000 ha of tropical forest in the Amazon region

Norway announces consultation process on the proposed opening of the Barents Sea for oil and gas exploration

Biggest West Asia recycling plant opens in Jeddah. The plant is designed to manage the city's mounting waste disposal problems

The Ministry of Agriculture and Fisheries in the United Arab Emirates announces the establishment of the largest desert botanical garden in the Arab world. The project aims at preserving environmental resources, fauna and flora

August

The Sub-Commission on the Promotion and Protection of Human Rights, the main subsidiary body of the UN Commission on Human Rights, adopts a resolution containing guidelines to ensure compliance by international companies with existing human rights, labour and environmental standards

Heatwaves in large parts of Europe. Many excess heat-related deaths reported

Excess forest fires in Europe and western Canada

Canada announces designation of Ukkusiksalik National Park in Nunavut, the culmination of many years of work by Inuit communities and Parks Canada

Sixth Conference of the Parties to the Convention to Combat Desertification (CCD) held in Havana, Cuba

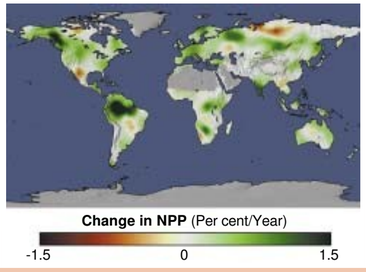
the World Conservation Union (IUCN) found that more than 12 per cent of the earth's surface is now protected (Chape and others 2003). According to the report, there are currently more than 100 000 protected areas covering 18.8 million km ^{2} , an area equivalent to the size of China and Canada combined. However, recognizing that marine ecosystems are largely unprotected, the Durban Action Plan, one of the outputs of the World Parks Congress, appeals for at least 20–30 per cent of the marine areas of the planet to be protected by 2012 (IUCN 2003).

Synergies and cooperation in environmental governance

In spite of these achievements, environmental governance at the international level is still sometimes fragmented, diffused and overlapping, due in part to the proliferation of

Box 4: Greening of the biosphere

A globally comprehensive analysis of satellite and climate data between 1982–1999 was published in 2003. The results indicate an apparent greening of the biosphere. These changes could not have been identified without the up-to-date, consistent, and comprehensive picture of the planet that was provided by the long-term satellite data sets that are now available.



The results of this study demonstrate that net primary production (NPP), the amount of energy produced by plants through photosynthesis minus what they use in respiration, increased globally by about six per cent during the last two decades of the 20th century. Increasing temperatures, precipitation, carbon dioxide levels, and nitrogen deposition, changes in cloud cover and land use have all been implicated in the global greening, even though their relative roles remain unclear. In addition, advances in agriculture and successful implementation of a number of conservation programmes around the world may have contributed to the greening trend.

The study revealed that ecosystems in tropical zones and in the high latitudes of the Northern Hemisphere accounted for 80 per cent of the increase in global net primary production. Tropical rainforests in the Amazon contributed nearly 40 per cent of the global increase, attributed to a decline in cloud cover and the resulting increase in the sun's energy that reached the surface. Changes in monsoon dynamics resulted in more rainfall in the 1990s that led to increased vegetation over the Indian sub-continent and the African Sahel.

Source: Nemani and others 2003

Box 5: Methyl bromide a sticking point

The Fifteenth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (MOP-15), which was held in November 2003 in Nairobi, adopted numerous decisions, including one on trade in hydrochlorofluorocarbons. It also addressed good housekeeping of, and destruction technologies for, ozone-depleting substances (ODS), and adopted a plan of action to modify regulatory requirements that mandate the use of halons on new aircraft.

However, the parties failed to agree on key issues related to ozone-destroying methyl bromide, including the critical-use exemptions for this broad-spectrum pesticide, conditions for granting and reporting on them and further interim reductions of methyl bromide consumption for the period beyond 2005, applicable to developing country parties. An extraordinary meeting of the parties was, therefore, proposed for March 2004 to follow up on issues related to this chemical.

Many experts believe that the amounts of methyl bromide nominated for critical use exemptions by several industrialized countries were excessive and could hamper progress in implementing the protocol. The methyl bromide issue is currently one of the key challenges faced under the Montreal Protocol.

Source: UNEP 2003

September

The XIIth World Forestry Congress held in Quebec City, Canada

Trade and environment ministers gather for the first time at a High Level Roundtable on Trade and Environment in Cozumel, Mexico, ahead of the WTO Ministerial Conference to discuss key trade and environment issues in negotiations on the Doha Development Agenda

The Cartagena Protocol on safety and trade in genetically modified organisms and their derivatives enters into force. The protocol is part of the Convention on Biological Diversity

Planet's list of protected areas tops 100 000 mark

The World Meteorological Organization (WMO) reports that the annual ozone hole over the Antarctic has matched the size record set three years ago of 28 million km

The Vth World Parks Congress sets the conservation agenda for the next decade through the Durban Accord, Action Plan and Recommendations.

World Climate Change Conference takes place in Moscow, Russia

Sustained drought in Argentina, the worst in more than 75 years. The drought extends to adjacent zones in Bolivia, Paraguay and Uruguay. It is particularly serious in some regions of Paraguay

Scientists report the break-up of the Arctic's largest ice-shelf – the Ward Hunt

Eighth meeting of the GCC ministers responsible for the environment held in Kuwait

October

The 1998 Aarhus Protocol on Persistent Organic Pollutants to the Convention on Long-Range Transboundary Air Pollution enters into force

The National Space Research Institute (INPE) of Brazil launches a second satellite, jointly developed with China, to monitor the state of forests in tropical Amazonia

Third Ibero-American Forum of Ministers of the Environment held in Oaxaca, Mexico

Reports show that Andean glaciers in the southern part of Argentina and Chile receded twice as quickly in the five years from 1995–2000 as in the previous 25 years

A new species of bird, the Semillero de Carrizal (*Amaurospiza carrizalensis*) is discovered in Venezuela. It is a chaffinch native to Carrizal Island, in the eastern part of Venezuela, whose habitat has already very seriously deteriorated

The Water Middle East International Conference held in Bahrain emphasizes demand management and technological solutions to the water problem in the region

Big forest fires in California, US

MEAs. This stretches the capacity of governments, especially in developing countries, to participate fully in the international environmental decision-making process.

Responding to calls for greater coordination between MEAs, the UNFCCC organized workshops in 2003 to explore synergies and cooperation with other conventions, while the Convention on Migratory Species and the Convention to Combat Desertification signed an agreement to cooperate in the development of specific targeted actions to address issues relating to migratory species in areas affected by drought and desertification. Efforts to cluster MEAs were also made during negotiations on a Strategic Approach to International Chemicals Management (SAICM), where countries, while calling for an ambitious scope and goal, also expressed keen interest in building upon existing initiatives and clarifying the role and implementation process of the SAICM (see November entry of timeline).

Traditional North-South relationships concerning capacity building and technology transfer remain important. However, 2003 also saw enhanced South-South cooperation. Whether organized by region, as seen through the New Partnership for Africa's Development (NEPAD – see Africa section), or areas with shared concerns such as the three SIDS regions (see SIDS section), or by stage of development, such as in the recent signing of an agreement between Brazil, India, and South Africa to collaborate in science and technology transfer, this trend can only bring positive energy to the sustainable development agenda.

LOOKING TO THE FUTURE

There are many challenges facing countries and their people in 2004 and beyond. While some governments continue to focus on peace and security issues, many of the poorest people will continue to hope for food, housing, healthcare, freshwater and a clean environment. The debates over climate change, GMOs, free trade, and other issues related to sustainable development are unlikely to abate in the coming year. International cooperation and multilateralism on these and other issues are imperative if the three pillars of sustainable development – environmental protection, economic development and social development – are to remain firmly in place.

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November

Ministers from Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan adopt and sign the Framework Convention for the Protection of the Marine Environment of the Caspian Sea

The fourth session of the Intergovernmental Forum on Chemical Safety (IFCS) held in Bangkok. The theme of Forum IV is "chemical safety in a vulnerable world"

The working group of the Strategic Approach to International Chemicals Management (SAICM), launched by the UNEP Governing Council in February 2002, meets in Bangkok

The Southern African Development Community (SADC) ratifies its Protocol on Shared Watercourse Systems

The UN launches $25 million appeal to save gorillas, chimpanzees, bonobos and orangutans from extinction and to secure their natural habitat

The 14th Meeting of the Forum of Ministers of the Environment in Latin America and the Caribbean held in Panama City, Panama

The golden lion tamarin has moved from critically endangered to endangered on the IUCN Red List of Threatened Species. The species, which is endemic to Brazil, was the only primate that shifted into a lower threat category on the list

The Association of South East Asian Nations (ASEAN) Agreement on Transboundary Haze Pollution enters into force

December

COP-9 of the United Nations Framework Convention on Climate Change (UNFCCC) held in Milan, Italy

The Pan-African Implementation and Partnership Conference on Water held in the Ethiopian capital, Addis Ababa

EU fisheries ministers agree on catch quotas and limited numbers of days trawlers may go to sea and adopt a long-term recovery plan for endangered fish stocks

International Meteorological Organization brings forward the deadline for phasing out single-hull oil tankers from 2007 to April2005

The 15th Session of the Council of Arab Ministers Responsible for the Environment held in Cairo, Egypt

Catastrophic earthquake strikes the city of Bam in southeast Iran

Africa

Africa recorded a number of political and environmental policy milestones in 2003, with immediate and long-term impacts on environmental management in the region

Armed conflict in some parts of the region dominated the headlines, but the less frequently mentioned regional environmental policy developments were no less significant. Environmental issues which dominated included freshwater, famine, and environment and security.

FRESHWATER FOR ALL – WORKING TOWARDS REALISTIC TARGETS

Water issues were a priority in 2003 in Africa, which experiences large spatial variations in rainfall and in 1990 saw at least 13 countries suffer water stress or scarcity (UNEP 2002). Governments in the region, and their partners, participated in various water-related events, including the Pan-African Implementation and Partnership Conference on Water, convened in December in Addis Ababa. One of its objectives was to explore ways of reaching the internationally agreed water and sanitation targets. A pre-conference report (UNEP 2003a) noted that for the region to meet the water targets:

- an additional 405 million people must have improved access to safe drinking water by 2015, from January 2004, an average of more than 36 million each year, 690 000 each week; and
- an additional 247 million people must get improved sanitation by 2015, with an average of more than 22 million every year, 425 000 people every week, from January 2004.

These targets are demanding. Africa lacks adequate human and financial resources, and the necessary investment has not been made. In addition, few African countries have adequate technical capacity for necessary infrastructure, engineering and installation. It has been suggested that the targets might be realistically approached in an incremental way (UNEP 2003a). Figure 1 shows how this could be achieved by 2015.

FAMINE AND DROUGHT

Once again famine was a major issue in the region, affecting millions of people and increasing their vulnerability to disease and other hardships. At the beginning of the year, 25 million people were being affected, and this figure had jumped to 40 million by April (Harsch 2003a). In Southern Africa, much of the famine was attributed to the severe drought that hit the sub-region during the 2002–2003 rainy season. In the Horn of Africa (Sudan, Eritrea and Ethiopia), famine was mainly a result of drought, although in Ethiopia and Eritrea, war was also a contributory factor (Harsch 2003b). A total of 13.6 million people in the two countries faced immediate food shortages in early 2003 (UN 2003).

ENVIRONMENT AND SECURITY

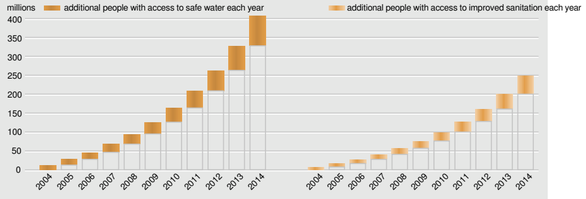
The overexploitation of resources over the years due to conflict has contributed to environmental degradation and human insecurity, directly and indirectly. For example, both the Democratic Republic of Congo (DRC) and Liberia have attracted international attention as areas where greed for diamonds not only fuelled armed conflict but also environmental degradation. Environmental management institutions in Africa

Key Facts

- Africa has the highest rate of urbanization in the world. The urban population is projected to reach 42.7 per cent by 2010. Despite this, the majority of the people in Africa still live in rural areas – about 498.4 million in 2000 compared to 295.2 million in urban areas.
- The number of people living in absolute poverty in sub-Saharan Africa is projected to rise from 315 million to 404 million over the next 15 years, making the continent the world's poorest region.
- Africa is the source of about a third of the world's biodiversity. In 2003, Africa had more than 1 200 national parks, wildlife reserves, and other protected areas, representing an area of more than two million km ^{2}, nine per cent of the region's total land area or more than 21 times the size of Malawi.
- The HIV/AIDS pandemic in Africa is seriously affecting conservation success in the region. For example, it is reducing staff in protected areas.
- About 180 million people in Africa – pastoralists, farmers and other land users – live on fragile drylands where growing numbers compete for water and land.
- In Africa, more than 20 per cent of the population's protein comes from freshwater fisheries.

Sources: UN-Habitat 2003, IUCN 2003a, IUCN 2003b, World Bank 2003a

Figure 1: Africa regional targets: annual increased access to safe water and improved sanitation required to reach those who need to be served before 2015

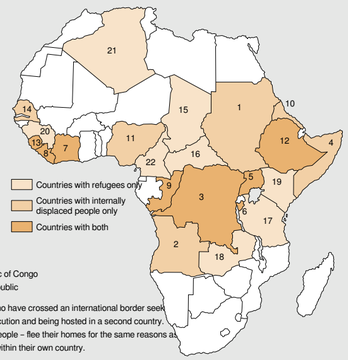


Source: UNWWAP 2003

Note: The baseline year for the proportion referred to in the targets is 1990 and highlighted in WWDR. These targets represent an annual increase of around 20 per cent in service delivery during 2004–14. If the service delivery achieved in 2014 is then maintained or increased, the target of water for all in Africa could be met by around 2020, five years before the global deadline of 2025.

Figure 2: Africa's uprooted people: The toll of conflict

	Refugees being hosted	Internally displaced peoples
1 Sudan	328 000	4 000 000
2 Angola		3 500 000
3 DRC*	330 000	2 500 000
4 Somalia		3 500 000
5 Uganda	217 000	650 000
6 Burundi	41 000	500 000
7 Côte d'Ivoire	45 000	200 000
8 Liberia	65 000	180 000
9 Congo	109 000	75 000
10 Eritrea		58 000
11 Nigeria		30 000
12 Ethiopia	133 000	13 000
13 Sierra Leone	64 000	10 000
14 Senegal		6 000
15 Chad	44 000	
16 CAR**	51 000	
17 Tanzania	690 000	
18 Zambia	247 000	
19 Kenya	234 000	
20 Guinea	182 000	
21 Algeria	169 000	
22 Cameroon	58 000	



* Democratic Republic of Congo
** Central African Republic

Refugees – people who have crossed an international border seeking sanctuary from persecution and being hosted in a second country.
Internally displaced people – flee their homes for the same reasons as refugees but remain within their own country.

Source: Adapted from UNHCR 2003

have generally been weakened as a result of armed conflict, and so were enforcement regimes; forests and other resources suffered (UNEP 2002). The issue of post-conflict assessment in Africa has recently attracted attention with UNEP initially focusing on Liberia. More post-conflict assessments are expected in other African countries in which conflict was a major issue.

Conflicts have increased the numbers of refugees and internally-displaced people. In 2003, the overall number of displaced people in Africa was 15 million (Wilkinson 2003), 3 343 700 of them refugees living in countries other than their own (UNHCR 2003) (Figure 2). The UN High Commission for Refugees (UNHCR) acknowledges that the unexpected arrival of large numbers of refugees, as well as lengthy stays in asylum countries, can have a significant environmental impact, including exploitation of protected areas.

UNHCR launched activities to generate awareness among displaced people of the value of water in 2003, the International Year of Freshwater. These were linked to planting trees, cleaning up camps and raising awareness among refugees in Africa about the need to protect and improve the physical environment (UN 2003). The Refugee and Returnee Environmental Education Programme, which was started in 1995 in refugee camps in Kenya, has since been expanded to Ethiopia, Djibouti, the Sudan, Tanzania and Zambia.

REGIONAL POLICIES

There has been progress on the policy front as the region took steps to consolidate the African Renaissance. Various structures and policy measures of the new African Union (AU) were strengthened, the most significant of which was the adoption by heads of state and governments of a new environmental action plan. The second session of the Assembly of the AU Heads of State and Government endorsed the Action Plan for the Environment Initiative of the New Partnership for Africa's Development (NEPAD) in July 2003. (Box 1).

The other significant policy development was the adoption by the AU Assembly of the revised African Convention on the Conservation of Nature and Natural Resources (Box 2). This updates and strengthens the 1968 Convention and boosts the commitment by African governments to a collective approach to biodiversity conservation in the region. Africa's commitment to biodiversity conservation was further reinforced by the Africa Forest Law Enforcement and Governance Ministerial Declaration of October 2003, which recognizes that the biodiversity of Africa's forest ecosystems is essential for the livelihoods of the African people (IISD 2003). The declaration highlights problems of illegal logging, a move that should pave the way for strong legislation supportive of sustainable forest management, fair profit-sharing and poverty alleviation.

Box 1: the NEPAD Environment Action Plan

The Action Plan of the Environment Initiative of the New Partnership for Africa's Development (NEPAD) was prepared to promote Africa's sustainable development and assist the region to confront its short-term economic growth challenges without losing sight of the long-term environmental, poverty eradication and social development imperatives.

The action plan is organized in clusters of programmatic and project activities to be implemented over an initial period of 10 years. Programme areas cover the following priority sectors and crosscutting issues:

- combatting land degradation, drought and desertification;
- wetlands;
- invasive species;
- marine and coastal resources;
- cross-border conservation of natural resources; and
- climate change.

The plan also addresses the related problems of pollution, forests and plant genetic resources, freshwater, capacity building and technology transfer. The implementation of the plan is a challenge which will require the support and/or active participation by African countries and development partners.

Source: AU 2003a

Several African countries announced new protected areas showing commitment to biodiversity conservation.
Source: Still Pictures

The Vth World Parks Congress, about two months after the AU second Assembly, reinforced Africa's commitment to biodiversity conservation, with several countries in the region announcing the establishment of new protected areas.

Africa made significant progress in 2003 to phase out leaded vehicle fuel, whose emissions are both an environmental and human health risk. A UNEP survey found that most African countries will be using lead-free petrol, or should be close to phasing out lead from vehicle fuel, by the end of 2005. Countries such as Cape Verde, Egypt, Ghana, Libya, Mauritius and Mauritania are already fully lead-free. Other countries that have drawn up action plans to phase out lead by 2005 include Eritrea, Kenya, Nigeria, South Africa, Togo and Uganda. (UNEP 2003b, World Bank 2003b).

CHALLENGES FOR THE FUTURE

Extreme poverty continues to affect millions of people in Africa. However, the focus on strategies to meet the MDG targets of water and sanitation, establishment of strong structures of the African Union and adoption of strategic environmental policies showed the region's commitment towards effectively managing its environment. The implementation of these policies remains the challenge for the region, so that it may achieve peace and security, improve governance, and alleviate extreme poverty.

Box 2: African nature convention adopted

The 1968 African Convention on the Conservation of Nature and Natural Resources was revised in 2003 with support from UNEP and the World Conservation Union (IUCN).

The new text makes the African Convention a comprehensive and modern regional treaty on environment and natural resources conservation, the first to deal with a wide spectrum of sustainable development issues, including land and soil, water, and biological diversity conservation and sustainable use. It also addresses processes and activities which affect the environment and natural resources, as well as their relationship with sustainable development.

The convention provides for procedural rights (to information, participation and access to justice), echoing Principle 10 of the Rio Declaration. It encourages cooperation among parties to implement the convention, and whenever transboundary effects are likely to occur, and provides mechanisms including an independent secretariat.

The revised convention will enter into force once it has been ratified by 15 African states.

Source: AU 2003b

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Asia and the Pacific

In 2003, Asia and the Pacific was marked by extreme natural events such as droughts, floods, typhoons, mudslides, earthquakes, heat and cold waves. There were also positive environmental policy developments

Key Facts

- Thirty-six per cent of Asia's 3 500 million population lived in urban areas in 2001 and more than 42 per cent of the continent's 1 300 million urban residents lived in slums. It is now estimated that one in two urban slum dwellers in the world are in Asia. About 900 million people or two-thirds of the world's poor live in this region. Nearly one in three Asians is poor.
- Asia is home to 60 per cent of the world's population, but has only 36 per cent of the world's freshwater resources. About 80 per cent of the global population without access to improved sanitation live in this region.
- The majority of the world's population most severely affected by desertification and drought live in Asia. Out of a total land area of 4.3 million km ^{2} , Asia contains some 1.7 million km ^{2} of dry sub-humid, semi-arid, and arid land.
- The Gobi Desert in China expanded by 52 400 km ^{2} from 1994 to 1999, creeping closer to Beijing. Over a quarter of China's land is officially classified as desert. Up to 400 million people are under threat from the fast-advancing deserts.
- Most Himalayan glaciers have been thinning and retreating over the past 30 years, with losses accelerating to alarming levels in the past decade.

Sources: UN-Habitat 2003, UNHCR 2003, UNEP 2002, Larsen 2004, Greenpeace 2003, ICIMOD 2003, UNESCO 2003

These natural anomalies took place amid other evolving environmental problems including land degradation, air pollution and loss of biodiversity. The region has however also witnessed significant policy developments in the abatement of transboundary air pollution, the protection of biodiversity and the fight against desertification.

DISASTROUS EVENTS

The El Niño that still persisted at the beginning of the year sharply changed rainfall patterns, influenced temperature and wind patterns in some areas, and probably contributed to droughts in India, China and Australia (IRICP 2003). The floods of the summer monsoon rains from April to August resulted in more than 180 deaths and around 400 000 homeless people in eastern India, Nepal and Bangladesh (Reuters 2003). In May, a tropical storm across the Bay of Bengal, which was accompanied by torrential rainfall, caused around 300 deaths and the displacement of 200 000 people. The flooding, which severely damaged the infrastructure, economy and livelihoods in the southwestern part of Sri Lanka, was considered the worst in over 50 years (UNOCHA 2003, NOAA 2003). Heavy rains in July also hit eight Chinese provinces. Numerous floods were blamed for hundreds of lives. One hundred million people were affected and the economic loss was estimated at US$5 000 million (CMA 2003a, IRICP 2003).

In eastern China, 640 000 ha of farmland were hit by drought and total crop failure was reported for over 24 000 ha (Tong 2003). More than seven million people suffered from a shortage of drinking water and economic losses were estimated at US$109 million (CMA 2003b). In May, 1 438 people in India and 40 in Bangladesh died from a heatwave in South Asia. The southern Indian state of Andhra Pradesh was the worst affected, with 1 317 reported deaths, as temperatures rose to between 45 and 49° C (IRICP 2003). At the other extreme, in January a cold snap gripped South Asia and took the lives of around 1 000 people in Bangladesh, India and Nepal (Disaster Relief 2003).

The devastating mudslides in the Philippines in December, triggered by a week of pounding rains in provinces near the Pacific Ocean, caused over 200 deaths (NOAA 2003).

Asia and the Pacific is well-known for its vulnerability to earthquakes. The earthquake which devastated Bam City in Iran in December was one of the worst events of the year (Box 1).

GLACIAL CHANGES

In Asia, more than 200 million people live in mountain and upland areas. The Himalayas contain the world's third largest ice mass after Antarctica and Greenland. A 2003 study of glaciers and glacial lakes in Nepal and Bhutan by the International Centre for Integrated Mountain Development (ICIMOD) and UNEP

Box 1: Bam earthquake

On 26 December 2003, an earthquake of magnitude 6.5 struck Bam City in south-eastern Iran, and killed at least 42 000 people, injured 30 000, and left 75 000 homeless. The earthquake destroyed 80 per cent of wells and 87 per cent of the buildings in the city of Bam, as well as the 2 000 year old medieval fortress, the largest earthern structure in the world, which sits on a cliff near the city and attracts thousands of tourists each year. A total of 18 000 buildings in Bam and surrounding villages were destroyed including 131 school buildings, three hospitals, 95 health centres and 14 rural health clinics.

The earthquake killed at least 42 000 people, injured 30 000, and left 75 000 homeless.

Source: REUTERS/Caren Firouz

Sources: IRIN 2004a, IRIN 2004b, UNOCHA 2003

identified 20 glacial lakes in Nepal and 24 glacial lakes in Bhutan as potentially dangerous in the event of a 'glacial lake outburst flood' (ICIMOD 2003). The formation of many glacial lakes on the glacier terminus is very likely the result of the remarkable retreat since the middle of the 20th century of glaciers in the Hindu Kush-Himalayan region, which may be related to climate change (UNEP RRC.AP 2003a) (see also GEO Indicators section). Nine glacial lakes in the Astor River basin in Pakistan and 24 in the Pumqu Basin of China Himalaya were also classified as potentially dangerous. Though no outburst has been recorded in the past decade, it is important to monitor the glacier lakes regularly in order to identify and design appropriate early warning and mitigation and response measures (ICIMOD 2003).

LAND DEGRADATION

Many Asian countries, including India, China, Afghanistan, and Mongolia, are facing the challenges of desertification. This process, caused by overgrazing, overploughing and vegetation removal, is intensifying as human and livestock numbers continue to increase. In China, approximately 2 674 000 km^2 – which represents 27.9 per cent of the total land area – is affected by desertification. It is estimated that one-third of China's population is threatened by desertification, mainly in northwestern, northern and northeastern parts of the country, and that the annual direct economic loss this causes is approximately US$6 500 million (UNCCD 2003a).

In June 2003, environment ministers from 30 countries in Asia and the Pacific signed an accord on implementing the UN Convention to Combat Desertification (UNCCD) to address this issue and called for a global effort to fight the problem. The Abu Dhabi Declaration for the Implementation of the UNCCD urges innovative approaches in fighting desertification and developing long-term strategies to promote sustainable land management. Specific measures include investigating the causes of desertification, establishing a network for information sharing, implementing control measures, and strengthening agricultural productivity through sustainable land management. Countries are also urged to pass relevant national action programmes (UNWire 2003, UNCCD 2003b).

BIODIVERSITY

In March, the government of Fiji declared that the nation's marine Exclusive Economic Zone (EEZ) is to become a whale sanctuary. The sanctuary covers 1.26 million km^2 of water used by migrating humpback whales for breeding and calving. The governments of Australia, the Cook Islands, French Polynesia, New Zealand, Niue, Papua New Guinea, Tonga, Vanuatu, Samoa, as well as the World Wildlife Fund for Nature (WWF) have applauded Fiji's efforts and emphasized the need for conserving whales in other Pacific island states. Besides implementing its main function – protecting marine biodiversity – the sanctuary is predicted to become a major tourist attraction, as has been the case in Tonga, New Zealand and Australia (ENS 2003).

The first regional marine plan under Australia's Oceans Policy was launched in July. More than two million km^2 of Australia's ocean territory around Victoria, Tasmania, eastern South Australia and southern New South Wales, as well as the sub-Antarctic Macquarie Island falls under the jurisdiction of this policy (National Oceans Office 2003). The development of the ocean management plan involved all relevant stakeholders, including commercial and recreational fishers, indigenous Australians, the conservation sector, industries and officials from different governmental bodies. The National Oceans Ministerial Board, established as a coordinating body, will provide for a comprehensive governmental framework for decision-making in the field of ocean protection. This is a big step toward protection of key ecosystems as well as the promotion of sustainable development of marine industries currently valued at more than US$19 400 million a year (National Oceans Office 2003).

Asia also has a great diversity of birds. Its 2 700 species represent over 27 per cent of all bird species described. However, one in eight (12.5 per cent) of all bird species in the Asia region is globally threatened. The two primary threats are habitat destruction and human overexploitation. A total of 323 bird species are at risk of extinction over the next 100 years (Birdlife International 2003). Of this number, 41 are listed as "critical" and a further 65 are "endangered," meaning that these species face a high risk of extinction over the next 10 years. The declining populations of birds such as the hornbill in Nepal (Box 2) reflect the general deterioration of biodiversity and the environment in the region (BirdLife International 2003).

Box 2: Endangered hornbill in Nepal

According to the IUCN's 2003 Red List of Endangered Species, the hornbill is among Nepal's most critically endangered birds. Habitat loss is the main threat to the hornbill, as deforestation in the region destroys nesting trees and feeding sites. The hornbill is also hunted by poachers who sell its beak and fat (which they call 'hornbill oil') for medicinal purposes. The dire circumstances of Nepal's four species of hornbill are indicative of the survival challenges of many Asian birds, which are faced with habitat destruction and overexploitation.

Sources: Poudel 2003; Birdlife International 2003

AIR POLLUTION

Air quality, especially the concentrations of particulate matter in major Asian cities, is of serious concern. More than 500 000 people die every year from diseases related to air pollution (WHO 2003). In the next few years,

Air pollution is a major environmental issue, particularly in Asian cities, and related diseases kill more than half a million people each year.

Source: Still pictures

Box 3: Agreement on transboundary haze pollution entered into force

The 2002 Agreement on Transboundary Haze Pollution of the Association of Southeast Asian Nations (ASEAN) entered into force in November 2003. The agreement, signed by the 10 member countries of ASEAN, is the first such regional arrangement in the world that binds a group of contiguous states to tackle transboundary haze pollution resulting from land and forest fires. It contains provisions on monitoring, assessment and prevention of transboundary haze pollution, technical cooperation and scientific research, mechanisms for coordination and communication, and simplified customs and immigration procedures for disaster relief. It also provides for the establishment of an ASEAN Coordinating Centre for Transboundary Haze Pollution Control. The agreement may serve as a model for dealing with other transboundary issues.

Source: ASEAN 2003

governments in the majority of countries in the region intend to address air pollution as their top priority. Measures have been intensified at all levels and include tougher new emission standards aimed at reducing suspended particulate matter, regulations to control air pollution at construction sites, and the introduction of alternative motor vehicle fuel, such as low sulphur diesel, ethanol blended petrol and compressed natural gas (CNG) (Enhesa 2003, CSE 2003). Although measures vary from country to country, most have a clear focus on the motor vehicle sector.

Transboundary air pollution is a concern in Asia, affecting many countries in the region. Successful initiatives undertaken in 2003 to tackle transboundary air pollution included:

- the ASEAN Agreement on Transboundary Haze Pollution in Southeast Asia (Box 3);
- a regional programme on establishing a dust and sand storm monitoring and early warning system in Northeast Asia initiated by the Asian Development Bank, the Economic and Social Commission for Asia and the Pacific, the Asia office of the UNCCD and UNEP, together with governments of China, Japan, the Republic of Korea and Mongolia; and
- a capacity-building programme, undertaken under Phase II of the Male Declaration, which aims to build national capacities to address issues of transboundary air pollution in South Asia. In-country training programmes, with monitoring equipment, have been provided to six participating countries, namely Nepal, Bhutan, Sri Lanka, Maldives, Iran and Bangladesh (UNEP RRC.AP 2003b).

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Europe

The expansion of the European Union (EU) was a major political development during the year while environmental issues, including extreme weather events, overfishing and unsustainable transport patterns were also important

Only a few issues can be covered in detail but this does not make other topics, such as biodiversity loss or waste disposal and management, less important.

EXTREME WEATHER EVENTS

Exceptionally high temperatures occurred in Western Europe in 2003, causing various heat and drought-related impacts, both on human health and environment. Heatwaves are often accompanied by power failures, high levels of local air pollution, failures in the water supply, excess forest fires and excess heat-related mortality. At the end of the hot 2003 summer, authorities reported high mortality figures (EEA 2003a, UNECE 2003a, and WHO 2003).

Two firemen dwarfed by giant flames during forest fires in Southern France.

Source: REUTERS/Pascal Deschamps

There is no doubt that hot and dry weather conditions can make fires much more severe. Direct pressures that cause fires vary widely and are both social and ecological in nature. Prevention and control strategies address public awareness, repression of crime, silvicultural cleaning measures to reduce the fuel load, and economic incentives for appropriate management measures, as well as effective fire suppression.

As with the heavy rainfall and floods in Central Europe in 2002, the 2003 extreme weather-related events in Europe cannot be attributed to climate change and its pressures alone, but they show what may happen if climate change continues. Europe has experienced an unprecedented rate of warming in recent decades, with an overall temperature rise of as much as 2 ºC over large areas of the Arctic since the early 1950s (Bernes 2002, Klein Tank and others 2002). Average temperatures are expected to further increase, droughts are likely to become more frequent in various parts of Europe, and heatwaves, although rare at present, could become more frequent, intense and longer (Houghton and others 2001).

The cost of climate change mitigation in Western Europe can be reduced significantly through the use of mechanisms under the Kyoto Protocol (EEA 2003b). In Eastern Europe, greenhouse gas mitigation costs are expected to be lower than in Western Europe but investments are needed in the energy sector (EEA 2003b). The Russian Federation, which is likely to have a significant surplus of emission allowances, could play a central role in the ratification process of the protocol as well as in the future market for GHG allowances (EEA 2003b). By the end of 2003, however, the Kyoto Protocol, had not yet entered into force.

Key Facts

- With the Treaty of Accession between the EU and the 10 accession countries, signed in April, Europe has entered a new era with numerous implications for the region's environment.
- The May 2003 Environment for Europe Ministerial Conference in Kyiv, Ukraine, adopted among others, three pan-European protocols – the Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context; the Protocol on Civil Liability and Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters to the Conventions on the Transboundary Effects of Industrial Accidents and on the Protection and Use of Transboundary Waters and International Lakes; and the Protocol on Pollutant Release and Transfer Registers to the Aarhus Convention.
- A Convention on the Protection and Sustainable Development of the Carpathians was adopted and signed by the seven countries of the Carpathians in May 2003 in the margins of the Kyiv Conference. A Framework Convention for the Protection of the Marine Environment of the Caspian Sea was signed in November 2003 by the five riparian countries.
- As of 31 December 2003, a total of 27 countries had ratified, approved, accepted or acceded to the Aarhus Convention (Access to Information, Public Participation in Decision-making, and Access to Justice in Environmental Matters), five of which did so in 2003.
- In 2003, the issue of environment and security was further pursued through a UNEP, UNDP and the Organization for Security and Cooperation in Europe (OSCE) project which established a mechanism to examine and address linkages between environmental problems and 'hot spots' and security issues affecting nations and people.
- The latest greenhouse gas emission projections show that neither existing, nor additionally-planned domestic policies and measures by member states to reduce emissions will be sufficient to allow the EU to reach its Kyoto target.

Sources: EEA 2003b and 2003c, UNECE 2003b, 2003c, 2003d, 2003e and 2003f

UNSUSTAINABLE TRANSPORT PATTERNS

The transport sector has clear links to climate change. In Western Europe, it has become the second largest consumer of energy (30 per cent of total energy use) and an important source of GHG emissions. In Central and Eastern Europe and Central Asia (EE & CA, the transport sector is a relatively less

Rail is one of the main modes of transport in Europe, particularly in Eastern Europe where it predominates.
Source: Still Pictures

important energy consumer but still accounts for around 22 and 17 per cent respectively of total energy use (EEA 2002).

In Eastern Europe, rail transport remains strong with no signs of decline (EEA 2002). Central Europe, where transport patterns are currently more favourable to the environment than in Western Europe, risks ending up with the present unsustainable, mainly road-dominated, transport patterns of Western Europe unless preventive action is taken. For instance, the number of cars per 1 000 inhabitants in Central Europe is currently half of that in Western Europe, but the rising trend in 1990–99 of a 61 per cent increase in car-ownership in Central Europe continues.

Economic growth and related changing lifestyle patterns create increasingly strong pressures on the transport sector all over Europe. Western European experiences, including voluntary agreements and fuel taxes, show that environmental regulation on vehicles and fuels has helped to reduce certain impacts, such as air pollution. But these gains in eco-efficiency have not been sufficient to mitigate the impact of the rapid growth of transport and infrastructure on GHG emissions, noise and habitat fragmentation. Better-integrated transport and environmental strategies are needed to restrain traffic growth and promote the use of more environmentally friendly modes – two of the key objectives of the EU Sustainable Development Strategy.

Box 1 lists some findings of a recent study on transport patterns and policy in Central Europe in relation to EU enlargement (EEA 2002).

An overall assessment of the transport sector, and of the economic, social and environmental impacts and benefits of the trans-European transport network and its eastern extension has not yet been made.

OVERFISHING

Fishing fleets are modern and efficient, and the market for protein from the sea is strong. Since 1990, total European landings of marine catch have increased by 25 per cent despite a reduced fleet capacity. Overfishing has resulted in a reduction of many marine fish stocks to levels below those that can sustain their populations (Table 1). (See Emerging Challenges and GEO Indicators sections.)

In October 2003, the International Council for the Exploration of the Sea (ICES) advised zero catches of cod and several other fish stocks, until stocks recovered to certain specific levels (ICES 2003). The European Commission adopted a proposal on the establishment of a revised fishing effort regime in the western waters, which aims to protect fish stocks (European Council 2003).

Commercial inland fisheries have fallen by 32 per cent since 1990 (EEA 2003b). The FAO notes that environmental degradation, rather than overexploitation, is the biggest threat to inland fish stocks. However, illegal landings, for example of sturgeon from the Caspian Sea,

Box 1: Transport and environment integration: trends in Central Europe

1. Pricing system to internalize external costs:
- few internalization instruments (eg a CO_2 tax on motor fuels) are in force in the accession; and countries
- trends in fuel prices are not encouraging the use of more fuel-efficient transport modes.

2. Introduction of cleaner technologies:
- the accession countries vehicle fleet is on average four to five years older than the EU fleet; and
- the number of end-of-life vehicles and used tyres are expected to grow significantly.

3. Use of environmental management and monitoring tools:
- integrated transport and environment strategies are lacking in accession countries; and
- accession countries are not monitoring the environmental integration in their transport policies.

Source: EEA 2002

Table 1: Recommended and estimated 2003 stocks of cod, plaice, whiting, hake and capelin

Area	Minimum recommended stock size (tonnes)	Estimated stock size in 2003 (tonnes)
Cod – North Sea and Skagerrak-Eastern Channel	150 000	52 000
Cod – Irish Sea	10 000	Just above 6 000
Cod – west of Scotland	22 000	2 500
Plaice – North Sea	300 000	152 000
Whiting – Irish Sea	7 000	1 700
Hake – Ireland down to Portugal	Northern stock: 140 000 Southern stock: 35 000	Northern stock: 114 100 Southern stock: 16 000
Capelin – Barents Sea	200 000	280 000

Source: ICES 2003

are often many times greater than legal landings and constitute a major pressure on the resource.

OTHER POLICY DEVELOPMENTS

Improvements in the state of the ozone layer, air and water quality, have mainly been brought about through policy measures that have regulated products such as lead in petrol, sulphur in liquid fuels or catalytic converters on cars and controlled release of emissions from power plants, industry and waste incinerators. In Central and Eastern Europe, economic restructuring was a major force behind the reductions in emissions that have been recorded. The loss of biodiversity and habitats has been reduced by protecting important nature sites.

Much of the environmental progress by 2003 is unlikely to be sustained with continuing or renewed economic growth, while many of the negative impacts are likely to be exacerbated. This trend is already apparent in the transport field. Clearly, the implementation of more integrated approaches to policy making needs to be accelerated if Europe is to ensure proper protection of its environment and meet its aspirations on sectoral integration and sustainable development throughout the region (EEA 2003c). One aspect of such integration is the need to further streamline environmental data and reporting across Europe (Box 2).

Box 2: Integration and sustainable development in Europe: monitoring and reporting

The search for more integrated approaches to policy-making directly relates to the need to improve reporting on the environment and sustainable development. Assessment and reporting is hindered by the continuing lack of comparable data and indicators across the whole European region. This applies for both environmental and socio-economic data. Recent efforts have been made to streamline monitoring at EU, pan-European and sectoral levels.

On sectoral integration, the most advanced examples are related to activities to streamline reporting on transport, environment and health:

- The European Environment Agency (EEA) (in cooperation with the European Commission) has developed an indicator-based reporting system, the Transport and Environment Reporting Mechanism (TERM), to monitor integration of environmental concerns into EU transport policies. Since 2002, the 10 EU accession countries have also been included in the assessment. Eurostat and UNECE are the major providers of the statistics on which the reports build.
- The World Health Organization (WHO) European Centre for Environment and Health is implementing an environmental health indicator system, to facilitate the assessment of health effects related to environmental conditions. The system will be recommended for endorsement to the 4th Ministerial Conference on Environment and Health, in Budapest, in 2004. The indicators have been developed in collaboration with EEA to maximize the possibility of data exchange between the two organizations and member states.

Source: UNECE 2003g

CHALLENGES FOR THE FUTURE

Even though some environmental progress can be witnessed, there is still much to be done to make the environment more sustainable. Issues such as transport, biodiversity and waste need to be kept high on the policy agenda in order to improve the state of the environment and reach set targets. Acceleration toward more integrated approaches and the implementation and enforcement of environmental policies – together with adaptation to technical progress and new insights – remain core tasks throughout the region (EEA 2003c).

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Latin America and the Caribbean

A number of key regional events helped to further the in the region. However, an ongoing challenge is still to address the growing levels of poverty and inequality, while at the same time integrating environmental and social concerns into development policy

Despite the continued economic and social crisis in many countries, the legal and institutional frameworks were maintained during the year. In November 2003, the Forum of Ministers of Environment of Latin America and the Caribbean identified concrete actions for the implementation of the Latin American and Caribbean Initiative for Sustainable Development (Box 1). Other progress in 2003 included the development of plans for biological corridors in the Andean region and the Amazon basin, the designation of new protected areas in numerous countries, as well as national legislation to enhance the role of the private sector in protected area management (Box 2).

While more state regulations have been introduced, enforcement emerges as a major problem. This is either due to an imbalance between economic and environmental goals or to the lack of adequate human and financial resources.

Key Facts

- In 2003, the number of people living in poverty was 225 million, nearly 44 per cent of the total population.
- LAC has the world's largest area of arable land, 576 million ha, 30 per cent of the total region. During the 1990s, profits from the region's agricultural exports increased at an average annual rate of 6.4 per cent.
- LAC lost almost 47 million ha of forests in the period 1990–2000, the second largest loss after Africa.
- The 178 eco-regions identified in LAC contain more than 40 per cent of the world's flora and fauna species. Brazil, Colombia, Ecuador, Mexico, Peru and Venezuela are all considered mega-diverse countries.
- LAC possesses more than 30 per cent of the global renewable water resources. Agriculture is the principal consumer of water in the region, accounting for 73.5 per cent of total withdrawals.
- 60 per cent of the population live within 100 km of the coast, and coastal and marine ecosystems continue to be threatened by pollution and degradation caused mainly by growing demographic pressure and associated increase in coastal resource use. Over 60 per cent of sewage from public drainage in LAC is discharged into water bodies without treatment.
- More than 80 million people in LAC are permanently affected by low air quality.
- LAC is the most urbanized region in the developing world: the level of urbanization was 75.3 per cent in 2000 and is expected to reach 80.4 per cent by 2020.
- The period 1995–2003 was the most active for Atlantic hurricanes on record, with a high social economic and environmental impact on the region, especially the highly-vulnerable Small Island Developing States (SIDS) of the Caribbean. Between 1970–2001 natural disasters killed 246 569 people, affected another 144.9 million and caused economic losses of US$68 600 million.

Sources: UNEP 2003a, FAO 2003

THE VANISHING FORESTS

Satellite data from the Brazilian Institute for Space Research (INPE, *Instituto Nacional de Pesquisas Espaciais*) showed that an estimated 25 476 km ^{2} of forest vanished between August 2001 and August 2002, the highest total in any of the past six years, and the second largest since record-keeping began in 1978 (INPE 2003). Agricultural and livestock expansion continue to be the main factors reducing forested areas in South America's tropical regions, as seen in the Cerrado and the Amazon in Brazil (UNEP 2003a) (Figure 1). Slash-and-burn activities continue to be important, but the expansion of soybean cultivation is exacerbating the situation.

Brazil is becoming a major soybean producer. In 1990, the area sown was more than 11.4 million ha. By 2002–03, it had reached

Box 1: Forum of Ministers of Latin America and the Caribbean

The 14th Meeting of the Forum of Ministers of Environment of Latin America and the Caribbean was held in Panama in November 2003. The Forum, created in 1982, helps coordinate environmental activities and ensure that regional and international cooperation is efficient and coherent, targeting the priorities of the region.

At an extraordinary meeting of the Forum held within the framework of the World Summit on Sustainable Development, the Latin America and Caribbean Initiative for Sustainable Development (ILAC) was approved and included in the WSSD Plan of Implementation.

The ILAC objectives include:

- increasing the use of renewable energy sources until 10 per cent of the regional energy requirements are met;
- increasing natural protected areas and forests;
- improving the management of watersheds and marine and coastal zones;
- adopting regulatory frameworks for access to genetic resources; and
- implementing plans and policies to reduce urban environmental vulnerability to disasters.

ILAC has become one of the most important policy tools for promoting sustainable development in Latin America and the Caribbean. The 14th Meeting of the Forum of Ministers reaffirmed the importance of the initiative and adopted concrete activities to further its goals, focusing on issues such as: access to genetic resources and fair and equitable sharing of benefits arising from their use, water resources, human settlements, vulnerability and land use planning and laws, renewable energies, trade and the environment, economic instruments and fiscal policy, climate change, and environmental indicators.

Source: UNEP 2003b

Box 2: Regulation for private protected areas in Chile

New Chilean legislation introduced in 2003 provides a solid legal framework for the creation and maintenance of private parks. It promotes private investment in the protection of natural resources and biodiversity and is complementary to the existing system of public parks.

With 14 million ha, the Chilean National Protected Areas System (Sistema Nacional de Areas Silvestres Protegidas del Estado, SNASPE) covers almost 20 per cent of Chile. However, 19 of the 85 eco-regions remain unprotected and others are insufficiently protected. Private protected areas, currently covering more than 500 000 ha, could make a considerable contribution to biodiversity protection in the country. With the new regulation, the government aims at significantly expanding the current four per cent of private protected areas and providing for more continuity and coordination in the protection of priority areas.

Sources: Corcuera and others 2002, University of Chile 2003, Villarroel and others (in press)

17.9 million ha (Conab 2003). As the area under this crop increases, traditional agriculture and livestock activities shift to marginal wilderness areas. A similar process is taking place in central Argentina, where soybean is the dominant crop, so other crops and cattle are taking over marginal areas, with increased impacts on water, soil and biodiversity.

The expansion of agriculture and livestock is, more than anything else, due to export opportunities and technological changes. In September 2003, the Brazilian government issued a provisional regulation (MP 131) permitting transgenetic soybean cultivation (WWF 2003a). This measure is a major issue in itself, and also allows further expansion of the area cultivated for soybean production.

FLOODS, DROUGHTS AND HURRICANES

The vulnerability of people and ecosystems in Latin America and the Caribbean to extreme weather events was again in the spotlight in 2003. There were record-breaking floods and droughts, as well as another abnormally heavy hurricane season. Argentina, Brazil, Colombia, Dominican Republic, Ecuador, Haiti and Venezuela all suffered extreme (and above average) floods and/or drought (IRICP 2003a, NOAA 2003, Pittaluga 2003).

Above-average rainfall in March and April brought floods to large areas of the Argentinian province of Santa Fe, resulting in more than 30 deaths, and leaving 150 people injured. There were outbreaks of infectious diseases, serious problems for agriculture and livestock, and disruption of industrial production in some urban areas. More than 28 000 dwellings were damaged, with economic losses estimated at almost US$1 000 million (Pittaluga 2003, ECLAC and UN 2003).

Heavy seasonal rains in October led to floods and landslides in Colombia, affecting some 72 000 people, mostly those displaced by conflict and living in marginal areas (Pittaluga 2003, WFP 2003).

The Dominican Republic suffered severe floods in November, which affected over 65 000 people. There were also sizeable livestock and crop losses (estimated at one month's supply of rice for the country) (IRICP 2003b).

In October, the most serious drought in recent decades reached its peak in central and northern Argentina, adjacent areas in Paraguay and Bolivia and to a lesser degree in western Uruguay. In some Argentine zones, the rainfall was below the historic minimum recorded in 1929 (ECLAC and UN 2003). This caused significant agricultural losses (especially of wheat, with two million tonnes ruined) and livestock, the total costs of which have been estimated at more than US$300 million (Pittaluga 2003). In Paraguay's Chaco region, the drought caused a shortage of food supplies (Pittaluga 2003, ECLAC and UN 2003).

There were more Atlantic hurricanes recorded between 1995–2003 than ever before for a similar period. There were 14 tropical storms, of which seven became hurricanes and three became major hurricanes (NOAA 2003). Mexico was hit by a series of these between

Figure 1: Satellite images of deforestation 2000–2003.
Source: MODIS Land Rapid Response Team at NASA GSFC

This image shows the extent of deforestation in the state of Rondonia, Brazil. Tropical rainforest appears bright red, while pale red and brown areas represent cleared land. Black and gray areas have probably been recently burned. The Jiparaná River appears blue. Most of the clearing is done for agriculture – grazing cattle, and planting crops. Large cattle pastures often replace rainforest to grow beef for the world market. Commercial logging is another common form of deforestation, cutting trees for sale as timber or pulp.

Sources: NASA/ GSFC/ METI/ ERSDAC/ JAROS, and US/ Japan ASTER Science Team

World's highest ski slope in Bolivia soon to disappear.
Source: REUTERS/David Mercado

August and October. Hurricanes Ignacio and Marty are estimated to have caused damage worth $1 000 million, and left some 50 000 people homeless (IRICP 2003). Hurricane Fabian (August to September) was the most destructive to hit Bermuda in over 75 years (NOAA 2003) and it also affected the Eastern Caribbean states to a lesser degree.

Any increased hurricane frequency and intensity increases economic, social and environmental vulnerability, especially in the Caribbean SIDS. Economic losses strain government finances, the loss of property affects vulnerable populations, and the environmental damage is having a negative impact on an already fragile tourist industry upon which many of the Caribbean states depend (see also SIDS section).

RETREAT OF CONTINENTAL GLACIERS

Reports published in 2003 presented, for the first time, multi-country evidence of the possible impact of global environmental changes such as climate change on the region's glaciers (Rignot and others 2003, WWF 2003b – see also the Polar and GEO Indicators sections). Reports from at least five countries (Argentina, Bolivia, Chile, Ecuador, and Peru) present accumulating evidence of the retreat of glaciers and ice fields in the tropical Andes and in the extreme southern part of Andean Patagonia (Rignot and others 2003). In Peru, over the past five decades, significant losses have been reported in the Andean glaciers of Yanamarey, Uruashraju and Broggi. In Ecuador, the Antisan glacier retreated eight times more quickly in the 1990s than in earlier decades. The Chacaltaya glacier in Bolivia, known for its ski runs, has lost half its area and two-thirds of its volume since the mid-1990s (WWF 2003b).

In the southern part of the continent, the Andean ice fields in Argentine and Chilean Patagonia – which cover 17 000 km^2 and have at least 63 glaciers – retreated twice as rapidly from 1995–2000 as they did in the previous 25 years, losing from four to six per cent of their surface area (Rignot and others 2003). Their meltwater supplies nine per cent of the total water in the world originating from glaciers. This is making a significant contribution to the rise in sea level.

New temperature change studies in the southern Andes conclude that the rise in temperature in the 20th century was the main cause of the retreat of the continental ice fields (Rignot and others 2003, WWF 2003b). This supports the connection between such impacts and climate change and once again highlights regional vulnerabilities to global environmental change.

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North America

Environmental issues and developments in North America included climate change, forest fires and biodiversity

Reporting on the environment using indicators was also prominent, with the release of indicator reports which describe and trace trends in various aspects of the environment and sustainability in Canada and the United States (Box 1).

CLIMATE CHANGE

Canada ratified the Kyoto Protocol (Natural Resources Canada 2003), making the climate change issue a national priority, and launched programmes to help reduce greenhouse gas (GHG) emissions to meet the country's reduction target. The Kyoto Protocol commits Canada, which is responsible for three per cent of the world greenhouse gas release, to cut its emissions to six per cent below 1990 levels by 2012.

In the United States, President Bush announced a new climate change strategy, which sets a voluntary 'greenhouse gas intensity' target for the nation (US EPA 2003b). Different approaches can be used to reduce emissions. One approach is to set an 'absolute' target requiring that emissions be reduced by a specific amount; the government's strategy, instead, sets a target for GHG intensity: the ratio of GHG emissions to economic output expressed in gross domestic product (GDP). This strategy expands existing programmes and provides extra incentives encouraging companies to voluntarily report and reduce their GHG emissions. It also proposes increased federal funding for climate change science and technology development. A recent report, *US Technology and Innovation Policies: Lessons for Climate Change*, released in November 2003 by the Pew Center, examined US policy experiences – both successes and failures – and drew lessons for climate change policy. The report cautions that technology policies, while important, can not by themselves achieve the GHG reductions necessary to mitigate climate change. 'Technology policies are only one piece of the solution, and will only work if coupled with other non-technology policies, such as a GHG cap-and-trade program.' (Pew Center 2003).

A new strategic plan for the US Climate Change Science Program (CCSP) was announced in response to the President's directive that climate change research activities be accelerated to provide the best possible scientific information to support public discussion and decision-making on climate-related issues (US CCSP 2003). The plan describes a strategy for developing knowledge of variability and change in climate and related environmental and human systems, and for encouraging the application of this knowledge.

Box 1: Sustainability reporting gains momentum

Environment and sustainability reporting is gaining momentum in North America, and 2003 witnessed the launch of two landmark products: the US Environmental Protection Agency's (EPA) *Draft report on the environment* and the Canadian National Round Table on the Environment and the Economy (NRTEE), *Environment and sustainable development indicators for Canada* report. Both are part of long-term reporting initiatives aimed at strengthening the information base for environment and sustainable development policy-making.

In the US, the draft report, billed as the EPA's 'first-ever national picture of the US environment', was the long-awaited first product of a federal-level Environmental Indicators Initiative. It drew considerable attention both because of the void it filled and due to the omission of climate issues. Related work (the high profile 2002 State of the Nation's Ecosystems project) by The Heinz Center preceded this EPA effort and contributed to raising awareness about the 'environmental information gap'.

Environment and sustainable development indicators for Canada is the final report of the Canadian NRTEE's Environment and Sustainable Development Indicators Initiative. This was a three-year 'multistakeholder program aimed at developing a small set of credible and understandable indicators to track whether Canada's current economic activities threaten the way of life for future generations'. One of the recommendations of the report is that the System of National Accounts be expanded to include measures of natural, human and social capital.

Sources: Heinz Center 2002, NRTEE 2002, US EPA 2003a

Key Facts

- The consumption of chlorofluourocarbons (CFCs), which deplete the ozone layer, has been reduced to nearly zero in North America.
- Emissions that cause acid rain have been reduced with strides made in controlling point source emissions of principal pollutants.
- Wetland loss in North America is slowing down and the land set aside for protected areas has increased by about 3.5 per cent since 1990.

Both Canada and the United States:

- place a high priority on deepening the understanding of the linkages between human health and environmental issues, whether it be air quality, the sound management of chemicals or contamination of fresh water supplies;
- are at the forefront of research to address climate change. Canada has ratified the Kyoto Protocol and has launched several programmes to help reduce greenhouse gas emissions. The US announced a new climate change strategy in 2003, which sets out a voluntary programme to reduce greenhouse gas intensity;
- with Mexico, have agreed to a North American strategy for biodiversity conservation, under the auspices of the Commission for Environmental Cooperation; and
- consider scientific research a high priority and a foundation for policy, and are actively seeking to improve environmental indicators. Both promote pollutant release inventories, and the provision of environmental information to the public.

Sources: CEC 2003, Environment Canada 2003a, Heinz Center 2002, Natural Resources Canada 2003, UNEP-WCMC 2003

Both countries also separately announced initiatives to develop and test hydrogen fuel-cell technologies and the systems needed to put them into widespread use. For example, the US government announced a hydrogen fuel initiative to reverse America's growing dependence on foreign oil (White House 2003a). The initiative is complemented by the International Partnership for the Hydrogen Economy, a partnership of 15 countries and the European Union to promote the development and application of hydrogen technology (US Department of Energy 2003).

In relation to air pollution, both countries announced in June a new Border Air Quality Strategy that will involve joint pilot projects to improve air quality (Environment Canada 2003b). One of the projects, the Georgia Basin/Puget Sound International Airshed Strategy, will identify measures to reduce emissions to the atmosphere and address transboundary pollution in northwestern Washington State and southwestern British Columbia (US EPA 2003b). Both governments also agreed to build on the transboundary air quality improvements of the last decades by beginning to develop new cooperative projects. Driven by domestic and international challenges, both countries are taking a lead in the development of new technologies to find solutions to environmental problems.

A partnership of 15 countries and the European Union are working together to promote the development and application of hydrogen fuel cell technologies and the systems needed to put them into widespread use.

Source: Still pictures

In Canada, a prominent element of the government's strategy was to impose, through its On-Road Vehicle and Engine Emission Regulations, strict new emissions standards for on-road vehicles and engines (Environment Canada 2003c). The regulations, which will be effective for the 2004 model year, will align Canadian emission standards for on-road vehicles and engines with those of the US EPA. The US measures are recognized as the most stringent national standards in the world.

FOREST FIRES

Both Canada and the US suffered a severe fire season. In Canada, the 2003 fire season was especially harsh in the Province of British Columbia. For example, in August 2003, the provincial government issued its most restrictive travel advisory ever after a wildfire near the city of Kelowna grew fivefold in a day. The wildfire at Okanagan Mountain Provincial Park, which started at a relatively manageable size, grew over several weeks, eventually covering more than 250 km^2 . Gusting winds, bone-dry forests and a lack of rain were blamed for the fire's growth. Two-kilometre-wide fire fronts burned through timber at rates of up to 50 metres per minute. The Province of British Columbia estimates that it spent more than US$400 million fighting forest fires in 2003 (Makarenko 2003).

In the US, in October 2003, fires raging from just north of Los Angeles to the Mexican border became one of the worst natural disasters to strike California State in years, darkening the skies, and raining ash over much of the surrounding area (Figure 1). In all, the southern California fires killed 20 people, burned almost 300 000 ha and destroyed about 3 400 homes. They are considered the worst in the state's modern history (Keating and Whitcomb 2003).

One of the major policy developments in the US is a new forestry bill, approved by the US Senate in 2003 (White House 2003b). It will give managers of the nation's 155 national forests more leeway to approve logging and other commercial projects with less formal environmental review. The plan overhauls the 1976 National Forest Management Act, easing environmental rules and allowing more tree thinning. California's lawmakers, who consider that thinning underbrush and small trees is crucial to prevent devastating wildfires, have praised the bill (Daly 2003).

BIODIVERSITY

Canada and the US together with Mexico adopted both national and regional measures to strengthen conservation. In Canada, for example, a new federal act to protect endangered species, the Species at Risk Act, became effective in 2003 following several years of intensive consultations. In addition, more than 450 km^2 of the Canadian Forces Base Suffield in Alberta was officially designated in June 2003 as Canada's 51st National Wildlife Area. This designation represents a significant contribution to the Government of Canada's goal of establishing protected areas to preserve critical wildlife habitats and protect species at risk. (Environment Canada 2003d).

In the US, The H. Heinz III Center for Science, Economics and the Environment, produced the first *Annual Update 2003*, a Web-only revision to the groundbreaking report *The State of the Nation's Ecosystems*, originally published in 2002 (Heinz Center 2002). The report lays out a blueprint for periodic reporting on the condition and use of ecosystems in the United States. Developed by experts from business, environmental organizations, universities, and federal, state, and local government agencies, it is designed to provide policymakers and the general public with a succinct and comprehensive – yet scientifically-sound and non-partisan – view of progress. *The State of the Nation's Ecosystems* identifies what should be measured, counted, and reported so that decision-makers and the public can understand the changes occurring in the American landscape. The new data contained in *Annual Update 2003* demonstrate a continuation of existing trends; no major deviations were reported (Heinz Center, 2004).

In keeping with a negotiated agreement to expedite the protection of 29 species under the Endangered Species Act, the US Fish and

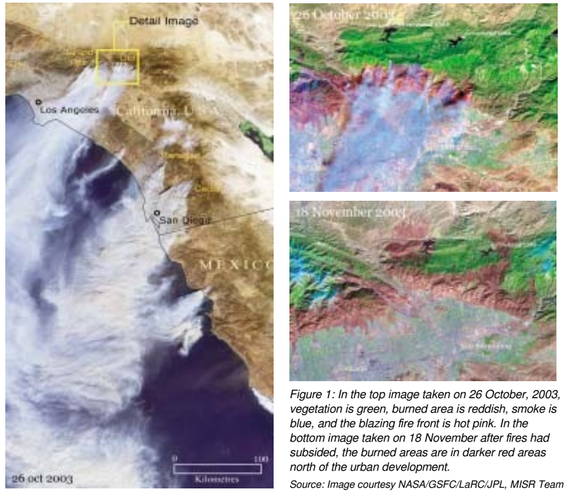

Figure 1: In the top image taken on 26 October, 2003, vegetation is green, burned area is reddish, smoke is blue, and the blazing fire front is hot pink. In the bottom image taken on 18 November after fires had subsided, the burned areas are in darker red areas north of the urban development.

Source: Image courtesy NASA/GSFC/LaRC/JPL, MISR Team

Wildlife Service (US FWS) acted in 2003 to protect seven species in five states (White House 2003c).

At the regional level, Canada, the US and Mexico adopted in June 2003 a long-term strategy for the conservation of critical species and habitats in North America (CEC 2003). The biodiversity strategy has been described as a 'landmark of cooperation' that creates an opportunity for North America to serve as a 'global leader' (CEC 2003) through the development of cooperative approaches to address biodiversity issues over which there is shared concern. The main goals of the strategic plan are to:

- promote the conservation of regions of ecological significance, migratory birds and transboundary species;
- facilitate data and information sharing on monitoring and assessment, as well as best practices and priorities;
- promote collaborative responses to the threats faced by ecosystems, habitats and species; and
- identify and evaluate trade and biodiversity linkages.

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West Asia

In 2003, the war in Iraq and increased tension in the Israeli-Arab conflict were the major developments of concern in West Asia. Although the governments of the region, the public and the international community were concerned over the environmental consequences of armed conflict, policymakers gave political developments and security issues highest priority

One of the main highlights related to freshwater resources in 2003 were signs evident from satellite imagery of a reversal of recent degradation trends in the Mesopotamian marshlands in Iraq (Box 1). There were also some positive policy developments in the area of air pollution (Box 2), institutional reforms, and public participation.

THE IMPACT OF WAR

The most significant event in 2003 in the political and environmental arena was the war in Iraq. Chronic problems, which accumulated over the past two decades under the former Iraqi government and the economic impact of sanctions, were exacerbated by the war. While the long-term environmental impacts of the war are as yet unclear, the short-term problems included water pollution (Box 3) and land degradation.

The destruction of military and industrial infrastructure released heavy metals and other hazardous substances into the air, soil and water (UNEP 2003a). Fires at Rumeila oil wells in southern Iraq and in oil trenches in and around Baghdad, generated large quantities of dense black smoke, containing toxic substances, with potential environmental and human health risks for local people (Figure 1). The oil trenches also cause soil pollution and potentially threaten contamination of aquifers and drinking water supplies (UNEP 2003a). Fire at the Al-Mishraq sulphur plant, 30 km south of Mosul in Northern Iraq, which lasted for about a month between June–July 2003 (UNEP 2003a), also contributed to air pollution.

A recent UNEP desk study on the environment in the Occupied Palestinian

Key Facts

- The total population of West Asia has increased from about 34.8 million in 1970 to 106.4 million people in 2002, and is projected to increase to about 130 million in 2010.
- Rapid population growth has induced growth and expansion of urban centres. For example, in the Gulf Cooperation Council (GCC) countries, the average percentage of the urban population increased from 66 per cent in 1980 to 87 per cent in 2000, and is projected to be 89 per cent by 2005.
- About 60 per cent of surface water resources in West Asia originate from outside the region, which causes tension regarding their use.
- Six GCC countries – Bahrain, Kuwait, Qatar, Oman, Saudi Arabia and United Arab Emirates – produce about half the world's desalinated water.
- Agriculture remains the largest water user in West Asia (91 per cent of the total water used) compared to 6 per cent and 3 per cent for domestic and industrial uses respectively.
- Forest wildfires are a recurring phenomenon in the Eastern Mediterranean forest vegetation, with 90 per cent caused by human activity. In 2003, they occurred in Lebanon, Syria and Saudi Arabia.
- Since 1991, Iraq's rank on the United Nations Human Development Index has fallen from 96 to 127. No other country has fallen so far, so fast. Over 60 per cent of the population – 16 million people – depended for survival on a comprehensive government food rationing system.

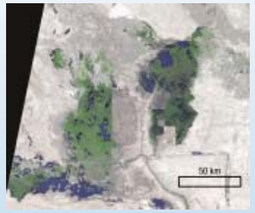
Sources: Alyaum 2003, CESR 2003, FAO 2003, Roufail 2003, UNEP 2003a, UNEP 2003b, UNPD 2002

Box 1: Mesopotamian marshlands 2003

The Mesopotamian marshlands, the largest wetland ecosystem in West Asia, now cover only seven per cent of their original area due to mismanagement over the past three decades.

The marshlands, which are reputed to be the site of the Garden of Eden, are an important sanctuary for migratory birds, sustain freshwater fisheries and are an essential nutrient source for fisheries in the Sea Area of the Regional Organization for the Protection of the Marine Environment (ROPME).

In the early 1970s, the marshlands covered more than 20 000 km ^{2} but by 2000, over 90 per cent had dried out, largely transformed into a vast and barren landscape of desert and salt flats. A third of the remaining 1 084 km ^{2} of marshland, the transboundary Al-Hawizeh/Al-Azim marsh, which straddles the Iran-Iraq border, dried out between 2000 and early 2003.



This image shows the main areas that were re-flooded following the spring snowmelt and removal of drainage and hydraulic structures by local communities in May 2003. Flood swollen rivers, canals, and re-inundated enclaves appear as dark blue patches.

Source: UNEP/GRID-Geneva 2003

However, signs of an environmental turnaround in the marshlands started to emerge almost immediately after the end of the war in May 2003, as the arid land was re-flooded for the first time in a decade. Satellite images taken in May 2003 show these changes. Formerly dry areas have been inundated as floodgates were opened, embankments and dykes breached, and dams emptied upstream, assisted by the heavy rainfall.

Sustained and coordinated efforts will be needed if the marshes are to recover.

Sources: UNEP 2003c, UNEP/GRID-Geneva 2003

Figure 1: Satellite images of smoke from oil trench fires over Baghdad during the Iraq War, 2 April, 2003.

Source: USGS EROS Data Center/UNEP/GRID-Sioux Falls

Box 2: Energy and transport – the development of a regional strategy

Per capita energy consumption in some West Asian countries is among the highest in the world, generating high emissions of greenhouse gases and traditional air pollutants. Countries are now developing a regional strategy to improve energy efficiency.

The strategy is being developed within the framework of the Water, Energy, Health, Agriculture, and Biodiversity (WEHAB) initiative, which advocates energy efficiency and alternative fuels, as well as cleaner fuels and technologies. These were reflected in the Abu Dhabi Declaration on Environment and Energy, issued jointly by the Arab Ministers of Energy, Oil and Environment during the Environment and Energy 2003 Conference and Exhibition convened in Abu Dhabi, United Arab Emirates in February.

Policy approaches in the region have focused mainly on switching to less polluting fuel types, such as unleaded motor vehicle fuel and natural gas. All the GCC countries and some other Arab States phased out leaded petrol in 2003. Among other initiatives, Lebanon, for example, has banned all old diesel vehicles from entering major urban areas, and legislated their replacement with newer petrol-powered engines. Efforts are also being made to introduce more sustainable fuels for power generation.

Sources: ERWDA 2003, UNDP 2003, UNEP 2003a

Territories identifies serious environmental problems, including sewage pollution, waste of water resources and problems with solid waste handling as a result of the escalating Israeli-Arab conflict (UNEP 2003d). The study further states that the relative scarcity of water in the Territories is a major constraint to economic development. The quality of water is rapidly deteriorating, mainly from agricultural practices, localized industrial activities, and inadequate or improper disposal of wastewater and solid waste. Over-pumping has resulted in seawater intrusion of groundwater, especially in Gaza. It also reports that the separation wall would not only separate people from their agricultural land and water wells, but would have environmental impacts, for example, fragmenting ecosystems and disconnecting natural ecological corridors.

SANDSTORMS, FLOODS, HEATWAVES, FOREST FIRE: SIGNS OF ENVIRONMENTAL CHANGE?

The increased incidence in 2003 of immense dust and sandstorms, as well as floods, heatwaves and forest fires in West Asia may indicate long-term environmental change. Countries are, however, taking measures to improve coping capacity in terms of natural disasters.

Seven years of severe droughts in West Asia came to an end in 2002–2003 with record rainfall. Heavy rain flooded rivers, wadis and agricultural areas in Jordan, Lebanon, Oman, Syria and Saudi Arabia. There were other extreme weather related events:

- The heaviest snowstorm since 1950 swept across the Eastern Mediterranean on 25 February, cutting power and closing highways and schools in Lebanon, Jordan and Syria (NOAA 2003a, BBC Weather 2003);
- In Oman, thunderstorms on 14 April produced torrential rains and flash flooding in the northern part of the country, leaving 14 dead, and causing extensive damage to property (Gulf News 2003);
- In Nizwa, southwest of the capital city of Muscat, 66 mm of rain fell in one day, which is more than double the normal rainfall received in the entire month of April (NOAA 2003b);
- In the Makka area in western Saudi Arabia, flooding from the heaviest rain in 25 years caused 12 fatalities and 50 injuries (Al-watan 2003); and
- Similar intense floods occurred across the kingdom during December, disrupting power supplies and telephone services;

Streets of Alriyadh city, central Saudi Arabia, after flash floods on December 3, 2003.

Source: Alriyadh Daily Newspaper

Box 3: Impact of conflict on freshwater systems

Physical damage to Iraq's water and sanitation infrastructure has led to higher levels of pollution and health risks, worsening an already critical waste management situation, particularly in urban areas. There were reports of water logging and salinization as a result of regular power blackouts, which seriously affected the pumping out of saline water from irrigated lands in the southern floodplains.

In addition, the collapse of sewage treatment systems due to frequent power cuts has resulted in large amounts of sewage, mixed with industrial waste, entering directly into water bodies such as the Tigris River, Baghdad's only water source.

The indirect impacts on water quality and quantity occur as a result of conflict-related institutional challenges. Chronic uncoordinated and fragmented management of water resources and infrastructure has contributed to water quality and quantity degradation.

Source: UNEP 2003a

destroying farms, greenhouses, and buildings; and killing a large number of domestic animals (Civil Defense 2003).

Overall, the rains in West Asia were far more severe than had been anticipated, and the region was ill-prepared to deal with the impacts. Human lives were lost, and fish farms, large areas of agricultural land, and irrigation networks were destroyed.

Severe dust and sandstorms were frequent in 2003, affecting large areas (Figure 2) and increasing the risk of respiratory, eye and skin diseases.

West Asia was no exception to the heatwave which affected many other parts of the world during the year, the third hottest year in more than 150 years (WMO 2003). Although high temperatures are common, heatwaves of up to five degrees Celsius higher than normal swept across the region (NOAA 2003b). Even the GCC countries, usually well-prepared for the heat, had problems with power systems, and cases of heat-related illnesses and deaths were reported around the region.

Forest fires were also associated with weather patterns in West Asia. Lightning ignited forest fires in Saudi Arabia, along the Syrian-Turkish borders, and also in Syria (NASA 2003). In August, fires broke out in many parts of Lebanon, during a heatwave, destroying pine forests in the Shweifat area near the capital, and pines and other trees in the north (Alyaum 2003).

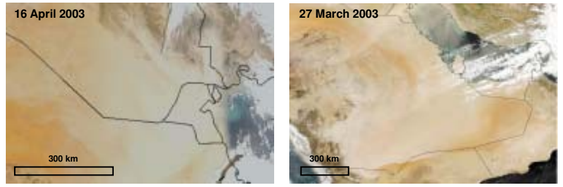


Figure 2: Satellite images of sandstorms in West Asia in 2003. Images were taken over Iraq (April 16) and Saudi Arabia (March 27).

Source: MODIS Rapid Response Project at NASA/GSFC

COASTAL DEGRADATION

Dredging and land reclamation in coastal and marine areas in West Asia intensified during the year, particularly in GCC countries. These activities were due to development of recreational facilities to meet growing tourism, urbanization and population increase characterized by migration to coastal areas. An emerging trend of large-scale land reclamation to boost economic growth is now evident in some parts of the region. This rapid rate of development in coastal areas, especially in the Gulf region, was the most striking development in West Asia other than war. However, concerns have been expressed that some of these developments may put pressure on the environment as well as existing infrastructure. Major environmental effects of dredging and in-filling include direct loss of often highly productive shallow-water habitat; and sedimentation, leading to degradation particularly of coral reefs, seagrass, and macroalgal beds.

CHALLENGES FOR THE FUTURE

Environmental issues linked with conflict and security were of major concern. Short-term impacts such as water and air pollution and land degradation are obvious and require immediate action.

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Polar

Atmospheric emissions, environmental pollution, and the impacts of activities associated with the exploitation of natural resources had negative impacts on the Polar Regions

Evidence continued to emerge in 2003 that average temperatures in the Arctic were rising even more rapidly than the global average. Satellite data indicated that the rate of the surface temperature increase over the last 20 years was eight times the global average over the last 100 years (Comiso 2003).

POLAR SEA ICE EXTENT

Studies reported that the Arctic sea ice extent had shrunk by 7.4 per cent over the past 25 years, with record-low coverage in September 2002 (Johannessen and others 2003). An analysis of 30 years of satellite data suggests that the loss of Arctic sea ice is also accelerating (Cavalieri and others 2003).

There are projections that much of the sea ice, until now thought to be permanent, will melt during the summer by the end of this century if the current trend in global warming continues. This will have major direct impacts on indigenous people and Arctic marine wildlife such as polar bears and seals, and will also open the region to increased development pressure as access by sea to valuable natural resources becomes easier (Figure 1). The global impacts may also be significant as absorption of solar radiation increases, and could lead to changes in the world ocean circulation (UCL 2003, NASA 2003, Laxon and others 2003).

In the Antarctic, satellite data indicate that the overall extent of sea ice has gradually increased since 1977, following a significant decrease in the early part of the 1970s (Cavalieri and others 2003). This reversal demonstrates a greater variability in the trend for Antarctic sea ice extent in comparison to a more consistent trend of decline in the Arctic. However, on the Antarctic peninsula, and in the Amundsen Sea sector of west Antarctica, several ice shelves that were thousands of years old have disintegrated within the last few decades – a sign of rapid change in the region (Shepard and others 2003).

Key Facts

- Inuit populations in Greenland and Canada were found to have one of the highest environmental exposures in the world to some persistent organic pollutants and mercury.
- An analysis of satellite data indicated that Arctic sea ice has retreated by 900 000 km ^{2} – an area the size of Nigeria – over the last 30 years.
- The stratospheric ozone hole over Antarctica peaked in size at 28 million km ^{2} in mid-September 2003, the second largest value on record.

Sources: AMAP 2003a, BAS 2003a and 2003b, Cavalieri and others 2003

Argentine scientists have documented surges in tributary glaciers following these break-ups (de Angelia and Skvarca 2003). Their study – with new results from theoretical models – suggests that ice shelves may play an important role in the stability of some inland ice streams, and their loss could result in the accelerated collapse of glaciers. Particular attention is being paid to the behaviour of critical ice flows in the West Antarctic ice sheet, which could raise global sea level by five metres, were it to collapse completely (Casassa 2003).

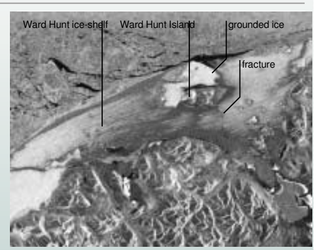
Figure 1: Projection of Arctic sea ice extent by 2030 and possible ice-free transpolar shipping routes

Source: New Scientist 2002

Box 1: Ward Hunt Ice-shelf

The Arctic's largest ice-shelf is breaking up. The Ward Hunt Ice-shelf is a remnant of the compacted snow and ancient sea ice that extended along the northern shores of Ellesmere Island in Northern Canada until the early 20th century. Rising temperatures have reduced the original shelf into a number of smaller shelves, the largest of which was the Ward Hunt Ice-shelf on the northwest fringe of the island. Between 2000–2002, the Ward Hunt Ice-shelf began to crack and eventually broke in two. This Standard Beam Mode RADARSAT-1 image, which was acquired September 27, 2003, clearly shows a large crack dividing the ice-shelf in half. The crack runs from the Arctic Sea to the right of Ward Hunt Island and the bright white ice grounded there and back to the rougher, mountainous region.

Source: Earth Observatory 2003



Break-up of the Ward Hunt Ice-shelf.

Source: NASA and Earth Observatory

The break-up of the Ward Hunt sea ice-shelf in northern Canada (Box 1), the Arctic's largest, was also reported in 2003 (Mueller and others 2003). The Ward Hunt has existed for some 3 000 years. When it was mapped by explorers in the 1870s it was 1 000 km long and 60 km wide. By the late 1990s, its dimensions had decreased to some 70 km by 20 km, and now it's disintegration is almost complete.

This sequence may be attributed to natural climate variability. However, just as the recent collapse of ice shelves in west Antarctica has been interpreted as evidence of accelerated climate change in that region, the break-up of the Ward Hunt may suggest the same in the high Arctic (Mueller and others 2003).

Box 2: International conventions addressing Arctic contaminants

Most of the critical contaminants impacting the Arctic environment and the health of its inhabitants come from distant sources. The solution to these problems, therefore, lies in regional and global efforts to reduce worldwide emissions of persistent organic pollutants (POPs) and heavy metal pollutants.

2003 marked the entry into force of two important regional protocols under the Convention on Long Range Transboundary Air Pollution (LRTAP) set up under the United Nations Economic Commission for Europe (UNECE).

The Protocol on Persistent Organic Pollutants (POPs), entered into force on 23 October 2003. It bans or severely restricts the use of 16 substances, including 11 pesticides, two industrial chemicals and three industrial by-products/contaminants.

The LRTAP protocol on heavy metals entered into force on 29 December 2003, and targets cadmium, lead and mercury. Parties are required, by 2012, to reduce their emissions for these three metals below their level in 1990 (or an alternative year between 1985–1995). It will target industrial sources (metals industry), combustion processes (power generated and road transport) and waste incineration.

Sources: AMAP 2003b, UNECE 2003

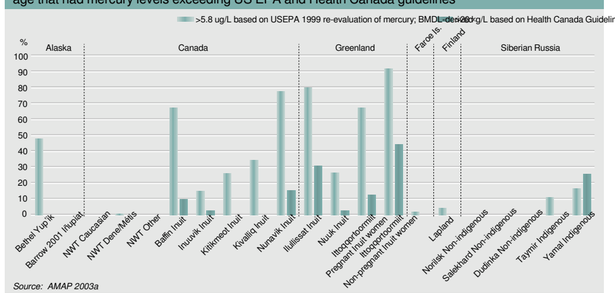
ENVIRONMENTAL POLLUTION

The Polar Regions are particularly exposed to the effects of pollutants emitted in other parts of the globe (Box 2). Though most sources of pollutants are located far from the Polar Regions, some human-made chemicals can be transported over long distances by prevalent winds, ocean currents and other mechanisms such as grasshopping of Persistent Organic Pollutants (POPs) (Wania and Mackay 1996) and have an impact on the polar environment through a variety of biological and chemical mechanisms.

The resident population of the Arctic bears the effects of environmental pollution. Indigenous people are particularly exposed to heavy metal and persistent organic contaminants through their traditional diets based on marine mammals. In some areas of East Greenland, up to 100 per cent of the population was found to have levels of blood contamination higher than a 'level of concern', and 30 per cent were over the level of action at which people were advised to reduce their intake of traditional food (Figure 2) (AMAP 2003a). Indigenous peoples' organizations are undertaking a number of monitoring programmes to assess the risks and benefits associated with traditional diets and to design community-level strategies to cope with the situation (Crump 2003).

Implementation of the 1979 Geneva Convention on Long Range Transboundary Air

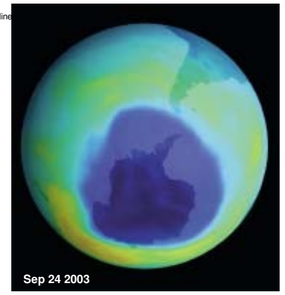
Figure 2: Percentage of blood samples taken from indigenous and non-indigenous women of reproductive age that had mercury levels exceeding US EPA and Health Canada guidelines



Source: AMAP 2003a

Figure 3: The 2003 ozone hole over Antarctica dark blue denoting high levels of ozone depletion was very large, close to the all-time record.

Source: NASA 2003



Pollution (Box 2) and the Stockholm Convention on Persistent Organic Pollutants is important for reducing the burden of contamination on the Arctic and its inhabitants.

STRATOSPHERIC OZONE DEPLETION IN ANTARCTICA

Over the past few years, the ozone hole over Antarctica has varied considerably in size and severity. In 2002, both its size and the time it stayed in position were less than usual (Angell and others 2002). In 2003, however, the ozone hole developed comparatively early and in September was one of the biggest on record. The resulting depletion covered the entire Antarctic area by mid-September (BAS 2003a) (Figure 3). Some scientists believe that it will take a decade or more before it will be clear whether the ozone layer is recovering – assuming that the global phase-out of ozone-depleting chemicals continues successfully (BAS 2003b).

EXPLOITATION OF NATURAL RESOURCES

Exploitation of mineral resources is an important driver of change in many areas of the Arctic, including northern Canada, Alaska, Norway and Russia. There has been increasing interest in exploiting hydrocarbon resources in the Arctic, motivated by higher oil prices, and a geopolitical trend towards diversification in sources of oil supply. Development pressure is also increasing, with the building of new roads, oil and gas infrastructure, holiday cabins, and new military training grounds, all contributing to the fragmentation of wilderness areas (Nellemann and Vistnes 2002, Nellemann and others 2002). Environmental impacts can be direct and obvious in the event of oil spills, or indirect, such as pipelines, roads and power transmission lines, which, with spreading human settlements, fragment natural habitats.

In the latest release of the United Nations List of Protected Areas a significant increase in the protected areas of key Arctic biomes was reported (Chape and others 2003). In particular, the proportion of tundra listed as protected has increased from 8.4 per cent in 1997 to 11.8 per cent in 2003. Significant new protected areas were also declared in Svalbard and northern Canada during the year.

However, the protected areas are distributed unevenly across Arctic countries and biogeographic zones, and levels and effectiveness of protection vary. The size of some areas is not enough to sustain biodiversity or the traditional lifestyles of indigenous peoples.

In the Antarctic the management regime has evolved quite differently, and implicitly builds on international coordination through the Antarctic Treaty System. The main, and substantial, challenges presented from exploitation of natural resources come from the fishing fleet operating in the Southern Ocean, and the threat to the marine ecosystems from illegal, unregulated and unreported activities.

CHALLENGES FOR THE FUTURE

The events and information brought forward in 2003 suggest:

- significant and accelerating climate change impact on the polar environment;
- significant and concerning impacts of pollutants from distant sources on human health and polar fauna; and
- a potential for long-term damage to the polar environment through unsustainable development.

However, there was also evidence of an increasing international political will to address environment and sustainable development issues in the polar areas.

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Small Island Developing States

Small Island Developing States (SIDS) face economic, social and environmental vulnerability due to factors such as their size, geography, fragile ecosystems and dependence on imports of essential commodities

Some well known challenges are certain to dominate debate during the 10-year review of the Barbados Programme of Action for the Sustainable Development of Small Island Developing States (BPoA + 10) scheduled for Mauritius from 30 August–3 September, 2004.

SIDS are heavily dependent on a natural environment exposed to impacts from internal and external forces, including fluctuating commodity prices and trade regulations, and climate change. This situation is exacerbated by the relatively low Human Development Index of many of these countries (UNDP 2003) (Table 1).

GROWING VULNERABILITY OF COUNTRIES

The SIDS have been facing problems such as narrow resource bases, vulnerability to natural hazards, high external debt, difficulties in conforming to sanitary and phytosanitary regulations, overexploitation of forest and marine resources, high population growth and mobility, relative poverty, skilled human resource scarcity and weak institutional capacities (SIDSNet 2003a). The Food and Agriculture Organization (FAO 2003a) reported that the SIDS are increasingly dependent on food imports while the rates of nutrition-related health problems are growing.

Table 1: Human Development Index rank for selected SIDS

High ranking	Medium ranking	Low ranking
Bahamas, Bahrain, Barbados, Cuba, Seychelles, St. Kitts and Nevis, Trinidad and Tobago	Antigua and Barbuda, Cape Verde, Comoros Dominica, Dominican Republic Fiji, Grenada, Jamaica, Maldives, Mauritius, Papua New Guinea, São Tomé and Principe, Solomon Islands, St. Lucia, St. Vincent and the Grenadines, Vanuatu, Western Samoa	Haiti, Madagascar

Source: UNDP 2003

Climate change, including sea level rise and vulnerability to natural disasters such as hurricanes, is a major concern (Box 1). It has been projected that sea levels will increase by half a metre by 2100, severely threatening islands and low-lying coastal states and the very existence of some SIDS. If the sea level rises in the Maldives, for example, a large proportion of the landmass could disappear over the next 30 years, and be completely submerged by 2100 (IPCC 2001). Climate change and sea level rise are also expected to have adverse impacts on other natural resources of SIDS, such as land, freshwater, forests, and coastal and marine areas (IPCC 2001).

Global warming is also likely to lead to an increase in maximum tropical cyclone wind speeds and lower central pressures, leading to more damaging storm surges.

The Pacific, Caribbean, and the AIMS (the Atlantic, Indian Ocean, Mediterranean and the South China Seas) regions of SIDS reported in 2003 on their growing vulnerability. Meeting in August 2003, the Pacific SIDS noted that the vulnerability of SIDS has not only increased over the last decade but their resilience has not improved (SIDSNet 2003c).

SIDS have been trying to respond to these challenges by implementing various measures. Governments in the AIMS region reported in 2003 that they have been developing climate change action plans and identifying their most vulnerable sites, with some countries implementing adaptation measures. All countries in the region have submitted their initial national communications to the UNFCCC (SIDSNet 2003d). A meeting of the AIMS countries in Cape Verde in September 2003 noted the increasing risk of the adverse effects of climate change, highlighting the urgency for the international community to ratify and fully

Box 1: Forum highlights climate change concerns

At the 34th Pacific Islands Forum meeting in Auckland in August 2003, the SIDS countries adopted a communique, which highlighted among several concerns, those of climate change, climate variability and sea level rise.

The communique stressed the need for:

- urgent action to reduce greenhouse gas (GHG) emissions and for further commitments in the future by all major emitters;
- all countries to commit to a global effort to reduce GHG emissions and the adverse impacts of climate change, taking into account the special circumstances of SIDS;
- Forum members to advocate internationally for immediate reductions and limits to GHG emissions at levels that will prevent dangerous interference and for the Council of Regional Organizations in the Pacific to continue to provide support at the UN Framework Convention on Climate Change (UNFCCC) related meetings;
- a range of adoption options, particularly for extreme weather and climate events, that are maintained and well funded, including through the Global Environment Facility; and
- being proactive and developing appropriate, affordable, and cost-effective adaptation response measures immediately with support from relevant regional and national institutions.

Source: SIDSNet 2003b

implement the Kyoto Protocol. They also recognized the need to identify and develop policies that build SIDS' resilience, redressing vulnerability comprehensively. This includes the need to diversify economies and address security concerns. (SIDSNet 2003d).

Some AIMS countries have established national early warning systems and disaster mitigation plans, including national and regional oil spill contingency plans. However, national capacity is unlikely to cope with the growing frequency of extreme weather events, and the costs associated with rehabilitation. The meeting, therefore, called for further international assistance to develop capacity for national disaster mitigation preparedness and create appropriate insurance and re-insurance schemes for SIDS (SIDSNet 2003d).

The Caribbean SIDS consider that, to build resilience, there is a need:

- for assistance from the international community to develop climate change models at scales appropriate to SIDS to better plan for adaptation to climate change;
- to mainstream adaptation to climate change into various sectors, particularly agriculture, fisheries, health and water resources management;
- to incorporate climate change adaptation concerns in national sustainable development plans; and
- to improve public education and awareness of climate change issues in the region (UNDESA 2003).

Concern over the vulnerability of the environment in SIDS has also led to the development of the Environment Vulnerability Index (EVI), which reflects a country's environmental vulnerability to damage and degradation. Development of the EVI is being undertaken by the South Pacific Applied Geoscience Commission (SOPAC), and preliminary results were released in 2003 (Kaly and others 2003). The results confirmed that SIDS are among the most vulnerable countries in the world.

BIODIVERSITY

Many small islands are characterized by a high level of endemism. For example, Madagascar has the highest number of endemic species of any country in Africa, and ranks sixth in the world. Up to 8 000 of the 9 500 species of higher plants and over 50 per cent of all vertebrate species found on the island are known or thought to be endemic. In Mauritius, around 50 per cent of all higher plants, mammals, birds, reptiles and amphibians are endemic, and the Seychelles has the highest level of amphibian endemism of any island country in the world (UNEP 2002). Over 1 200 species of reef fish, 250 species of haematitic corals and 285 species of algae have been identified in the Maldives. In addition, five sub-species of seabirds have been identified as endemic to the Maldives (UNEP RRC-AP 2003). Despite such richness in biodiversity, many species in SIDS already face extinction (Table 2). Virtually all the SIDS have species threatened with extinction and these total about 1 680 (UNSD 2003), excluding Madagascar but also including more developed countries such as Singapore and Malta. Biodiversity is threatened by habitat degradation/loss, alien species, overexploitation of living resources, climate change, and other factors.

The Pacific Islands contain the world's highest proportion of endemic species per unit of land area or human inhabitants. There are already far too many examples of illegal access, overexploitation, and extinction of Pacific Island biological resources, and the loss of associated traditional knowledge (SIDSNet 2003c).

Coral reefs, among the most biologically diverse ecosystems, have experienced widespread degradation in all three SIDS regions due to global warming, pollution, destructive fishing practices and other pressures (Burke and others 1998, Wilkinson 2000). Many poor people are economically dependent on coral reefs and their degradation has significant implications for poverty in SIDS (Wittingham and others 2003). Likewise, reefs underpin the lucrative tourist activities of many SIDS and their economies.

Table 2: Number of endemic, threatened and extinct species by SIDS regions (2003)

	Indian Ocean	Caribbean	Pacific Ocean
Plants			
Endemic	406	2 010	222
Threatened	380	2 595	273
Extinct	47	23	0
Total number of species	1 171	7 328	3 492
Animals			
Endemic	303	698	824
Threatened	196	571	427
Extinct	44	51	24
Total number of species	4 273	13 891	11 270
Number of protected areas	124	823	219

Source: UNEP-WCMC 2003

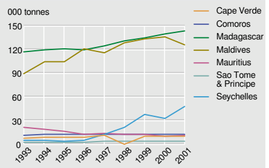
A recent study shows that up to 80 per cent of shallow-water reefs in some areas of the Caribbean have been destroyed (Gardner and others 2003). However, reefs in deeper waters of the Caribbean appear to be in better condition (Kramer 2003).

Many SIDS have established both marine and terrestrial protected areas. Since 1961, over 50 marine reserves have been established in the Caribbean, with the rate of establishment increasing since the mid-1980s (Appeldoorn and Lindeman 2003).

FISHERIES

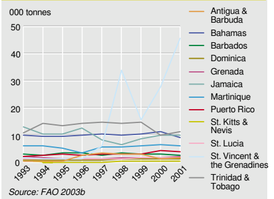
Data published in 2003 show trends in marine fish catches for the period 1991–2001 for selected SIDS for the Atlantic and Western Indian Ocean, Caribbean, and Pacific (Figures 1–3). Although the catches of a few countries showed significant increases, most have been stable or have declined. Considering the general increase in fishing pressure, this may indicate that the fish stocks of these countries are already being exploited at or above their maximum sustainable levels, with little or no potential for further increases under current management regimes (FAO 2002). Levelling off or declining fish catches are significant in view of the projected increases in human population

Figure 1: Marine fish-catches for the period 1991–2001 for selected SIDS in the Atlantic and Western Indian Oceans



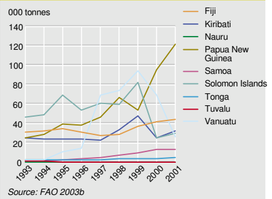
Source: FAO 2003b

Figure 2: Marine fish-catches for the period 1991–2001 for selected SIDS in the Caribbean



Source: FAO 2003b

Figure 3: Marine fish-catches for the period 1991–2001 for selected SIDS in the Pacific



Source: FAO 2003b

Bleached Anemones caused by ocean warming.
Source: Still Pictures

in SIDS, and the dependence of national economies and subsistence livelihoods on SIDS fisheries resources (see also section on Emerging Challenges).

Increased catches can also be a source of concern. For example, a record tuna catch in the Indian Ocean in 2003, which is about 100 000 tonnes greater than the sustainable limit, has prompted the Indian Ocean Tuna Commission to express concerns about depletion of tuna stocks in this region (Seychelles Nation 2003). According to FAO (2002), most tuna stocks are fully exploited in all oceans, including the Western Indian Ocean, and some are overfished or severely depleted.

FRESHWATER

Availability of freshwater is a serious issue in many small islands. Rainfall is often unpredictable and variable, and run-off high. Related issues include increasing domestic, agricultural and industrial consumption, lack of storage capacity, and pollution from a variety of sources. There are, therefore, problems with both the quality and quantity of water. As climate change has an impact on rainfall patterns, many SIDS will experience increased periods of drought (IPCC 2001). This has already become a problem in Cape Verde and Madagascar which are now suffering drought-related food emergencies (FAO/GIEWS 2003).

In the Pacific, there are particular problems with maintaining water supply and quality in low and raised atolls, with the threat of poor effluent disposal, fertilizers and pesticides entering water supplies, leaching from waste dumps, activities close to boreholes which can pollute groundwater, and possible salt water intrusion during storms or rising sea level.

NATURAL DISASTERS

In December 2003, for the first time in decades, the Caribbean experienced a hurricane after the official hurricane season had ended. In 2003, several SIDS experienced natural disasters and though the impacts were not as severe as in the late 1990s, many lives were lost and thousands affected (Table 3). The most severe impacts were seen in those SIDS that are among the poorest in their respective regions (Figure 4).

MANAGEMENT STRATEGIES

Some of the environmental vulnerabilities of SIDS are intrinsic and cannot be influenced by human actions. Others could be managed, at least in part, by the governments and people of SIDS, and to this end, the BPoA and other programmes and initiatives have been adopted. In 2003, SIDS, the UN, and other regional and international organizations have been preparing for the 10-year review in 2004 of progress in implementing the BPoA.

Regional meetings in 2003 to prepare for the 10-year review have been crucial in highlighting some progress and critical issues

Table 3: Natural disasters in SIDS in the first nine months of 2003

Country	Event	No. Killed	Total No. Affected
Dominican Republic	Floods	1	460
	Earthquake	3	2 015
Fiji	Storm	17	132 823
Haiti	Floods	36	4 070
Madagascar	Floods	16	25 585
	Cyclones	89	162 586
	Drought	0	527 000
Papua New Guinea	Landslides	13	621
Puerto Rico	Floods	2	2 405
Solomon Is.	Cyclones	0	425
Total		177	857 990

Source: OFDA/CRED 2003

for attention. Most Caribbean SIDS, for example, now have draft disaster management policies and programmes. Some have developed hazard mitigation policies and have sought to include these measures into their national development plans. There has been an improvement in the early warning system of the region. In addition, a more coordinated regional approach to disaster management and recovery has been developed (UNDESA 2003).

Countries and territories in the Pacific have recommended the full implementation of the Action Strategy for Nature Conservation in the Pacific Islands (2003–2007) to effectively deal with biodiversity conservation. They have also called on governments to complete and implement national biodiversity strategic action plans as well as ratify and implement the Cartagena Protocol. The Pacific region has also called for the development of rules to legally protect traditional knowledge of indigenous and local communities, particularly in the context of the Convention on Biological Diversity (CBD). They have also advocated for regulatory frameworks or instruments to ensure fair and equitable benefit sharing to indigenous and local communities while providing a fair system of access of investors (SIDSNet 2003c).

CHALLENGES FOR THE FUTURE

While progress has been made since the adoption of the BPoA for the SIDS, much more still needs to be done to achieve sustainable development in these countries. For example, many SIDS lack sound water infrastructure and adequate water management and distribution systems. Affordable access to water for all and protecting water quality remain important challenges (UNDESA 2003). The Caribbean SIDS have, for example, called for the establishment of national authorities for administration and management of watershed and land to address such issues as land degradation, soil erosion and desertification.

The BPoA + 10 scheduled for Mauritius in August–September 2004 provides an opportunity for policymakers to redefine priorities and put a revitalized programme into action. All stakeholders have a critical role to play.

Figure 4: Hurricane Fabian struck the Caribbean in September 2003. Vulnerability to natural disasters such as hurricanes are a major concern among SIDS.

Source: REUTERS/Noaa-Handout

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Freshwater

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SUSTAINING THE ENVIRONMENT ● ROLE IN SOCIO!ECONOMIC DEVELOPMENT ● PARTNERSHIPS TO FACILITATE SUSTAINABLE DEVELOPMENT ● SUSTAINING THE FUTURE AND MEETING OUR GOALS

feature
focus

Freshwater: meeting our goals, sustaining our future

From household and boardroom to regional and global fora, water generated debate in 2003 among the rich and poor, corporate and public sectors, and industrialized and developing countries. Water was not only topical but also defined the sustainable development agenda during the year. It will remain a major issue in the decades to come, because water is life – for people and the environment

Key Facts

- The total volume of water on earth is about 1.4 billion km ^{3}.
- The volume of freshwater resources is approximately 35 million km ^{3}, or 2.5 per cent of the total water volume.
- Of these freshwater resources, about 24 million km ^{3}, 68.9 per cent, is in the form of ice and permanent snow cover in mountainous regions, the Antarctic and Arctic.
- Some 8 million km ^{3}, 30.8 per cent, is stored underground in the form of groundwater (shallow and deep groundwater basins up to 2 000 metres, soil moisture, swamp water and permafrost).
- Freshwater lakes and rivers contain an estimated 105 000 km ^{3} or 0.3 per cent of the world's freshwater.
- The total usable freshwater supply for ecosystems and people is around 200 000 km ^{3} of water, which is less than one per cent of all freshwater resources.
- 3 011 freshwater species are listed as threatened, endangered, or extinct, 1 039 of which are fish. Four of the five river dolphins and two of the three manatees are threatened, as are around 40 freshwater turtles and more than 400 inland water crustaceans.
- The amount of groundwater withdrawn annually is estimated at 600–700 km ^{3}, representing about 20 per cent of global water withdrawals. About 1.5 billion people depend upon groundwater for their drinking water supply.
- According to estimates for the year 2000, agriculture accounted for 70 per cent of the world's total freshwater use.
- Per capita water consumption in developed countries is on average about 10 times more than in developing countries. In developed countries, it ranges from 500 to 800 litres per day whereas it is 60–150 litres per day in developing countries.
- Industrial uses account for about 20 per cent of global freshwater withdrawals. Of this, 57–69 per cent is used for hydropower and nuclear power generation, 30–40 per cent for industrial processes, and 0.5–3 per cent for thermal power generation.

Sources: IUCN 2003, Shiklomanov 1999, UNEP 2002a, UNESCO 2000, UNDP and others 1998, WMO 1997

At the beginning of this century, world leaders declared their intention to work for a world in which people would be free from want and fear. This focus on a sustainable future included "confronting the water crisis".

The Millennium Declaration, adopted by 189 Heads of State and Government at the United Nations Millennium Summit in September 2000, presented eight goals and 18 underlying targets. Target 10 of Goal 7 focuses specifically on freshwater: it aims to halve the proportion of people without sustainable access to safe drinking water by the year 2015. But this is not the only goal where water has a role to play. Freshwater is relevant and important for achieving all eight development goals contained in the Millennium Declaration (MDGs) (Box 1).

Water issues have remained high on the international environment agenda since the Millennium Summit. At the 2002 World Summit on Sustainable Development (WSSD), protection and management of water resources was recognized by world leaders as fundamental for all three pillars of sustainable development. The WEHAB Initiative, proposed by UN Secretary-General Kofi Annan as a contribution to the WSSD, targets actions to facilitate sustainable development in five key areas, water and sanitation – and energy, health, agriculture and biodiversity – in which water resources also play a significant part. The WSSD reaffirmed the MDG target on water and added two more development targets related to water: a target for integrated water resources management and a target for improved sanitation (Box 1). This reflects the growing severity of water problems and the urgent need for solutions. International attention on water will continue, particularly with the water and sanitation theme of CSD-12 and the recently-declared UN Decade of Freshwater between 2005–2015. This will build upon the efforts made in 2003: the International Year of Freshwater.

The year 2003 flowed with various international and regional meetings and other activities, and generated volumes of material in print and on the web. The Third World Water Forum was held in the Japanese city of Kyoto in March, and the G-8 industrialized countries used Evian, the French city famous for its bottled water, as the venue for their discussions on water in June. In November 2003, the 14th Forum of Ministers of the Environment of Latin America and the Caribbean, held in Panama City, highlighted water as one of the eight priority themes of the Forum's Initiative for Sustainable Development. In Africa, Addis Ababa hosted the Pan-African Implementation and Partnership Conference on Water in December, bringing down the curtain on the year but not the issue.

Water is often key in terms of poverty alleviation, consumption, production, sanitation, human settlements and biodiversity. Transboundary water resource issues are important in terms of governance and sustainability. Water sustains all life and links environmental issues on land and in marine areas. It is therefore, essential that freshwater, including groundwater, and marine issues are considered as part of an integrated system.

Sound water management is important for the environment, for reducing human vulnerability resulting from degradation of water quality and water scarcity, and for enhancing human security and well-being through strategic and effective management responses. The water issues in this section of the *Year Book* are discussed within the context of the MDGs, starting with Goal 7 which focuses on environmental sustainability. This first part highlights the water resource base and its distribution, emphasizing issues related to land use change and biodiversity, and how water resources management is linked to ecosystem functioning.

The second part highlights socio-economic issues, addressing the linkages between water and poverty alleviation, provision of safe water and sanitation, human health, food security, education and gender roles. Human vulnerability resulting from poor management of water resources is an issue that links all of these. It becomes clear that a supply of clean and adequate water is fundamental to achieving the development goals.

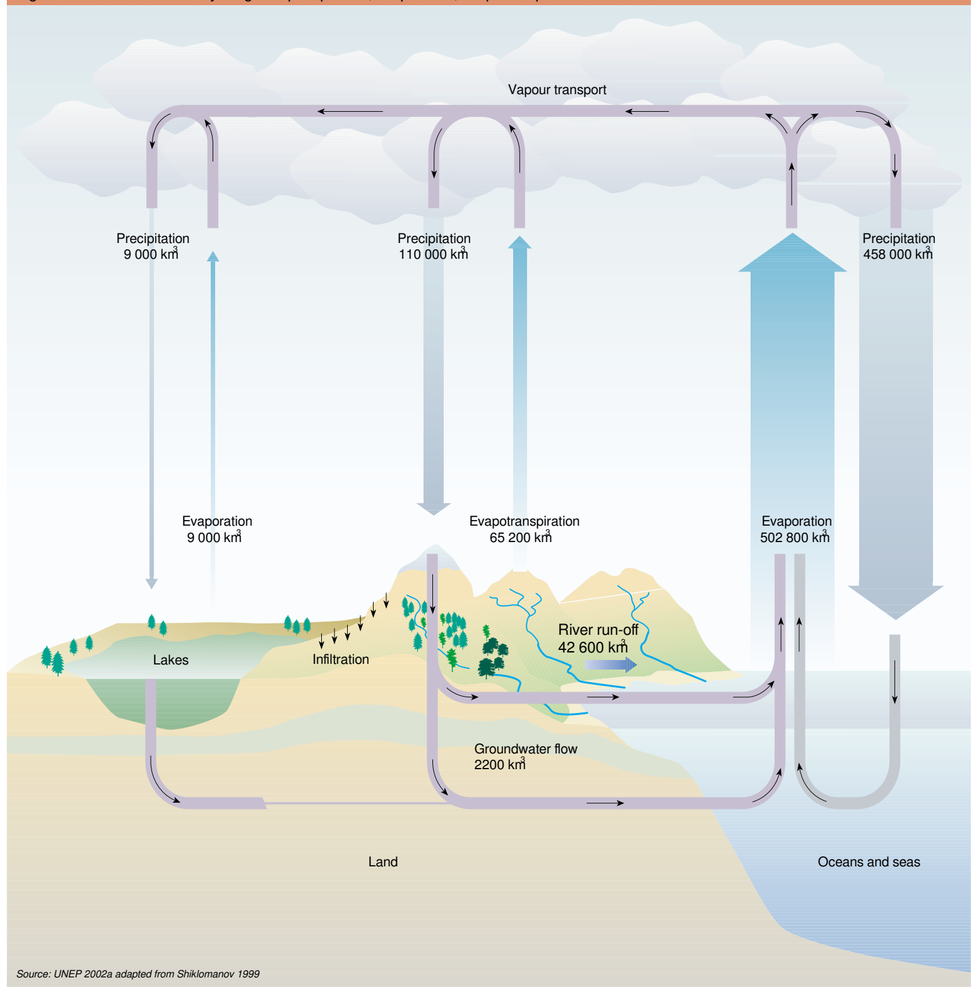
The third part emphasizes the importance of partnerships, examines the roles of different stakeholders, and reviews efforts at different levels to manage water resources effectively. It demonstrates that the partnership principles outlined in Goal 8 are as applicable in the field of water as they are to the rest of the development arena. Integrated Water Resources Management (IWRM) and integrated coastal area and river basin management (ICARM) are two of the approaches covered. Throughout the *Feature Focus* examples show how technologies can play a role in sustainable water supply and use at the local level. The *Feature Focus* concludes by recognizing some important policy issues for consideration in charting the way forward.

Box 1: Internationally agreed development goals and selected targets relevant to water

Millennium Declaration	**Targets**
Goal 1 Eradicate extreme poverty and hunger	• Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day • Halve, between 1990 and 2015, the proportion of people who suffer from hunger
Goal 2 Achieve universal primary education	• Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling
Goal 3 Promote gender equality and empower women	• Eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015
Goal 4 Reduce child mortality	• Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate
Goal 5 Improve maternal health	• Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio
Goal 6 Combat HIV/AIDS, malaria and other diseases	• Halt by 2015 and begin to reverse the spread of HIV/AIDS • Halt by 2015 and begin to reverse the incidence of malaria and other major diseases
Goal 7 Ensure environmental sustainability	• Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources • Halve by 2015 the proportion of people without sustainable access to safe drinking water • Achieve by 2020 a significant improvement in the lives of at least 100 million slum dwellers
Goal 8 Develop a global partnership for development	• Develop further an open, rule-based, predictable, non-discriminatory trading and financial system. Includes a commitment to good governance, development, and poverty reduction – both nationally and internationally • Address the special needs of the least developed countries, landlocked countries and Small Island Developing States (SIDS) • In cooperation with the private sector, make available the benefits of new technologies
WSSD Plan of Implementation	• Halve, by the year 2015, the proportion of people who are unable to reach or to afford safe drinking water (as outlined in the Millennium Declaration) and the proportion of people who do not have access to basic sanitation. • Develop integrated water resources management and water efficiency plans by 2005

Sources: UN 2000a, UN 2002

Figure 1: The world's water cycle: global precipitation, evaporation, evapotranspiration and run-off



Source: UNEP 2002a adapted from Shiklomanov 1999

FRESHWATER: SUSTAINING THE ENVIRONMENT

Goal 7: Ensure environmental sustainability

Water is a key component of all ecosystems. These provide critical goods and services to people, including materials, food and other organic products, water storage and purification, biogeochemical cycling and waste removal. Most global freshwater is bound up as ice in the Polar regions. Only a small, but varying proportion is active at any one time within the global water cycle (Figure 1).

The world's ecosystems are under pressure from numerous human activities and developments, including urbanization, industrialization and food production. Such activities require freshwater, and to meet demands, the water cycle is inevitably disrupted. It is also influenced through land use changes that directly affect water quantity, quality and water flows. Ecosystems can be damaged, functions lost and vulnerable plants and animals endangered. Much of the degradation of freshwater ecosystems results from overexploitation, habitat destruction, pollution and the introduction of non-native species.

At the earth's surface, freshwater provides the habitat for large numbers of organisms. Species richness in relation to habitat extent is extremely high in many freshwater groups. For example, 40 per cent of the 25 000 known fish species are freshwater forms. Given the distribution of water on the earth's surface, this is equivalent to one fish species for every 15 km ^{3} of freshwater, compared with one species for every 100 000 km ^{3} of sea water. The species richness increases strongly toward the equator.

In addition to the negative impacts on aquatic species caused by disrupting the quantity and quality of surface water sources, encroachment of non-native species is also having a major impact on aquatic ecosystems around the world, reducing or eliminating native species in many cases (Heywood and Gardner 1995). Studies of the introduction of non-native fish in Europe, North America, Australia, and New Zealand revealed that 77 per cent of the species introduced led to a drastic reduction or elimination of native fish species (Ross 1991).

Similarly, the introduction in the 1970s of Nile perch and Nile tilapia to Lake Victoria, the world's largest tropical lake, has fundamentally changed the fish and associated biological communities of the lake. Approximately half the 350 species of cichlids have died out due to the introduction of these two exotic fish species which fed on, and out-competed, the resident populations. Although a new fishery has now been developed based on Nile perch, which currently generates about US$400 million in export income, few within the local community are benefiting, as they have not made the transition to this industry (UNDP and others 2000). The unintended introduction of zebra mussels into the Great Lakes of North America has almost completely displaced native mussel species. This organism has already cost more than US$1 000 million merely to control (Great Lakes Water Quality Board 2001). In African wetlands, countries spend billions of dollars every year to control alien species, such as the water hyacinth, with little success (IUCN 2003).

Land use: a critical factor

Land cover and land use changes have great influence on freshwater resources around the world. The protection of catchment areas is extremely important in maintaining high freshwater quality (Box 2). Forest cover is particularly beneficial. Recent literature shows a clear link between forests and the quality of water from a catchment, a more sporadic link between forests and the quantity of water available, and a variable link between forests and constancy of flow (Dudley and Stolton 2003). Well managed natural forests almost always provide higher quality water, with less sediment and fewer pollutants, than water from other catchments. Forests therefore, often provide the basis for integrated management of water resources. Removal of forest can adversely affect water supplies, putting people at risk and damaging the environment (FAO 2003a).

Both aquatic and terrestrial ecosystems play important roles in regulating freshwater flows. Wetlands, for instance, buffer flood flows and filter incoming water, among other benefits (Table 1). This natural capacity however, has been much reduced due to human activities. About half of the world's wetlands were lost during the 20th century, primarily through conversion for agriculture (Finlayson and Davidson 1999). As we understand more about aquatic ecosystem dynamics, technologies are being developed that mimic their functions, such as the construction of artificial wetlands for the purification of water (Box 3).

Box 2: Land cover – a key to water quality

There appears to be a clear link between the presence of forests and the quality of water coming out of a catchment. A large bottler of mineral water in Europe, draws its main water supplies from heavily-farmed watersheds, where the run-off of nutrients and pesticides threatens the aquifers upon which the company depends. In response, the company has found that reforesting sensitive infiltration zones and switching to organic farming practices is proving to be cheaper than building water filtration plants.

Some water authorities also have made the link between protecting for water supply and protecting for nature. The city of New York applies a catchment protection approach to maintaining its high quality drinking water. A land and forest resource protection strategy is being implemented that will result in substantial savings for New York City, as compared to putting in a new water treatment plant. The start-up cost for this strategy is estimated to be US$1 000–1 500 million over 10 years, as compared to the cost of US$6 000–8 000 million, plus US$300–500 million annual operating costs, otherwise required for a treatment plant.

In Ecuador, about 80 per cent of Quito's drinking water comes from two protected areas, the Cayambe Coca Ecological Reserve and the Antisana Ecological Reserve. A nominal water use fee on citizens of Quito, together with one per cent of revenues of hydroelectric companies, are used to finance conservation of the reserves.

On a global scale, about one-third of the largest cities obtain a significant proportion of their drinking water directly from protected areas.

Source: Dudley and Stolton 2003, Echavarria 2002

Table 1: Benefits of wetlands

Ecological functions		Products	
● Water storage and purification	● Groundwater recharge and discharge	● Forest resources	● Wildlife resources
● Flood control	● Water transport	● Fisheries	● Forage resources
● Shoreline stabilization	● Sediment retention and erosion control	● Agricultural resources	● Water supply
● Storm protection	● Nutrient storage and recycling	● Medicinal resources	● Genetic resources
● Biomass export	● Micro climate stabilisation	● Raw materials for building, construction and industrial use	● Tourism and recreation opportunities
● Maintenance of ecosystem stability	● Maintenance of integrity of other ecosystems		● Energy supply
● Maintenance of biodiversity			

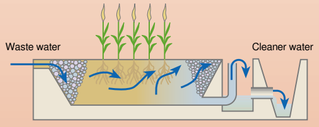
Sources: adapted from Dugan 1990 and Schuyt and Brander 2004

Box 3: Technology at work – biological water purification

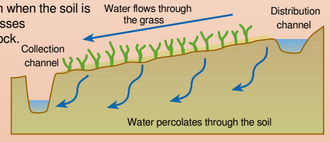
Water purification is based on physical, chemical and biological processes. While we tend to rely on human engineered systems, technologies based on natural processes can also be used to purify water and treat wastewater. These include phytotechnology based on wetlands, lagoons, grass-filtration, soil purification, and soil aquifer storage and treatment. These technologies, shown in the graphics below, link water and food production, and are generally suited to developing communities.

Natural purification systems designed, constructed, operated and maintained in the same way as engineered systems perform just as well and usually cost less to construct and operate. The lower cost compared to mechanical treatment, which occupies less land area, depends on the sufficient availability of free or cheap land.

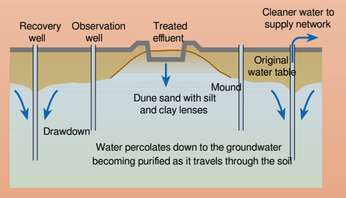
Constructed wetlands or phytoremediation:
This is a technology for treating stormwater or wastewater. A constructed wetland consists of a gravel bed on which suitable wetland plants are grown. As water passes through the substrate, it is purified through the activity of bacteria attached to the gravel, plant roots and other particles.



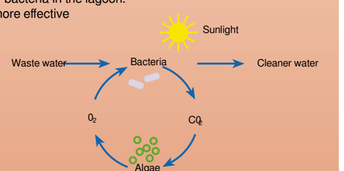
Soil and grass filtration for purification of wastewater:
Soil filtration relies on filtration by soil particles and bacteria growing on the surfaces of the soil particles and plants (usually grasses) which take up water and nutrients (nitrogen and phosphorus), reducing the concentration of these nutrients. Soil filtration is used during the dry season. Grass filtration is used in the rainy season when the soil is saturated by water. Grasses can be grazed by livestock.



Soil aquifer treatment for purification and storage of treated wastewater:
Soil aquifer treatment relies on filtration through the soil and purifying action of bacteria attached to soil particles. Purified water is stored in the groundwater aquifer and can be drawn for agricultural purposes, for example.



Symbiotic activity between algae and bacteria in a wastewater lagoon to purify sewage:
As wastewater flows through a lagoon, bacteria consume the organic carbon in the waste. In assimilating the organic carbon, bacterial respiration produces carbon dioxide (CO_2) and takes up oxygen (O_2). Algae utilize the carbon dioxide for photosynthesis and in turn produce oxygen required by the bacteria, hence the symbiotic activity. Solids settle to the bottom of the lagoon, and pathogenic bacteria die-off in competition with other bacteria in the lagoon.
Several lagoons in series are more effective and the last lagoon can be used for aquaculture.



Source: UNEP 2000

Drawing down supplies

The withdrawal of freshwater from surface (rivers, lakes) or underground (aquifers) sources, at a rate faster than it is naturally replenished, is unsustainable and can ultimately deplete the resource. The Aral Sea in Central Asia is a dramatic example of the devastating environmental and socio-economic impact of unsustainable water withdrawal (UNEP 2002a and 2002b – Figure 2), while withdrawals of groundwater from the Ogallala Aquifer in the United States points to potentially harmful effects on the country's agriculture and environment as the aquifer's waters are depleted (Morris and others 2003).

On the global scale, the agricultural sector accounts for over two-thirds of freshwater withdrawal (Figure 3). Industrial use currently accounts for a fifth of total global water use, while domestic use of freshwater was 10 per cent of global water use in the year 2000 (FAO 2003b). The proportion of water used for different purposes, however, varies between regions. The developing regions use relatively far more water for agricultural purposes, whereas the industrial sector accounts for the largest share of water use in the developed regions.

In the past 100 years, the world population tripled, but water use for human purposes multiplied sixfold (WWC 2000). There is much competition for water resources and in their allocation, the needs of ecosystems are often forgotten or ignored. This is due partly to our limited understanding of the complex linkages and dependencies between and within ecosystems, and of their relation to human needs and activities now and in the future. Ecosystems, which are subject to water stress become less robust and more prone to succumb to additional pressures. Aquatic ecosystems and their flora and fauna are especially at risk.

Figure 2: Aral Sea degradation

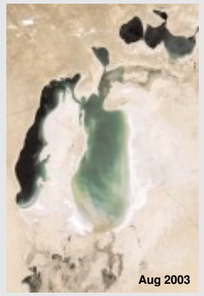
The Aral Sea was once the world's fourth-largest inland sea. Problems began in the 1960s and 1970s with the damming of the main rivers that feed it in order to grow cotton on arid land in what was then Soviet Central Asia. The surface of the Aral Sea once measured 66 100 km². The sea is now a quarter of the size it was 50 years ago and has split into two.

Source: USGS EROS Data Center/ UNEP-GRID Sioux Falls

Source: USGS EROS Data Center/ UNEP-GRID Sioux Falls

Source: UNEP-GRID Sioux Falls

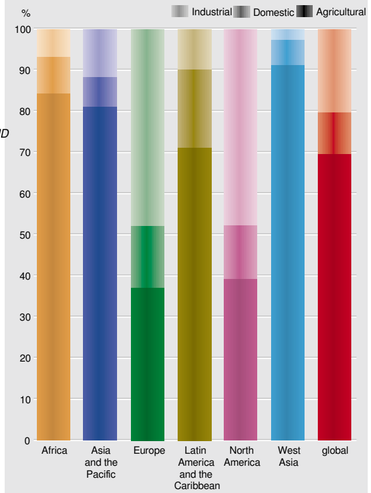
Source: UNEP-GRID Sioux Falls



Source: MODIS Land Rapid Response Team at NASA GSFC

Source: UNEP 2004

Figure 3: Estimated water use by sector, globally and regionally, for the year 2000



Source: GEO Data Portal, compiled from FAO 2003b

Box 4: The increasing global mercury threat

Expanding industrialization over the last two centuries has increased levels of mercury in the environment. Although a naturally occurring metal, excess mercury in ecosystems can be highly toxic; it accumulates in living tissue and is particularly associated with underdevelopment of the nervous system.

Mercury contaminates the water cycle, both directly and indirectly, although the most significant releases of mercury are into the air. Once deposited, mercury can change to methyl mercury and become concentrated as it moves through the food chain (biomagnification).

The worldwide risks of mercury are more severe than was previously understood. To address the growing mercury challenge, it is necessary to reduce the use of mercury, substitute or eliminate mercury-containing products and processes, control its emissions with end-of-pipe technologies, and manage mercury wastes.

Source: UNEP 2003a

Disrupting the flow

During the 20th century, large dams became a highly visible tool for managing freshwater resources, contributing to socio-economic development by securing food production and drinking water supply, energy generation and flood control. However, an enormous price in environmental terms, although rarely accounted for, often had to be paid to secure these benefits (WCD 2000). Many negative biological, physical and chemical impacts have been attributed to dams, including changes in the timing and frequency of downstream water flows, upstream inundation, degradation of water quality and upstream catchment areas, increased in-lake sedimentation, lake and river bank scouring, degradation and loss of forests and wildlife habitat, blocked movement of migratory species, modification of lacustrine and downstream habitats and loss of aquatic biodiversity. Some of these effects have also had a very negative impact on local and downstream human communities, including the disruption of fisheries and other water-related ecosystem services.

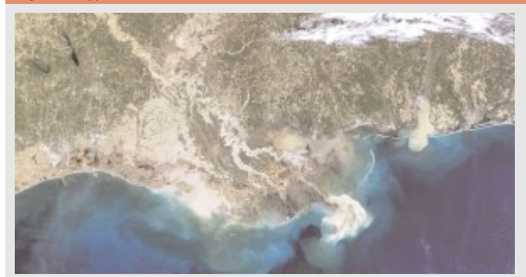
Dams and canals have fragmented almost 60 per cent of the world's 227 largest rivers (Revenga and others 2000). The only remaining large free-flowing rivers are found in the tundra regions of North America and Russia, and in parts of Africa and Latin America.

Degrading quality

While industry does not use the largest quantities of freshwater, nor produce the largest volume of water pollutants, it is responsible for the production and use of some of the most hazardous water pollutants (Fry and Rast 1998). These include heavy metals such as mercury (Box 4), polychlorinated biphenyls (PCBs), industrial solvents and other organic chemicals dangerous to environmental and human health.

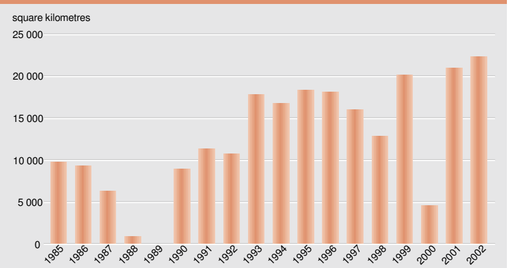
Groundwater represents 90 per cent of the world's readily-available freshwater (Boswinkel 2000). An estimated one-and-a-half billion people, a quarter of the world's population, depend directly on this source for their drinking water (Shiklomanov 1997). It is also the main source for irrigation in many countries. Despite their importance, groundwater resources are often overexploited, managed badly, and their dynamics are usually poorly understood. As a result, they are under constant threat of degradation from contamination and depletion. For example, poor irrigation

Figure 4: Hypoxia in the northern Gulf of Mexico



Satellite image of the northern Gulf of Mexico/Mississippi Delta, showing hypoxic coastal water (light blue), January 2003

Source: Jacques Descloitres, MODIS Land Rapid Response Team, NASA/GSFC



Comparative size of hypoxia areas between 1985–2002. Nutrient enrichment is causing dense algal blooms and a growing hypoxic area.

Source: Rabelais and others 2002

practices and drawdown of groundwater near coastal areas can both result in groundwater salinization. Poor sewage, waste and effluent management can result in the release of pollutants into surface waters and allow contamination of aquifers. Depletion occurs through overexploitation of available groundwater and land use changes that alter surface run-off and reduce the replenishment of groundwater supplies (UNEP 2002b).

On a global scale, agriculture is the main source of both nitrate and ammonia pollution of surface and groundwater (FAO 2003c; see also the section on Emerging Challenges). In addition to damaging many aquatic organisms or making water less suitable for drinking, excessive loading of nutrients in river basins can result in eutrophication and algal blooms in coastal waters, and the formation of deoxygenated (hypoxic) zones which threaten benthic marine life and economically important fisheries (Figure 4).

Where strong measures have been taken and sustained to reverse negative trends some improvements in water quality have been achieved. For example, nearly 30 years of European Union (EU) environmental legislation, with national and international actions to protect and improve the aquatic environment, are yielding results (EEA 2003). Pollution of rivers and lakes by phosphorus and organic matter from industry and households has been reduced and the pollution of rivers with heavy metals and other hazardous substances is generally decreasing. There has been progress in reducing overall water withdrawals and use in most parts of Europe. There is, however, little or no progress in combating nitrate and pesticide pollution, and water withdrawals for irrigation, energy use and tourism.

Weak data on some issues mean that the conclusions listed above must be treated with caution (EEA 2003). Overall, there are still knowledge gaps about the world's freshwater quality. Better data collection and information systems are required to provide reliable, consistent and appropriate freshwater data and information (Box 5).

Box 5: Water quality data

Existing water quality data collection and monitoring systems are inadequate because of:

- incomplete data coverage (spatial and temporal);
- slow reporting and sharing of data; and
- insufficient training and capacity of local water authorities to collect data.

The main steps to invest in monitoring, assessment, and information systems are to:

- include monitoring programmes in water management plans, and invest in data collection and analysis capacity in countries, particularly in Africa, SIDS and Central Asia;
- encourage country participation in regional and global water quality monitoring and assessment programmes, such as GEMS/Water; and
- ensure that data and information about water quality are collected frequently and regularly using comparable methods.

Over 800 stations for freshwater monitoring worldwide have contributed data to the UNEP GEMS/Water Programme (see map below). Of these, 98 are measuring water quality in lakes and reservoirs. There are four types of stations:

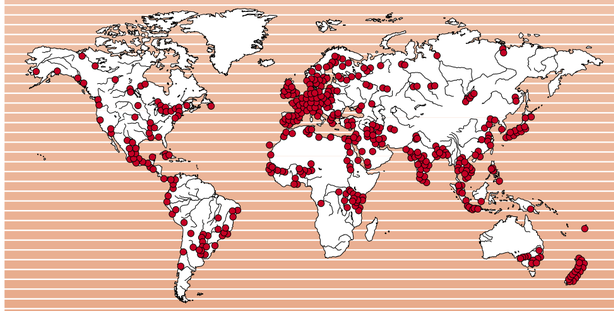
Baseline stations are located in areas where there is little or no effect from point sources of pollutants and removed from obvious anthropogenic influences;

Impact stations are located at sites with at least one major use of the water such as drinking water supply, irrigation, or conservation of aquatic life;

Trend stations are primarily located on large rivers that are representative of large basins in which human activity is high; and

Flux stations are monitoring at the mouths of major rivers upstream from estuarine effects.

By the end of 2003, the GEMS/Water database contained more than two million data points covering over 100 water quality parameters, including physical/chemical parameters, such as temperature, pH, major ions, nutrients, metals, microbiological parameters, and organics. As the requirements for assessment and identification of national, regional and global water quality issues of concern increase, the need for data that accurately reflect environmental conditions becomes greater.



The geographic distribution of the data contained in the GEMS/Water database is widespread with a higher concentration of stations in European countries, India and Japan.

Source: GEMS/Water 2003

FRESHWATER AND ITS ROLE IN SOCIO-ECONOMIC DEVELOPMENT

As stressed in the previous section, safeguarding water for environmental needs is essential to achieve environmental sustainability (Goal 7). The disruption of the water cycle will inevitably affect biodiversity and ecosystem functioning and ultimately the provision of ecosystem goods and services to humans. Degrading water quality, water shortages and changes in the flow not only have an indirect impact on people through such ecosystem changes, but the use of water for human needs such as drinking water, agriculture and industrial processes also directly affect people's health and well-being.

Safe drinking water and sanitation and human health

Goal 4: Reduce child mortality

Goal 5: Improve maternal health

Goal 6: Combat HIV/AIDS, malaria and other diseases

Goal 7: **Target 10/WSSD Plan of Implementation:** Reduce by half, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation

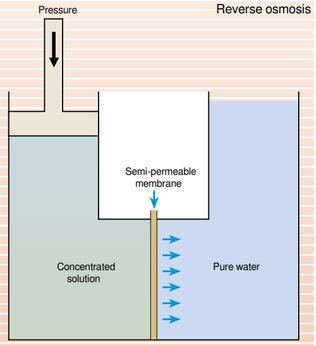
Freshwater and human health are intimately linked. Contaminated drinking water is one of the major causes of sickness and death. The vast majority of water-related deaths occur in developing countries and many are caused by relatively easily-treated and preventable diarrhoeal diseases. Nine out of 10 of the people affected are children under five (Prüss and others 2002).

Although direct human consumption and sanitation are among the smallest uses of freshwater on an absolute scale, providing freshwater of the quantity and quality required is one of humanity's greatest continuing challenges. The global population is now more than 6.3 billion people, and the number is growing by about 77 million people every year (UNPD 2003). The availability of safe drinking water is critical to meeting the goals for

Box 6: Technology at work – membrane technology

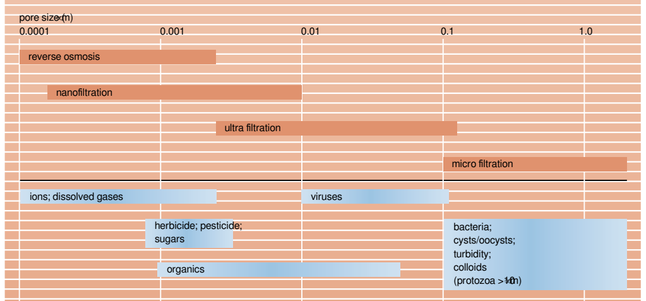
Mimicking nature (membranes in seagull beaks, plant roots and kidneys), artificial membranes can be used to purify water.

Whereas natural permeation through a membrane will take place from low to high salt concentration, reverse osmosis is the application of pressure to force water to move from high to low salt concentration. This technology can be used for desalinating water.



With the wide range of membranes now available most contaminants of concern can be separated from raw water sources. Membranes come in a range of pore sizes and permeability from micro-filtration, ultra-filtration, nano-filtration to hyper-filtration (reverse osmosis) and can filter out corresponding particle sizes (see diagram below). Membranes are also available in various materials – polymers, organo-mineral, ceramic or metallic – to cope with differing conditions. They are used to produce safe drinking water from brackish water, remove turbidity, algae, pathogens, viruses, and metal contaminants, clean industrial effluent, concentrate, purify or fractionate temperature sensitive solutions in the food, drug and biotechnology industries, and are used in artificial kidneys. Fouling impedes performance, but several cleaning mechanisms are available such as back flushing, air bubbles and chemicals.

The costs of large-scale application of membrane technology for the desalinization of saline water to produce drinking water are double those of conventional treatment costs. However, the potential for lower cost applications in the removal of bacterial and parasitic pathogens from surface water using micro-filtration are very promising. For example, off-cuts from hollow-fibre membrane micro-filters are now being developed for use in developing countries for water purification at household and community level.



Pressure-driven membrane types with associated pore sizes (indicated by box outline) and the type of contaminant that they can remove.

Source: ETC 2003

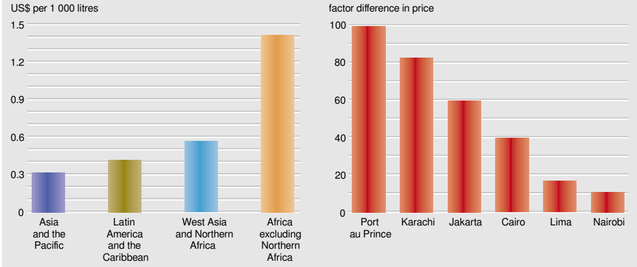
enhancing human well-being and security.

The proportion of people served with some form of improved water supply rose from 78 per cent in 1990 to 82 per cent in 2000. Over the same period the world's population with access to improved sanitation increased from 51 per cent to 61 per cent (WHO and UNICEF 2003). Despite these gains, about 1.1 billion people in the world lacked access to safe drinking water in 2000, while another 2.4 billion lacked access to improved sanitation (see the GEO Indicators section). As expressed by the UN Secretary-General Kofi Annan in 2000: "No single measure would do more to reduce disease and save lives in the developing world than bringing safe water and adequate sanitation to all" (UN 2000b).

Freshwater distributes pollutants, and many disease-causing micro-organisms (pathogens) and their vectors live in it. Infants and children are especially susceptible to sickness associated with contaminated drinking water and inadequate sanitation, particularly to diarrhoeal diseases. Lack of safe drinking water and sanitation also has obvious implications for maternal health and can exacerbate illnesses which affect the immune system, such as HIV/AIDS. Improved sanitation alone could reduce related deaths by up to 60 per cent, episodes of diarrhoea by up to 40 per cent, and stunting of child growth by up to 50 per cent (WEHAB Working Group 2002).

Illness and disability caused by water-related diseases contribute to a huge loss in human economic productivity. The Disability-Adjusted Life Year (DALY) is a unit of measurement reflecting lost years of healthy life; the WHO has used it as a measure to report on the impact of some water-associated diseases on health (WHO and UNICEF 2000). By far the largest impact is caused by malaria (42.3 million DALYs), followed by lymphatic filariasis (5.64 million DALYs), water-borne diseases such as schistosomiasis (1.76 million DALYs), and related infections (1.42 million DALYs). Various technologies, however, including membrane technologies (Box 6), offer solutions and can significantly improve drinking water quality.

Figure 5: The price urban residents pay for water in selected regions and the factor difference in price for rich and poor living in the same city for selected cities



Sources: UNEP in press, UN-Habitat 2001

Existing water and sanitation systems are inadequate for 30–60 per cent of the urban population, mainly in developing countries. The situation is most severe for the estimated 924 million people living in urban slums (UN-Habitat 2003a). There is a link between the urban population who do not have access to clean water through reliable piped water service, and poverty, partly due to the fact that low-income groups often have to buy their water from vendors at greatly inflated prices. People on a low income end up paying two to 50 times more for a litre of water than higher income groups, who are connected to often heavily subsidized water infrastructure (UN-Habitat 2003b). In some cities this difference is even higher (UNEP in press) (Figure 5). This further reduces the limited financial resources of poor people and their coping capacity. It is not surprising that many turn to water supplies that may not be clean, such as a local river, to meet their daily needs.

Privatization of water supply and sanitation is often seen as a way to improve services and lighten the burden on scarce public finances (UN-Habitat 2003b). Although the aim is to provide water and sanitation services more efficiently through market mechanisms, several high profile privatization initiatives in developing countries have actually resulted in price increases that made the cost of access to safe water and sanitation prohibitive for the poor (UN-Habitat 2003b). The more vulnerable members of society, particularly poor women, are the worst affected by such changes to water and sanitation pricing, and the stresses that they cause to people's livelihoods (Grossman and others 2003).

Poverty, hunger and freshwater linkages

Goal 1: Eradicate extreme poverty and hunger

In terms of socio-economic status, the poorest often comprise the 'water poor' (Box 7). The most vulnerable in this group include women and children, the elderly, minorities including indigenous people, those suffering from HIV/AIDS and other illnesses, physical or mental impairments, and those living in arid rural areas, slums and surviving in the informal economy.

The incidence of hunger is rising again, after falling steadily during the first half of the 1990s (FAO 2003d). Between 1995–1997 and 1999–2001, the number of chronically hungry increased by more than 18 million people (FAO 2003d). The link between extreme poverty, hunger and drought is strong: over a three-year period, drought was listed as a cause in 60 per cent of all food emergencies across the world (FAO 2003d).

In developing countries, rainfed agriculture still accounts for about 60 per cent of

Box 7: The water poor

The water poor can be defined as those:

- whose natural livelihood base is persistently threatened by severe drought or flood;
- whose livelihood depends on cultivation of food or gathering of natural products, and whose water source is not dependable or sufficient;
- whose natural livelihood base is subject to erosion, degradation, or state confiscation (for example for construction of major infrastructure) without due compensation;
- living far from a year-round supply of drinking water;
- obliged to expend a relatively high (greater than five per cent) proportion of household income on water;
- whose water supply is bacteriologically or chemically contaminated, and who cannot afford to use, or have no access to, an alternate water source;
- living in areas with high levels of water-associated disease (schistosomiasis, guinea-worm, malaria, trachoma, cholera, typhoid, etc.) without means of protection; and
- women and girls who spend hours a day collecting water, putting their security, education, productivity, and nutritional status at risk.

Source: GWP 2003

agricultural production (FAO 2003c). Farmers who depend on rainfed agriculture in regions with insufficient or variable rainfall are, therefore, vulnerable to crop yield reduction or total crop losses caused by dry spells and drought.

Irrigation has considerably increased crop production and yields and has contributed immensely to better food security. An estimated 40 per cent of agricultural products and 60 per cent of the world's grain is nowadays grown on irrigated land (IFPRI 2001). In 1998, irrigated land made up approximately one-fifth of total arable land in developing countries but produced two-fifths of all crops (FAO 2003c). Although food production cannot do without irrigation, current practices have caused serious environmental damage in many areas. Poor irrigation management sometimes pollutes aquifers and causes soil salanization and waterlogging, which together have affected 40 million ha of land globally (UNEP 2002b). Rehabilitation is costly but, without it, such damage to arable land will result in a reduction of productivity per hectare, and may even lead to total abandonment of severely affected areas.

In addition, agricultural irrigation practices are particularly water-intensive and sometimes wasteful. Data from 90 developing countries show that the total amount of water withdrawn for irrigation varies per region, with water use efficiency ranging from 24 per cent in Latin America and the Caribbean to 39 per cent in West Asia (FAO 2003c). There is an absolute ceiling to the amount of water available in any country or region for irrigation and as that ceiling is approached it will be essential to find ways to make more efficient use of water to achieve more crop per drop.

One of the projected manifestations of climate change is altered precipitation patterns (IPCC 2001). Climate change may adversely affect the availability of freshwater for food production that could make a significant contribution to the eradication of hunger and poverty. Spatial and temporal changes in precipitation are of most concern and relevance. African communities, with their limited institutional and financial resources, would be particularly vulnerable to such changes.

The collection of rainwater for irrigation and domestic use has proved extremely valuable to deal with rainfall variability, particularly at the household and community levels (Box 8). With the right equipment or further treatment, freshwater collected in this manner can even be used as drinking water.

Aquatic ecosystems are a major source of cheap, high quality protein, such as fish, for many local communities. Degraded aquatic ecosystems, will not be able to produce as much food, and this will have negative economic impacts on people, communities and the private sector that depend on these resources. For example, the Aral Sea fisheries that used to employ more than 65 000 people have collapsed (Glazovsky 1995). These effects are particularly acute for communities living by along rivers and lake shores, who are dependent on activities such as fishing and tourism.

Part of the difficulty in meeting freshwater needs for human use is due to a mismatch between the global distribution of this resource and population distribution. The Congo River, for example, contains about a third of Africa's total river flow, yet only about 10 per cent of Africa's population lives within its drainage basin (Shiklomanov 1997). In Latin America and the Caribbean, about 40 per cent of the population is concentrated in 25 per cent of the territory, which only contains about 10 per cent of the region's freshwater resources. Asia has the largest volume of renewable freshwater resources; yet per capita water availability is the lowest in the world. In contrast, Australia and New Zealand have the smallest quantity of available freshwater resources, yet the highest per person water availability in the world, because of the much smaller population (Gleick 1993).

It is clear that the plight of many of those living in poverty cannot be alleviated without a sustainable natural resource base, including freshwater (Table 2). It is essential to ensure that poverty alleviation or reduction strategies do not result in additional degradation of freshwater resources and the productivity of life-supporting systems (Hirji and Ibreek 2001).

Box 8: Technology at work – rainwater harvesting

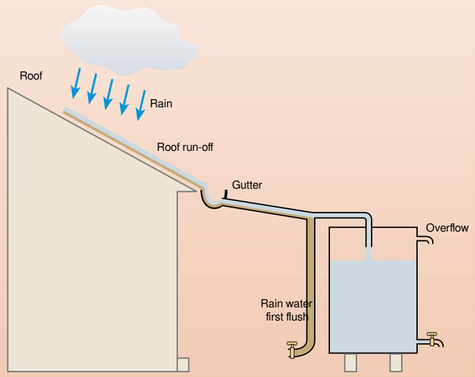
This age-old technology is resurfacing as a solution for providing non- or under-serviced communities with potable water at or near the point where water is needed. Recent innovations have included cleaner collection (a first flush diverter), storage and hygiene maintenance (on-site, low cost detection of contamination, purification and sterilization) and adaptation for local conditions.

Rainwater harvesting systems can be either owner or utility-operated and managed. Rainwater collected using existing structures (such as rooftops, parking lots, playgrounds, parks, ponds and flood plains), has few negative environmental impacts compared to other systems built for water resource development such as dams. Rainwater is relatively clean and of a quality usually acceptable for most purposes with little or no treatment.

Other advantages of rainwater harvesting are:

- it can exist with, and provide a good supplement to, other water sources and utility systems, relieving pressure where other sources are scarce;
- it provides a water supply buffer for use in times of emergency or if there is a breakdown of the public water supply system, particularly during natural disasters;
- users of rainwater are usually the owners and operators of the catchment system so they are likely to conserve water and prevent the storage tank from drying up or leaking;
- rainwater harvesting technologies are flexible and can be adapted for almost any requirement;
- construction, operation, and maintenance are not labour intensive;
- rainwater is free from chlorine;
- rainwater is the softest naturally-occurring source of water available (soft water contains less minerals that cause hard scale formation when water is boiled, and requires less soap for lathering than hard water); and
- the security of the water supply is increased significantly with decentralized rainwater harvesting points.

Diverter for the first flush from roof run-off



Before developing a rainwater harvesting system, however, the following need to be considered:

- are the catchment area and storage capacity adequate to sustain the system?
- are maintenance of the system and the quality of collected water within the owner/operator's capacity?
- what measures need to be taken to prevent rainwater storage tanks from becoming breeding habitats for disease-vectors, such as the malaria mosquito?
- rainwater is unlikely to contain fluoride, unlike commercial water supplies. Will users need to supplement their intake from other sources to ensure dental health?

The amount of water harvested with this technology is small, but increasing, and there is an emerging worldwide movement to promote rainwater harvesting. It is, however, unclear whether the widespread use of these technologies is feasible (IFPRI 2002). Construction and maintenance costs of water harvesting systems, particularly the labour costs, are very important in determining whether a technique will be widely adopted at the individual farm or household level.

Sources: IFPRI 2002, UNEP 2002c

Source: Murdoch University Environmental Technology Center

Table 2: Water-poverty linkages

Dimension of poverty	Water – poverty linkages	Factors conducive to reducing poverty
Income and consumption	Sustainable growth requires development of natural capital (eg water resources) for human development and welfare, protecting and maintaining human health and protecting natural capital from irreversible damage. It must ensure that social and economic security of those dependent on the water resources for their livelihoods is not compromised	Access to water for productive use, access to natural resources, sustainable growth
Inequality and equity	Inequitable and unjust laws and ill-defined property rights that restrict access to, and control of, natural resources are major obstacles to efficient management of natural resources. Unfair distribution of costs and benefits and planning processes alienates affected communities from decision-making, and from sharing water development project benefits. It also fosters social stratification, limiting prospects of poverty reduction through economic growth	Secure tenure and access to natural resources, water rights and entitlements
Sustainable livelihoods	Natural resources remain the most important safety net available to most poor rural households	Sustainable land and water use practices
Health	Human health is improved by reducing exposure to water-borne and vector-borne diseases, and to toxic substances, by increasing access to clean water and adequate sanitation. Inadequate water supply and sanitation poses the largest environmental-related health threat on a global scale	Water quality, safe drinking water and sanitation, water bodies protected from vectors and disease
Security and vulnerability	Poor people, particularly in developing countries, are especially vulnerable to natural disasters and changes in environmental conditions. The poor also often live in environmentally-hazardous areas (flood plains, steep slopes), thereby increasing their vulnerability	Improved disaster preparedness and response, water harvesting and conservation
Inclusion and empowerment	Empowering people to manage their own environment and water resources must be supported by ensuring participation of all stakeholders in decision-making, equipping people with the ability to monitor and influence resource allocations, creating user organizations, transferring operation and maintenance responsibility to the water users, and other measures	Participation, devolution of ownership, rights, and responsibilities to water users

Source: Adapted from Hirji and Ibreek 2001

Gender roles in using and managing freshwater resources

Goal 3: Promote gender equality and empower women

In many countries, water access and use are differentiated by gender. In locations without reliable piped water supplies, women are often responsible for locating, obtaining and transporting freshwater for household use. They frequently depend on drawing water from naturally occurring sources – springs, streams and rivers, lakes – or on groundwater from wells and boreholes. However, decision-making fora and processes for addressing freshwater resources issues are often gendered, with women being consistently under-represented (ADB 2003). Because of this, the considerable practical experience in managing these resources gained by women is not contributing to sustainable water use.

Women also bear a disproportionate share of the negative impacts of inadequate freshwater supplies. In rural Africa, for example, women and girls spend as much as three hours a day fetching water; an energy expenditure greater than one-third of their daily food intake (WEHAB Working Group 2002). Safe drinking water may be increasingly difficult to obtain, due to environmental degradation, which affects water quality or quantity. Unsafe water supplies that cause sickness of family members increase the workload of women and girls who are largely responsible for family health (UNICEF 2003a), and this can also affect their reproductive health. When freshwater resources are degraded the livelihoods of women become highly vulnerable (Khosla and Pearl 2003).

Participatory decision-making processes support more equitable policy approaches. In principle, participation "gives a voice to relatively powerless groups, such as women, central to providing, managing, and safeguarding water" (UNWWAP 2003). Gender mainstreaming can help address the gap between responsibilities and rights of women in freshwater management and governance and contribute to addressing poverty (WWC 2000).

Towards achieving universal primary education

Goal 2: Achieve universal primary education

Factors related to water, sanitation, and hygiene affect children's right to education in many ways. Children in poor health are unable to fulfill their learning potential. For example, 400 million school-aged children a year are infected by intestinal worms, which, research shows, undermine their health and sap their learning abilities (UNICEF 2003b). School-based water, sanitation and hygiene programmes make schools healthier, have had a positive effect on children's participation and reduce drop-out rates, especially for girls.

Healthier children are more effective learners, and those who spend less time fetching water have more time for school. Hygiene promotion in schools also creates conditions where children themselves become agents of change in their families and communities (UNICEF 2003c). In order for the word to be spread, children need to

attend school where they can absorb the message that water is valuable and understand basic health skills. Where education promotes improved water and sanitation practices, these improvements in turn support educational development (UNWWAP 2003).

FRESHWATER PARTNERSHIPS TO FACILITATE SUSTAINABLE DEVELOPMENT

Goal 8: Develop a global partnership for development

Efforts toward securing sustainable freshwater resources should bring together a range of different stakeholders such as community members, governments and the private sector. This diversity of stakeholders encompasses a wide spectrum of expertise, including hydrologists and climatologists, engineers and planners, ecologists and sociologists, lawyers and diplomats. The establishment of partnerships is necessary. This is equally evident at the international level – ranging from age-old river basin agreements to the most recent multilateral environmental agreements.

Freshwater-related initiatives and processes at the global level

A series of global conferences, meetings and events focusing totally or in part on freshwater resources and sustainable development have taken place over the past three decades. An extensive knowledge base on water-related issues has been built. Major decisions and recommendations have been made, most recently in the framework of the MDG and WSSD goals and targets. Yet most water problems remain. The increasing freshwater demands of an expanding global population continue to outstrip the investment and infrastructure needed to accomplish the goals, particularly in developing countries. Stronger and more concerted efforts are clearly required on the part of governments, UN agencies and other water stakeholders to overcome the primary constraints to implementing the recommended actions in a timely and effective manner. These primary constraints include limited public awareness and understanding of human impacts on freshwater resources and ecosystems, lack of stakeholder participation, weak governance and accountability systems, and inadequate funding and human resources (WLVC 2003). Legal and institutional frameworks are critical to effective partnerships at different level. Box 9 gives an overview of basic principles for good freshwater governance, emphasizing the need for strong and effective institutions and laws.

Transboundary initiatives and river basin agreements

Freshwater resources are widely shared among nations, regions and communities. International river basins account for nearly half the planet's land surface, and host about 40 per cent of the world's population (UNEP 2002d). However, a common, long-term vision of transboundary water systems, needed for their efficient, environmentally-sustainable management and use, is still lacking in many cases. There is inevitably the potential for conflict over the shared use of these resources. On the plus side, the increasing number of river basin agreements offers a platform for collaboration that can lead to a more equitable and sustainable use of shared freshwater resources. A recent report highlighted the need for countries to share freshwater as a major force for peace and cooperation, noting that the historical norm has been to establish treaties, rather than resort to armed conflicts over this issue (UNEP 2002d).

There are 263 rivers that cross or demarcate international boundaries (UNEP 2002d). Issues

Box 9: Principles of good freshwater governance

Approaches

Open and transparent: water institutions should work in an open manner, using language understandable to the general public; water policy decisions should be transparent, particularly regarding financial transactions.

Inclusive and communicative: wide participation should be ensured throughout the water policy chain, from conception to implementation and evaluation; governance institutions must communicate among water stakeholders in very direct ways.

Coherent and integrative: water policies and actions must be coherent, with political leadership and a strong responsibility taken by institutions at different levels; water institutions should consider all potential water users and sectors and their linkages with, and impacts on, the traditional water sector.

Equitable and ethical: equity between and among various water interest groups, stakeholders and consumers should be carefully monitored throughout the policy development and implementation process; penalties for malfeasance should be equitably applied – water governance must be strongly based on the ethical principles of the society in which it functions and on the rule of law.

Performance and operation

Accountable: the rules of the game, as well as legislative roles and executive processes, must be clear; each water-related institution must explain and take responsibility for its actions; penalties for violating the rules and arbitration-enforcing mechanisms must exist to ensure that satisfactory solutions to water issues can be reached.

Efficient: concepts of political, social, and environmental efficiency related to water resources must be balanced against simple economic efficiency; governmental systems should not impede needed actions.

Responsive and sustainable: water demands, evaluation of future water impacts and past experiences should be the basis for water policy; policies should be implemented, and decisions made, at the most appropriate level; water policies should be incentive-based, to ensure clear social or economic gain if the policy is followed; long-term sustainability of water resources should be the guiding principle.

Source: Adapted from Rogers and Hall 2003

involved in sharing transboundary freshwater resources have grown more complex over time. The process of reaching agreements on international water systems, and the mechanisms created therein for consultation and cooperation, provide countries with a means of managing conflicting interests over shared freshwater resources. Organizations such as the Organization for Economic Cooperation and Development (OECD) and the Southern African Development Community (SADC) have brokered agreements and protocols, including the Convention on the Protection and Use of Transboundary Water Courses and International Lakes (1992) and the Protocol on Shared Watercourse Systems in the Southern African Development Community (2000). In 2003, the meeting of the Forum of Ministers of Latin America and the Caribbean also defined management of water resources as a priority area for cooperation toward sustainable development of the region (Box 10).

Box 10: LAC environment ministers place water high on the agenda

The 14th Meeting of the Forum of Ministers of Latin America and the Caribbean (LAC) defined the management of water resources as one of the priorities in the implementation of the LAC Initiative for Sustainable Development. A decision adopted during their November meeting in Panama City recognizes water as an essential resource for life and economic development, and highlights activities such as tourism and agricultural irrigation.

In reaffirming the internationally-agreed target to halve, by the year 2015, the proportion of people with no sustainable access to safe drinking water and sanitation, the ministers committed their countries to initiatives for integrated management of water resources through watershed management. They guaranteed the active participation of all stakeholders, especially through the creation of watershed councils or local management bodies, and through workshops.

Furthermore they committed their countries to promote:

- user friendly and accessible technologies to prevent water loss and pollution by fostering sound water use and sanitation;
- the identification and evaluation of groundwater resources in arid regions as an alternative for guaranteeing access to water in terms of quality and quantity;
- incentives and economic instruments for the protection of natural resources (forests and water), such as economic compensation for public and private stakeholders who contribute to conservation of the environment; and
- The adoption of integrated planning approaches that take into account the linkages between land use, watershed and coastal zone management, especially for the region's Small Island Developing States (SIDS).

Source: UNEP 2003b

Integrated Water Resources Management

WSSD Plan of Implementation: Develop integrated water resources management and water efficiency plans by 2005

In developing an integrated approach to water resource management, it must be recognized that there are fundamental linkages between upstream river basins and associated coastal zones. More than a third of the world's population currently lives in settlements either on, or in close proximity to, coastal areas, and this proportion is expected to increase in the future. An estimated 80 per cent of the pollutants entering coastal waters, mostly from land-based sources, are transported via rivers (Box 11). Deforestation and other land use changes in a river basin can increase loads of sediment, nutrients and other chemicals to coastal zones. Changes in flows attributable to water withdrawals for agricultural, industrial and domestic use, and for hydropower production, can change salinities in estuaries and lagoons.

Tourism plays a major role in many river basins and coastal areas and has numerous linkages with water in both systems (Box 12). At the same time, coastal zones contain some of the world's most productive, and environmentally-sensitive, aquatic ecosystems, including estuaries, lagoons, mangrove forests, and coral reefs, all of which are being subjected to increased pressures.

Integrated Water Resources Management (IWRM) was introduced at the 1992 UN Conference on Environment and Development as a comprehensive approach for achieving sustainable freshwater resource use, reducing human vulnerability to water-related environmental change. At the same time Integrated Coastal Zone Management (ICZM) was widely advocated as the most appropriate policy framework for the coastal-marine interface. Integrated Coastal Area and River Basin Management (ICARM) is a third approach, merging the two. It promotes the adoption of goals, objectives and policies and the establishment of governance mechanisms that recognize the relationships between the two systems, with a view to developing environmental protection and encouraging socio-economic development. Some international agreements and declarations already recognize this freshwater-coastal linkage such as the Convention on Protection and Use of Transboundary Waters and International Lakes, the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, and the EU Water Framework Directive.

Box 11: Freshwater – coast linkages in the Danube-Black Sea region

The Danube and Black Sea region contains the single most important non-oceanic water body in Europe. Every year, about 205 km ^{3} of river water pour from the Danube into the Black Sea from an 800 000 km ^{2} basin.

The Black Sea is one of the most remarkable regional seas in the world. It is almost cut off from the rest of the world's oceans but it is up to 2 212 metres deep. Its eutrophication since the 1960s, due to excessive loads of nutrients that enter via the rivers and directly from the coastal activities, has had a major impact on biological diversity and human use of the sea, including fisheries and recreation.

During recent years there has been a major change for the better due to a reduction in the use of fertilizers in Black Sea catchment areas (see nitrogen cascade issue in the Emerging Challenges section).

Sources: ERN 2003, CEC 2001, Mee 2001

Many governments, international agencies and organizations, and donors currently use IWRM as a guiding principle to achieve sustainable freshwater resources. The World Water Council and the Global Water Partnership (2000) actively promote the implementation of this concept. Nevertheless, successful implementation of IWRM remains elusive and there are few concrete examples of it in action. Practical guidance on appropriate methods and techniques for better identifying, analysing and integrating the various scientific, technical and socio-economic elements to be considered in a given case is still urgently needed (Box 13), and remains a significant constraint to the effective implementation of relevant freshwater programmes and activities.

Stakeholder roles

Weak accountability, on the part of both citizens and governments, is a significant cause of the unsustainable use of freshwater resources (WLVC 2003). At international level the responsibility for freshwater issues is spread among many agencies in the United Nations system (FAO, IAEA, UNDP, UNEP, UNESCO, WHO, WMO, World Bank, and others). Although many agencies have a role in one or more facets of freshwater management, there is often no central entity providing overall guidance. This pattern of institutional fragmentation is not unusual – it can be seen at virtually all government and agency levels, whether international, national or local, and also between ministries with overlapping responsibilities.

Water governance refers to the range of political, social, economic and administrative systems in place to develop and manage water resources and deliver water services, at different levels (Rogers and Hall 2003). Transparency in the decision-making process is essential, particularly to engender trust among freshwater stakeholders. Without it, public confidence in government policies and programmes can be completely undermined, especially at the local level. Effective training of local and national governmental and non-governmental staff, particularly in building coalitions, managing projects and increasing monitoring and evaluation skills, are also essential elements of practical programmes and activities directed to sustainable freshwater resources. Finally, for their part, citizens need to assume a more vigilant role in holding governments and agencies accountable for addressing the fundamental linkages between socio-economic development and sustainable freshwater resources. The principles developed by the World Lake Vision Committee in 2003 certainly also apply to the implementation of freshwater programmes (Box 14).

Box 12: Some tourism – water interlinkages

Over the last 30 years, there has been an explosive increase in international tourism – a sector that now generates US$474 billion per year or about US$1.3 billion per day. In addition to economic benefits, tourism also has water-related impacts. For example, tourism contributes about seven per cent of the total wastewater pollution in the Mediterranean, where an average tourist accounts for 180 litres of wastewater per day. In some Mediterranean islands, drinking water sources have become contaminated with saltwater, as a result of excessive withdrawals.

Tourists often use a disproportionate amount of water. In Granada, for example, the average tourist uses seven times more freshwater than a local person, a ratio that is common in many tourist areas in developing countries. In the Philippines, the quantity of water used for tourism is so high that rice paddy cultivation is threatened by reduced water availability.

There is a range of technical and management approaches for mitigating the negative impacts of tourism on water quality and quantity. These include measures for water conservation, engineered and natural wastewater treatment systems, and options for water reuse. Some of these solutions can be directly implemented by tourism managers, whereas others require broader political support, such as the development of a water management and wastewater treatment plan.

Sources: Mastny 2002, UNEP 2003c, UNWWAP 2003, WTO 2003

Box 13: Integrated assessment for IWRM

To achieve sustainable freshwater supplies IWRM requires a comprehensive assessment of the readily-available freshwater resources, as well as the natural and anthropogenic factors affecting their supply and demand.

The scientific and engineering elements of such an assessment are themselves demanding and include the quantity, quality and location of the freshwater resources in a drainage basin (or aquifer), as well as the basin's geology, physiography, soil types, flora and fauna, types and sources of pollution, population centres, range of land uses, locations of water withdrawals and return flows, and so on. The environmental linkages between these various components must also be identified and factored into the sustainable management equation.

Even more important are the relevant socio-economic elements that need to be assessed. These include the institutions responsible for water allocation, use and protection in the drainage basin; the existing legal framework(s) and effectiveness of existing water governance mechanisms, the prevailing social and cultural customs, the basin demography, the health and educational characteristics of the basin's inhabitants, the economic characteristics of the basin and its inhabitants, the enforcement of existing regulations and standards and the prevailing political realities, among others. These socio-economic and institutional elements are critical because they define how people use their freshwater resources, and whether or not they do so in a sustainable manner.

Sources: Laszlo and others 1988, Rast 2003

Box 14: Principles for implementing the World Lake Vision

- a harmonious relationship between humans and nature is essential for sustainable use;
- the drainage basin (or aquifer) is the logical starting point for planning and management actions for sustainable use;
- a long-term approach directed to preventing the causes of freshwater degradation is essential;
- policy development and decision-making for freshwater management should be based on sound science and the best available information;
- the management of freshwater for sustainable use requires the resolution of conflicts among competing users, taking into account the needs of present and future generations and of nature;
- citizens and other stakeholders should be encouraged to participate meaningfully in identifying and resolving critical water problems; and
- good governance, based on fairness, transparency and empowerment of all stakeholders, is essential for sustainable water use.

Source: Adapted from WLVC 2003

SUSTAINING OUR FUTURE AND MEETING OUR GOALS

Sound water management is key to sustaining the future of both humanity and the environment. It is closely linked to the internationally-agreed development goals. Properly harnessed and utilized, water becomes an indispensable resource for development; squandered and abused it becomes a source of human suffering.

An adequate freshwater supply is required to maintain the viability of life-supporting ecosystems. Polluting water not only damages ecosystems, but renders water unsafe for drinking, and unsafe drinking water is, on a global scale, currently the single most important environment-related health threat. Irrigation has significantly improved crop yields, but in many areas, it has lead to serious environmental degradation – such as salinization and the depletion and contamination of aquifers – which in turn reduces the amount of food that can be produced. Negative environmental impacts such as these soon translate into poor human health and economic loss. One of the main global challenges to sustainable development is, therefore, to balance water consumption for economic and social development as well as for ecosystem functions and services.

Although the water outlook is still too often one of degradation and depletion, a crisis is not inevitable. UNEP's Executive Director has described 2003 as "a year where the world has more than ever come to understand that cooperation over water is something like a peace policy for the 21st century." Coupled with this, more governments and other freshwater stakeholders are recognizing that an approach that integrates the protection of aquatic and terrestrial ecosystems within the context of sustainable development is the way forward to improved water supply and sanitation, food production, human settlements, and other priority issues.

In many parts of the world, we are far from achieving efficient and effective management of the limited amount of freshwater that is available on our planet. And the longer we wait to change prevalent patterns of water use, the more difficult and expensive it will be to achieve the MDGs and WSSD targets for sustainable environmental, social and economic development, including poverty eradication.

A broad range of policy instruments, management techniques and longstanding as well as innovative technologies are at our disposal. Firm commitments by political leaders and decision-makers are needed to implement prioritized action plans incorporating water management to achieve the relevant goals and targets at different levels: local, basin, national, transboundary, regional and/or global. To do so, countries must strengthen institutions and legal frameworks, secure sufficient financial resources, build capacities in managing water resources and equitably involve all stakeholders – including women – in the design and implementation of integrated water resource management plans and frameworks.

More than a billion people still live in a world of want in terms of water and sanitation and their numbers are still increasing. Meeting this water challenge is vital to moving toward a world where people are "free from want" as underlined in the Millennium Declaration in 2000. The 2003 International Year of Freshwater has re-emphasized the urgency behind this commitment by the world leaders at the Millennium Summit. Achieving the agreed goals and targets requires the urgent and concerted attention of freshwater stakeholders at all levels – today.

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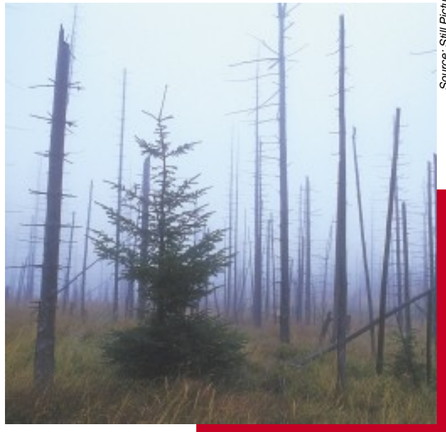

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Emerging Challenges – New Findings

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THE NITROGEN CASCADE: IMPACTS OF FOOD AND ENERGY PRODUCTION● OVERFISHING: HARVESTING FISH FASTER THAN THEY CAN REPRODUCE

Emerging Challenges – New Findings

New scientific research findings in 2003 on the nitrogen cycle and marine overfishing have shed light on ongoing environmental challenges of global significance. Both issues are emerging environmental challenges in terms of strategic and adaptive policy responses and action at appropriate levels

Human activity is radically altering the world's nitrogen cycle through food and energy production. While some important food-producing systems are nitrogen-deficient, others are generating excess nitrogen, affecting air, land, and freshwater, and ultimately environmental and human health. Nitrogen overload is also contributing to the rapid growth of oxygen-starved zones in some coastal waters. A new understanding of nitrogen cycling provides the opportunity to develop innovative and effective strategies to reduce the negative impacts of nitrogen on the environment and human health, while maintaining its benefits for society.

Three-quarters of the world's fish stocks are being overexploited, threatening their existence, and jeopardizing the resources available for future generations. New data about fish stocks and the impacts of fishing methods provide a sound scientific foundation to develop effective management regimes.

While both these emerging environmental issues (Box 1) are globally relevant, their extent, magnitude and impacts vary significantly at regional and lower levels. For example, problems related to nitrogen exist all over the world but the nature of the problem varies: there is too much nitrogen in some areas, while others have too little to meet human needs. Local and regional perspectives are, therefore, critically important to advance our understanding of the threats and opportunities they provide. This local and regional texture is also important in designing and implementing solutions because social, cultural, political, and economic factors need to be considered for sound and effective environmental management. It is also clear that, while people contribute to the problem, they are also part of the solution.

Box 1: Defining emerging environmental issues

"An issue (positive or negative) which is not yet generally recognized but which may have significant impact on human and/or ecosystem health.

"Emerging issues are often not 'new' issues, but the intensification, wider extension, transformation or changed perception of familiar issues."

Source: Munn and others 2000

THE NITROGEN CASCADE: IMPACTS OF FOOD AND ENERGY PRODUCTION ON THE GLOBAL NITROGEN CYCLE

Human activities have greatly increased the amount of reactive nitrogen that circulates through the earth's land, air, and water each year (Galloway and others 2003). The main reason for this is the manufacture of reactive nitrogen as a fertilizer to increase food production (Box 2). Nitrogen is necessary to increase crop yields, but plants are inefficient at taking it up and often more fertilizers and animal wastes are added than the plants need. As a result, only a fraction of the nitrogen applied to soils actually ends up in crops; in some regions it is less than 20 per cent (Smil 1999). The rest ends up moving freely through the environment where it may have serious impacts on the air, land, freshwater and oceans, as well as on human health. However, some parts of the world, notably Africa, suffer the opposite problem – a deficiency of reactive nitrogen in the soil. This contributes to low crop yields and to food insecurity in the region.

Another main source of excess reactive nitrogen in the environment has been its inadvertent creation, in gaseous forms such as nitrogen oxides, from burning coal, oil, and natural gas. Finally, untreated or partially treated human and animal wastes add reactive nitrogen to aquatic ecosystems, contributing to degradation and human health risks.

New insight – new understanding

Although the environmental significance of nitrogen has been studied for at least 150 years (Box 3) scientists have only recently documented how reactive nitrogen 'cascades' through ecosystems, creating environmental and human health problems all along the way (Galloway and others 2003). We have also recently come to a better understanding of the magnitude of the problem: human production of reactive nitrogen is now greater than the amount created by natural processes on land, leading to a large increase in the amount of nitrogen moving within the environment. Globally, humans create about 160 million

Box 2: What is reactive nitrogen?

Most of the nitrogen in the environment is in the global atmosphere in the form of atmospheric nitrogen (di-nitrogen or N_2), where it makes up 78 per cent of gases. This form of nitrogen is 'non-reactive' and unusable by almost all living things, but can be made usable, or 'reactive', through both natural and artificial processes. In the natural process, bacteria (such as Rhizobium and cyanobacteria) transform N_2 from the air into ammonia (NH_3) through biological nitrogen fixation.

Humans create reactive nitrogen from N_2 in several ways: through the NH_3-producing Haber-Bosch process (used mostly for fertilizer); through agriculture that induces biological nitrogen fixation (such as soybean cultivation); and as a byproduct of burning fossil fuels, which converts N_2 and fossil N to reactive nitrogen oxides (NO_x). Globally, about five times more reactive nitrogen results from food production than from energy production.

Source: Galloway and others 2003

Box 3: Our incremental understanding of nitrogen

The 7th element of the periodic table was named 'nitrogene' in 1790 by Jean Antoine Claude Chaptal (1756–1832). By 1850, the fundamental role of nitrogen in living systems and its beneficial role in crop production became clear: it was a common element in plant and animal tissues, indispensable for plant growth, underwent constant cycling between organic and inorganic compounds, and was an effective fertilizer. Knowledge on the negative impacts of nitrogen compounds on people and ecosystems also grew with time. The contribution of nitrogen compounds to air pollution was certainly known by the late 19th century, as was the impact of excess nutrients (including nitrogen) on coastal marine ecosystems, although for the latter, the focus was on the positive impacts of nutrients on marine productivity. It was not until the mid-20th century that negative impacts of excess nutrients were recognized as a serious international problem.

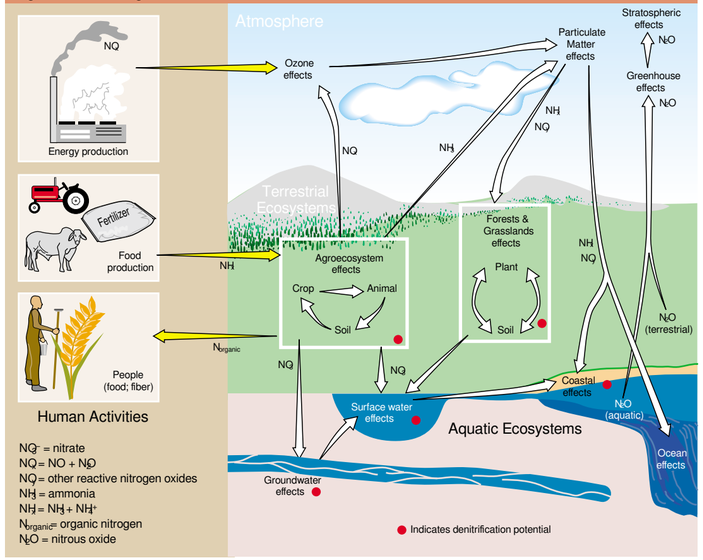
Source: Nixon and Buckley 2002

tonnes of reactive nitrogen per year, compared to natural rates of terrestrial biological nitrogen fixation, which are between 90–120 million tonnes annually. However, we have not similarly increased de-nitrification processes which convert nitrogen primarily back to non-reactive N_2. Reactive nitrogen is, therefore, accumulating in the environment.

Cascading through the environment

Nitrogen is now known to be unusual among the elements that have had their cycles significantly perturbed by human action. As it moves along its biogeochemical pathway, the same atom of nitrogen can contribute to many different negative impacts in sequence. Once nitrogen is converted into reactive nitrogen, it can be transported to any part of the system, no matter where it was introduced into the environment. This sequence of effects has been termed the nitrogen cascade (Figure 1). The concept of the cascade, and the extensive research that underlies it, has allowed us not only to determine the linkages among the various aspects of the nitrogen cycle, but also to begin to assess how changes in one part of the cycling can delay or enhance the transfer of nitrogen to other parts of the cycle (Galloway and others 2003).

Figure 1: The nitrogen cascade



A single atom of nitrogen can have sequential effects in various parts of the environment after it has been converted from non-reactive N_2 to a reactive form during energy or food production.
There are three groups of reactive nitrogen compounds:

- *inorganic reduced forms of N: ammonia [NH_3] and others forms [NH_x], such as ammonium [NH_4^+];*
- *inorganic oxidized forms: nitrogen oxide [NO], nitrous oxide [N_2O], nitrate [NO_3^-] and others [NO_y]; and*
- *organic compounds: urea, amines, proteins, nucleic acids and others [$N_{organic}$]*

Source: adapted from Galloway and others 2003 and redrawn by Robert Smith, Charlottesville, US

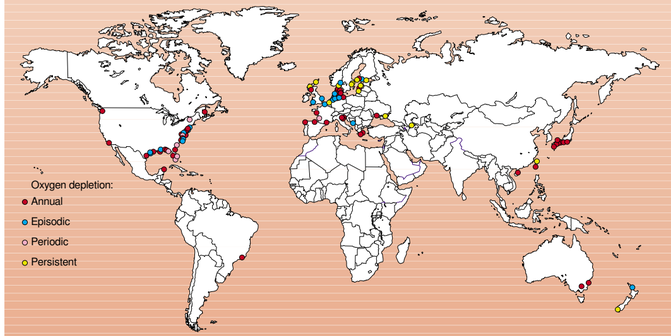
Nitrogen accumulates in the lower part of the atmosphere in the form of nitrous oxide that contributes to global warming and is also transported to the stratosphere where it contributes to ozone depletion. Excess reactive nitrogen in the air also results in higher concentrations of small particles (aerosols) and increased ozone levels (smog) in the lower part of the atmosphere, that cause respiratory ailments in people. It may fall back to the surface as acid rain, harming plants, corroding buildings, and acidifying soils, lakes, and streams. In addition to acidification effects, it can also fertilize grasslands and forests, causing changes in species composition and often an initial increase in plant growth, followed by, for some systems, a decrease in ecosystem health. Nitrates may seep into groundwater, making it unfit for human consumption. Excess reactive nitrogen is also transferred from the land into rivers, where it reduces biodiversity, and then to the seas and oceans where it can cause a variety of

Box 4: Oxygen-starved coastal zones

Oxygen-starved areas in bays and coastal waters have been expanding since the 1960s. The number of known locations around the world has doubled since 1990. While many of these sites are small coastal bays and estuaries, seabed areas in marginal seas of up to 70 000 km ^{2} are also affected. Increased flows of nitrogen from agricultural run-off and the deposition in coastal areas of air-borne nitrogen compounds from fossil-fuel burning stimulate blooms of algae in these waters. The algae sink to the bottom where they are decomposed by micro-organisms that use up most of the oxygen in the system, creating an inhospitable habitat for fish, shellfish, and most other living things. In recent decades, large areas of coastal waters with harmful algal blooms, severely depleted oxygen levels, and disappearing seagrass beds have been identified and clearly linked with increased inputs from the nitrogen cascade.

The primary cause of these oxygen-starved areas varies. For example, the very large 'dead-zone' in the Gulf of Mexico is caused primarily by nitrogen from agricultural run-off, whereas the problems in the Baltic Sea, northern Adriatic Sea, Gulf of Thailand, Yellow Sea, and Chesapeake Bay result from a combination of agricultural run-off, nitrogen compounds from fossil-fuel burning being deposited from the air, and discharges of human wastes. Because of these different causal factors, different solutions are required.

Severe oxygen depletion of coastal waters has significant negative consequences to economically important fisheries, ecosystem services, and biodiversity. These effects are difficult to quantify because the waters are often simultaneously affected by overfishing and habitat destruction related to extensive coastal development.



Global distribution of oxygen-depleted coastal zones. The 146 zones shown are associated with either major population concentrations or with watersheds that deliver large quantities of nutrients to coastal waters. (Annual – yearly events related to summer or autumnal stratification; Episodic – events occurring at irregular intervals greater than one year; Periodic – events occurring at regular intervals shorter than one year; Persistent – all-year-round hypoxia)

Sources: Boesch 2002, Caddy 2000, Diaz and others (in press), Green and Short 2003, Rabalais 2002

problems, including oxygen-starved coastal waters that harm many forms of marine life (Box 4). The cascade continues as long as the nitrogen remains active in the environment, and it ceases only when reactive nitrogen is stored for a very long time, or is converted back to non-reactive di-nitrogen (N_2).

The enormous significance of the nitrogen cascade comes into focus with the realization that it is linked with so many of the major global and regional environmental challenges that policymakers face at these levels today: ozone layer depletion, acidification of soils, global warming, surface and groundwater pollution, biodiversity loss, and human vulnerability. While the extent of its contribution to these problems is still unclear, addressing the issue of excess reactive nitrogen is one of the critical challenges for policymakers.

More than was bargained for

Reactive nitrogen does not cascade at the same rate through all sectors of the environment. Some systems (most notably forest and grassland soils) are able to slow down the continuation of the cascade by accumulating reactive nitrogen and therefore acting as reservoirs. However, most systems have a finite capacity to accumulate reactive nitrogen. As a system becomes saturated, more and more reactive nitrogen moves from these storage reservoirs to systems downwind or downstream. Table 1 shows those systems that have large accumulation potential and those from which reactive nitrogen is most readily transferred. It also shows where reactive nitrogen is likely to move to, and some potential effects of excess nitrogen within each system.

With more anthropogenic reactive nitrogen present in the environment, it is likely to be increasingly mobilized from storage reservoirs, compounding the consequences on people and ecosystems. However, just as anthropogenic activities have substantially increased the rate of reactive nitrogen formation, so is it possible to intervene at critical points along the nitrogen cascade and make reactive nitrogen less abundant. This can be done in two ways – decreasing the rate of reactive nitrogen creation during energy and food production, or converting reactive nitrogen back to N_2 after it has been created and used.

Addressing the imbalance

Recent research is now able to help policymakers identify the dominant factors in each problem area of the nitrogen cascade. Where there is excess nitrogen, the challenges are to use fertilizer more efficiently in agriculture, treat animal and human waste in a manner that will either reuse or eliminate reactive nitrogen, and reduce the amount of nitrogen emitted from fossil-fuel burning. Each of these steps would help to reduce both global and regional impacts. In areas of nitrogen deficiency, the challenge is to boost

Table 1. Characteristics of different systems in relation to the nitrogen cascade

System	Accumulation potential	Transfer potential	Links to other systems	Effects potential
Atmosphere	Low	Very high	All but groundwater	Human and ecosystem health, climate change
Agroecosystems	Low to moderate	Very high	All	Human and ecosystem health, climate change
Forests	High	Moderate, high in places	All	Biodiversity, net primary productivity, plant mortality, groundwater
Grasslands	High	Moderate, high in places	All	Biodiversity, net primary productivity, groundwater
Groundwater	Moderate	Moderate	Surface water, atmosphere	Human and ecosystem health, climate change
Wetlands, streams, lakes, rivers	Low to moderate	Very high	Atmosphere, marine coastal systems	Biodiversity, ecological structure, eutrophication, harmful algal blooms
Marine coastal regions	Low to moderate	Moderate	Atmosphere	Biodiversity, ecological structure, fish, eutrophication, harmful algal blooms, hypoxia

Source: adapted from Galloway and others 2003

reactive nitrogen in an affordable and sustainable manner.

Precision agriculture is part of the solution as it matches the amount of nitrogen supplied with how much plants need both in amount and timing, reducing excessive and poorly-timed fertilizer application. Using biological sources of nitrogen inputs, such as nitrogen-fixing trees and cover crops (Sanchez 2002, Conway and Toenniessen 2003), together with, or as an alternative to, fertilizer made in industrial processes, can be part of a sustainable solution in regions where reactive nitrogen is still a limiting factor for food production, whether due to short supply, poor distribution or high cost. Developing countries have an opportunity to avoid the nitrogen overload problems currently plaguing industrialized nations by choosing improved, alternative and appropriate technologies and land use practices for supplying needed nitrogen. The challenge is, of course, not to have a negative impact on food production.

While recognizing that trade flows are based on a wide range of factors and considerations, from the nitrogen perspective, relocating linked activities could have positive spin-offs. For example, producing animals in the same regions as the food that feeds them (eg soybeans), would avoid shipping large amounts of nutrients into regions such as the European Union, where there is already an excess of nitrogen. Locating food processing and value-added industries in developing regions will not only help alleviate poverty but also maintain nutrients near their agricultural sources for more effective recycling.

Other interventions at strategic points in the nitrogen cascade can reduce the damaging impacts of nitrogen compounds transferred to other parts of the system. Existing technologies can remove virtually all the nitrogen compounds from exhaust gases from burning fossil-fuel. There are costs associated with this, but they are comparatively less than the costs of continued widespread pollution (Moomaw 2002). Alternative energy sources, which are not based on combustion or nitrogen-containing compounds, can also be part of the solution, while appropriate sanitation technologies can help reduce the influx of nitrogen in water systems (Box 5).

A number of countries and regional intergovernmental organizations have taken action on the problem of oxygen deprivation linked to excess nitrogen accumulation in aquatic and marine ecosystems. Goals have been set through regional compacts to reduce reactive nitrogen input to coastal and marine ecosystems such as the Baltic Sea, Chesapeake Bay, and Seto Inland Sea, Japan (Boesch 2002). Steps have been taken to reduce agricultural nitrogen run-off, atmospheric deposition of nitrogen, and emissions of nutrients through sewage and

Box 5: Technology at work – sustainable sanitation

Sustainable sanitation can provide the solution for non-serviced or under-serviced communities to meet their hygiene needs while receiving the benefits of recycling organic carbon, nitrogen and phosphorus. By closing nutrient loops, nitrogen and phosphorus fertilizers are recycled back to grow plants, rather than being flushed to rivers and seas where they cause contamination.

One approach is to separate the collection of urine and faecal matter. Urine is generally sterile but contributes much of the nitrogen and phosphorus in wastewater. Once diluted, it can be used as a fertilizer. Collected separately, the faecal matter can be composted in a composting toilet of which several designs are available. An alternative approach to achieve sustainable sanitation for household waste is for the graywater (from bathroom and laundry) to be treated through a wetland and the blackwater (faeces and urine) treated to produce biogas (containing methane [CH_4]), a source of energy. After treatment the residue, which contains organic carbon, nitrogen and phosphorus, can be applied to crops, producing food rather than moving on through the environment.

Source: UNEP 2002

industrial waste. Much of the progress in reducing reactive nitrogen sources is the result of technologically-advanced waste treatment facilities, particularly in Europe and North America, rather than of reductions from diffuse non-point sources such as agriculture, which are more difficult to control.

The northwestern coastal area of the Black Sea is an example of a dramatic improvement of an oxygen-starved zone. Following the collapse of the centrally planned economies in Eastern and Central Europe, use of manufactured fertilizers declined quickly because they were no longer affordable. Within seven years, the amounts of nitrogen and phosphorus entering the Black Sea from the Danube and other rivers had dropped to half of previous levels; the 'dead zone' largely disappeared and fisheries have rebounded. Now the management goal is to maintain this situation as the economy of the region redevelops (Mee 2001).

Another example of reduction in nitrogen pollution, this time through policy intervention, comes from the Rhine River. With an internationally agreed policy target to reduce the nitrate load in the Rhine by 50 per cent, improvements in sewage effluents and industrial discharges by countries within the Rhine basin contributed to an estimated 37 per cent reduction in total nitrogen discharge to the North Sea between 1985–2000. Further reductions will largely depend on efforts to reduce diffuse pollution from agriculture (International Commission for Protection of Rhine 2001). The dominance of point sources in the heavily populated and industrialized Rhine region made quick reductions more easily attainable than is likely to be the case in river basins dominated by diffuse agricultural sources of nitrogen.

OVERFISHING: HARVESTING FISH FASTER THAN THEY CAN REPRODUCE

In 2002, 72 per cent of the world's marine stocks were being harvested faster than they can reproduce (FAO 2002a) and fishing activities were shown to be having an impact on important, and until recently, unresearched and even undiscovered, marine ecosystems. Major changes in the exploitation and management of marine habitats are needed to avoid many marine fisheries from becoming commercially extinct.

Despite an increase in the reach and intensity of commercial fishing operations and contrary to some official data (see GEO Indicators section), the total quantity of fish catches is estimated to have been declining by about 700 000 tonnes a year since the late 1980s (Watson and Pauly 2001). The initiatives that have been taken for specific fisheries have been ineffective in addressing this downward trend. Alder and Lugten (2002) demonstrated for the North Atlantic that there has been a decline in landings, despite a plethora of agreements which focus on the management of stocks. The measures taken for some species such as tuna may be too little and in some cases, such as for the cod off Newfoundland, possibly too late (Myers and Worm 2003).

Fish stocks that are recovering or rebuilding are generally small, isolated and easily managed, such as the orange roughy stock on New Zealand's North-east Chatham Rise (Ministry of Fisheries 2003). The gains in abundance are minor compared to other stocks that continue to decline, especially those in the high seas shared among countries (such as the Patagonian toothfish) (Figure 1).

Other changes are taking place. Fishing fleets are venturing farther from their home ports, off the continental shelves and into deeper waters to meet the global demand for fish (Pauly and others 2003). Consequently, fish are being captured from stocks which were previously unexploited and the long-term viability of a number of species may be jeopardized.

Figure 1: Patagonian toothfish (Dissostichus eleginoides)
Source: USDA Regulatory Fish Encyclopedia

Illegal, unregulated and unreported (IUU) fishing has also increased in many areas. Fisheries management is primarily based on landing data: if fish are caught and not recorded in the official statistics then the data (including age, sex and size structure) needed for management are distorted. If stock assessment specialists do not have a good estimate of illegal fishing or account for it in their analysis, the management measures that are recommended may be inappropriate or inadequate. Techniques employed in IUU fishing also go unchecked: gear may be used that damages the marine environment or other, non-targeted, species including seabirds such as the albatross, caught on long-line hooks. In 2003, greater attention was paid to illegal fishing, with many governments increasing their enforcement activities as one of many measures to address the problem of overfishing (FAO 2003a).

Fishing for food and revenue

The world marine fish catch in 2001, the most recent year for which global data are available, was reported at 84 million tonnes (FAO 2003b), much of it caught by very few countries. According to reported statistics, the top four, accounting for over a third of the production from marine capture fisheries, were China, followed by Peru, the US and Japan.

Fisheries (marine plus inland) provide close to 17 per cent of the total annual animal protein consumed globally (FAO 2002a). International trade in all fisheries products (marine and inland fisheries and aquaculture) continued to be an important source of revenue on the global commodities markets. About 38 per cent (live weight equivalent) of world production entered international trade in 2001. The net foreign exchange earnings for fishery commodities by developing countries increased from US$4 billion in 1981 to US$17.7 billion in 2001 (Vannuccini 2003).

New analyses – new understanding

In 2003, new large-scale analyses of marine habitats and species, and new ways of analysing data became available. The results have provided a stark warning about the

impacts of fishing on the marine and coastal environment and will be helpful in addressing trade-offs in fisheries management.

Impacts on predatory species

Christensen and others (2003) used multiple models, which incorporated historical fisheries information and environmental parameters, to predict the abundance of predators, such as halibut, cod and sharks, in the North Atlantic over a 100-year period. This is the first long-term study to investigate the North Atlantic fisheries within an ecosystem context and document the decline of biomass for a number of groups of organisms rather than selected single-species fisheries of commercial interest. Results show that the biomass (the weight of fish in a given area) of top predators in the North Atlantic has decreased by two-thirds in approximately 50 years. Similar declines were noted for other important species such as perch, anchovies, and flatfish due to overfishing between 1900–1999.

A study of large predatory fish such as tuna, shark, and swordfish in tropical and subtropical oceans also pointed to an ongoing decline of top-level ocean predators (Myers and Worm 2003). Their biomass was reduced by 80 per cent within 15 years of being targeted by the fishing industry.

These studies show how fishing activities can have a rapid impact on marine fish populations. Many large top predators risk the same fate as the barndoor skate, which made up 10 per cent of the biomass in tows by research vessels in the 1950s. In the last 20 years none have been caught (Casey and Myers 1998). They also demonstrate how existing data, re-analysed with new techniques, can describe the current and possible future status of different stocks with enough resolution or detail to be of use to policy advisors and managers.

New impacts on long-lived species

Fleets are increasingly moving beyond the 200-mile limit of national jurisdiction (the Exclusive Economic Zone) into the high seas and deeper waters (Pauly and Watson 2003). Consequently, fishing activities have spread into areas where old long-lived species such as the orange roughy and Patagonian toothfish occur and, until recently, were unexploited.

This is problematic. Many of these species take a long time to reach sexual maturity, and stocks may be quickly depleted or overexploited once most of the older fish have been harvested, because the older fish are the ones that reproduce. Rebuilding these stocks to sustainable levels can take 10–20 years or longer depending on the species and degree of overexploitation. Some species may never recover. Stocks of the armorhead (*Pseudopentaceros wheeleri*), once found on seamounts of the North Pacific, collapsed in 1977 after a decade of fishing. Since then no major landings of this species have been recorded (Glover and Smith 2003).

The evidence shows that many of these deep sea fish stocks are highly vulnerable to overfishing. Any exploitation should, therefore, take a precautionary approach until the life history of the species is understood. Recent experience has shown that, without this understanding, sustainable fishing is not possible – otherwise we are just mining the resource. A first step for policymakers would be to put in place an international mechanism to designate and monitor high seas protected areas. This would allow for the protection of important areas or ecosystems on which many of these long-lived species depend.

Ecosystem effects

Seagrasses form an important shallow water ecosystem that binds the seabed and reduces coastal erosion. They also provide shelter and nursery grounds for many species. For example in the Philippines, 20 per cent of the fish caught are associated with coral reefs and seagrass beds. The global distribution of seagrasses was plotted for the first time in 2003 (Green and Short 2003). This atlas used information from a variety of sources and then predicted distributions through modeling.

In many cases, distribution of seagrass beds overlaps with intensive commercial fishing operations. This is a problem because certain fishing techniques drag heavy trawling gear over the seabed, severely damaging the seagrass. Off Tanzania, in fisheries that use such trawling gear, 80 per cent of the by-catch in the prawn fishery is seagrass (Green and Short 2003). Studies in Maquoit Bay, Maine, US, have projected that even small areas (0.3 km^2) may take between 10–17 years to recover. This can have a direct impact on the biodiversity, on local fisheries, and, ironically, on the livelihoods of the very people who cause the damage. Tropical and temperate coral reef ecosystems are similarly at risk from damaging fishing techniques (Box 6).

Box 6: Cold and deep water corals

Coral reefs do not only occur in warm tropical oceans. Cold water reefs are built by stony corals such as *Lophelia pertusa* which flourish in the cold, nutrient and plankton rich currents on the seabed of continental shelves and fringes down to several hundreds of metres below sea level. Cold water reefs rival their tropical shallow-water counterparts in size, structure, complexity and biological functions, providing rich habitats that support and sustain thousands of marine species, including commercial fish. Environmental threats, such as the physical impact from trawling operations, have devastated many assemblies before scientists even know their full distribution and begin to understand the ecological role of these biodiversity hotspots.

An example of a cold water coral system is the Darwin Mounds. These are located 180 km off the west coast of Scotland. The mounds are at a depth of about 1 000 m, and cover an area of approximately 100 km^2. Fishing activities in this area targeted deep water species (eg blue ling, roundnose grenadier, black scabbard fish and tusk).

2003 saw an increased recognition of the importance of cold water coral systems. A European Commission Regulation (2003/C 161 E/204) came into effect in August 2003, prohibiting the use of bottom trawls or similar towed nets within the vicinity of the Darwin Mounds. These emergency temporary measures were put in place while the commission develops more permanent measures to protect the area.

Source: DEFRA 2003, Freiwald and others (in press)

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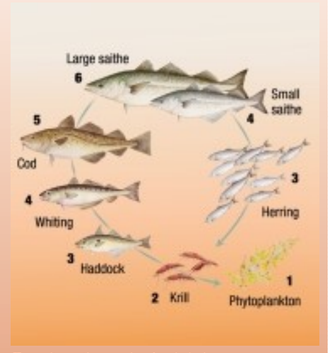
BOX 7: What is a trophic level?

One way to understand the structure of ecosystems is to arrange them according to who eats who along a food chain. Each link along the chain is called a trophic level. Levels are numbered according to how far particular organisms are along the chain from the primary producers at level 1, to the top predators at the highest level. Within marine systems, large predators such as sharks and saithe, are at a high trophic level, cod and sardines are in the middle, and shrimp are at a low trophic level with microscopic plants (mainly phytoplankton) at the bottom sustaining marine life.

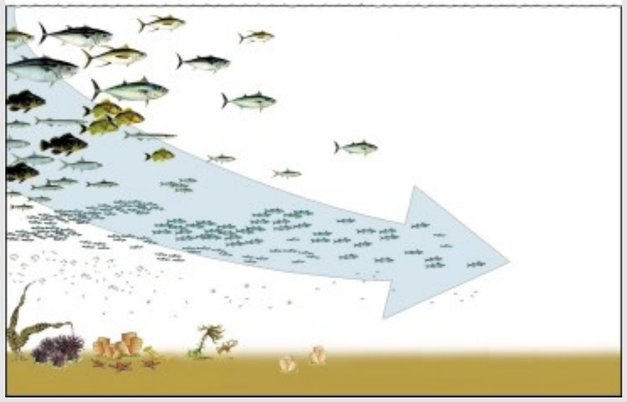
The arrows in the figure indicate who is eating who. In this example, cod are at trophic level 5, whereas the large saithe which eat them are on trophic level 6. The small saithe, which feed on smaller prey, are at a lower trophic level. A single species may consume prey from several different levels. In this case, its trophic level is calculated according to the proportion of its diet that comes from the various trophic levels it feeds on, and will not necessarily be a whole number.



Two alternative marine food chains.

Source: Pauly and Watson 2003

Figure 2: Fishing down marine food webs



The arrow indicates how, over time, humans have depleted stocks of larger fish found closer to the surface and are now fishing smaller fish from deeper water or on the bottom of the sea. When fish are taken from the bottom the habitat usually changes from one rich in various plants and bottom-dwelling organisms, to a near-lifeless muddy substrate.

Source: Daniel Pauly, Fisheries Centre, University of British Columbia, Canada

Fishing down the food chain

Another effect of overfishing is the progressive decrease of the trophic level (Box 7) of the catch. Overexploitation of the top of the food chain and the targeting of more abundant species lower in the food chain is called 'fishing down the food chain' (Pauly and Watson 2003). Overfishing has shortened the chain and sometimes removed one or more of the links, increasing the system's vulnerability to natural and human induced stresses, as well as reducing the supply of fish for human consumption (Figure 2).

Monitoring the average trophic level of fish catches can show when stocks of larger predatory fish are beginning to collapse. A study of fisheries off the west coast of Newfoundland, for instance, described how the average trophic level of the catch decreased markedly over a 43-year period. The level went from a maximum of 3.65 in 1957 to 2.6 in 2000 (Pauly and Watson 2003). This meant that, toward the end of this period, fewer fish such as cod were being caught, the average size of fish caught was smaller and other species, which the cod may have preyed upon, made up a greater proportion of the catch, and were therefore also being removed from the food chain. As well as the catch having less economic value, there are important long-term implications as, with less food, it may take cod stocks longer to recover. Overall, it is clear that managing target species without considering other species and the ecosystem that supports the fisheries is not an effective approach. Appropriate mechanisms are needed to effect ecosystem-based management that encompasses multi-species management.

Non-food fisheries: the marine aquarium trade

Between one-and-a-half and two million people worldwide are estimated to keep marine aquaria. The trade, which supplies this hobby with live marine animals, is worth an estimated US$200–330 million annually, and operates throughout the tropics. Ornamental marine species (corals, other invertebrates and fish) are collected and transported mainly

from Southeast Asia, but also increasingly from several island nations in the Indian and Pacific Oceans, to the main destination markets: the United States, the European Union (EU) and, to a lesser extent, Japan (Wabnitz and others 2003).

Some 1 471 fish species and 140 coral species are traded worldwide. With nearly all tropical marine aquarium fish and invertebrates in trade taken directly from coral reefs and adjacent habitats, the aquarium industry has attracted controversy, particularly regarding its sustainability. A maximum of 10 per cent of marine ornamental fish are captive-bred and probably less than one per cent of the total trade in hard corals is derived from cultured origins. Trade in this industry has been on the increase. In 1997, for example, 1 200 tonnes of coral were traded internationally, a tenfold increase on the amount of live coral traded in the late 1980s (Wabnitz and others 2003).

Opponents to the trade emphasize that there are significant challenges to achieving sustainability:

- The damaging techniques sometimes used to collect reef specimens. Sodium cyanide, for example, is a non-selective technique used to capture fish. This adversely impacts the overall health of fish and coral and non-target organisms;
- The over-harvesting of target organisms;
- The high levels of mortality associated with insensitive shipping and poor husbandry practices along the supply chain; and
- A paucity of information on the extent of the marine ornamental trade (Box 8).

Box 8: Gaining an overview: the Global Marine Aquarium Database

In 2000, the UNEP World Conservation Monitoring Centre (UNEP-WCMC), the Marine Aquarium Council and members of various aquarium trade associations began, in collaboration, to address the need for better information and created the Global Marine Aquarium Database (GMAD). In August 2003, the dataset contained 102 928 trade records (7.7 million imported and 9.4 million exported animals) covering a total of 2 393 species of fish, corals and invertebrates and spanning the years 1988–2003. An analysis of the database provided the first global picture of trade in marine ornamental species.

This innovative partnership with traders has led to the collection of a unique data set and an analysis that will assist national ministries and commercial organizations to develop a sustainable approach to the trade.

The GMAD can be accessed through the 'Species' page at http://www.unep-wcmc.org/

Source: Wabnitz and others 2003

Reducing pressure

Overfishing is recognized as a problem that needs to be dealt with at international as well as national level to protect fish stocks and entire ecosystems. Overall, there is a need to reduce fishing pressure in order to maintain or restore degraded marine environments to healthy ecosystems that include rich fish communities. If policymakers have the political will to change the future of fisheries, there are a number of options available to them, including:

- reduced quotas;
- phase-out of subsidies;
- fishery closures;
- improved monitoring and enforcement of local and international fishing regulations through increased budgets and reduced levels of corruption; and
- the establishment of marine protected areas (MPAs).

The European Commission recognized that certain marine stocks, including herring, cod, and hake, were being overexploited in the North Sea. In February 2003, measures came into force reducing fishing pressure in the area. One of the major pieces of legislation agreed was a maximum of 15 days per month for vessels fishing in restricted areas. This took into account both the conservation of stocks and also the economic reality of the impacts on livelihoods (Annex XVII to EU Regulation 2341/2002).

The federal government of Canada introduced in 2003 a plan of action to conserve cod stocks off eastern Canada. The plan included closing three areas to commercial fishing of cod, establishing no trawling zones, closing a recreational cod fishery and a 40 per cent reduction in capelin landings, a source of food for cod (Department of Fisheries and Oceans 2003). An economic assistance package to reduce the impact of the closure on coastal communities was also part of the action plan.

Marine protected areas (MPAs) are one of the tools that may be helpful in providing a refuge from exploitation, and protecting biodiversity and essential habitats such as nursery grounds for

On the way to the aquarium

Source: Peter Scott, Marine Aquarium Council, Hawaii, US

fish. Studies in the Florida Keys and Caribbean (Faunce and others 2002), Southern California (Rogers-Bennett and others 2002) and the Philippines (Alcala and others 2003) have demonstrated that MPAs contribute to the maintenance of fish stocks. For some species the spillover effect, whereby fish move from the MPAs into areas beyond, could help improve or at least maintain the exploited stocks. For example, several of Australia's seamounts in the Southern Ocean are included in the Heard Island and McDonald Islands Marine Reserve (the world's largest MPA) that may help to conserve the Patagonian toothfish. However, this MPA will not contribute to conserving the toothfish unless IUU fishing in the region is also addressed (Meyer and others 2000). MPAs are particularly useful when they are implemented in combination with other management measures such as reducing fishing effort.

CHALLENGES FOR THE FUTURE

Although the environmental issues discussed in this section are presented separately, they all interact within the complex backdrop of global change. Our ability to understand and unravel the integrated nature of environmental challenges is improving, enabling us to consider various solutions to the different problems of a complicated world and choose the best course to follow – one that causes the least damage, and leads to the most benefits.

It is also important to tease apart interacting local, regional, and global drivers of environmental change and to recognize that they vary substantially from place to place. This is vital to developing the appropriate mix of responses for any situation. Stratospheric ozone depletion, climate change, and biodiversity, for example, require global solutions. In other cases, including fisheries and various challenges related to nitrogen, regional and/or national solutions also have a major role to play.

The findings reviewed here underscore the urgent need to translate improved scientific understanding into improved policymaking and action. As science targets opportunities for better progress, decision makers can more effectively use this information to address environmental challenges and thereby improve conditions for all life on earth.

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Source: Still Pictures

Source: REUTERS/Utpal Baruah

GEO Indicators

Source: Still Pictures

ATMOSPHERE● NATURAL DISASTERS● FORESTS
● BIODIVERSITY● COASTAL AND MARINE AREAS
● FRESHWATER● GLOBAL ENVIRONMENTAL ISSUES

GEO Indicators

The GEO Indicators are a set of selected quantitative parameters which reflect headline trends for the major global and regional environmental issues addressed under the GEO reporting process

The set of GEO Indicators aims to give a consistent and harmonized overview of the major environmental trends at global and regional levels on an annual basis, making it easy to track major environmental issues over the years. For each issue, only one or two indicators, or a few at most, are presented. These are considered to be the most suitable and reliable indicators currently available to illustrate the particular issue. Data for the present or even previous year can rarely be presented, because it usually takes two to three years to collect data from countries and compile global databases of high quality.

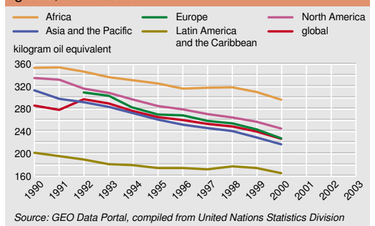
A lack of good-quality data continues to plague and limit indicator selection. Although there is a wealth of environmental information around nowadays, there are also many data gaps and shortcomings, at least with regard to robust, quantitative time series for many countries and regions of the world. Data in the economic and – to a certain extent – social domains are generally more widely available, reliable and well understood. In the environmental domain, data collection is often still at an early stage. High quality, comprehensive and timely data on the environment remains a scarce resource, and finding the 'right' information is not always easy or possible.

Important issues where data are inadequate include freshwater quality, marine pollution, waste generation and management, and land degradation. For other issues, such as freshwater use or hazardous waste transfer, we can currently only present a single year and show regional differences – not yet trends as such. Until such data sets are collected in a rigorous and timely manner, following internationally agreed standards and guidelines, significant difficulties will exist in assessing accurately the extent of these problems.

Knowledge and information gaps also limit the relevance and use of indicators in the decision-making process. For example, casualties and damage caused by natural disasters give at most a vague indication of the vulnerability of societies to environmental change. Likewise, although the observed retreat of glaciers around the world appears to be a very compelling indicator of global warming, the phenomenon could also be linked to other factors such as deforestation. Nevertheless, it is believed that the key trends in pressure, state and response dynamics for major environmental issues can still be successfully captured. As such, and not surprisingly, several of the indicators presented here coincide with those selected for monitoring the internationally agreed environmental goals and targets, including those in the Millennium Declaration (MDGs) and WSSD Plan of Implementation.

The GEO Indicators are grouped by environmental thematic areas and issues. Indicators are portrayed graphically with explanatory notes. Definitions of terms used, information sources and technical notes are provided in an Annex to this section. The definitions follow those given by the original data collecting agencies. The indicators are presented at the global, regional and, in a few cases, sub-regional level, based on the regional classification used in the GEO-3 report (UNEP 2002). All data and documentation have been extracted from the GEO Data Portal, which holds the reference database for use in the GEO assessment and reporting process (http://geodata.grid.unep.ch/).

Figure 1: Energy use (kilogram oil equivalent) per US$1 000 Gross Domestic Product (GDP) by region and global, 1990–2000



Source: GEO Data Portal, compiled from United Nations Statistics Division

Theme: ATMOSPHERE

Issues: Climate change
Stratospheric ozone depletion

Indicators: Energy use per unit of GDP*
CO_2 emissions, total
CO_2 emissions, per capita**
Consumption of CFCs***
Mountain glacier mass balance

** MDG indicator no. 27 under Target 9, Goal 7*
*** MDG indicator no. 28(a) under Target 9, Goal 7*
**** MDG indicator no. 28(b) under Target 9, Goal 7*

Energy use

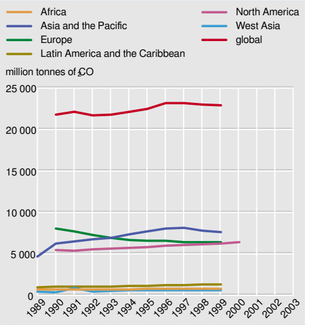
The amount of energy used to produce one unit of gross domestic product (GDP) indicates the extent to which economies are efficient in their consumption of supplied energy. Differences over time and across regions reflect natural conditions, structural changes in the economy, changes in the energy efficiency of particular sectors and differences in fuel mixes. In principle, the lower the ratio the better the energy efficiency. Energy use per unit of GDP has decreased in all regions of the world (Figure 1), although there are not enough data to draw a trend line for the West Asia region.

Carbon dioxide emissions

Carbon dioxide (CO_2) emissions account for the largest share of anthropogenic emissions of greenhouse gases associated with global warming (IPCC 2001), and are, therefore, to be considered as an indicator of human pressure on the global climatic system.

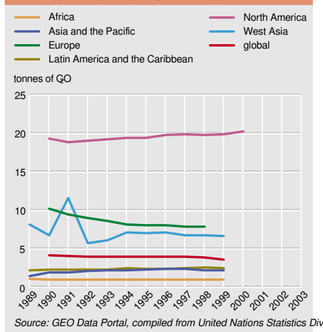
Total CO_2 emissions continue to rise in most regions (Figure 2). In Europe, the emissions have decreased slightly since 1990, partly because of implementation of stricter regulations in the energy sector, but also du economic downturn in the Central and Eastern Eur countries. Per capita CO_2 emissions show a general stabilization or slight decline in most regions, with t highest average for North America (Figure 3). The increase for West Asia around 1991 is mainly due emissions related to the 1990–1991 Gulf War (Ma and others 2003).

Figure 2: Total carbon dioxide emissions (million tonnes of CO_2) by region and global, 1989–2000



Source: GEO Data Portal, compiled from United Nations Statistics Division

Figure 3: Total carbon dioxide emissions (tonnes of CO_2) per capita by region and global, 1989–2000



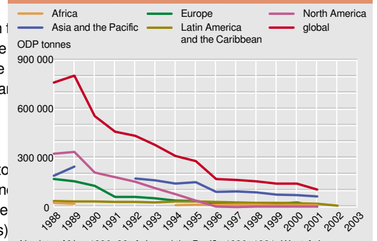
Source: GEO Data Portal, compiled from United Nations Statistics Division

Consumption of CFCs

The depletion of the stratospheric ozone layer is to extent brought about by chemicals known as ozon depleting substances (ODS). The most widely use these are the group of chlorofluorocarbons (CFCs) Emission of CFCs ultimately leads to higher conce of chlorine in the atmosphere, resulting in the destr of ozone molecules and a thinner ozone layer.

The consumption of CFCs is decreasing in most regions (Figure 4), following successful implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer (UNEP 2003). It is expected that the gradual restoration of the ozone layer will take place, but over several decades, provided that control measures under the Montreal Protocol are adhered to by all countries.

Figure 4: Consumption of chlorofluorocarbons (tonnes of ozone depleting potential) by region and global, 1988–2002



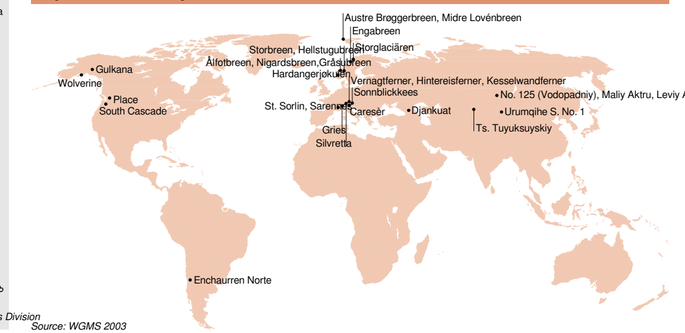
No data: Africa 1990–93; Asia and the Pacific 1990, 1991; West Asia

Source: GEO Data Portal, compiled from UNEP Ozone Secretariat

Mountain glacier mass balance

The global climate shows signs of change, as witnessed by higher average temperatures during the last years, leading to melting ice caps and the retreat of mountain glaciers around the world (IPCC 2001). The yearly decrease balance of a representative set of major mountain glaciers

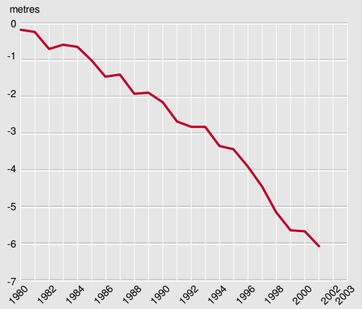
Figure 5: Location of glacier measurements



Source: WGMS 2003

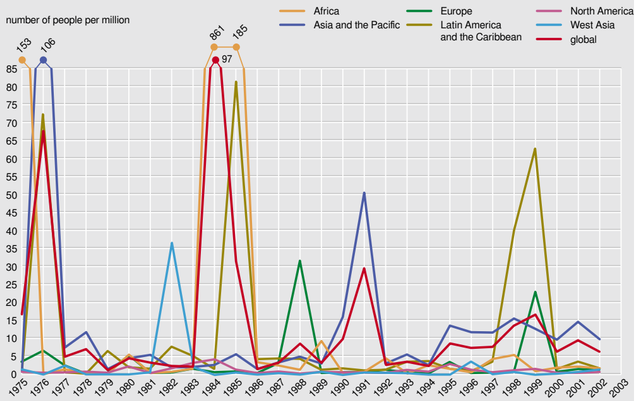
The consequently reflect the pace of global warming. The yearly balance as measured at the glacier surface represents the thickness change of the glacier in terms of volume and area. Between 1980–2001, the thickness of 30 major mountain glaciers (Figure 5) has decreased by an average of six metres (Figure 6) (WGMS 2003). Only Scandinavia has witnessed an increase, which is probably related to changes in precipitation patterns. The flow of glacier tongues reacts with a time delay of several years to even decades compared to climatic changes. The average retreat process of mountain glaciers is, therefore, expected to continue rather dramatically in the coming decades if the current trend in global warming remains unchanged (Haeberli and Holzhauser 2003).

Figure 6: Glacier mass balance (metres), global average, 1980–2001



Source: WGMS 2003

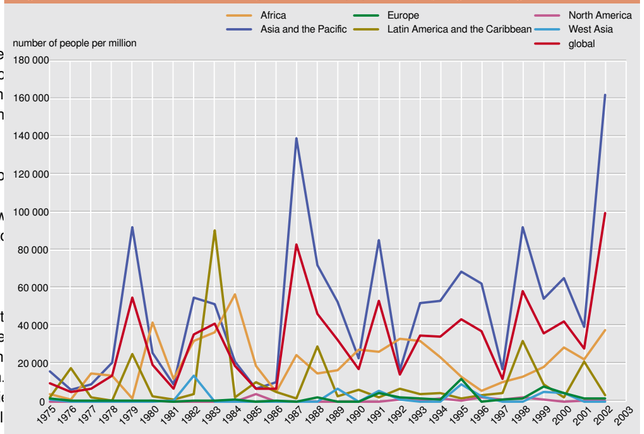
Figure 7: Number of people killed (per million of population) by region and global, 1975–2002



No data: West Asia 1976, 1978, 1979, 1980, 1984, 1986, 1988, 1990, 1994, 1995, 1999.

Source: GEO Data Portal, compiled from OFDA/CRED

Figure 8: Number of people affected (per million of population) by region and global, 1975–2002



No data: North America 1975, 1976. 1978, 1981, 1988, 1990; West Asia 1976, 1978, 1979, 1980, 1983, 1984, 1986, 1988,1990, 1994,1997, 2001.

Source: GEO Data Portal, compiled from OFDA/CRED

Theme: NATURAL DISASTERS
Issue: Human vulnerability to extreme natural events
Indicators: Number of people killed by natural disasters
Number of people affected by natural disasters

The numbers of people killed and affected during disasters reflect both exposure to the physical thre and the capacity of individuals and communities to with those threats. Both of them are indicators of h vulnerability and (in)ability to cope with these even

Number of people killed
For the period 1986–2002, the average total numb of reported deaths from natural disasters was approximately 46 000 per year for the world as a w Actual numbers vary considerably from one year t next, and no clear trend is discernible (Figure 7).

Number of people affected
Over the same period, the number of people affect globally by natural disasters, including those injure left homeless, has risen substantially (Figure 8). In this figure reportedly reached a total of 600 million.

Economic losses are estimated to have multiplie five times since the 1970s, to a total of US$629 bil for the 1990s (IFRC 2002), while it should be note many costs are unaccounted for, especially in developing countries.

Theme: FORESTS

Issue: Deforestation

Indicator: Proportion of land area covered by forest*

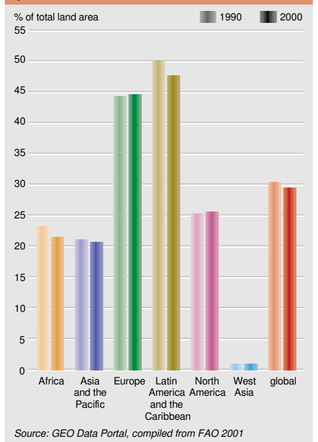
**MDG indicator no. 25 under Target 9, Goal 7*

Between 1990–2000, the proportion of land area covered by forest for the world as a whole decreased from 30.4 to 29.7 per cent. The decrease was most significant in Latin America and the Caribbean (−2.3 per cent) and Africa (−1.8 per cent), with Europe and North America showing a slight increase (about 0.4 per cent and 0.2 per cent respectively) (Figure 9).

Total forest area in those 10 years decreased by 2.4 per cent from 38.79 million km² to 37.85 million km². This deforested area, 940 000 km², is equivalent to the size of a country like Colombia or Egypt.

Globally comprehensive annual and more recer on forest cover are not available at the moment. H recent preliminary findings of FAO indicate that agricultural land is expanding in about 70 per cent countries, is declining in 25 per cent and is roughly in five per cent of countries (FAO 2003), suggestin global forest area may be further decreasing.

Figure 9: Proportion of land area covered by forest (% of total land area) by region and global, 1990 and 2000



Source: GEO Data Portal, compiled from FAO 2001

Theme: BIODIVERSITY

Issues: Species loss

Habitat loss

Indicators: Number of threatened species

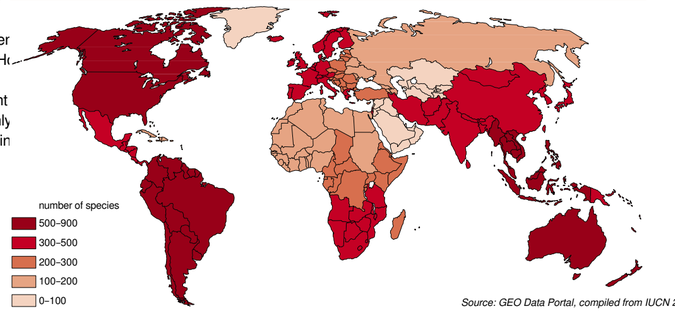
Ratio of area protected to maintain biological diversity to surface area*

**MDG indicator no. 26 under Target 9, Goal 7*

Threatened species

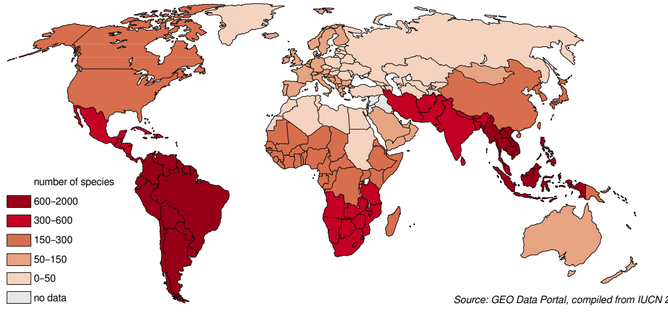
The number of threatened species serves as an indicator of overall threats to biodiversity. Of all the animal groups, mammals and birds have both the highest proportion and the highest number of threatened species. Altogether, more than 5 000 animal species are now threatened with extinction. At the same time, almost 6 800 plant species are endangered or vulnerable, 2.4 per cent of the total that have been described (Table 1). Of the threatened species, birds are concentrated in tropical Central and South America, and Southeast Asia, while mammals are concentrated in Central Asia, Central Africa and Meso-America (Figure 10). South and Central America, Southern Africa and South and Southeast Asia have the highest number of threatened plant species (Figure 11).

Figure 10: Threatened animal species by sub-region in 2003



Source: GEO Data Portal, compiled from IUCN 2003

Figure 11: Threatened plant species by sub-region in 2003



Source: GEO Data Portal, compiled from IUCN 2003

Table 1: Threatened species

Group	Number of described species	Threatened species in 2003	Threatened species in 2003 as percentage of described species
Mammals	4 842	1 130	23.3
Birds	9 932	1 194	12.0
Reptiles	8 134	293	3.6
Amphibians	5 578	157	2.8
Fishes	28 100	750	2.7
Insects	950 000	553	0.1
Molluscs	70 000	967	1.4
Plants	287 655	6 774	2.4

Source: IUCN 2003

Protected areas

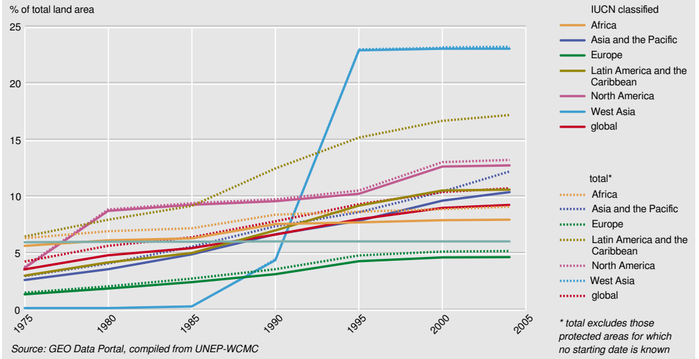
The proportion of area protected to maintain biodiversity indicates the level of policy response to the issue. It is that many important natural sites are not protected (Chape all, and realizing that those under protection are not always very well managed and adequately recorded in the proportion of area under protection has increased since the 1970s and is now estimated to be more than 12 per cent of the earth's land surface (or 18.8 million km²). Excluding those for which no starting data is known to exist total is about 11 per cent (Figure 12).

Approximately 1.64 million km² comprise marine protected areas – 0.5 per cent of the surface area of the oceans and less than one-tenth of the overall extent of protected areas worldwide. Marine areas remain under-represented in the global protected area system (Chape and others 2003).

About nine per cent of total land area is classified in the IUCN management categories. The areas with no classified account for about 35 per cent of the total number of sites, or 25 per cent of the total protected area.

The jump for West Asia between 1990–1995 is due to the establishment of a single large protected area (640 000 km²) in Saudi Arabia in 1994.

Figure 12: Protected areas as percentage of total land area by region and global, 1975–2004



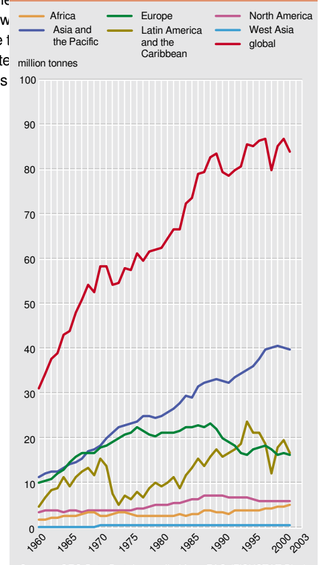
Source: GEO Data Portal, compiled from UNEP-WCMC

Theme: COASTAL AND MARINE AREAS
Issue: Unsustainable use of living marine resources
Indicator: Marine capture

Overexploitation of fisheries and other living marine resources threatens not only human food security but also the sustainability of marine ecosystems. Three-quarters of fisheries stocks are maximally exploited, and many have collapsed as a result of years of unsustainable harvests (FAO 2002).

In 2001, reported global marine capture amounted to about 84 million tonnes of fish, crustaceans and molluscs (Figure 13) (but see Annex on data reliability). Since the late-1980s, this figure has not changed dramatically at the global level, with oscillations in the second half of the 1990s having been attributed to the 1997–1998 El Niño event.

Figure 13: Catch of living marine resources (million tonnes) by region and global, 1970–2002



Source: GEO Data Portal, compiled from FAO (FISHSTAT Plus)

Theme: FRESHWATER

Issues: Sustainable water use

Access to improved water supply and sanitation

Indicators: Water use per capita

Water use as percentage of annual renewable resources

Proportion of population with access to improved water supply*

Proportion of population with access to improved sanitation**

**MDG indicator no. 30 under Target 10, Goal 7*

***MDG indicator no. 31 under Target 10, Goal 7*

Water use

The indicators of water use reflect the overall anthropogenic pressure on freshwater resources. They also give an indication of human vulnerability to water shortages and the need for adjustments in water management policies. In many areas, water use is unsustainable: withdrawal exceeds recharge rates and the water bodies are overexploited. The depletion of water resources can have negative impacts on aquatic ecosystems and, at the same time, undermine the basis for socio-economic development.

The map of per capita water use in 2000 by sub-regions (Figure 14) illustrates a high consumption, for example, in Central Asia, North America and the Mashriq. (The global average amounts to 633 m³/capita/year.) Water use is relatively low in most African sub-regions: Southern Africa, Western Africa, Eastern Africa and Central Africa.

When relating water use to the availability of renewable water resources in the regions, countries in Northern Africa, the Arabian Peninsula and the Mashriq stand out with values well over 100 per cent, indicating that more water is consumed than is available internally (Figure 15). A high percentage of use of renewable water resources is also observed in Central and South Asia.

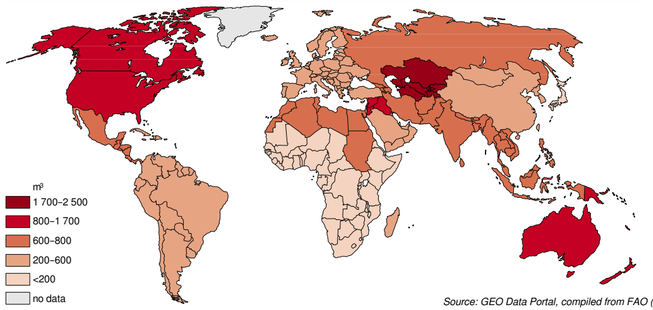
Water supply and sanitation

Access to improved water supply and sanitation is absolutely crucial to human health while the availability of a reliable water supply and sanitation infrastructure helps protect water resources from overexploitation and pollution, and maintain ecosystem health.

During 1990–2000, the percentage of the world population with access to improved water supply and sanitation rose from 78 to 82 per cent and 51 to 61 per cent respectively (WHO/UNICEF 2003) (Figures 16 and 17). However, despite the progress achieved, in 2000 about 2.4 billion people still lacked access to improved sanitation and 1.1 billion lacked access to safe drinking water (UNSD 2002).

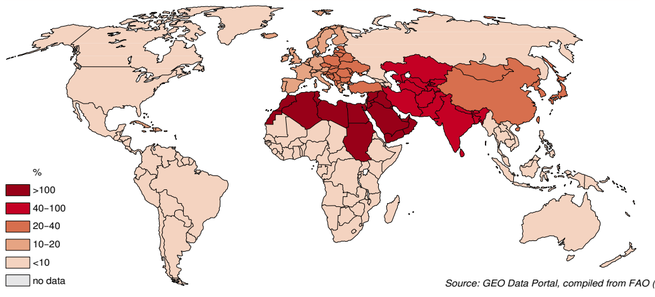
There are not enough data reported by European countries to include this region in the figures.

Figure 14: Per capita water use (m³) by sub-region in 2000



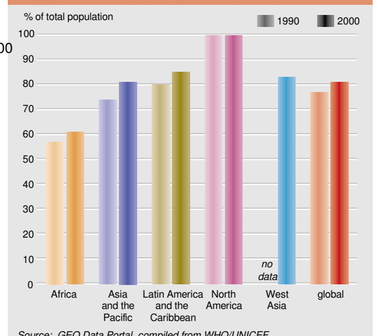
Source: GEO Data Portal, compiled from FAO (AQUASTAT)

Figure 15: Water use as percentage of quantity of annual renewable water resources by sub-region in 2000



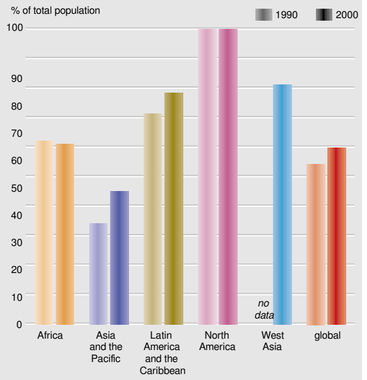
Source: GEO Data Portal, compiled from FAO (AQUASTAT)

Figure 16: Population with access to improved water supply (% of total) by region and global, 1990 and 2000



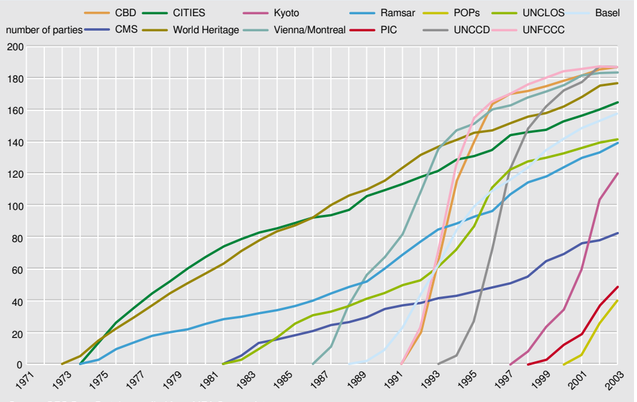
Source: GEO Data Portal, compiled from WHO/UNICEF

Figure 17: Population with access to improved sanitation (% of total) by region and global, 1990 and 2000



Source: GEO Data Portal, compiled from WHO/UNICEF

Figure 18: Number of parties to multilateral environmental agreements, 1971–2003



Source: GEO Data Portal, compiled from MEA Secretariats

Theme: GLOBAL ENVIRONMENTAL ISSUES
Issue: International environmental governance
Indicator: Number of parties to multilateral environmental agreements

A number of multilateral environmental agreements (MEAs) have been negotiated and adopted to address environmental issues of global significance. The MEAs are important frameworks for global environmental governance, and the number of countries and regional organizations that have ratified an MEA is an indicator of political will to address the issue concerned.

Ratification of the selected agreements has steadily grown over time (Figure 18), with conventions such as CITES, CBD, World Heritage, UNFCCC (excluding its Kyoto Protocol) and Vienna (including the Montreal Protocol) approaching the maximum possible number of parties. Taking an overview of the ratification of the 13 MEAs, the proportion of maximum possible ratifications has increased in all regions. Europe, for example, has reached a ratification rate of 78 per cent of the maximum possible if all countries ratified all the MEAs. The rate stands at 71 per cent for the world as a whole (Table 2).

Table 2: Number of parties to multilateral environmental agreements, by region*

Region (no. of countries)	Number of ratifications													Sum of ratifications of all 13 MEAs	Potential maximum (no.of countries x13)	Overall % ratified (of possible maximum)
	CBD	CMS	CITES	World Heritage	Kyoto	Vienna/ Montreal	Ramsar	PIC	POPs	UNCCD	UNCLOS	UNFCCC	Basel			
Africa (53)	52	27	51	45	23	51	38	13	11	53	38	52	37	491	689	71
Asia and the Pacific (45)	44	9	28	39	33	41	23	8	8	44	33	44	33	387	585	56
Europe** (49)	46	36	44	48	34	46	46	15	11	46	35	46	46	499	637	78
LAC (34)	32	7	32	31	27	33	25	6	7	33	27	33	30	323	442	73
West Asia (12)	10	3	7	11	1	10	0	5	2	2	9	10	10	80	156	51
North America (2)	1	0	2	2	1	2	2	1	1	2	0	2	1	17	26	65
Global (195)	185	82	164	176	119	183	134	48	40	180	142	187	157	1 797	2 535	71

** Data on the number of parties as of December 2003. **Including the European Community as a separate party.*
Source: see Annex

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Annex

GEO Indicators, units of measurement, sources of data and notes

Indicator, unit of measurement and source(s)	Notes
Energy use per unit of GDP Unit of measurement: kilogram of oil equivalent per US$1 000 of GDP converted from national currencies using purchasing power parity (PPP) conversion factors for the year 1995. *Source: UN Statistics Division (UNSD) (as compiled from the International Energy Agency (IEA) and the World Bank).*	Energy use is calculated by the IEA as production of fuels + inputs from other sources + imports − exports − international marine bunkers + stock changes. It includes coal, crude oil, natural gas liquids, refinery feedstocks, additives, petroleum products, gases, combustible renewables and waste, electricity and heat. Real GDP comes from the national income accounts deflated by reference to PPP tables prepared by the International Comparisons Program.
Emission of CO_2 per capita) is the total amount of CO_2 emitted by a country as a consequence of human production and consumption activities, divided by the population of the country. Unit of measurement: tonne. *Source: UNSD (as compiled from the United Nations Framework Convention on Climate Change (UNFCCC) and Carbon Dioxide Information Analysis Center (CDIAC)).*	In the CO_2 emission estimates of the CDIAC, the calculated country emissions of CO_2 include emissions from consumption of solid, liquid and gas fuels; cement production; and gas flaring. National reporting to UNFCCC that follows the Intergovernmental Panel on Climate Change guidelines is based on national emission inventories and covers all sources of anthropogenic CO_2 as well as carbon sinks.
Consumption of CFCs is defined as production plus imports minus exports of controlled substances reported to the Secretariat of the Montreal Protocol by parties. Unit of measurement: tonne of ozone-depleting potential. *Source: UNEP (Ozone Secretariat).*	Ozone-depleting potential (ODP) is the ratio of the impact on ozone of a chemical compared to the impact of a similar mass of CFC-11. Thus, the ODP of CFC-11 is defined as 1.0. The five CFCs compiled for MDG indicator no.28 are CFC-11, CFC-12, CFC-113, CFC-114 and CFC-115. Not all parties meet reporting deadlines in time. Illegal production and trade are not covered by the reporting process.
Mountain glacier mass balance represents a mean specific net (annual) balance of a representative set of major mountain glaciers. Unit of measurement: metre. *Source: World Glacier Monitoring Service.*	Mass balance is calculated by dividing volume (expressed as kg/m^2) by density (expressed in g/m^3) and represents thickness change of glaciers. Reliable time-series data are only available for a limited set of glaciers.
Number of people killed by natural disasters is the number of persons confirmed as dead and persons missing and presumed dead. Number of people affected is the number of persons requiring immediate assistance, ie requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance. Unit of measurement: number. *Source: OFDA/CRED EM-DAT.*	A disaster is a situation or event, which overwhelms local capacity necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering. Natural disasters include droughts, earthquakes, extreme temperatures, famine, floods, insect infestation, slides, volcanic eruptions, wave/surges, wild fires and windstorms. Though often caused by nature, disasters can have human origins. Wars and civil disturbances that destroy homelands and displace people are included among the causes of disasters. Other causes can be building collapse, blizzard, tornado, epidemic, explosion, fire, hazardous material or transportation incident (such as a chemical spill), or nuclear incident. The number of persons killed is usually more reliable than the number of affected people, because deaths are formally and better registered than those left homeless or injured. The database of people affected is compiled from various sources, including UN agencies, NGOs, insurance companies, research institutes and others, who may apply different procedures and definitions for the collection and reporting of the data. The total number of affected people could exceed the country population due to the fact that the same individual could be affected by more than one disaster or could be counted in more than one category.
Proportion of land area covered by forest. Unit of measurement: per cent. *Source: FAO (Global Forest Resource Assessment).*	Forest includes natural forests and forest plantations. The term refers to land with more than 10 per cent tree cover and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be capable of reaching a minimum height of five metres. Young stands that have not yet reached, but are expected to reach a crown density of 10 per cent and tree height of five metres are included under forest, as are temporarily unstocked areas. The term includes forests used for purposes of production, protection, multiple use or conservation (i.e. forest in national parks, nature reserves and other protected areas), as well as forest stands on agricultural lands (eg windbreaks and shelterbelts of trees with a width of more than 20 m) and rubberwood plantations and cork oak stands. The term specifically excludes stands of trees established primarily for agricultural production, for example fruit tree plantations. It excludes trees planted in agroforestry systems.

Indicator, unit of measurement and source(s)	Notes
Number of threatened species. Unit of measurement: number. *Source: IUCN (Red List of Threatened Species).*	The term 'threatened species' includes species listed as Critically Endangered, Endangered and Vulnerable i.e. those facing an extremely high risk, ve risk or high risk of extinction in the wild, respectively, according to the relevant criteria for population size, range, and maturity as established under the Red List system. Regional time-series data cannot be presented due to the changes in reporting and definitions over the years. On the whole, only a small proportion of described species has been evaluated for threatened status. For animals, only birds and mammals are (almos allevaluated (100 and 99 per cent respectively), while insects have been evaluated for less than 0.1 per cent of species. For plants, gymnosperms (ma the conifers and cycads) are the only major group to be almost completely evaluated (93 per cent). The data on species threatened in each group do not mean that the remainder are all not threatened. A number of species in many of the groups listed listed as Near Threatened or Data Deficient. Species assessed as Least Concern are often not reported and are not included. The numbers evaluated therefore an under-estimate. Due to changes in the classification system, the plant figures do not include species from the 1997 IUCN Red List of Threatened Plants.
Ratio of area protected to maintain biological diversity to surface area. Unit of measurement: per cent. *Source: UNEP-WCMC (World Data Base on Protected Areas)*	Protected area is area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated resources, and managed through legal or other effective means. The six IUCN management categories provide an internationally agreed framework within which countries can structure their protected area systems. management categories are Strict Nature Reserve (Ia); Wilderness Area (Ib); National Park (II); Natural Monument (III); Habitat/Species Managemen Protected Landscape/Seascape (V); Managed Resource Protected Area (VI). Some sites (about eight per cent of the number of sites or five per cent of the total area) do not have a start or entry date registered in the database, ar therefore cannot be included in trend analysis.
Marine capture is a nominal catch of fish, crustaceans and molluscs in marine areas. Unit of measurement: tonne. *Source: FAO (FISHSTAT Plus).*	Fish categories include demersal, pelagic and other marine fish and freshwater and diadromous fish caught in marine areas, as taken for commercial, industrial, recreational and subsistence purposes. The harvest from mariculture, aquaculture and other kinds of fish farming is excluded. Catches are expressed in live weight, that is the nominal weight of the organisms at the time of capture. Data include all quantities caught and landed for both food and feed purposes but exclude discards. Data on illegal fish catch are not available. The general availability of fisheries data has not improved significantly over the last two decades, and although the available statistics probably reflect trends reliably, the annual figures and the assessments involve some uncertainty. Recent publications have questioned the accuracy of the statistics f certain countries (Watson and Pauly 2001, FAO 2002).
Water use per capita is annual gross quantity of water produced and used for agricultural, industrial and domestic purposes divided by the population of the country. Unit of measurement: cubic metre. *Source: FAO (AQUASTAT).*	It does not include other *in situ* uses: energy, mining, recreation, navigation, fisheries and the environment, which are typically non-consumptive uses The typology of water use is independent from the source of water. Demands are covered by water production: withdrawals from natural sources, foss abstraction (non-renewable production), non-conventional water production (including use of desalinated and treated wastewater). Some countries us term 'water withdrawal' or 'water abstraction' instead of 'water use', which could result in an under-estimation of total water use or consumption. Time series data for water consumption are not available for most countries.
Water use as a percentage of annual renewable resources is annual gross quantity of water produced and used for agricultural, industrial and domestic purposes as a percentage of the quantity of annual renewable water resources. Unit of measurement: per cent. *Source: FAO (AQUASTAT).*	Renewable water resources is the sum of internal and external renewable water resources. Internal renewable water resources (IRWR) is the part of t water resources (surface water and groundwater) generated from endogenous precipitation. External renewable water resources is the part of the cou renewable water resources shared with neighbouring countries. Renewable water resources corresponds to the maximum theoretical amount of wate available for a country in an average year over a long reference period. IRWR is computed by summing average annual surface run-off and groundwa recharge occurring inside the countries' borders. Data refer to water use divided by natural renewable resources, except for regional values, where IRWR estimates were used to avoid double countin (See also the notes on water use above.)
Proportion of population with access to improved water supply. Unit of measurement: per cent. *Source: WHO/UNICEF (Joint Monitoring Programme for Water Supply and Sanitation).*	'Improved' water supply technologies are: household connection, public standpipe, borehole, protected dug well, protected spring, rainwater collectio 'Not improved' are: unprotected well, unprotected spring, vendor-provided water, bottled water (based on concerns about the quantity of supplied wat concerns over the water quality), tanker truck-provided water. It is assumed that if the user has access to an 'improved source' then such source woul likely to provide 20 litres per capita per day at a distance no further than 1 km. In 1990, data for 75 per cent of world population were available. In 2000, data for 90 per cent of world population were available. Time series cannot b shown due to lack of data.
Proportion of population with access to improved sanitation. Unit of measurement: per cent. *Source: WHO/UNICEF (Joint Monitoring Programme for Water Supply and Sanitation).*	'Improved' sanitation technologies are: connection to a public sewer, connection to septic system, pour-flush latrine, simple pit latrine, ventilated impro pit latrine. The excreta disposal system is considered adequate if it is private or shared (but not public) and if it hygienically separates human excreta human contact. In 1990, data for 75 per cent of regional population were available. In 2000, data for 87 per cent of regional population were available. Time series car be shown due to lack of data.
Number of parties to multilateral environmental agreements is the number of countries and political and/or economic integration organizations, which have deposited their instrument of ratification, accession, acceptance or approval of each of the 13 multilateral environmental agreements (MEAs) listed in the next column. The list also includes status of ratification Web page addresses of MEA secretariats. Unit of measurement: number. *Source: MEA Secretariats.*	Convention on Biological Diversity (CBD): http://www.biodiv.org/world/parties.asp. Convention on the Conservation of Migratory Species of Wild Animals (CMS): http://www.unep-wcmc.org/cms/. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): http://www.cites.org/eng/parties/chronolo.shtml. Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage): http://whc.unesco.org/nwhc/pages/doc/main.htm. Kyoto Protocol to the UN Framework Convention on Climate Change (Kyoto): http://unfccc.int/resource/convkp.html. Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer (Vienna/Montreal): http://www.unep.ch/ozone/ratif.shtml. Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar): http://www.ramsar.org/key_cp_e.htm. Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC): http://www.pic.int/en/ViewPage.asp?id=345. Stockholm Convention on Persistent Organic Pollutants (POPs): http://www.pops.int/documents/signature/signstatus.htm. UN Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa (UNCCD): http://www.unccd.int/convention/ratif/doeif.php. UN Convention on the Law of the Sea (UNCLOS): http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm. UN Framework Convention on Climate Change (UNFCCC): http://unfccc.int/resource/convkp.html. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel): http://www.basel.int/ratif/ratif.html.

Acronyms and abbreviations

Aarhus Convention	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters
AC	Accession Countries
AFP	Asia Forest Partnership
AIA	Advance Informed Agreement
AIMS	Atlantic, Indian Ocean, Mediterranean, and the South China Seas (SIDS grouping)
AMAP	Arctic Monitoring and Assessment Programme
AMCEN	African Ministerial Conference on the Environment
ANWR	Arctic National Wildlife Refuge
ASEAN	Association of Southeast Asian Nations
ASTER	advance spaceborne thermal emission and reflection radiometer
AU	African Union
Basel Convention	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
BPoA	Barbados Programme of Action
CAC	Codex Alimentarius Commission
CAFF	Arctic Council's Conservation of Arctic Flora and Fauna
Cartagena Protocol	Cartagena Protocol on Biosafety to the Convention on Biological Diversity
CBD	Convention on Biological Diversity
CCD	Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa
CDIAC	Carbon Dioxide Information Analysis Center
CDM	Clean Development Mechanism
CE	Central Europe
CEC	Commission for Environmental Cooperation
CEE	Central and Eastern Europe
CFCs	chlorofluorocarbons
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CNG	compressed natural gas
CO_2	carbon dioxide
CPAN	Circumpolar Protected Areas Network
CRED	Centre for Research on the Epidemiology of Disasters
CSD	Commission on Sustainable Development
DALY	disability adjusted life year
DRC	Democratic Republic of Congo
EC	European Community
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EfE	Environment for Europe
ENN	Environmental News Network
EROS	Earth Resources Observation System of USGS
ERSDAC	Earth Remote Sensing Data Analysis Center
Espoo Convention	Convention on Environmental Impact Assessment in a Transboundary Context
EVI	Environment Vulnerability Index
EU	European Union
FAO	Food and Agriculture Organization of the UN
FLEG	Forest Law Enforcement and Governance
G-8	Group of 8, an informal group of eight countries: Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States
GCC	Gulf Cooperation Council
GC/GMEF	Governing Council/Global Ministerial Environment Forum
GDP	Gross Domestic Product
GEO	Global Environment Outlook of UNEP
GEMS	Global Environment Monitoring System
GFMC	Global Fire Monitoring Center
GHG	greenhouse gas
GIWA	Global International Waters Assessment
GMAD	Global Marine Aquarium Database
GMOs	genetically modified organisms
GRID	Global Resource Information Database
GSFC	Goddard Space Flight Center
HCFCs	hydrochloroflourocarbons
HIPCs	Heavily Indebted Poor Countries
HIV/AIDS	human immunodeficiency virus/acquired immunodeficiency syndrome
IAEA	International Atomic Energy Agency
IBAMA	Brazilian Institute of the Environment and Renewable Natural Resources
ICARM	integrated coastal area and river basin management
ICES	International Council for the Exploration of the Sea
ICIMOD	International Centre for Integrated Mountain Development
ICRAN	International Coral Reef Action Network
ICZM	integrated coastal zone management
IEA	International Energy Agency
IFCS	Intergovernmental Forum on Chemical Safety
IFRC	International Federation of Red Cross and Red Crescent Societies
ILAC	Latin American and Caribbean Initiative for Sustainable Development
IMO	International Maritime Organization
INPE	National Institute for Space Research (Brazil)
INSERM	French National Institute for Health and Medical Research
IPCC	Intergovernmental Panel on Climate Change
IPPC	International Plant Protection Convention
IRWR	internal renewable water resource
ITOPF	International Tanker Owners Pollution Federation Ltd.
ITTO	International Tropical Timber Organization
IUCN	World Conservation Union
IUCN/SSC	World Conservation Union/Species Survival Commission
IUU	illegal, unregulated and unreported
IWRM	integrated water resources management
JAROS	Japan Resources Observation System Organization
KNMI	Royal Netherlands Meteorological Institute
Kyoto Protocol	Kyoto Protocol to the UN Framework Convention on Climate Change
LAC	Latin America and the Caribbean
LMOs	living modified organisms
MAC	Marine Aquarium Council
MDGs	internationally agreed development goals contained in the UN Millennium Declaration
MEAs	multilateral environmental agreements
METI	Ministry of Economy, Trade and Industry of Japan
MODIS	moderate resolution imaging spectroradiometer
MPAs	marine protected areas
N	nitrogen
N_2	di-nitrogen
NH_3	ammonia
NH_4^+	ammonium ion
N_2O	nitrous oxide
NO	nitric oxide
NO_2	nitrogen dioxide
NO_3^-	nitrate
NO_X	nitrogen oxides
NASA	National Aeronautics and Space Administration
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
NRCAN	Natural Resources Canada
NRTEE	National Round Table on the Environment and the Economy (Canada)
O_2	molecular oxygen
ODP	ozone depleting potential
ODS	ozone-depleting substance
OECD	Organization for Economic Cooperation and Development
OFDA	Office of US Foreign Disaster Assistance
OSCE	Organization for Security and Cooperation in Europe
PCBs	polychlorinated biphenyls
PIC	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC)
PM	particulate matter
POPs	persistent organic pollutants
PPP	purchasing power parity
PRTRs	Pollutant Release and Transfer Registers
Ramsar Convention	Convention on Wetlands of International Importance Especially as Waterfowl Habitat
REC	Regional Environmental Centre for Central and Eastern Europe
ROPME	Regional Organization for the Protection of the Marine Environment
SADC	Southern African Development Community
SAICM	Strategic Approach to International Chemicals Management
SIDS	Small Island Developing State(s)
SNASPE	National System of Protected Areas of the State (Chile)
SOPAC	South Pacific Applied Geoscience Commission
TERM	Transport and Environment Reporting Mechanism
UNCLOS	UN Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UNGA	United Nations General Assembly
UN-Habitat	United Nations Programme for Human Settlements
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Fund
UNSD	United Nations Statistics Division
UNWWAP	United Nations World Water Action Programme
USCCSP	United States Climate Change Science Program
USEPA	United Sates Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
Vienna/ Montreal	Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer
WE	Western Europe
WEHAB	Water, Energy, Health, Agriculture and Biodiversity Initiative
WGEM	Ad Hoc Working Group on Environmental Monitoring of the UNECE
WGMS	World Glacier Monitoring Service
WHO	World Health Organization
WMO	World Meteorological Organization
World Bank	International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA)
World Heritage	Convention Concerning the Protection of the World Cultural and Natural Heritage
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWC	World Water Council
WWDR	World Water Development Report
WWF	World Wildlife Fund for Nature

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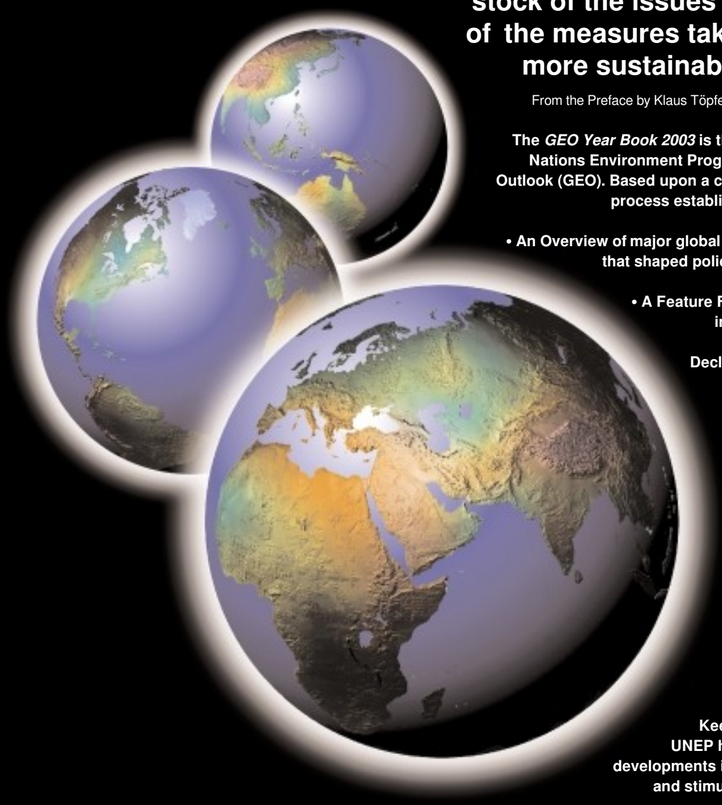

"It is our duty individually and collectively to take stock of the issues and developments of 2003 and of the measures taken during the year to achieve a more sustainable future for the environment."

From the Preface by Klaus Töpfer, Executive Director, United Nations Environment Programme

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