GEO YEAR BOOK 2007

An Overview of Our Changing Environment

UNEP United Nations Environment Programme

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UNEP

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Preface

The 2007 Global Environment Outlook Year Book is focused on the interface between two powerful trends: concerns for environmental integrity and accelerating globalization. In the first years of the 21st century we became all too aware of how global events can affect local attitudes and actions. In 2006 we witnessed how local actions affect global outcomes: for instance, how local consumer demand can lead to certification schemes for sustainable production of goods and services on another continent or how local integration in development of biodiversity corridors can create a destination for the global tourism market.

Globalization is inescapable and its many advances seem self-perpetuating but its consequences should and must be shaped in ways that maximize benefits for people and for the planet. It presents both risks and opportunities. If globalization is managed to optimize the opportunities—to enhance the forces that bring food to the undernourished and clean water to millions and to avoid tendencies towards social or economic exclusion and homogenization of culture—it will become a major force for world-wide sustainable development.

This is why the topic of environment and globalization has been chosen as the key theme for the 24th Session of the Governing Council / Global Ministerial Environment Forum (GC-24/GMEF). The health and wealth of every economy and every region are dependent on the successful reconciliation of these two trends.

Many components of their interface are presented in the GEO Year Book's global and regional **Overview** chapter which details progress and problems at the global scale and within each region. It reports significant developments over the past year and describes recent policy decisions and innovative schemes aimed at resolving potential clashes of economic growth with environmental concerns, including initiatives to reconcile issues of conflict and the environment.

The importance of environment and globalization in the modern world is also why the Year Book's **Feature Focus** is dedicated to the issue. Action towards a more intelligent, socially responsible, and environmentally sensitive form of globalization is long overdue. In some ways, the need for such action has become even more critical as the production and consumption patterns of the developed world are being matched by those of rapidly developing economies such as Brazil, China, and India.

Innovative technologies and techniques are being developed to facilitate the integration of environment and justice concerns into the management of globalization. Paying for ecosystem services, financing environmentally sound technologies, harnessing consumer demand for certification of sustainable produced goods and services, and distributing access to environmental monitoring information for responsible decision-making—these are all mechanisms presented here with the goal of disseminating good ideas and building synergies that will produce more innovations.

The chapter on **Emerging Challenges** looks at one area of those opportunities: nanotechnology—materials and technologies at a scale of one billionth of a meter. Nanotechnology promises to transform sectors as diverse as medicine, manufacturing, energy, water supply, and transportation. Public and private sectors, particularly in developed countries and economies in transition, are investing heavily in research and applications.

By 2014, nanotechnology is projected to have 14 per cent or US$2.6 trillion of the global manufacturing market. But what are the potential impacts of nanotechnology on the environment and human health? Do current regulatory frameworks deal adequately with the special challenges posed by these 'smart' particles? Policy-makers need to develop and extend science-based risk frameworks and to look at how best to address transboundary issues on the development and deployment of nanomaterials and products.

The **Indicators** chapter depicts up-to-date data on key environmental trends and growing stresses on ecosystems. The latest trends from data tracking $C0_2$ emissions and forest harvest rates continue to head in the wrong direction. In comparison there are positive trends in areas like the consumption of ozone depleting substances and renewable energy.

The Year Book also highlights how the Multilateral Environmental Agreements are evolving. For example, member governments of the Basel Convention on the Control of Transboundary Movements of Hazardous

Wastes agreed in 2006 to accelerate efforts to reduce the risks and maximize the benefits from the dramatic worldwide growth in electronic wastes—a globalization issue if ever there was one.

The UN Convention on Climate Change estimates that the its Clean Development Mechanism alone could generate some US$100 billion of funds for developing countries. The Kyoto Protocol is also helping to drive investment and trade in new and renewable technologies like wind, solar power, and biomass fuels.

The GEO Year Book series has many aims—not least to bring together science and policy-making. More than 80 experts worldwide were involved this Year Book's preparation. UNEP and the Year Book team also benefited from your comments and suggestions. I hope you find the GEO Year Book 2007 informative and stimulating for your discussions during the 24th Regular Session of the GC/GMEF. As always, your feedback is most welcome.

Achim Steiner
United Nations Under-Secretary General and
Executive Director,
United Nations Environment Programme

2006 OVERVIEW

Source: Thomas Reineke

- Global
- Africa
- Asia and the Pacific
- Europe
- Latin America and the Caribbean
- North America
- West Asia
- Polar

Global

Environmental threats in 2006 highlighted the need for national and international efforts to address global problems. Climate change commanded increased attention, including a number of business initiatives, but policy makers also addressed issues such as marine biodiversity and global chemicals and waste management.

CLIMATE CHANGE: A GLOBAL PROBLEM

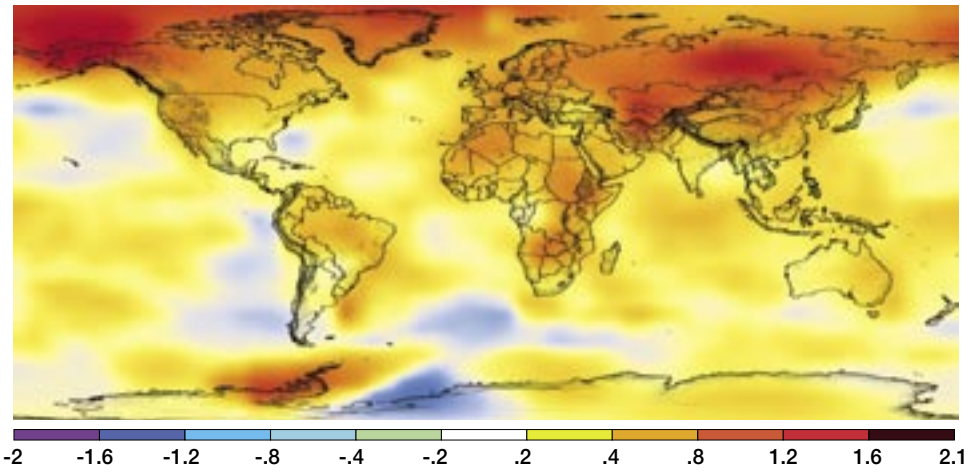
Following an ongoing trend since the late 1980s, 2006 was the sixth warmest year since records began in 1880 (NOAA 2006a). There were other signs of increasing climate instability. Chinese officials attributed extreme droughts to climate change—droughts that left millions short of water (Reuters/MSNBC 2006). In East Africa, persistent drought was followed by heavy rainfall and flooding that displaced two million people and took hundreds of lives (Oxfam 2006, CNN 2006).

New research and climate modelling published in 2006 strengthened the case for action on global warming. A new US National Aeronautics and Space Administration (NASA) study found that the world's temperature had increased by about 0.2°C per decade in the past 30 years, reaching the warmest levels since the end of last ice age nearly 12,000 years ago. It is now within 1°C of the maximum temperature of the past million years, threatening dangerous climate change based on the likely effects of sea level rise and species loss (Hansen 2006) **(Figure 1)**.

New data showed an alarming increase in the human output of greenhouse gases. Figures published in 2006 showed that between 2000 and 2005 carbon dioxide (CO_2) emissions grew by 3.2 per cent—four times faster than in the preceding 10 years, according to researchers at the Global Carbon Project (Le Quéré 2006). Average concentrations of CO_2 in 2005 were measured at 380 parts per million (ppm), up from 377.5 ppm in 2004 (NOAA 2006b).

Among countries with commitments to cut emissions under the Kyoto Protocol only Denmark, France, Iceland, the UK, Germany, and Norway reported lower emissions in 2004 than in 1990, along with ten formerly communist countries where problems of transition depressed economic activity. These results exclude activities related to land use, land use change, and forestry (UNFCCC 2006a).

Figure 1: Mean Surface Temperature Anomaly 2001-2005



Source: NASA Godard Institute for Space Studies

Given the complexity of reducing CO_2 emissions, interest has grown in sequestration. Amid some controversy regarding sequestered CO_2's potential contribution to ocean acidification, the London Convention on marine dumping was amended in November, making it legal from February 2007 to bury CO_2 in natural structures under the oceans (IMO 2006).

The story for methane has been more encouraging. Atmospheric methane concentrations have remained stable for the past seven years (Simpson and others, 2006). Among 41 Annex I parties to the Kyoto Protocol who reported data, overall methane emissions fell by 18 per cent between 1990 and 2004. In 24 of these countries methane emissions declined by more than 10 per cent and increased by more than 1 per cent in only 8 countries (UNFCCC 2006a).

Ocean surveys are illustrating that the pace of planetary change is variable and not linear. Over time global warming is expected to raise ocean temperatures, but a 2006 study found that the average temperature of the upper ocean fell by 0.03°C from 2003 to 2005, compared with an increase of 0.09°C from 1993 to 2003. The dip was significant, equal to about one-fifth of the heat gained by the ocean between 1955 and 2003 (Lyman and others 2006).

Last year a 30 per cent slowdown was reported in the Atlantic Conveyor currents, which carry warm water from the Gulf of Mexico to Northern and Western Europe (Bryden and others 2005, UNEP 2006c). In 2006 this alarming finding was subject to downward revision and doubt. Readings from the first year of detailed monitoring show a very high variation within the year. Many scientists now suggest that years or decades of monitoring will

be needed to determine if any long term trend in the conveyor is under way (Kerr 2006). Other studies have revealed no sign of a slowdown (Meinen and others 2006, Schott and others 2006).

Meanwhile, the Stern Review on the Economics of Climate Change, released in late 2006, warned that failure to control climate change could cut 5 to 10 per cent annually from the global economy by the end of the century and lead to economic and social disruption on a scale similar to the Great Depression. In the same report, research indicated that tackling climate change could boost economic growth (Stern 2006).

Stakeholders and groups around the globe increasingly voiced their alarm about climate change in 2006. In a recent international survey, at least 80 per cent of respondents in 27 of the 30 countries polled described climate change as either 'very serious' or 'somewhat serious' (Globescan 2006). This heightened concern was paralleled by increased media coverage in many countries, most dramatically in the US (see North America section).

Taking on the climate agenda at multiple levels

Action on climate is being undertaken by private and public actors at all levels. In the business sector, many companies are demonstrating a genuine commitment to addressing the problem, while many more are recognizing that there are promising opportunities to reduce costs and find new sources of profit (Green Money Journal 2006, LaMonica 2006, Lash 2006, Webb 2006). Rupert Murdoch declared that his News Corporation would become a carbon neutral company (NewsCorp 2006). Lee Scott, president of Wal-Mart, the world's largest retailer, committed to reduce the company's greenhouse gas emissions by 20 per cent over the next seven years and to double fleet fuel efficiency over 10 years (Alter 2006). Virgin Group Chairman Richard Branson pledged to invest US$3 billion over ten years in renewable energy and to cut greenhouse gas emissions by aircraft (Virgin Atlantic 2006).

For several years, insurance and reinsurance companies have been among the leaders in highlighting the challenges of climate change. Following record damage from extreme events in 2005 (Hurricane Katrina created US$45 billion in insured losses), the industry announced many new initiatives, including 'green building credits' and incentives to invest in renewable energy (Mills and Lecomte 2006). According to a new report from UNEP's Finance Initiative, disaster losses could reach US$1 trillion annually by 2040, posing huge challenges to the industry (UNEP 2006d).

At the level of local government, in August mayors belonging to the Large Cities Climate Leadership Group—which includes Cairo, Delhi, Johannesburg, London, Mexico City, New York, and Sao Paulo—announced a partnership with the Clinton Climate Initiative to combat climate change in large urban areas (Blood 2006). Close to 650 local governments now belong to Local Governments for Sustainability (ICLEI), which promotes action on climate change locally and lobbies for action internationally (ICLEI 2006).

On the national front, positive news included China's new energy law committing US$180 billion to renewable energy (Li 2006).

Internationally, diplomats at the 12th Conference of the Parties of the UN Framework Convention on Climate Change (UNFCCC), held in Nairobi in November, considered how an international climate change regime could look after 2012, when the current commitments come up for evaluation and renewal. Despite mounting scientific evidence and concerns of civil society, multinational commitments regarding GHG emissions cuts were not agreed. However, significant initiatives were launched to help Africa benefit from the international carbon finance market and the Clean Development Mechanism (CDM) (see Africa section). It was also agreed to launch a scientific study of the potential for expanding the CDM to reward developing countries that act to halt deforestation (IISD 2006d) **(Box 1)**.

The UN Framework Convention on Climate Change (UNFCCC) was one of four initiatives emerging from the 1992 Earth Summit held in Rio de Janeiro. All of these initiatives continued to guide the global environmental agenda in 2006. The original initiative on Forest Principles has evolved into today's UN Forum on Forests **(Box 2)** There were two other 'Rio Conventions', the Convention on Biodiversity and the Convention to Combat Desertification **(Box 3 and Box 4)**.

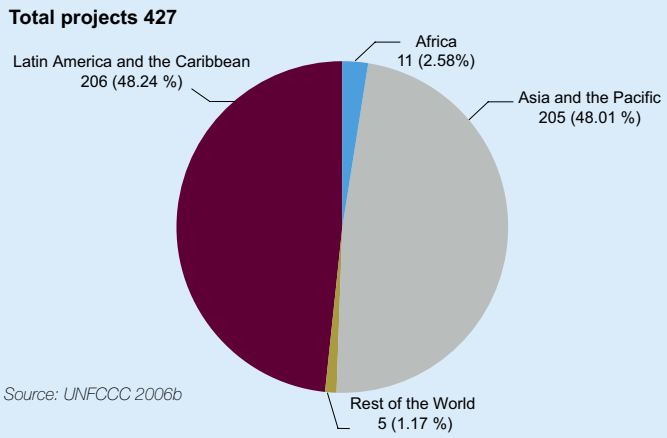
Box 1: Carbon markets and new technologies

2006 marked a breakthrough year for global and regional cooperation to employ market-based mechanisms and find cost effective solutions in combating climate change. The Kyoto Protocol's Clean Development Mechanism (CDM), which encourages investment from industrialized countries in renewable energy and other emissions reduction efforts in the developing world, also experienced a very rapid increase in support. By early December, more than 1 300 projects were in the pipeline and 427 were fully registered, with the UN's Framework Convention on Climate Change (UNFCCC) estimating that more than 1.5 billion tonnes of emissions reductions would be achieved from the CDM by 2012—the equivalent of the UK and Spain's annual emissions combined.

Emissions trading experienced a surge in popularity. At the regional level, the European Union's Emissions Trading Scheme was expected to generate almost US$30 billion in trades in 2006—almost a threefold increase on the previous year (see Europe section). Other emissions trading initiatives, such as the Chicago Climate Exchange, the New South Wales Emission Trading Scheme in Australia, and the Regional Greenhouse Gas Initiative in the Northeastern US, also continued to develop. Such mechanisms seem certain to continue growing rapidly and are becoming increasingly interconnected. Given the difficulty of meeting short-term energy demand with renewables, discussions have already started on carbon capture and storage in the context of the UNFCCC and Kyoto Protocol.

Sources: UNFCCC 2006b, Environmental Finance 2006, Point Carbon 2006, Mitchell 2006, IISD 2006b,c

Registered CDM projects by region 2006



Source: UNFCCC 2006b

Box 2: Illegal logging on the agenda

With less than 10 per cent of the world's forests being managed sustainably, illegal logging remained on the international agenda in 2006. A major achievement early in the year was the completion of negotiations of a successor agreement to the International Tropical Timber Agreement, which now states as an objective the need to address illegal logging and its related trade in tropical timber. While the sixth session of the UN Forum on Forests did not follow suit with an equally decisive decision on illegal logging in February, the Secretariat later announced that the Forum would build on the ongoing efforts of the Forest Law Enforcement and Governance processes to galvanize international and multi-stakeholder commitment to combat the problem of illegal logging and its related trade. In September, the G8 Illegal Logging Dialogue was launched to bring together stakeholders from the G8 and major timber producing nations to develop a plan of action to address illegal logging by focusing on financial transparency, support for progressive companies committed to sustainable production, and the development of a discerning market for legal and sustainable timber in EU and G8 markets.

Additional efforts in 2006 to stem illegal logging included the release by the International Tropical Timber Organization (ITTO) and FAO of guidelines on best practices to improve law compliance in the forest sector. These best practice guidelines support national and regional initiatives in design and implementation of measures to combat illegal logging. Demand-side policies are also playing a role in combating illegal logging. Certification schemes have been used to inspire private sector involvement in this issue. There are now 10.5 million hectares, or three per cent, of natural production forests in ITTO producer member countries where sustainable production practices are certified by independent forestry organizations such as the Forest Stewardship Council. In light of the small percentage of certified tropical forests, consumer country experts have also pointed to public timber procurement policies as a means to reduce their countries' contribution to illegal logging.

Sources: Brack and Saunders 2006, ITTO 2006a,b, UNFF 2006, USTR 2006, World Bank 2006.

FSC timber hauled from certified forest in Amazonas, Brazil. Over 90 per cent of the certified wood from the area is exported to Europe.

Source: Joerg Boethling / Still Pictures

MARINE BIODIVERSITY: GLOBAL RESPONSES AND INSTITUTIONAL INTERLINKAGES

In 2006, scientific information derived from explorations carried out during the previous decade created alarm over the mounting vulnerability of marine biodiversity, particularly in areas beyond national jurisdiction (DOALOS 2006c). There was also concern over the limitations of the current legal system in dealing with scientific and technological advances and humans' expanding impact on the oceans (UNEP and IUCN 2006).

One of the most comprehensive studies of marine biodiversity ever made established that diversity was crucial to productivity. Ecosystems with higher diversity had 80 per cent more biomass and greater system stability than more impoverished ones (Worm and others 2006). The study cast doubt on the feasibility of reaching the 2002 World Summit on Sustainable Development (WSSD) target for the restoration of fish stocks to sustainable levels by 2015. Documenting an alarming decline in marine biodiversity across most marine ecosystems, the authors projected that the last of today's commercial fish and seafood species would collapse by 2050. However, protected areas and fishing closures boosted the biodiversity, measured in species richness, by 23 per cent and led to a fourfold improvement of fishing in neighbouring waters. The report called for the creation of more marine reserves, sustainable management of fishing, and tighter control of pollution (Worm and others 2006).

Contradictory national initiatives in 2006 further highlighted the need for an enhanced international framework. While France announced in June 2006 the creation of a new sanctuary for whales and dolphins in the West Indies, Iceland resumed commercial whaling in October (WWF 2006, Oceana 2006). The International Whaling Commission (IWC) adopted a declaration recognizing that it had failed to complete and implement a management regime to regulate commercial whaling and supporting 'sustainable' whaling in principle (IWC 2006). The United States started work with regional organizations on guidelines for sustainable fisheries practices, while the European Union, rejecting the advice of scientists and conservationists, did not close its cod fisheries in the Eastern Baltic, but instead cut the quota by ten per cent (White House 2006, ENS 2006).

High seas protected areas

The WSSD also set a goal of establishing representative networks of marine protected areas by 2012. Evaluations in

School children watch a Beard's Beaked whale brought to the Japanese port city of Wada 21 June 2006. Beard's Beaked and pilot whales are not subject to the International Whaling Commission's 1986 ban on commercial whaling.
Source: David Guttenfelder/AP Photo

Ecosystem approach

The WSSD called for the application of the ecosystem approach for sustainable development of the oceans by 2010. Reports in 2006 confirmed that the ecosystem approach provides the "best available framework for managing multiple threats, ecological uncertainties, human uses and interests," but is still sparingly applied in open oceans and deep waters (UNU 2006). Enhanced application of the ecosystem approach received widespread support at the international level. The Review Conference of the UN Agreement on Fish Stocks concluded with a commitment to integrate ecosystem considerations in fisheries management (DOALOS 2006b).

The seventh meeting of the UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea, held in June 2006, reached consensus on elements for a definition of the ecosystem approach as it applies to oceans, for implementation tools and principles and for its improved application (DOALOS 2006d).

Competence and institutional collaboration: the high seas as a final frontier

Many biodiversity-oriented and oceans-related instruments and forums have addressed issues related to marine biodiversity in a sectoral fashion. The UN Food and Agriculture Organization and the International Maritime Organization have dealt with illegal, unregulated and unreported (IUU) fishing; the International Seabed Authority has dealt with the environmental impacts of mining on the deep seabed; the Informal Consultative Process has discussed bioprospecting and destructive fishing practices; and the Convention on Biological Diversity (CBD) has dealt with high seas protected areas (IISD 2006a).

In 2006, the focus of the international community shifted to integrated responses and better institutional coordination at the global level to tackle the multiple threats to oceans. This was particularly evident during the CBD's eighth Conference of the Parties in March 2006, when discussions on marine biodiversity were dominated by the question of the CBD mandate in regards to other international organizations. The Conference concluded that the CBD should concentrate on specific tasks: providing scientific and technical information and advice related to marine biodiversity, advising on the application of the ecosystem and precautionary approaches, and delivering the WSSD target to significantly reduce the current rate of biodiversity loss by 2010 (CBD 2006). This newly defined role was intended—together with

Trawlers in the Elbe River, Germany.
Source: argus / Still

2006 showed that such areas account for only 0.6 per cent of all the oceans—at the current rate of designation, the target will not be reached until 2085 (Cicin-Sain and others 2006). The Review Conference of the UN Fish Stocks Agreement, convened in May 2006, also recognized the role of marine protected areas, but called upon States and regional fisheries management organizations to develop these areas and protect marine biodiversity only on a case-by-case basis (DOALOS 2006b).

Box 3: Biodiversity threats and conservation hopes

The year brought new evidence of growing threats to global biodiversity—especially to bird species in tropical habitats. However, studies also indicate that conservation efforts such as listing and protection can reverse declines.

A very detailed species-by-species assessment published in 2006 found that the rate of extinctions among birds may be far higher than previously estimated. The extinction rate before human impact was about one extinction per million species per year (E/MSY). The rate since 1800 has been estimated at 26 E/MSY. However, allowing for extinctions before 1800 and probable extinctions not yet recorded, the rate since 1800 may have reached 100 E/MSY. Rates in the last decades are less than 50 E/MSY—but they would have reached 150 E/MSY without conservation efforts.

The researchers conclude that most bird species' extinctions were previously confined to islands but that continent-wide extinctions have been documented recently. They predict that the 21st century rate could reach 1000 E/MSY and that, if the predicted deforestation and transformation of tropical landscapes continues, extinction rates may reach 1500 E/MSY by the end of the century. The scientists attribute extinctions to invasive species, expanding human technologies, and global environmental change. However, the most intriguing—and motivating—result of their inquiry suggets that conservation efforts can work to significantly reduce species loss.

The World Conservation Union (IUCN) issues a biennial Red List of Threatened Species based on criteria including quantitative thresholds of population size, distributional range, rates of decline, and extinction risk. The 2006 Red List provides an accurate measure of progress, or lack of it, in achieving the globally agreed target to significantly reduce the current rate of biodiversity loss by 2010.

The overall number of species considered to be critically endangered increased by seven per cent between 2004 and 2006—from 2 791 to 2 985. The most significant increases in the critical category were among fish species (48 per cent increase), insects (45 per cent), and reptiles (14 per cent).

The percentage of 'described species' which were threatened was highest among vertebrates, ranging from 31 per cent among amphibians and 20 per cent among mammals, to 12 per cent of birds and 4 per cent each of reptiles and fishes. Among gymnosperms such as conifers, 31 per cent were threatened. Mammals, birds, amphibians, and gymnosperms were the first groups to be completely or almost completely evaluated.

Sharks and rays are among the first marine groups to be assessed: 20 per cent of the 547 species listed are threatened with extinction. Freshwater fish are also at risk: 56 per cent of the 252 endemic freshwater Mediterranean fish are threatened.

One species which moved into the threatened categories in the 2006 Red List is the polar bear. There are an estimated 20 000 to 25 000 polar bears left in the Arctic and their survival is severely threatened by the retreat of ice due to global warming. Bears rely on broad expanses of ice to gain access to their food sources. When unstable or absent ice prevents access to food, they will give birth less often to smaller cubs with higher mortality rates. Their slow rate of reproduction means that they are unlikely to develop new behaviour patterns in time to adapt to global warming. The 2006 IUCN assessment projects a population reduction of more than 30 per cent within 45 years—and possible extinction in the wild in 100 years. Other stress factors include pollution, shipping, tourism, oil and gas operations, and traditional hunting by indigenous communities.

Following a 2005 petition from three environmental organizations, the US Fish and Wildlife Service officially announced in December 2006 that it would propose listing the polar bear as a threatened species under the Endangered Species Act (ESA). This decision is highly significant. This would be the first listed species to which global warming is officially acknowledged to be the major threat. Protection under the ESA would require the US government to develop a conservation plan and to ensure that government agencies take no action that might jeopardize the animal's existence. There follows a 12 month review of threats and options for conservation. While the official announcement downplays any implications for US climate and oil exploration policies, environmental NGOs believe they would be empowered to take legal action over these threats.

Polar bear on thin ice

Source: Fred Bruemmer / Still Pictures

Protection and conservation can pay off. A well known example of a species which would be extinct save for conservation is the California condor, which was down to the last nine in the wild before a conservation breeding and release programme began in 1987. Numbers in the wild have now risen to 138. However, the released condors are still highly vulnerable and conservation efforts must remain vigilant. Most of the chicks hatched in the wild have died—some by ingesting trash left by hikers, such as bottle caps and glass fragments. Since 1997, nine condors have died of lead poisoning derived from hunters' ammunition and three hunters have been convicted under the Endangered Species Act and required to pay fines varying from US$1500 to US$20 000.

Sources:
Pimm and others 2006, IUCN 2006a, Schliebe and others 2006, US Fish and Wildlife Service 2006, Church and others 2006, CRES 2006.

other international organizations and processes on biodiversity or oceans—to complement the central role of the General Assembly. The Assembly's capacity to steer ocean and biodiversity related agencies, treaty bodies, and forums towards effective and timely international action to protect marine biodiversity in the deep sea is now to be tested.

CHEMICALS AND WASTE MANAGEMENT: TOWARDS A GLOBAL APPROACH

A number of efforts in 2006 moved the international community towards the 2002 WSSD agreed objective that, by the year 2020, chemicals should be produced and used in ways that minimize significant adverse effects on the environment and human health. The importance of a global approach to chemicals and waste management was closely tied to the globalization of trade in wastes.

During 2006, cases involving the transboundary movement of wastes confirmed the need for a globally accepted life cycle approach to chemicals and waste. The Secretariat of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was asked to become involved in two prominent cases of this type. The first involved a retired French aircraft carrier en route to Alang, India, to be dismantled. Several non-governmental organizations protested that the departure violated the Basel Convention. The Secretariat encouraged India and France, both Parties to the Convention, to resolve the issue bilaterally (Basel 2006a). The ship was eventually ordered back to France. The Secretariat was also involved when a foreign ship delivered toxic material to Abidjan, Côte d'Ivoire, in August (see Africa section). As of late December 2006, donor contibutions of US$15 million were still being sought to meet clean-up costs.

Problems associated with electronic equipment waste raised international attention due to both the escalating levels of e-waste and the growing tendency to export it for disposal to countries other than the country of production or use. According to one report, 20 to 50 million tonnes of e-waste are produced each year, much of it containing toxic materials (Economist 2006). In response, beginning on 1 July 2006, Europe began limiting the use of particular substances—including lead, mercury, and cadmium—in new electronic products. On the same date California began requiring mobile phone retailers to take back and recycle old phones. The Conference of the Parties

to the Basel Convention took up this issue for the first time at its November-December meeting in Nairobi. Delegates recommended phasing out technologies that are not environmentally sound and agreed to develop a plan on the environmentally sound management of e-waste, focusing on the needs of developing countries and countries with economies in transition (IISD 2006e).

Amid the growing need for a global approach to chemical waste, negotiations on the Strategic Approach on International Chemicals Management (SAICM) were completed in February 2006, bringing a new policy framework for international action on chemical hazards to the three legally binding multilateral instruments that currently govern chemicals issues: the Stockholm Convention on Persistent Organic Pollutants (POPs), the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PICs), and the Basel Convention. SAICM is a voluntary agreement that covers issues from risk assessments of chemicals and harmonized labelling to elimination of obsolete and stockpiled products. It includes provisions for establishing national centres to help countries, especially in the developing world, to train staff in chemical safety, including dealing with spills and accidents.

The three legally binding convention bodies considered a global approach to chemicals and waste management through the use of a life cycle or 'cradle-to-grave' approach, and addressed the possibilities of coordinating and combining their activities. All three conventions agreed in 2006 to establish an ad hoc joint working group to consider options—such as establishing a common Executive Secretary and core management functions for the three conventions or integrating administrative support, implementation, and technical assistance—with the Parties to the Stockholm Convention calling for cooperation and coordination among the three conventions (UNEP 2006a, IISD 2006e).

LOOKING TOWARD 2007

Developments in 2006 suggest a few encouraging trends in addressing sustainable development concerns. Multilateral efforts to enhance the coordination among, and to rationalize the different inputs of, international institutions and natural resource management were underway at a number of levels. At the same time, there is a growing recognition of the importance of addressing cross-cutting issues in a holistic manner and developing global partnerships between international institutions and non-State actors.

The High-Level Panel on UN System-Wide Coherence in the areas of Development, Humanitarian Assistance, and the Environment, along with consultations on international environmental governance within the General Assembly, delivered options to improve coordination among UN agencies. The High-Level Panel recommended an independent assessment of international environmental governance within the UN system. It also recommended that any duplications should be eliminated and that UNEP should be upgraded and have real authority as the environmental policy pillar of the UN system (UN 2006).

However, 2006 was not a 'breakthrough year' in key negotiations such as climate change. The issue will require some countries to act as champions if the world is to act in a timely manner. Efforts must be made to link the environment and economics—as pioneered by the UN Economic Commission for Europe's Recommendations on Payments for Ecosystem Services in Integrated Water Resources Management, which offer international guidance for the establishment of payment for ecosystem services at the local, national, and transboundary levels (UNECE 2006). All stakeholders will need to be involved if emerging issues are to be dealt with from a sustainable development perspective—and sustainable development will need to move from the periphery to the center of decision-making considerations.

Boy hired to haul electronic scrap from Alaba market in Lagos, Nigeria to this nearby informal dump sitting on a swamp. Imported scrap televisions and computers that could not be repaired are burned.
Source: Basel Action Network

Box 4: Priorities for Action on Deserts and Desertification

The UN's designation of 2006 as the International Year of Deserts and Desertification (IYDD) sought to focus international attention and action on the situation of approximately 500 million people who live in deserts and desert margins, totaling eight per cent of the global population. An average of 68 per cent of the species found in the desert biome are endemic, but the pressures and impacts of agriculture and other human land use, fragmentation associated with infrastructure, and climate change may cause biodiversity losses that could decrease this average of original species to 58.3 per cent by 2050.

IYDD-related events identified actions to address the issue in relation to migration, scientific options, and sustainable water and land management among other matters. Several studies released in 2006 further identified approaches to manage the water crisis in drylands. *Global Deserts Outlook* stressed the need to discourage wasteful water consumption as well as to combine new technologies such as drip irrigation, micro-sprinklers, and fog harvesting in coastal deserts, with traditional water-efficient management techniques. The Comprehensive Assessment of Water Management in Agriculture identified improving agricultural water management in developing countries as a key priority, particularly on rain-fed farms on Africa's savannas, and recommended building more water storage, installing better irrigation systems, and developing drought-resistant crops. The *2006 UN World Water Development Report* emphasized modifying water demand and usage through increased awareness, education and water policy reforms, and adopting Integrated Water Resources Management (IWRM) and water efficiency plans. Ministers at the 4th World Water Forum in Mexico City in March 2006 reaffirmed their commitment to achieve internationally agreed IWRM goals of access to safe drinking water and basic sanitation agreed upon in Agenda 21, the Millennium Declaration, and the Johannesburg Plan of Implementation.

Sources: CA 2006, National Water Commission of Mexico 2006, UNEP 2006b, World Water Assessment Programme and UNESCO 2006, and UNESCO 2006

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Calendar of selected events in 2006

PHONE Brandelet Didier / Still Pictures

JANUARY

1 January The United Nations launches the International Year of Deserts and Desertification to raise global public awareness of advancing deserts, which cover 41 per cent of the earth's surface.

1 January A voluntary mechanism to exchange information about registered importers of chlorofluorocarbons (CFCs) before issuing import/export licenses is piloted in countries of South and South East Asia.

4 January The Framework Convention on the Protection and Sustainable Development of the Carpathians enters into force. The convention provides key principles for cooperation on conservation, agriculture, forestry, transportation, and infrastructure among the Czech Republic, Hungary, Poland, Romania, Serbia, the Slovak Republic, and Ukraine.

11-12 January The first ministerial meeting of the Asia-Pacific Partnership on Clean Development and Climate adopts a charter document and a work plan.

8 February The Strategic Approach to International Chemicals Management is adopted at the International Conference on Chemicals Management, to ensure that chemicals are used and produced in ways that minimize adverse effects to health and the environment.

13-24 February Delegates at the sixth session of the UN Forum on Forests agree on a successor agreement to the International Agreement on Forests. There are four global objectives: to prevent forest degradation; enhance forest benefits and their contribution to international development goals; increase the area of forests; and increase official development assistance for sustainable forest management.

MARK EDWARDS / Still Pictures

MARCH

6-9 March The Africa Ministerial Conference on Hydropower and Sustainable Development commits to working together to unlock Africa's hydropower potential. Ministers recognize the need for sound environmental and social impact assessments, for investing in capacity building, and for ensuring that affected local communities derive positive sustainable benefits.

14 March The World Meteorological Organization's first annual Greenhouse Gas Bulletin reports that globally averaged concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in the planet's atmosphere reached their highest ever recorded levels in 2004.

H.Windeck/UNEP / Still Pictures

26 April 20th anniversary of the world's largest ever nuclear accident, at Chernobyl in Ukraine. The effects continue to affect the lives of people in Ukraine, neighbouring Belarus and Russia, and across the northern hemisphere.

PHONE Brandelet Didier / Still Pictures

MAY

16 May The African Union, World Bank, FAO, and the World Wildlife Fund launch an Africa-wide partnership with the aim of restoring depleted fish stocks and reducing poverty. This partnership establishes a Sustainable Fishing Investment Fund—the first of its kind—focussing on fisheries in Africa's large marine ecosystems.

Ron Giling / Still Pictures

JULY

3 July The Millennium Development Goals Report 2006 finds that developing countries have made progress in providing access to clean water and schooling, but efforts to achieve other internationally agreed targets are falling behind schedule.

/ Still Pictures

7 July The World Conservation Union (IUCN) announces that despite improvements in conservation of most of Africa's black and white rhinoceros sub-species, the West African black rhinoceros (*Diceros bicornis longipes*) is now feared extinct mainly due to poaching for rhino horn. Wild northern white rhino (*Ceratotherium simum cottoni*) populations have reached an all time low.

15-17 July Leaders at the G8 Summit, hosted by Russia, issue a Global Energy Security Statement in which they agree that ensuring sufficient, reliable, and environmentally responsible supplies of energy at prices reflecting market fundamentals is a challenge for G8 countries and for mankind as a whole.

4 September The creation of the first international organization to reduce the negative impacts of soy production is announced at the second Conference of the Roundtable on Responsible Soy in Asunción, Paraguay. An initiative of soy producers, processors, traders, financial institutions, and non-governmental organizations, it will develop principles, criteria, and indicators for the responsible production, processing, and trade of soy.

28 September UNEP awards the 2006 Sasakawa Prize to two grassroots initiatives—Mauritania's Tenadi Cooperative Group and Rodrigo Vivas Rosas of Colombia—for their achievements in combating desertification and land degradation. The Tenadi Cooperative developed immersed borehole pumps for drinking water and reforested 80 hectares around the boreholes to stabilize dunes.

OCTOBER

By October 2006, Avian flu is found among poultry in Niger, Cameroon, Cote d'Ivoire, Burkina Faso, Egypt, and Sudan. In 2006 ten people died in Egypt, nine in Europe. The largest number of cases continues to occur in East and South East Asia, with 45 deaths in Indonesia alone. Vietnam and Thailand—first to be affected in the recent outbreak—have zero and three deaths respectively in 2006.

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5 October The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) decides to suspend exports of 60 tons of elephant ivory from Botswana, Namibia, and South Africa. Permission for the sales is conditional on the Monitoring of Illegal Killing of Elephants (MIKE) system establishing comprehensive baseline data on elephant poaching and population levels, which has not yet been achieved.

26 October The European Commission proposes legislation to ban all European Union exports of mercury beginning in 2011.

30 October The Stern Review on the Economics of Climate Change by thehead of the UK's Economic service, Sir Nicholas Stern, calculates that the costs of unabated climate change range from 5-20 per cent of GDP or more while the costs of action to avoid the worst impacts of climate change can be limited to approximately one per cent of global GDP per year.

NOVEMBER

6-17 November UN Climate Change Conference in Nairobi fails to result in commitments for the post-Kyoto era that begins in 2012, or in a timetable for negotiating new targets.

10 November Environment ministers of the Association of South East Asian Nations (ASEAN) endorse a Plan of Action to implement the ASEAN Agreement on Transboundary Haze Pollution, signed in 2002.

9 November The High-Level Panel on UN System-wide Coherence in the Areas of Development, Humanitarian Assistance, and the Environment recommends consolidating all UN country-level programme activities, upgrading UNEP into the lead UN agency for environment with a renewed mandate and improved funding, and increasing the resources of the Global Environment Facility.

15-17 January The first World Assembly on Labour and the Environment proposes adding environmental rights such as access to water and energy to workers' traditional rights of freedom of association and collective bargaining.


Enrico Bartolucci / Still Pictures

FEBRUARY

6 February The deadly H5N1 bird flu virus is detected for the first time in Africa—on a large commercial chicken farm in Nigeria.

7-9 February Environment ministers at the ninth special session of UNEP's Governing Council/Global Ministerial Environment Forum discuss issues related to energy and environment, environmental governance, and approve an agreement on international chemicals management.

20-31 March The eighth Conference of the Parties to the Convention on Biological Diversity adopts an island biodiversity work programme, reaffirms a ban on field testing of genetic use restriction technologies, and rejects case-by-case risk assessments.

27 March The world's largest Forest Stewardship Council tropical forest, totaling 570,000 ha, is certified in Guyana.

27-29 March The Third International Conference on Early Warning calls for more funds and emphasizes the importance of local communities in readiness training and the need to integrate early warning into disaster risk reduction strategies in national development frameworks.

16-22 March The fourth World Water Forum is attended by almost 20 000 participants. The adopted Ministerial Declaration calls for international action on water and sanitation issues.

APRIL

1 April The International Association of Antarctica Tour Operators reports that over 26 000 visitors travelled to the Antarctic region from November 2005 through March 2006, the austral summer period. This is a record number and a threefold increase since 1992.

20 May Final concrete is poured for the Three Gorges Dam's main wall amid controversy over costs and benefits, including environmental costs. It is the largest hydroelectric dam in the world. Designed for power generation as well as flood control, when operating at full capacity now scheduled for 2008, the project's 26 hydropower turbines are expected to produce 18.2 million kilowatts, up to one-ninth of China's electricity output.

25 May The International Tropical Timber Organization, in an analysis of the state of tropical forestry in 33 countries in Asia, the Pacific, Latin America, the Caribbean, and Africa, reports that over 90 per cent of tropical forests are not being managed sustainably.


FREELENS Pool Tack / Still Pictures

JUNE

9 June- 9 July The 2006 FIFA World Cup goes carbon-neutral. Greenhouse gas emissions are cut drastically, partly by encouraging half of the estimated 3.2 million fans to take public transport. FIFA also offsets the carbon produced by financing alternative energy projects in India and South Africa.

12-16 June The first session of the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture adopts a standard Material Transfer Agreement, implementing the Treaty's multilateral system of access and benefit-sharing. Recipients who commercialize plant material without making it freely available for further research and breeding will pay a percentage for activities to help small farmers in developing countries.

28 July A new US federal rule takes effect protecting over 95.83 million hectares of ocean floor around Alaska from bottom trawling to help save Alaska's rare coral gardens.

AUGUST

12 August The Framework Convention for the Protection of the Marine Environment of the Caspian Sea enters into force. It will coordinate efforts by Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan to reverse an environmental crisis of habitat destruction, industrial pollution, and over-exploitation of fish and other marine life.

28 August The Global Environment Facility (GEF) Council, led by its new CEO/Chair Monique Barbut, endorses the outcome of the long-negotiated fourth replenishment of the GEF Trust Fund at a level of US$3.13 billion for 2006-2009 to finance environmental projects over the next four years.

30 August California, the 12th largest carbon emitter in the world, passes the first bill in the United States to cap CO_2 emissions. It aims to cut them by about 25 per cent, back to 1990 levels by 2020.

SEPTEMBER

1 September 'Project Sky Hole Patching' is launched—a far-reaching operation to curb illegal trade in ozone-depleting substances and dangerous waste by 20 national customs administrations in Asia and the Pacific. Customs authorities will cooperate with environmental agencies to monitor suspicious shipments of ozone-depleting chemicals and dangerous commodities.

5 October A draft bylaw of the Arab Union for Wildlife Sanctuaries is ratified in Riyadh, Saudi Arabia. The Arab Union aims to provide technical support and consultation to member-countries in the establishment and management of wildlife sanctuaries.


A.ET.E.LAPED / Still Pictures

24 October WWF's Living Planet Report 2006 calculates that humanity's Ecological Footprint—the demand we place upon the natural world—has exceeded the Earth's sustainable capacity by about 25 per cent. Measures such as carbon sequestration and emission reductions due to energy conseravtion or new technologies would improve the situation.


S. Zesse / Still Pictures

26 October – 3 November The first Meeting of Contracting Parties to the London Protocol decides to allow burial of CO_2 in natural structures under the oceans from February 2007, despite concerns over the potential for leakage that would exacerbate ocean acidification dangers.


NICK COBBING / Still Pictures

17 November The US National Oceanic and Atmospheric Administration releases its State of the Arctic report, highlighting continued warming in the Arctic. On average, global temperatures have been steadily warming for decades but the Arctic appears to be warming twice as fast as the rest of the world.

22 November Five Central Asian countries endorse the Framework Convention on Environmental Protection for Sustainable Development to more effectively address common and transboundary environmental issues.


Peter Hirth / Still Pictures

DECEMBER

13 December EU Member States approve Registration, Evaluation and Authorisation of Chemicals (REACH), the much debated law on toxic chemicals. REACH will enter force in June 2007 requiring companies to prove that new or existing substances in every-day products like cars, clothes, and paint are safe.

Africa

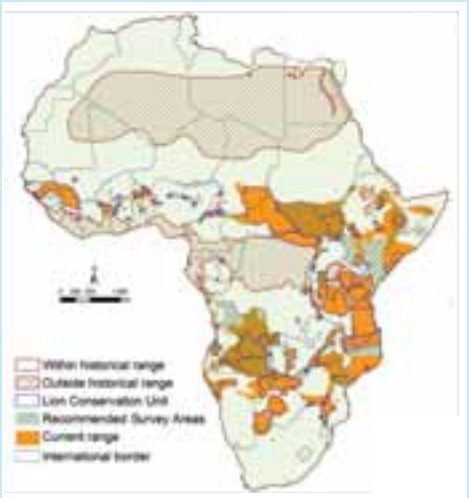
In 2006, man-made and natural disasters continued to hamper Africa's development opportunities. However, environmental cooperation proved to be a valuable tool for reducing conflict, increasing economic opportunities, and enhancing livelihoods as well as achieving conservation objectives.

ENVIRONMENTAL COOPERATION—AN INVESTMENT IN PEACE AND REGIONAL INTEGRATION

Violent conflict and pressures on arable land continue as significant causes of environmental degradation in Africa, leading to deforestation and the bush meat trade as well as undermining the resilience of local communities. But conversely, environmental cooperation can offer a promising route to regional peace and integration (Hammill 2005). Several new and ongoing environmental initiatives in Africa are exploring this promise for different species and for different ecological regions.

Lion populations have disappeared from about 80 per cent of their former rangelands **(Figure 1)** (UNEP-WCMC 2006). Over the last two decades their numbers are believed to have declined by 30-50 per cent and current estimates suggest that between 23 000 and 39 000 lions remain (Bauer and Van der Merwe 2004, Chardonnet 2002). Approximately 90 per cent of the remaining lion population is located in eastern and southern Africa, half of these in Tanzania. There are smaller viable populations in Kenya, South Africa, Mozambique, Botswana, Zimbabwe, Zambia, and Namibia. Lions have been completely eliminated in Eygypt, Libya, Tunisia, Algeria, Morocco, and Mauritania. In western and central Africa only small, fragmented lion populations remain. This biodiversity loss also represents an economic loss, as lion populations are a focal point for tourism.

Figure 1: Africa's lion population is in steady decline. Lion Conservation Units are areas that are critical for the long-term conservation of lion populations. In Recommended Survey Areas further monitoring and research are necessary to determine population status and appropriate resonses.



Source: Wildlife Conservation Society

In 2006, 24 lion range states began a process to develop a pan-African lion conservation strategy. Two sub-regional strategies—one for western and central Africa and another for eastern and southern Africa—have been developed (IUCN ROSA 2006). Africa's lion range states recognize that protecting this asset means addressing the causes of declining lion populations (IUCN ROSA 2006). These include the vulnerability of lions in conflict zones, conflicts between lions and rural people whose lives and livestock they may threaten, and various diseases (Dudley and others 2002, Chardonnet 2002, Frank and others 2006).

Great apes are even more severely threatened by the bush meat trade, encroachment, and conflict **(Box1)**. The 2005 Kinshasa Declaration on Great Apes pledges signatories to reduce the current loss of great ape populations by 2010 and to secure the future of all species and subspecies of great apes in the wild by 2015. Sierra Leone and Sudan signed the declaration in March 2006, joining the original 16 signatory great ape range states, followed by Rwanda and Gabon in May and by Equatorial Guinea in June (UNEP 2006a). Only two of the 23 African great ape range states have not yet signed. By connecting protected areas, the parties hope to improve conservation and livelihood opportunities (UNEP and UNESCO 2005).

Box 1: Building peace through environmental cooperation

The International Gorilla Conservation Programme (IGCP) promotes cooperation for mountain gorilla conservation in the Great Lakes region, which has experienced multiple conflicts over several decades.

IGCP has three coalition partners—African Wildlife Foundation, Fauna & Flora International, and the World Wide Fund for Nature. It works with all stakeholders whose activities potentially affect the survival of gorillas and their habitat including farmers, park and military authorities, local and regional governments, and environmental experts. By building partnerships and developing synergies between conservation and development, IGCP has changed attitudes to the gorillas.

Since IGCP's inception, there has been a 12 per cent increase in the mountain gorilla population which totalled 700 at the time of the latest census. Preliminary assessments suggest that conservation activities have improved dialogue between different stakeholders. Improved communication builds trust and understanding while joint activities create interdependencies, all of which helps to reduce political tensions.

Source: Johannes Refisch

Separating farming communities and the gorilla population, the Nkuringo buffer zone along the south side of Uganda's Bwindi Impenetrable Forest is 12 kilometres long and a few hundred metres wide.

IGCP aims to build partnerships between development and humanitarian agencies and environmental efforts. Mainstreaming environment in development and humanitarian activities potentially creates new support for conservation development initiatives that can enrich local livelihoods. However, success depends on making sure that interventions do not entrench inequities or create new ones—such as unequal rights to land and forest resources.

Sources: IGCP 2006, Besançon and Hammill 2006, van der Giessen 2005, Lanjouw undated

The declaration encourages cooperation, including partnerships with the private sector, to create sustainable economic activities that enhance livelihoods.

Ecological regions can also act as a focus for regional cooperation. The upper Zambezi and Kavango region is biodiversity-rich and home to the well-known Okavango Delta. The area has significant tourism potential but three decades of violent conflict have hindered investment. Landmines from Angola's 26-year civil war have displaced communities, disrupted livelihood activities, and blocked elephant (*Loxodonta africana*) migratory routes, restricting the largest surviving elephant herd to Botswana's northern protected areas (Hoare 2004, UNEP undated). This constrained elephant herd is growing at an unsustainable rate of five per cent per year, resulting in environmental degradation and conflict with communities living nearby. On 7 December 2006, government ministers from Angola, Botswana, Namibia, Zambia, and Zimbabwe signed a Memorandum of Understanding that establishes the Kavango-Zambezi Transfrontier Conservation Area ((KAZA TFCA) (Peace Parks Foundation 2006). The KAZA TFCA will link human security and development with conservation. An initial step will be a project run by UNDP, Conservation International, Roots of Peace, and the Government of Angola to de-mine 150 000 hectares and and restore elephant migratory routes. This will link protected areas within KAZA TFCA, increasing tourism potential and related development (Suich and others 2005). The initiative will restore elephant migratory routes.

Covering an even larger area, the African Union is considering a 'Green Wall for the Sahara Initiative,' which will include over 20 countries in a 30-year project. This initiative aims to arrest desertification and improve sustainable livelihoods in the fragile Sahelo-Sahara zone. The Green Wall concept recognizes that policy coordination and better integration of environment in development policies are essential to harmonize approaches to community participation, to rehabilitate transboundary ecosystems, and to develop a strong data base (AU Commission 2006).

Recovering from violent conflict can leave countries and communities vulnerable to natural and man-made disasters (**Box 2 and Box 3**). Regional cooperation can build local resiliency as well as transboundary conservation success.

After de-ming in Angola, elephants in Botswana's wetlands should be able to resume their transfrontier migratory habits.
Source: © BIOS Guntherr Michel / Still Pictures

Box 2: Regional cooperation in early warning and conflict management

In east Africa, environmental change and the lack of rural investment combine to create fertile ground for pastoral conflict. The convergence of pastoral groups around state boundaries increases the likelihood of cross-border migrations. In recent years pastoral confl ict has increased and currently there are 30 potentially threatening inter-community conflicts in the region. Tension points include the Karamoja cluster composed of pastoral groups in southwestern Ethiopia, northwestern Kenya, southeastern Sudan, and northeastern Uganda.

Increased tension is linked to:

- growing competition for land as a result of desertification, displacement of pastoral people, and population growth among herders and farmers;
- the breakdown of traditional cattle-raiding rules and the commercialization of raiding;
- the proliferation of small arms from wars in the region; and
- reduced food security and water availability due to rainfall variability and extended droughts.

In one significant regional initiative, the Intergovernmental Authority on Development (IGAD) has linked its drought and conflict monitoring activities into the Conflict Early Warning and Response Mechanism (CEWARN). CEWARN monitors pastoral conflict and provides timely information on specific events and their causes, thus helping member states to prevent escalation into larger conflicts. CEWARN's Drought Monitoring Centre reports on drought and forage conditions and makes food production projections—important factors influencing migrations.

Sources: CEWARN 2006, Grahn 2005, Nori and others undated, Ame 2006, NASA 2006

Box 3: Illegal dumping crisis in Côte d'Ivoire

Citizens of Abidjan wait outside a local hospital to be examined by medical personnel for the effects of toxic exposure.
Source: Luc Gnago/Reuters/The Bigger Picture

In AAbidjan, Côte d'Ivoire's largest city, the illegal dumping of over 400 metric tons of toxic sludge in late August killed at least 12 people and led more than 100 000 others to seek medical care. Reportedly, a ship unloaded petrochemical waste into trucks that then dumped it in at least 15 sites around Abidjan. The waste contained a mixture of petroleum distillates, hydrogen sulphide, mercaptans, phenolic compounds, and sodium hydroxide.

The disaster led to the resignation of the government, which had been reaching the end of a UN-brokered administration comprised of parties that were warring factions in the recent civil war. International waste treatment experts helped with the first phase of clean-up but even by the end of 2006 residents still suffered as local dumps were closed and waste piled up on city streets. The Ivorian Government estimated a total cost of US$30 million to recover and transport the waste to France for de-contamination. As of 20 December 2006 US$15 million was still needed from international donors to finish the job.

Source: (UNNS 2006, UNEP 2006)

INVASIVE ALIEN SPECIES

Invasive alien species (IAS) are the second largest threat to global biodiversity after habitat loss (MA 2006). In many small island developing states, IAS are the greatest threat to biodiversity. They pose a region-wide challenge to Africa, driving environmental change, affecting agriculture and water availability, and under-mining the continent's ability to meet the Millennium Development Goals and other efforts to reduce extreme poverty and hunger (GISP 2006).

The threat is likely to increase due to the combined effects of climate change, land-use change, and globalization (Mooney and Hobbs 2000). Climate change and land conversion disrupt ecosystems and favour the establishment of opportunistic species (Mace and others 2006). Increased human mobility and trade have opened new pathways of introduction, creating new management challenges and complicating efforts to exclude IAS (Chenje and Mohamed-Katerere 2006, Barnard and others 2006).

Globally-accepted IAS policy focuses on the prevention of new introductions as top priority. Once a species becomes established, the focus shifts to eradication and control. The parties to the Convention on Biological Diversity (CBD) agreed to significantly reduce the rate of biodiversity loss by 2010—including the loss attributable to invasive species. For IAS, the goals are to control pathways of invasion and to establish management plans for the most threatening alien species (CBD 2002, CBD 2004).

With only four years left before the 2010 target date, challenges to meeting these goals remain and it seems unlikely that IAS can be eradicated in the foreseeable future. For example, by 2006 only five countries out of the 22 assessed had identified some or all major IAS and established a tracking system. Africa's capacity to control IAS is affected by weak policy and institutions, inadequate funds, and lack of information and managerial capacity (GISP 2006). Prevention measures are insufficient: There is a lack of standards to address animal IAS, as well as inadequate control measures on IAS introductions via civil air transportation, shipping, transboundary waters, tourism, and emergency relief (CBD 2006a).

IAS can affect livelihoods in positive as well as negative ways, making some management choices difficult. While particular IAS may have financial value, in situations where these species displace native species and cause significant environmental change, the environmental and social costs may outweigh any economic benefits. For example, in 2005 the export of Nile Perch fillets from Lake Victoria earned Uganda, Kenya, and Tanzania US$272 million. But since the species was introduced in the 1950s, Nile Perch have transformed Lake Victoria's ecosystem and reduced the diversity of fish species on which many local people rely (Josupeit 2006).

Once established, IAS are extremely difficult to eradicate (MA 2005). One promising approach that complements other control measures is to encourage enterprises that use IAS by-products, creating an incentive to harvest invasive species **(Box 4)**. In Niger, planners are considering management approaches to develop economic use of the invasive *Prosopis spp.*—commonly known as mesquite (Geesing and others 2004). Mesquite was introduced to Mauritania, Senegal, and other Sahelian countries to help combat desertification by stabilizing dunes. In some parts of northwestern Africa mesquite is one of the sole sources of firewood. While mesquite has become an invasive problem in areas with more rainfall, in parts of Africa subject to desertification and drought due to climate variability and climate change mesquite serves as a valuable resource **(Box 5)** (FAO 2006).

In 2003, the New Partnership for Africa's Development (NEPAD) named IAS as a priority area in its Environmental Action Plan, marking a first step towards establishing a regional framework and identifying 14 projects to address the issue (NEPAD 2003). However, only 29 African countries met reporting requirements under the CBD in 2006 and country reports reveal ongoing managerial challenges (CBD 2006b).

In 2006, the CBD drew attention to the need for a multilevel cooperative approach to capacity-building at national, sub-regional, regional, and global levels to promote consistency and mutual support for adopted measures (CBD 2006a). A 2006 UNEP Global Invasive Species Programme capacity-building initiative will assist countries to develop and implement national and regional strategies and action plans, as well as facilitate information sharing.

LOOKING TO THE FUTURE

For Africa, building durable peace as the basis for development and human prosperity will remain a long term priority. Environmental cooperation can contribute to this vision by decreasing tensions over livelihood resources, by equitable sharing and joint planning—and by building trust. Successful environmental cooperation requires improved funding to support better integration of environment and development policies and stronger partnerships between governments and other stakeholders.

By continuing to invest in environmental cooperation among governments and other stakeholders (including non-governmental organizations, experts, communities, and entrepreneurs) Africa can make important steps towards achieving sustainable development goals and reducing vulnerabilty to both man-made and natural disasters.

Box 4: Value-added industries

In South Africa, 8 750 plants are introduced species and 198 of those are classified as invasive. Recent estimates suggest that these plants cover over 10 million hectares—about 8 per cent of South Africa's land area. South Africa's 2006 report to the CBD noted that its Working for Water (WfW) Programme invests heavily in eradication, increasing from about US$6 million in 1995/6 to more than US$72 million in 2003/4, and has cleared over a million hectares of land of invasive alien plants. Nevertheless, invasive alien species continue to spread—wasting 7 per cent of water resources, intensifying flooding and fires, eroding soils, silting dams and estuaries, degrading water quality, and reducing biodiversity.

WfW's Valued-added Industry Programme encourages entrepreneurs to use the biomass collected from land-clearing operations. IAS biomass is used to make screens and blinds, interior décor items such as lamps, bathroom accessories, indoor and outdoor furniture, fencing and arches, and toys, as well as fuel.

The programme has three primary objectives:

- Improving the economic benefits of the WfW programme, by creating extra jobs through the harvesting and processing of plant material.
- Reducing the cost of clearing invasives by involving entrepreneurs, contributing to the sustainability of the WfW programme.
- Minimizing the potential negative environmental impacts, such as fire damage, by leaving less biomass behind after clearing.

Source: Working for Water Programme 2006, Government of South Africa 2006

Craftsperson using bark from IAS, Working for Water Programme, South Africa

Source: Working for Water

Box 5: Climate change mitigation and Africa

Climate change in Africa was one of the key priority topics at the 12th Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC), held in Nairobi in November 2006. A conference background paper reported that Africa is acutely vulnerable to climate change. It is already stressed by climate factors such as rainfall variability, water shortage, and low crop yields as well as climate-related diseases such as Rift Valley fever, cholera, and malaria. During the 21st century 30 per cent of Africa's coastal infrastructure could be inundated by sea-level rise. Cereal crop yields could decline by up to five per cent by the 2080s. Meanwhile the range, frequency, and severity of disease outbreaks may increase.

So far Africa has received the least help with mitigation efforts that benefit developing countries. The Clean Development Mechanism (CDM) permits industrialized countries to offset their CO_2 emissions by funding emission-reducing projects in developing countries. But sub-Saharan Africa had just five of the 410 registered Clean Development Mechanism (CDM) projects—four in South Africa and one in Nigeria, as of November 2006. This compares with 192 for Latin America and the Caribbean and 203 for Asia. The situation with projects in the planning stage is no better.

Africa has a huge potential for carbon sequestration through afforestation and reforestation projects that would also deliver strong local community, environmental, and economic benefits. However, these approaches are not yet accepted under the CDM.

Several initiatives announced at the UNFCCC Conference will begin to remedy this situation. UN Secretary-General Kofi Annan announced the Nairobi Framework—a joint initiative of five UN agencies to help poorer countries benefit more from the CDM. UNEP and UNDP announced a partnership to help poorer countries, especially those in sub-Saharan Africa, to secure a greater share of the international carbon finance market. This partnership will provide rapid expert support to governments assessing potential climate change impacts on infrastructure projects such as roads, dams, and power systems.

Meanwhile the World Bank announced that its Community Development Carbon Fund will buy 900 000 tons of carbon credits from the Kenya Electricity Generating Company (Kengen). Clean geothermal energy from the planned expansion of Kengen's Olkaria II power plant will displace electricity produced by fossil-fuel powered plants, equivalent to 150 000 tons of carbon dioxide per year. This is the first CDM geothermal project on the continent.

Sources: UNFCCC 2006a and 2006b, World Bank 2006, UNEP 2006b, Ayeiko 2006.

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Asia and the Pacific

Warming temperatures, extreme weather events, and threats to sustainable water supplies and biodiversity pose growing environmental challenges in the region while Governments are beginning to address some key environmental problems.

REGIONAL WARMING TRENDS

In 2006, researchers reported a progressive and accelerated long-term Asian warming trend over the period 1860-2004 (Huang 2006). This trend has been accompanied by an increase in frequency of extreme weather events. Analysis of rainfall gauge data in India shows that over the last fifty years the frequency of severe rainstorms increased while the frequency of moderate events decreased. The number of storms delivering more than 100 millimeters in a day has increased by 10 per cent per decade while those delivering over 150 millimeters per day doubled. This trend suggests increasing risks of extreme rainfall. The resulting landslides, flash floods, and crop damage could have major impacts on the economy, society, and environment (Goswami and others 2006).

Throughout 2006, storms lashed countries across Asia, flooding landscapes in Timor-Leste, China, India, Pakistan, Thailand, Bangladesh, Sri Lanka, Korea, Kashmir, and Afghanistan. The flooding brought mudslides and, in Sri Lanka, re-exposed landmines. In December, the Philippines faced the fourth typhoon in as many months with flooding and deadly mudslides that buried hundreds of victims (ReliefWeb 2006).

In Australia, a drought trend persisting since 2002 reached severe levels in 2006. According to the Australian Bureau of Meteorology, the situation worsened since August, with a near total failure of the rains needed for planting season (BOM 2006).

Underlying continent-wide trends, local and regional climate patterns are also shifting **(Box 1)**. Despite episodes of flash flooding, parts of Central Asia will soon mark a decade of drought **(Figure 1)**. Theories explaining the persistent lack of precipitation over the Iranian Plateau vary from a teleconnection (long-distance relationship) with warmer temperatures in the western Pacific and the eastern Indian Oceans to an anomalously persistent South Asia High over the region (Hoerling and Kumar 2003, Qian and others 2002). In China, 2006 was a disastrous year of weather, characterized by less rain, drought, and high temperatures. The anomalous weather was attributed to global warming by the Beijing Climate Center of the China Meteorological Administration (CMA 2006, Xinhua 2006). **(Box 2 and Box 3)**.

Source: Still Pictures

In India the frequency of severe events has increased over the last fifty years.

Figure 1: November 2006 floods in the normally arid desert of western Afghanistan

30 October 2006 — 17 November 2006

At least 56 people were killed and thousands of hectares of farmland were washed away during this flooding in arid western Afghanistan. The dried-up beds of the Farah and Khash Rivers and their tributaries on 30 October 2006 turned into flood plains (in turquoise) less than three weeks later on 17 November 2006.

Source: NASA Earth Observatory and Reliefweb 2006

Source: Reuters/The Bigger Picture

On 25 August 2006 a boatman repairs his craft on the dry bed of the Jialing River that joins the Changjiang (Yangtze) River in Chongqing municipality.

Box 1: Anomalous patterns in Indus Valley Basin Glaciers

The Himalaya Mountains contain high altitude glaciers that supply water to many of Asia's major rivers. The Syr Darya and Amu Darya supply water to much of Central Asia, while the Huanghe, Changjiang (Yangtze), Red, Mekong, Salween, Brahmaputra, Ganges, and Indus Rivers provide water to more than half of the world's population.

Throughout much of Asia, people depend heavily on glacial melt-water for their main dry season water supply. Currently, this water is supplied gradually to downstream users—including hydroelectricity generating plants—as ice and snow pack melt over the warm months. But in a warmer world problems of water scarcity will be exacerbated. Rising temperatures will add glacier melt to snowmelt, increasing flooding during planting season. They will also lead to less winter precipitation being stored as snow. Dry season flows of water will be reduced and crop production will be affected.

According to monitoring data, temperatures in the mountain and high plateaus are rising and most glaciers are rapidly retreating. In Nepal and Bhutan, melting glaciers are filling glacial lakes beyond their capacities, resulting in outburst floods. Tibet's glaciers have accelerated their rate of melting since the 1990s. According to China's foremost glaciologist, Yao Tangdong, most glaciers in the Himalaya region of Tibet could melt by 2100, causing ecological catastrophe.

However, in the western extremes of the Himalaya, along the Karakoram and Hindu Kush ranges, scientists have recently detected some contrasting trends. According to an analysis of data collected for the Upper Indus Basin from 1900 to 2000, winters since 1960 have been warmer and summer temperatures cooler in the basin. At the same time winter and summer precipitation has increased. The lower summer temperatures produce a downward trend in runoff because the winter accumulation is not melting away quickly. Glaciers are gaining volume and mass. The researchers have found similar tendencies in parts of northwest India and in some of Nepal's lower altitudes, as well as in northern parts of Pakistan and the Wakhan Corridor of Afghanistan.

Scientists suggest this cooling may be related to shifts in large scale atmospheric circulation patterns in Asia and feedback related to the Indian monsoon. The implications for water resources in the Indus valley are complex but researchers anticipate that understanding climate variability at these smaller scales will lead to better forecasting of water supply over the short and long terms.

Sources: Barnett and others 2005, USGS 2005, Cyranoski 2005, UNESCO 2006, Fowler and Archer 2005, Fowler and Archer 2006

Evidence of glacio-lacustrine deposits and recent tree growth at the foot of an old slope collapse, Karakorum Range, Pakistan

Source: Karl Schuler/ Mountain Forum

BIODIVERSITY CONSERVATION INITIATIVES

Many Asian governments recognize the value of biodiversity conservation and actively support surveys to document diversity and programs to protect biodiversity-rich areas. The Asia Pacific region has made progress in protecting natural areas **(Box 4)**. The ratio of protected area to surface area in the region increased from 7.4 per cent in 1990 to 10.6 per cent in 2006 (GEO Data Portal 2006 based on UNEP-WCMC). In 2006, the World Heritage Convention inscribed Khao Yai National Park in Thailand and Shiretoko in Japan as World Heritage sites (IUCN 2006a). Two natural forest areas in central Laos were also certified under the Forest Stewardship Council (FSC) Certification scheme in 2006 (WWF 2006).

In May, Australia announced 58.5 million hectares of new protected zones—a total area as big as the State of Victoria—included in 13 new marine protected areas. Currently, about one-third of the world's marine protected areas are in Australian waters (DEH 2006). Despite these new additions, there is considerable scope for improvement in regional efforts to protect the marine environment—marine protected areas have advanced only modestly from 1.6 per cent of the territorial area in 1990 to 2.2 per cent in 2006 (GEO Data Portal 2006 based on UNEP-WCMC).

The wealth of the region's biodiversity was further documented in 2006. In February, Conservation International (CI) announced the discovery of dozens of new species during a biodiversity survey of Western New Guinea's Foja Mountains. The expedition—co-sponsored with the Indonesian Institute of Science and including scientists from Indonesia, the United States, and Australia—documented a rhododendron with a six-inch wide flower, four new species of butterflies, and 20 new kinds of frogs. The scientists spotted the first

Box 2: Water Issues in China

In 2006 more than 17 million people and 16 million livestock suffered drinking water shortages in southwest China, caused by drought. Estimates indicate that at least 1.3 million hectares of agricultural land in the Sichuan Basin, which includes Chongqing municipality, suffered drought effects and another 280 000 hectares of crops were destroyed. Crop losses cost the region more than US$1 billion, with some estimates putting losses as high as US$2.43 billion. Levels of the Changjiang (Yangtze) River near Chongqing were at a 100-year low during the drought, and reservoirs that supply Chongqing's water were only one-third full, leaving 7.9 million of the city's 31 million inhabitants without adequate drinking water.

In China, urban water supplies have deteriorated in step with booming economies. In a survey of 600 Chinese cities, two thirds had inadequate water supplies and 1 in 6 had severe water shortages. Industrial and domestic wastes are insufficiently treated before entering the surface water so the quality of surface water has become a serious problem. A survey of seven major rivers in the country found that nearly one third of the river section samples registered the worst grade possible of national water quality standards, indicating that the water supply in these sections is of very poor quality and has no practical use, not even for irrigation.

Chinese policy makers recognize the gravity and complexity of their environmental problems and have formulated policies to protect the environment while fostering economic growth. Strengthening water conservation is one of the top priorities set out by the Chinese Premier for environmental protection: others include controlling water, atmospheric, and soil pollution; enhancing protection of ecosystems; adjusting the economic structure to be more environmentally sound; and boosting the environmental technology and protection industry.

Sources: Xinhua 2006, Li 2003, SEPA 2005, Shao and others 2006, Wen 2006

The "Giant White" Rhododendron, a species yet to be described, is the largest rhododendron species in the world.

Source: Wayne Takeuchi/ Conservation International

A new species of honeyeater was discovered in the Foja Mountains of Papua province, Indonesia, on the island of New Guinea.

Source: Bruce Beehler/Conservation International

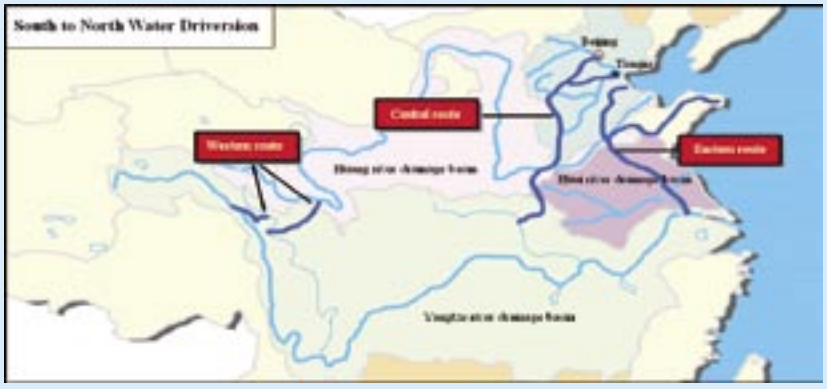
live male Berlepsch's Six-Wired Bird of Paradise (*Parotia berlepschi*) ever seen and an orange-faced honeyeater, the first new bird discovered on the island of New Guinea since 1939 (CI 2006a).

The Indonesian government has already designated the region a wildlife sanctuary and CI is working with government officials and the people within the greater Mamberamo Basin, which includes the Foja Mountains, to preserve the area's incredibly diverse wildlife (NPR 2006).

Two more surveys led by Conservation International in 2006 documented the marine biodiversity of the Bird's Head Seascape, off the northwestern end of Indonesia's Papua province. This part of the 'Coral Triangle' includes more than 1 200 species of fish and almost 600 species of reef-building coral—75 per cent of the world's known total. Only 11 per cent of the seascape is currently protected, most of it in the Teluk Cenderawasih National Park (CI 2006b).

The three surveys are part of CI's Rapid Assessment Program, an initiative to document forest and marine sites around the world to inform and promote knowledge-driven conservation. The collected data supports priority-setting, definition of conservation outcomes, and decision-making by local stakeholders and leaders (CI 2006c).

Box 3: Supplying water to the thirsty



Source: Li Qiangzi / Chinese Academy of Sciences

Over 80 per cent of water runoff in China takes place in the south, while the north—with 37 per cent of the country's total population and 45 per cent of cultivated land—has only 12 per cent of China's total water resources. The colossal South to North Water Diversion Scheme will shift water across great distances to supply drinking and irrigation water to China's northern regions where 96 million people now lack adequate water supplies, according to Chinese government estimates. The project involves creating three canal systems linking the country's four major rivers—the Changjiang (Yangtze), Yellow, Huaihe, and Haihe—and is expected to take 50 years to complete.

In July of 2006, construction of a tunnel was completed linking canal sections on either side of the Caohe River. The canals and sub-river tunnels run between pumping stations, reservoirs, and dams. According to the long term plan, two more phases of the scheme—a central route running from the Three Gorges Dam reservoir and a western route delivering water from Tibet—will add to the eastern supply by 2050, altogether transferring a total of 44.8 billion cubic metres of water northward every year.

Critics of the scheme are concerned about ecosystem destruction and contamination from pollution. To counter pollution in the first phase alone, around 130 sewage treatment plants will be established as well as a series of supporting activities that include 149 industrial pollution control projects, 21 polluted water diversion schemes, and 16 comprehensive pollution control initiatives. Health concerns loom over the possible spread of schistosomiasis when the channels all connect. The snails that carry schistosome flukes are endemic to the Changjiang (Yangtze) River in Jiangsu Province—the southeastern source of the scheme's first phase. Public health officials are advising on preventive measures to control the spread of the snails when the water flows.

The official release of the western leg project proposal was scheduled for the end of 2006. Regional scholars and engineers recommend further inquiries addressing concerns about geology, ecology, and the environment; the Qinghai-Tibet Plateau and its shrinking glaciers; the volume of water to be transferred; influence of the transfer on electricity supplies; relocation and protection of people and cultural relics; compensation to residents; and fundraising.

Sources: Chinapage 2006, Stone and Jia 2006, Liu 2006, China Daily 2006, China Newsweek 2006

Box 4: Fijians honoured with conservation award

Fijian Prime Minister Laisenia Qarase and Paramount Chief Aisea Katonivere of Fiji's Macuata province on the island of Vanua Levu received the second annual Global Ocean Conservation Award on World Ocean Day, 8 June 2006.

They were honoured for their work ensuring that at least 30 per cent of Fiji's inshore and offshore marine areas will be effectively managed and financed within a comprehensive and ecologically representative network of marine protected areas by the year 2020.

Last year Palau, the Federated States of Micronesia, the Marshall Islands, Guam, and the Northern Mariana Islands matched Fiji's pledge to protect 30 per cent of near-shore marine resources and 20 per cent of terrestrial resources on their islands by 2020. Inspired by this 'Micronesia Challenge', the Caribbean island of Grenada pledged in March of 2006 to put 25 per cent of its near-shore marine resources under effective conservation by 2020.

Source: IUCN 2006b

Regional Biodiversity Conservation

One of the most ambitious multilateral biodiversity conservation projects in the world is taking shape in the Greater Mekong Sub-region (GMS), comprised of Cambodia, Laos, Myanmar, Thailand, Viet Nam, and China's Yunnan Province. Home to more than 300 million people, the sub-region's vast wealth of human and natural resources marks it as a new frontier for economic growth in Asia.

The GMS Biodiversity Conservation Corridors Initiative promotes biodiversity conservation as an important component of economic development and endorses sustainable use of natural resources. By 2015, GMS countries plan to establish nine priority biodiversity conservation landscapes and corridors. Core aims of the initiative include maintaining the quality of ecosystems through enhanced connectivity while restoring and protecting ecological integrity. At the same time, the initiative intends to ensure sustainable use of shared natural resources, reduction of poverty, and improvements in the livelihoods of people (ADB 2005, ADB 2006).

CONCLUSIONS

Reconciling economic development and conserving nature is a challenging but essential goal of sustainable development. Rapid economic development is a key factor responsible for environmental challenges faced by the region. But that same economic development can provide resources and motivation to drive environmental policy formulation and implementation, especially on the use of scarce resources and conservation.

The Mekong Basin provides ecosystem services, transportation routes, resources—and a location for floating markets like this one in Can Tho, Viet Nam.

Source: Jean-Léo Dugast / Still Pictures

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Europe

Growing concern over climate change and energy security dominated the political agenda in Europe in 2006. Urban air quality has much improved in the region, but air pollution continues to have serious adverse health effects.

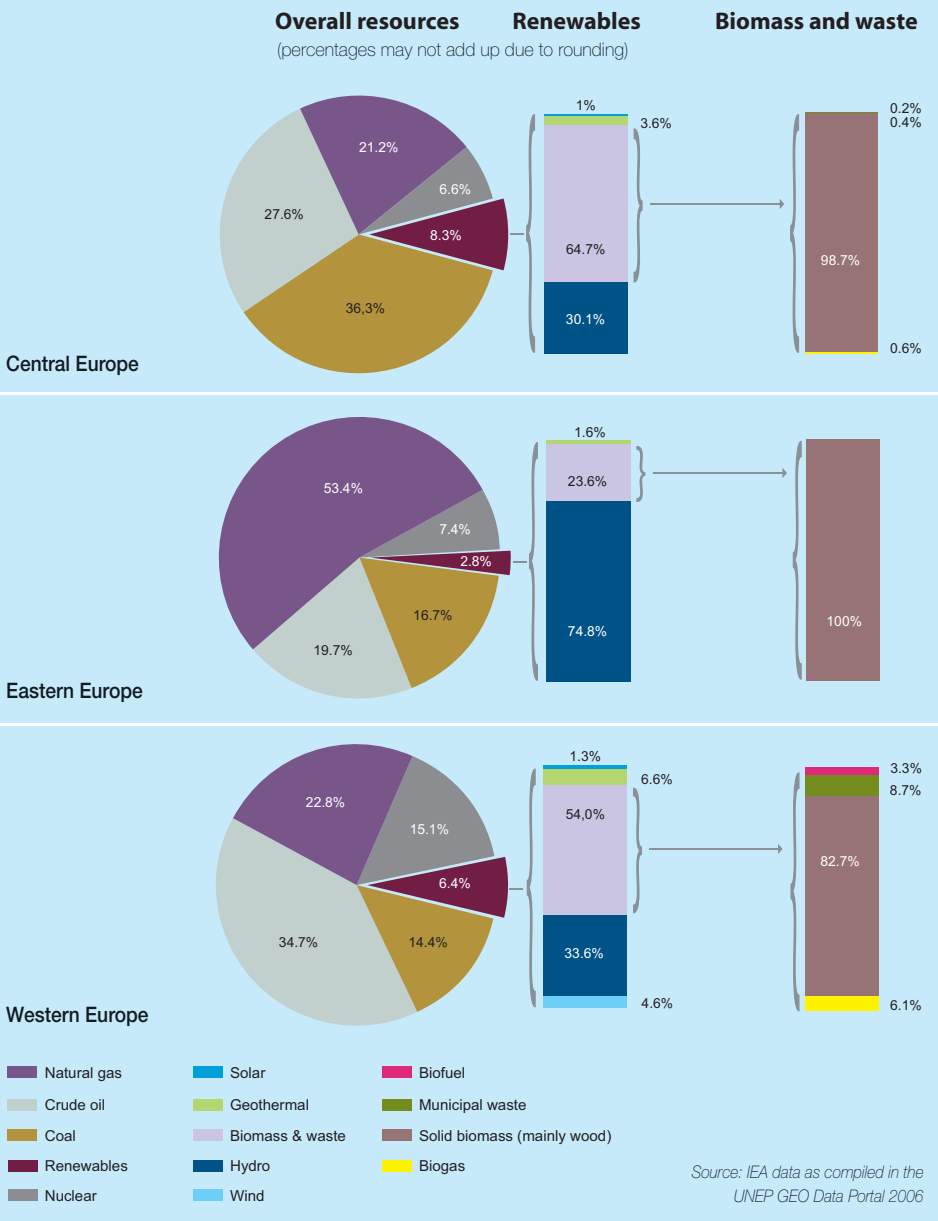
ENERGY SECURITY

Despite clear energy efficiency improvements, the whole of Europe continues to release increasing amounts of greenhouse gases (GHGs) and air pollutants, putting serious pressure on Europe's environment, economies, and human health (EEA 2006a, EEA 2006b, Kowalski 2006). Nearly 80 per cent of the energy consumed in the European Union comes from fossil fuels, as does over 85 per cent in Central Europe and 90 per cent in Eastern Europe **(Figure 1)**. These fuels are expected to dominate Europe's energy sources in coming decades (EC 2006a, IEA 2006a, Kowalski 2006). Fossil fuel dependence is a growing concern in Europe—perceived as reponsible for problems with energy security; climate change effects such as extreme weather events and sea level rise; and other problems such as generation, oil spills, and health problems from air pollution (EEA 2006a, EEA 2006b, Kowalski 2006, WHO 2006a).

The energy security context varies considerably within Europe. The European Union (EU-25) imports 50 per cent of its energy requirements, while Russia is the world's second largest exporter of oil and the world's largest exporter of natural gas (EEA 2006b, IEA 2006b). The potential for energy resource scarcities over the long term causes some concern among analysts—more so for oil and natural gas, less so for coal and uranium. Other major concerns are soaring energy prices, power disruptions due to extreme weather events, effects of climate change and air pollution on environment and human health, and potential threats to supply—a concern heightened by Russia's early 2006 interruption of gas supplies to the Ukraine pipeline network, which also supplies several Western European countries **(Box 1)**.

Although changes in Europe's fuel mix have slightly reduced emissions of GHGs per unit of energy produced, total GHG emissions are rising again. This is mainly caused by increasing use of coal for electricity production—a reaction to rising gas prices (EEA 2006b, EEA 2006c, Kowalski 2006). In addition, energy efficiency gains are largely offset by the continuous growth in total energy consumption, particularly in the EU-25, but also in Southeastern and Eastern Europe where consumption is rising (GEO Data Portal 2006). Energy production and consumption are major sources of GHG emissions and air pollution, but they are key to economic growth. Therefore, many European governments are in the process of revising their energy policies to better balance energy security, economic efficiency and competitiveness, and environmental acceptability by seeking to diversify the energy mix and energy supply routes among other options **(Box 2)**.

Figure 1: Energy consumption in Europe



Source: IEA data as compiled in the UNEP GEO Data Portal 2006

Box 1: European energy security issues, objectives, and policy priorities

This box summarizes some of the major issues involved in the energy security debate and lists various objectives and policy priorities proposed by authors and institutions.

Issues
- Continually increasing energy consumption
- Environmental degradation
- Unreliable energy supply and fluctuating prices
- Disruptions and uncertainties due to terrorism, social unrest, price disputes, and natural disasters.

Objectives
- More efficiency in energy production and consumption
- More environmentally sound technologies
- More diversity in energy mix and supply
- Reduced vulnerability through safer energy infrastructure (pipelines, refineries, electricity networks) and better emergency preparedness
- Sufficient levels of environmental and human health protection
- Long term reliability and availability of energy at reasonable prices
- Reliable access for producers to resources, markets, and consumers to justify future investment.

Policy priorities
- Stimulate technological innovation in energy efficiency and low carbon energy
- Promote a radical change in public attitudes towards drastic energy savings
- Tighten free credits, include more sectors in the EU Emission Trading Scheme, and expand UNFCCC projects under the Clean Development Mechanism
- Foster partnerships among energy-producing and energy-consuming countries so that supply sources and routes can be diversified and procedures agreed for sharing strategic emergency reserves
- Enable stable investment regimes through liberalized markets.

Sources: Yergin 2006, EC 2006a, EC 2006b, Howell of Guildford 2006, IEA 2006c , MNP 2006, NEA 2005, Kowalski 2006

Europe's coal reserves are abundant, readily accessible, and prices are stable, so coal remains an important fuel for electricity generation and heavy industries, despite the high levels of GHG emissions and air pollutants resulting from its use (EC 2006a, EC 2006b, Kowalski 2006). Capturing and sequestering carbon instead of emitting it to the atmosphere is seen by many as a promising technology to reduce GHG emissions and air pollution.

Opinions about the use of nuclear energy are shifting. Electricity is generated from 204 nuclear units in 19 European countries spread across the region, and uranium resources are considered adequate and widespread. Since the energy generated is carbon free and stockpiles can be maintained at reasonable costs, some countries such as the United Kingdom are reconsidering nuclear energy as a potential measure to reduce GHG emissions (NEA 2005 and 2006). Other countries such as Germany and Sweden are still phasing out nuclear energy, while others are building new units—ten are under construction in Bulgaria, Finland, Romania, Russia, and Ukraine (IAEA 2006). However, there are still serious public concerns and political debate about nuclear energy, especially over the disposal of nuclear wastes and the potential for accidents. These concerns, along with the problems of ageing of most European nuclear units, high investment costs, and long construction times, have prompted recent energy outlooks to project a slight nuclear reduction in Europe (EC 2006a, IEA 2006a).

Another promising option for diversifying Europe's energy mix is commercialization of renewable energy. Total renewable energy supply remains low in Europe, but there is considerable variation among countries. Some countries have achieved real increases and much higher percentages of energy from renewable sources. The share of renewable energy in the EU-25's electricity generation averages at 12.8 per cent, but nine countries including Belgium, Hungary, Poland, and the UK get less than 3 per cent from renewables while Austria, Latvia, Portugal, and Sweden get 35 per cent or more of their energy from renewable sources (Eurostat in EEA 2006b). Wind energy is virtually absent in Central and Eastern Europe, while Western Europe has 69 per cent of the world's total installed capacity of wind energy (REN21 2006). Overall, wind turbines supply only 2.5 per cent of Europe's current electricity demand (IEA 2006d).

Recently, promising renewable energy policies have been established, such as the EU-25 Biomass Action Plan and subsidies in favour of renewables in Denmark, Germany, and Sweden. Some new technologies are also showing promise. Today's wind turbines produce 180 times more electricity than 20 years ago at less than half the cost per unit. The International Energy Agency (IEA) projects that the share of renewable energy sources (excluding hydropower) in the EU will grow from 5 per cent in 2004 to 19 per cent in 2030, or 24 per cent in that same year if policies currently being considered to promote renewable energy are actually and fully implemented (EC 2005, Greenpeace 2006, IEA 2006a).

Progress towards a more energy-sustainable Europe will depend on improved energy efficiency achieved through a wide variety of innovative policies and technologies. Action should focus on replacing or decommissioning ageing coal and nuclear installations and introducing radical innovations in fuel switches, energy efficiency, carbon storage, and low carbon and carbon free technologies. All options need to be considered and large investments will be required to further research, develop, and exploit viable new

Box 2: The Baku-Tbilisi-Ceyhan oil pipeline inaugurated

In May 2006 the Baku-Tbilisi-Ceyhan (BTC) oil pipeline became operational. This 1 770 kilometre pipeline, with a capacity of 1 million barrels per day, runs from Baku, Azerbaijan through Georgia to Ceyhan on the Mediterranean coast of Turkey. The pipeline was commissioned by a consortium of 11 energy companies led by BP (formerly British Petroleum), which has a 30.1 per cent stake and operates the pipeline.

The pipeline will provide Caspian countries, Azerbaijan and Kazakhstan in particular, with adequate infrastructure for their growing oil shipments to international markets. It will advance EU efforts to diversify sources and routes of energy supplies and it will also eliminate some 350 tanker cargoes per year through the sensitive Bosphorus and Dardanelles straits that are dangerously congested by oil traffic. However, environmental concerns range from the threats to watersheds of the Borjomi National Park in Georgia (an area of mineral water springs that are a major export commodity) to the dangers posed by frequent and strong seismic activity throughout the region. The pipeline management is convinced that the environment of the three nations will be maintained through adherence to three separate environment and social impact assessments, very careful construction procedures, and community and environmental investment programmes (BP 2006).

Sources: EU 2006, BP 2006.

In Europe, woody biomass is by far the largest renewable energy source.

Source: Oed / Still Pictures

The full potential of wind energy is yet to be realized.

Source: Mike Schroeder / Still Pictures

technologies (EEA 2006b, IEA 2006a, MNP 2006). The new EU Emissions Trading Scheme (ETS) is expected to stimulate investment in emission reduction technologies **(Box 3)**. In addition, regulatory policy tools need to be considered, such as stricter ETS credits, licensing, information campaigns, energy-efficient labelling, and improved insulation standards for buildings.

Box 3: EU's Emissions Trading Scheme

The Emissions Trading Scheme (ETS) of the EU, launched in 2005, is the world's first market for buying and selling the right to emit CO_2. The scheme is the EU's key instrument to fight climate change and meet its Kyoto targets; it is seen as a more business-friendly way to reduce production of GHGs than taxes. Under the scheme, EU countries have set mandatory limits on how much CO_2 power plants and heavy industries may emit at country level. Companies receive a quota of free carbon credits allowing them to emit CO_2 up to that limit. If they emit less they can sell their credit surplus, but if they exceed it they have to buy credits from others.

In April this year the carbon credit reached its highest value (around US$40). However, when the first national emission reports were delivered in mid-April, it became clear that the allocation of credits had been too generous in the first phase of the scheme (2005-2007). Most companies had more credits than they needed, leading to a dramatic drop in carbon prices which fell below US$13 per metric ton in May.

To enhance the effectiveness and environmental benefits of the EU Emissions Trading Scheme, the European Commission urged Member States to present tougher credit limits in their National Allocation Plans (NAP) for the second trading period (2008-2012). The Commission is also examining the need for changes in the trading scheme. Legislation has been proposed to include the aviation sector and its implications are under study. The NAPs establish emission totals for different sectors and decide how the total is divided among installations covered by the scheme. Some countries have included more installations or more GHGs, others have not. Many countries have been late in submitting their NAPs.

In August ETS prices recovered to a level nearing US$26. In November the European Commission approved a first set of ten National Allocation Plans for the 2008-2012 trading period, provided that for nine out of the ten plans the emission allowances are reduced (only the emissions proposed by the United Kingdom were accepted). By 10 December 2006 the CO_2 prices had dropped to about US$10.

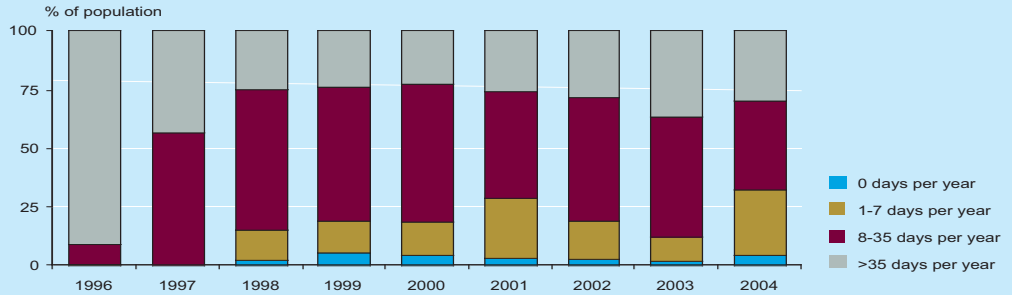
Source: EEA 2006c

URBAN AIR POLLUTION

Air quality has improved significantly in Europe over the last decades, due mainly to drastic policy measures at national and EU levels and the impact of the pan-European UNECE Convention on Long-Range Transboundary Air Pollution (EEA 2006a, EEA 2006e, EMEP 2006, UNEP 2006). In Western Europe and a significant proportion of Central Europe the air quality limit for sulphur dioxide, established by the EU, is now rarely exceeded—attributable to relatively simple measures such as switching to fuel with lower sulphur content or installing equipment in coal power stations to remove sulphur dioxide from stack emissions. However, improvements in emission trends are beginning to plateau. By 2020, sulphur emissions from international shipping on seas surrounding Europe are expected to be larger than the total land-based emissions in the EU-25 (Acidrain.org 2006). And evidence mounts that air pollution, ground-level ozone, and particulate matter (PM) continue to have serious adverse health effects **(Figure 2)**.

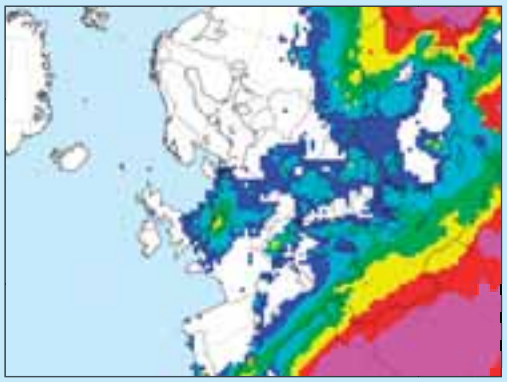
Recent World Health Organization (WHO) calculations show that current levels of PM reduce life expectancy by 8.2 months in the EU-15 and 10.3 months in the 10 new member states. In the EU-25 some 348 000 premature deaths per year are attributed to PM exposure. Effects are three times higher in hot spots polluted by traffic and heating emissions than in the least polluted areas (WHO 2006a). Effects of long term exposure to air pollution on life expectancy are thought to be mostly attributable to fractions of PM smaller than 2.5 micrometres ($PM_{2.5}$) (WHO 2006a). A new modelling report of the Environmental Monitoring, Evaluation, and Protection Programme (EMEP) shows that many major European cities are hotspots with daily and annual mean $PM_{2.5}$ concentrations that far exceed the WHO guidelines for PM, which are more stringent than the EU limits (EMEP 2006). The WHO guidelines are also exceeded in large areas outside Europe's highly populated urban areas, due to long-range transport of small particles **(Figure 3)**. Fine

Figure 2: Population in Western and Central Europe living in urban areas where concentrations of particulate matter under 10 micrometres exceed the daily EU limit



Source: EEA 2006e

Figure 3: Areas exceeding WHO guidelines for particulate matter air pollution

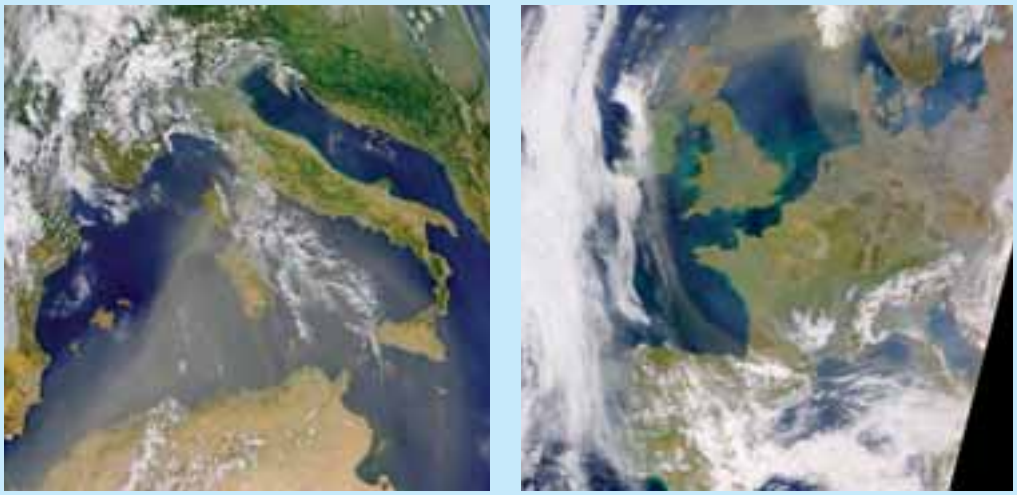


Annual mean concentrations of $PM_{2.5}$ as calculated for 2004. Only grid cells with values higher than the guideline value (10 µg/m³) are shown in colour

> 70 µg/m³
31 – 70 µg/m³
21 - 30 µg/m³
16 - 20 µg/m³
13 – 15 µg/m³
10 - 12 µg/m³
< 10 µg/m³

Source: EMEP 2006

Box 4: Desert dust from Africa travels far into Europe



The left-hand true-colour image from 19 August 2004 shows a large plume of Saharan dust (light brown) blowing northward over the Mediterranean Sea, partially obscuring the islands of Corsica, Sardinia, and Sicily. The right-hand image from 16 April 2003 shows how far north the dust can be transported. Here a long trail of dust from Africa (light brown) can be seen arcing to the northwest over southern France, stretching north over the Atlantic Ocean and across Ireland and Scotland, continuing eastward to Sweden and Norway, and then turning south to Denmark.

Source: SeaWiFS Project, NASA/Goddard Space Flight Centre, and ORBIMAGE

dust and other small particles can be transported over thousands of kilometres and affect people living far from the actual pollution source, as shown in satellite images (Box 4).

Until now, air quality and related health policies have focused mainly on end-of-pipe measures. These will continue to be important, but more action is needed at local, national, and international levels to reduce air pollution at the source, for example through energy savings and low-carbon technologies in the energy and automobile industries (WHO 2006a, MNP 2006, EEA 2006d).

Street-level air pollution is still causing too many health problems

Source: argus/Still Pictures

CHALLENGES

Measures to improve air quality have had significant co-benefits in reducing GHGs, just as efforts to combat climate change can reduce local air pollution. The key environmental policy challenge for Europe is to develop and implement more integrated policy frameworks, in which climate change objectives largely coincide with air quality aims while achieving substantive cost savings (EEA 2006d, MNP 2006). Such integrated policies may receive more public support, as local air quality has so far been more relevant for voters than climate concerns.

More research and technology development is needed on energy supply efficiency, including more environmentally sound energy systems. Innovative technology and stronger corporate responsibility could be stimulated by introducing more stringent vehicle emission standards, raising energy prices so that they reflect the external costs of climate change and air pollution, and information campaigns to promote radical change in public attitudes towards energy consumption.

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Latin America and the Caribbean

In 2006, disputes continued over nature conservation and economic development issues. While global demand for biofuels may lead to the transformation of large tracts of natural areas, innovative schemes have been initiated to reconcile economic growth with environmental concerns.

NATURE CONSERVATION VS ECONOMIC DEVELOPMENT

Intense use and export of natural resources have dominated the economies of the Latin America and the Caribbean (LAC) region. Pressures on natural resources depend not only on national needs and consumption patterns, but also on demands from global markets.

In 1992, practically all LAC countries embraced the environmental agreements from the Rio Declaration and their subsequent protocols, aiming for the protection and sustainable management of natural capital (ECLAC 2001) (Box 1). However, over the last few years internal social and external economic pressures have forced some governments to shift their emphasis and efforts from nature conservation to large revenue-generating projects. Recent examples demonstrate how this shift can lead to conflicts between nature conservation and economic development, pitting local communities against corporate interests and sometimes one country against another.

Botnia's pulp mill under construction in Uruguay.

Source: Metsa Botnia

Pulp mills on the Uruguay River

ERRATUM:

The planned construction of the two pulp mills on the banks of the Uruguay River, the natural border between Argentina and Uruguay, led to acute tension between the two countries and is a source of a dispute being currently substantiated before the International Court of Justice.

Civil opposition to the projects started in Gualeguaychú, an Argentinian town across the river. Argentina claims that these plants were authorized in violation of a bilateral treaty, the 1975 Statute of the Uruguay River, and will cause significant environmental and health impacts. Uruguay rejects those claims. As of 31 December 2006 the conflict continues.

Pascua-Lama: conflict over gold-mining

The Pascua-Lama mining project involves open-pit mining in the high Andes Mountains (Figure 1). Located on the Chilean-Argentinean border, approximately 150 kilometres southeast of Vallenar, Chile, Pascua-Lama has stimulated controversy and public protest in Chile and internationally (Universidad de Chile 2005). The mineral fields contain vast deposits of gold and silver, with 75 per cent of the fields in Chile and 25 per cent in Argentina. The mining and processing of ore proposed by the Barrick Gold Corporation will straddle the two countries. With a planned investment of US$1.5 billion over an initial 20-year period, the project would create some 5 500 jobs during construction and 1 660 jobs during full production (Barrick 2006).

The fields lie close to two glaciers that feed the rivers of Chile's Huasco Province. Critics of the project claim that it will involve the removal of these glaciers, disrupting the water supply of the 70 000 farmers in the Huasco valley (Gonzalez 2006, MineWeb 2005). They say that mining operations will release cyanide and other contaminants into the valley's rivers and that the project represents only temporary economic benefits for the zone. In November 2005, a petition was presented to the Chilean government by a coalition of environmentalist groups.

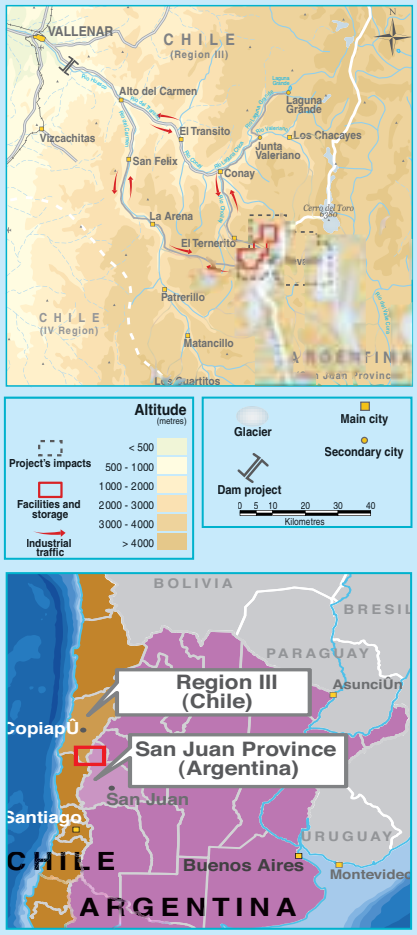
The Barrick Gold Corporation maintained that the project was environmentally sound in terms of water treatment and that only five hectares of 'ice reserves' would be directly removed by its operations. In addition to stimulating the local economy, the project would also support development projects (Torres 2006).

In Chile, an environmental impact assessment of the project was approved by the regional environment authority, Comisión Regional del Medio Ambiente (COREMA), in 2001. Since then, the project inspired extensive public debate, was suspended a few times, and was subject to several modifications before it was finally approvedl in 2006 by the Chilean national environment commission, CONAMA (Minería Chilena 2006).

Figure 1. Pascua-Lama mining project

The Pascua-Lama mining project will use open pit techniques at altitudes over 3 000 metres with facilities built at the base of vital glaciers that supply water to lowland farms as well as to Vallenar, a city of more than 40 000 inhabitants in the Atacama desert.

Source: GRID/Geneva



Box 1: Deforestation on the retreat

After decades of rampant deforestation, reports suggest that the overall forest decline in Latin America and the Caribbean may be slowing. In 2000-2005 net forets area loss in the LAC region was running at an average of 4.74 million hectareas per year—37 per cent of the global total for countries with a net loss of forest area. The vast majority of these losses occurred in South America, where Brazil alone accounted for over 70 per cent of the regional total.

However, recent studies suggest that forests are recovering in Puerto Rico and the Dominican Republic. In El Salvador, a survey of all types of forest and woodlands revealed that land with more than 25 per cent tree cover expanded from 72 per cent of the country's total area in 1992 to 93 per cent in 2001.

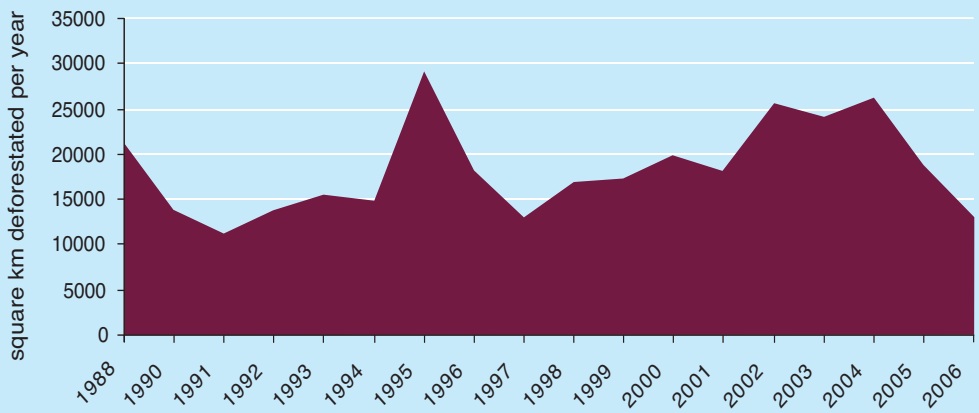
In 2004 the Brazilian government put in place the Amazonia Protection Programme, which includes measures for detailed monitoring and improved law-enforcement against illegal loggers and land developers. Thanks to the programme, deforestation in Amazonia has decreased substantially—from 2.6 million hectares in 2004 to 1.9 million hectares in 2005. Preliminary results for 2006 indicate a further reduction to 1.3 million hectares.

Until 2004, Paraguay had one of the highest deforestation rates in the world. In November of that year, the Paraguayan Congress passed the Zero Deforestation Law, prohibiting the conversion of forested areas in the Upper Parana Atlantic Forest. Implementation of the law has reduced the deforestation rate in Paraguay's Eastern Region by 85 per cent. The Zero Deforestation Law has resulted in lawsuits and convictions against landowners for punishable acts of deforestation.

In December of 2006 the governor of Brazil's Pará state signed decrees for the creation of seven new conservation areas in the Amazon, including the largest strictly protected area ever created in a tropical forest, the 4.25 million hectare Estação Ecológica Grão-Pará. The seven new protected areas total about 15 million hectares. Two are under strict protection allowing only conservation and research—these two alone may house 54 per cent of all animal and plant species found in Amazonia. The other five are designated for sustainable use, where activities such as timber and non-timber forest product extraction, ecotourism, and controlled mining will be permitted to supply the needs of local communities.

Sources: Aide and Grau 2004, Conservation International 2006a and 2006b, Derivi 2006, FAO 2006a, Forests.org 2002, GEO Data Portal 2006, Government do Pará 2006, Hecht and others 2006, INPE 2006, Laurence and others 2001, WWF 2006

Deforestation rates in the Brazilian Amazon 1988-2006 km²



Source: INPE 2006

In its resolution, CONAMA set strict measures to eliminate, mitigate, or prevent the negative environmental impacts that the project might cause. It stresses that the glaciers must not be removed in any way and that any pollutants dumped into water courses must not exceed national emission and quality standards. The company has also negotiated with the Huasco Valley's farmers and reached agreements on compensation related to the Valley's water supply. The Barrick Gold Corporation resumed operations in September 2006, with mining scheduled to begin in 2009.

BIOFUELS AND THE ENVIRONMENT

In 2006 a sharp increase in oil prices once more brought attention to energy security. Several Latin American and Caribbean countries—Argentina, Bolivia, Colombia, Ecuador, Mexico, Trinidad and Tobago, and Venezuela—are net oil exporters and they benefit from high prices. However, projections show that demand for oil will continue to increase, regardless of price. This will induce further pressure for oil exploration and development, with all their environmental consequences. It will also increase the attraction of alternative energy sources (IEA 2006).

In the face of high oil prices, many developing countries have discovered a new product for their crop-based economies: biofuels. In Brazil alone, projections estimate that in the next eight years the national and international combined demand for sugar cane and ethanol will grow from 354 to 553 million metric tons (Ministério da Agricultura 2006a). By 2030 the Brazilian government expects to produce about 120 million metric tons (petroleum equivalent), double the current total (Ministério da Agricultura 2006b).

Ironically, the pursuit of markets in 'environmentally sound' biofuels may lead to the destruction of large tracts of natural habitat. The area planted to sugar cane and soy (for ethanol and biodiesel, respectively) will need to increase. Governments in the region are already concerned about sugar cane plantations' severe effect on the environment (PNUMA/MARENA/OEA 2005, Guzman 2004).

In terms of biodiesel production, estimates indicate that Brazil would need 58 million hectares dedicated to soybean production to fully replace the diesel used currently. Ten million hectares of the Cerrado, one of the world's biodiversity hotspots, have already been planted to soy in the past 15 years, more than tripling the plantation area since 1990 (Kink and Machado 2005). Potentially the Cerrado has 90 million hectares available for biodiesel crops (Crestana 2005). The expansion of this agricultural frontier has already transformed 50 per cent of the Cerrado ecosystem into pasture and cash crops and taken more that 1.25 million hectares of forest between 2003 and 2004 in the state of Mato Grosso alone (Kink and Machado 2005, Schlesinger 2006). In Amazonia, the advance of soybean plantations poses an enormous threat (Fearnside 2005, Soares-Filho 2006) (See Feature Focus section).

Regional and global institutions are already weighing the potential negative impacts of biofuel development (Rios Roca 2006, FAO 2006b). Aspects under consideration include competition for land between fuel crops and food crops, excessive use of agrochemicals, concentration of production in a few large agribusiness enterprises, and lack of benefits for rural workers. These problems stimulated the Brazilian government to launch the "Social Fuel Label", a certification granted by the Ministry of Agrarian Development to biofuel producers who maintain standards that promote social inclusion and regional development.

South America's Cerrado is an expansive and diverse landscape of forest, wetlands, savanna, and hills. It is a biodiversity hotspot that is shrinking in the push for sugarcane and soybean production to produce biofuels.

Source: Jacques Jangoux / Still Pictures

Filling stations for cars fueled by alcohol are a common sight in Sao Paulo.

Source: Ron Giling / Still Pictures

CONCLUSION

Protection of natural capital continues to improve in the region of Latin America and the Caribbean **(Box 2)**. However, the challenges of balancing economic development with nature conservation will continue. In the long term view they do not have to be opposite forces but may be complementary, considering that natural capital sets the limits to economic growth and human development.

The environmental dimension needs to be mainstreamed into economic and social decision making. The pursuit of sustainable development involves evaluating the true economic cost of environmental degradation in terms of ecosystem service loss and building this into taxation and pricing policies and into national accounting systems.

Box 2 : Transforming Dominica into an organic island

The Commonwealth of Dominica is a small Caribbean island-state. Historically, Dominica relied on agriculture as the mainstay of the economy, particularly banana crop production for export. The spread of monocropping reduced crop diversity, increased vulnerability to natural disasters and fluctuations in international markets, and created dependence on food imports.

In an attempt to address effects of the declining banana industry and to diversify economically, Dominica explored the potential for a viable ecotourism industry. In 2004, the island became the first Caribbean country to obtain GreenGlobe21 certification as an ecotourism destination.

Since then, Dominicans recognized that low-impact, environmentally sound tourism could fit neatly with organic agriculture and that these two complement the concept of wellness or health maintenance. This trio could provide an ideal mix for sustainable use of Dominica's natural resources—and for a particular type of up-market holiday.

Dominica plans to embark on a 10-year programme of action to establish the country as an 'Organic Island' and wellness tourism destination, combining ecotourism, agrotourism, and health tourism opportunities into a high-end image of an unspoiled country. The concept is based on implementing organic production and marketing systems that are sustainable and that do not require excessive consumption of natural resources.

Among the main objectives of this strategic development are to:

- Establish a sound and sustainable basis for economic and social development;
- Reverse declining agricultural sector employment and increase other employment opportunities;
- Reverse the trend in decreasing agricultural revenue by establishing Dominica as a world leader in the production of organic agricultural products;
- Address pressing environmental and natural resource management issues through sustainable agricultural practices;
- Establish an agricultural export market based on products that are free from genetically modified organisms;
- Improve rural development through the establishment of improved land management practices supporting organic production.

Source: Government of Dominica 2006

Dominica wants to reposition itself as an island for ecotourism, health maintenance, and organic agriculture. *Source: Schafer & Hill/Still Pictures*

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North America

2006 was a mixed year for the environment in North America. The United States set aside the world's largest Marine Protected Area. Rising public concern about climate change motivated states and provinces to move ahead on mitigation initiatives, despite their federal governments' reluctance to cap greenhouse gas emissions.

FEDERAL GOVERNMENTS BYPASS KYOTO PROTOCOL

In per capita terms, North America emits far more carbon dioxide than any other region in the world, and in absolute terms is second only to much more populous Asia. Yet, at the end of 2006 neither the US nor the Canadian governments are engaged in the Kyoto process.

Canada ratified the Kyoto Protocol in 2002 and committed to achieve a 6 per cent cut in emissions over the 1990 level by 2012. However, between 1990 and 2004, total Canadian emissions grew by 26.6 per cent (EC 2006) **(Figure 1)**. Canada's Commissioner of the Environment and Sustainable Development, part of the Office of the Auditor General, released a report urging the country intensify its efforts to combat—and to prepare for—climate change (OAG 2006). The Commissioner noted that rising emissions from booming oil sands projects in the province of Alberta will compromise efforts to reduce overall emissions. The report spelled out some of the risks from climate change, including drought in the Prairies, rising sea levels, more intense coastal storms, and increased smog levels in cities. It called for a believable, clear, and realistic plan to significantly reduce GHGs with short and long term national goals, as well as for new targets and specific time frames for achieving them.

In 2006 Canada's new Conservative federal government recognized the country's inability to achieve the Kyoto Protocol's goals and responded by discontinuing 15 Climate Change action projects, with a promise to develop a new "Made in Canada" approach (Ambrose 2006, Isaacs 2006). On 19 October, Canada introduced its proposed new plan in the House of Commons **(Box 1)** (Conservative Party of Canada 2006).

In the US, total GHG emissions increased by 15.8 per cent between 1990 and 2004 (EPA 2006). Rather than impose national limits on emissions, the United States continues to support voluntary reductions, market-based approaches, and the development of new technologies. In this spirit, the United States with Australia, China, India, Japan, and the Republic of Korea founded the Asia-Pacific Partnership on Clean Development and Climate. The partnership's inaugural meeting in January 2006 established eight public-private sector Task Forces covering cleaner fossil energy, renewable energy and distributed generation, power generation and transmission, buildings and appliances, steel, aluminium, cement, and coal mining. Each task force was charged to develop an action plan identifying specific opportunities for co-operation, ambitious but realistic goals, and means of achieving them (APCDC 2006). The task forces released their plans in October 2006.

States and Provinces Take Action

Advocating stronger action, a coalition of 12 US States and several environmental NGOs sued the US Environmental Protection Agency (EPA) for failing to regulate carbon dioxide (CO_2) emissions from vehicles under the national Clean Air Act. Under the Act, the EPA must regulate emissions from mobile sources that endanger public health or welfare. In November 2006, the US Supreme Court heard arguments about whether the EPA is obliged to regulate CO_2 and other GHG emissions, and whether the plaintiffs have legal standing to bring the case. The ruling, expected in 2007, could have significant consequences for US climate change policy (Marshall 2006, Commonwealth of Massachusetts v. Environmental Protection Agency 2006).

In the meantime, lower tiers of government continued to make progress in regulating carbon emissions in 2006 **(Box 2)**.

Box 1: Canada's new approach to climate change

The Conservative government proposed a new Clean Air Act as the centrepiece of Canada's green agenda. The Act will allow the setting of short, medium, and long term upper limits for emissions of air pollutants, which polluters will be compelled to respect. The aim is that these fixed targets will be at least as stringent as those in countries that are environmental leaders.

For greenhouse gas (GHG) emissions, short term targets will be set based on intensity which encourages efficiency but allows emissions to grow if output grows, an approach used in the United States Global Climate Change Initiative of 2002. There will be a longer term goal of cutting GHG emissions by 45 per cent to 65 per cent of 2003 levels by 2050. No mention is made of Canada's Kyoto commitments.

Opposition parties and environmental groups agree with a number of elements in the Act, but have been critical of the very long deferment of GHG emission limits and the lack of a compulsory timetable for cutting GHG emissions. They also note that some toxic substances are re-defined as 'air pollutants', which may weaken powers of regulation, and suggest that some of the measures are already covered in the existing Canadian Environmental Protection Act. Since the government does not command a majority of seats in Parliament, the Act may not pass into law without major revisions.

Sources: Government of Canada 2006a and 2006b, Bueckert 2006, David Suzuki Foundation 2006, Environmental Defence, Pollution Probe and Clean Air Foundation 2006, USEIA 2003).

Table 1: Carbon dioxide emissions 1990-2003 (million metric tons of CO_2)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GLOBAL VALUE	22210.00	22532.00	22174.00	22131.00	22538.00	22837.00	23515.00	23649.00	23285.00	23164.00	23693.00	23969.00	24849.00	26001.00
Canada	459.78	451.45	465.53	465.16	479.55	492.43	505.47	517.07	527.82	542.72	565.68	558.97	567.79	586.07
United States of America	5009.55	4969.26	5062.01	5177.35	5268.05	5319.38	5500.17	5579.98	5607.16	5677.97	5858.20	5744.78	5796.76	5841.50

Source: UNEP Geo Data Portal 2006 based on UNFCCC-CDIAC 2005.

Box 2: States and Provinces continue to lead in curbing GHG emissions

The State of California, the 12th largest carbon emitter in the world, passed a landmark climate change bill in 2006. The legislation limits the State's emissions to 1990 levels by 2020, representing an estimated 25 per cent overall reduction from current levels. It also establishes a mandatory reduction reporting system and sets up a 'cap and trade' program allowing businesses to buy and sell emission rights (Office of the Governor 2006).

Canada's Provinces of Newfoundland and Labrador, Quebec, and Manitoba are committed to implementing the Kyoto Protocol regardless of the federal government's stance. To help finance its efforts to meet Kyoto targets, Quebec announced it will introduce a carbon tax on all fossil fuels sold in bulk to retailers.

Sources: CBC 2006, Gouvernement du Québec 2006.

Public interest and knowledge about climate change grew over the past year. Signs that the US government acknowledges human-induced climate change stimulated media attention on the issue, accompanied by decreasing coverage of scientific scepticism. In a significant indicator of culture shift, a coalition of 86 evangelical Christian leaders advocated urgent action on climate change by government, business, individuals, and churches, committing to influence their congregations to limit GHGs (ECI 2006). Former US Vice-President Al Gore's cautionary documentary about climate change, *An Inconvenient Truth*, released in May 2006, became an unexpected box office hit (Svetkey 2006).

NEW MARINE PROTECTED AREAS CREATED

In 2006, the United States took an historic step in creating the world's largest contiguous marine protected area in the Hawaiian Islands (Box 3).

2006 also saw the creation of a new network of marine reserves off California's central coast. This network encompasses 29 Marine Protected Areas (MPAs) representing over 52 800 hectares of marine habitat. About 8 per cent will be out-of-bounds to all fishing, while the rest will permit restricted fishing (DFG 2006a, Scheer 2006a). The MPAs will help in efforts to restore depleted fish stocks and to protect coastal marine habitat and biological diversity from the impacts of coastal development, water pollution, and other human activities (DFG 2006b).

A landmark US federal rule banned bottom trawling for fish in over 95.83 million hectares of sensitive ocean habitat extending into the Gulf of Alaska and surrounding Alaska's Aleutian Islands, a chain that reaches 2 200 km westwards from the Alaska Peninsula (NURP 2004, Oceana 2006).

Bottom trawling in Alaska generally involves dragging large weighted nets across the sea-floor to harvest commercial fish species such as Pacific cod and black rockfish. It devastates sensitive marine life, including slow growing cold-water corals and sponges (Enticknap 2002). An estimated 453 600 kilograms of corals and sponges are lost as by-catch in Alaskan waters every year (Roberts and Hirshfield 2004).

Source: Robert Stone, NOAA Fisheries

The common pink bubblegum coral (*Paragorgea arborea*) near the coast of Alaska's Tanaga Island.

These cold-water deep-sea corals provide important habitat for fish and other marine life. The ban, prompted by pressure from conservationists and scientists, is the most extensive of its kind in the United States (Roberts and Hirshfield 2004, Oceana 2006).

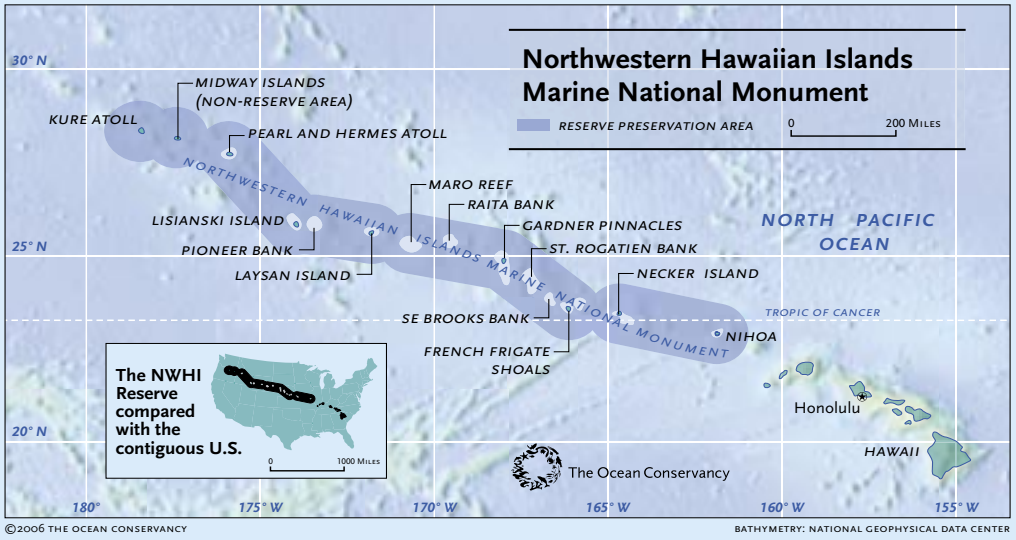
Leading up to United Nations negotiations on international efforts to ban or control unregulated bottom trawling, the US government called for an end to such destructive fishing practices (The White House 2006). Canada opposed an international moratorium and proposed creation of regional fisheries management organizations for unregulated ocean areas, with powers to identify and protect vulnerable habitats (DFO 2006). In November the UN Review Conference on the Fish Stocks Agreement decided against a moratorium, in favour of closer monitoring of the impacts and subsequent restricting of activities that damage sensitive marine areas (Mittelstaedt 2006).

Box 3: The Northwestern Hawaiian Islands Marine National Monument

On June 15, 2006, US President George W. Bush created the world's largest marine conservation area off the coast of the northern Hawaiian Islands. The Northwestern Hawaiian Islands Marine National Monument covers nearly 36 million hectares of US waters, including 1.16 million hectares of coral reef ecosystem of coral reef ecosystem. The archipelago provides habitat to more than 7 000 marine species of which a quarter are endemic. It is home to nearly 1 400 Hawaiian Monk Seals—almost the entire world population of this critically endangered species—and to about 90 per cent of the threatened Hawaiian Island Green Sea Turtle population. The designation puts the area under immediate and permanent protection. Unauthorized ships, illegal recreational and commercial activity, resource extraction, and waste dumping will be prohibited and commercial fishing will be phased out over a five-year period.

Sources: NOAA 2006a, The White House 2006a.

Source: Northwestern Hawaiian Islands Marine National Monument, Map © The Ocean Conservancy; Bathymetry: National Geophysical Data Center



Bottom trawl roller-gear *Source: © OCEANA / David Hall*

PRESSURES GROW ON PARKS AND PUBLIC LANDS

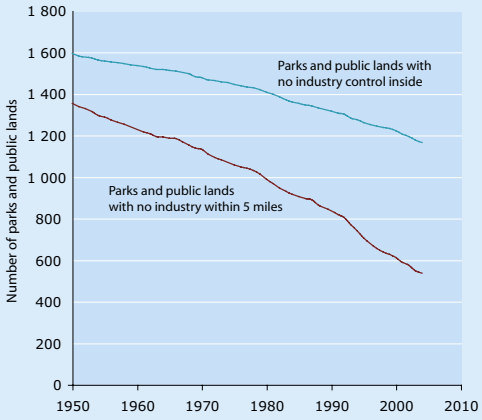
On land, by contrast, several years have gone by with little US action to set aside more parks, while protected areas in both Canada and the US face numerous and growing threats to their ecological integrity and beauty (Defenders of Wildlife 2005, Tourtellot 2005, NRDC 2005, NPCA 2006a, Bass and Beamish 2006, USDA 2006a). For example, the US has proposed selling more than 121 400 hectares of public lands in 35 states to fund rural schools and roads (USDA 2006b). Furthermore, it passed legislation allowing the construction of energy transfer corridors to supply electricity from 11 Western states to population centres in the Southwest. These energy transfer corridors will likely cross national parks and other public lands (DOE 2006, Scheer 2006b).

Mining operations and oil and gas development are already allowed on and near protected areas in both Canada and the United States. A recent study estimates that these industries actively operate in 35 per cent of 1 855 parks and other public lands in 13 Western states of the US and expects the trend to increase **(Figure 1)** (EWG 2005).

Mining and energy industries also threaten Canadian Parks. A 2002 study showed that mining occurred inside or within 10 kilometres of almost half of Canada's National Parks (MAC and CNF 2002). In 2006, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Sites Committee reported that open-pit mining near Jasper National Park threatens grizzly bear habitat (World Heritage Committee 2006). Untimely water withdrawals from the Athabasca River for oil sands surface mining operations affect fish populations and threaten the sustainability of the Athabasca River and the Peace-Athabasca Delta **(Box 4)**. The river enters Lake Athabasca in Wood Buffalo National Park, a UNESCO World Heritage site, and the delta is one of the most important waterfowl nesting and staging areas in North America (Woynillowicz 2006).

Other commercial interests are increasingly encroaching on Canada's parks. In 2006, the British Columbia government eased the way for private resort development within 12 provincial parks, including Mount Assiniboine Provincial Park, part of the Canadian

Figure 1: Industry access to US parks and public lands



Note: Number of US parks and public lands that remain free of operating mines and active oil and gas wells controlled by industry inside or within eight kilometres of boundary
Source: EWG 2005
Metadata: government land use data from the Bureau of Land Management (2004)

Box 4: Mining the Athabasca oil sands near Fort McMurray Alberta, 1974 and 2004

In 1967 The Great Canadian Oil Sands Company began construction at its Mildred Lake site. In 1974 they were joined by the Syncrude Corporation in the same area (light grey area in the center of 1974 Landsat image, left). By 2004 the mining operations had expanded to cover an area roughly 30 km by 20 km (2004 ASTER image, right). Syncrude operates a second mine, the Aurora, approximately 30 km to the north of Mildred Lake (visible near the top of the 2004 image).

Source: UNEP/GRID Sioux Falls, from U.S Geological Survey data

Source: UNEP/GRID Sioux Falls, from U.S Geological Survey data

The Syncrude mine in Alberta's Athabasca oil sands.

Rocky Mountain UNESCO World Heritage Site (BC Parks 2006). In addition, in 2006 the Quebec government planned to sell public land in the Parc National du Mont-Orford, created in 1938 and one of its oldest provincial parks; public outcry led to a compromise that keeps the land under development in public hands (MRC de Memphrémagog 2006).

Finally, exurban expansion (clusters of low density housing in the countryside) is threatening adjacent protected areas in both countries. The results of all these pressures include habitat fragmentation, biodiversity loss, and air pollution. Fragmentation creates remnant, isolated wilderness patches of varying size that constrain wildlife movements and that may not be able to support viable populations of certain wildlife species (Forrest and others 2004, Bass and Beamish 2006, NPCA 2006b).

CONCLUSION

North American states, provinces, and cities are moving forward on regulations to reduce emissions, producing concrete results while also exerting political pressure on federal governments that aren't party to the Kyoto Protocol (the US) or deny its relevance (Canada). North America needs to set firm short term targets and time frames to reduce GHG emissions and to invest more heavily in energy conservation and renewables.

Source: Catherine McMullen/UNEP

Exurban expansion fragments habitats along Lake Ontario's Hay Bay.

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West Asia

2006 saw progress in environmental management, with particular success in reducing the use of of ozone-depleting substances. However, the region still faces critical challenges related to the environmental effects of armed conflicts, safe management of chemicals, and conservation of forests and woodlands.

Clouds of smoke from Jiyeh power station in Lebanon

Source: Ali Hashisho/Reuters/The Bigger Picture

ENVIRONMENT AND CONFLICT

In Iraq and the Occupied Palestinian Territory (OPT) violence and frequent hostilities continue to intensify environmental degradation, as well as water and sanitation problems (UNICEF 2006). While the environmental situations in Iraq and OPT remain worrisome, the environmental implications of the Israeli-Lebanese conflict in July and August raised major headlines in 2006.

In Lebanon, the destruction of power utilities, fuel depots, factories, and buildings posed risks to local populations, relief workers, and the environment (Box 1). Clouds of burning fuel containing toxic polyaromatic hydrocarbons, asbestos particles, dioxins, and dust were emitted into the atmosphere; while liquid chemicals, including chlorine and polychlorinated biphenyls, were released into soil and aquatic ecosystems. This has raised concern over possible effects on human health and long term damage to the environment. Water pollution also became an issue, as heavy bombing damaged the infrastructure of water supplies as well as wastewater and sewage systems.

A number of wildfires occurred during the hostilities, damaging vegetation and wildlife habitats. About 6 680 hectares of forest and grazing lands were destroyed in northern Israel (Julian 2006, Puljak 2006). Similarly, on the Lebanese side, there was growing alarm over forest fires and destruction of woodland habitats (Fattah 2006). With the help of the Food and Agriculture Organization of the United Nations, the Lebanese Government is still assessing the extent of damage to forests and woodlands (Asmar 2006). An international team of experts, led by UNEP and working in close cooperation with Lebanese authorities, is starting an assessment of the overall environmental damage in Lebanon caused by the recent conflict (UNEP 2006a).

In one month of conflict, more than a million people were displaced from south Lebanon, the southern suburbs of Beirut, and Northern Israel—putting pressure on

Box 1: The oil spill along the Lebanese-Syrian coast on 21 July and 3 August; 2006, Radar Satellite Data

Source: DLR 2006

The bombing of the Jiyeh power station on 13 and 15 July 2006 caused between 10 000 and 15 000 tonnes of heavy fuel oil to spill into the Mediterranean Sea (MOE 2006a). The oil polluted 150 km of the Lebanese coastline area and reached as far as the Syrian coast of Tartus (Cyprus Oceanographic Centre 2006a and 2006b, REMPEC 2006). Two weeks after the spill, 80 per cent of the oil still remained in the coastal waters of Lebanon as thin foating sheets, about 20 per cent had evaporated, and 0.1 per cent remained along the beaches (Cyprus Oceanographic Centre 2006a and 2006b).

The oil spill was described as the 'worst environmental disaster' in Lebanon's history and it will have significant impacts on its economy and biodiversity (OCHA-UNEP 2006). The fuel oil contains toxic chemicals, with potentially serious implications for human health, fishery resources, and other marine biota (MOE 2006a). Oil on the beaches of Palm Islands Nature Reserve (off the coast of Tripoli) threatens loggerhead turtles, monk seals, and fish stocks as well as migratory birds (IUCN 2006). Full scientific data is not yet available. However, a comprehensive environmental damage assessment is underway that should reveal possible long term pollution effects of the spill.

In response to the Lebanese government's call for support, an international assistance action plan was formulated to address the problem (MOE 2006c, REMPEC 2006, UNEP 2006b). As of September 2006, 400 tonnes of oil had been recovered from various sites during ongoing national clean-up operations (MOE 2006b). While the clean-up may take 6 to 12 months, the harmful impacts of the spill could last much longer. The initial clean-up operation is estimated to cost about US$60 million and more funds may be needed in 2007 (MOE 2006c). Regional cooperation is vitally important in capacity-building for monitoring and assessing the environmental effects of oil pollution as well as proper remediation. Emergency measures and coordination of activities among agencies and affected states are needed to effectively control oil pollution and limit its damage to the marine and coastal environment.

The two images show how oil dispersed after the spill, moving along the coasts of Lebanon and reaching the southern coast of Syria between 21 July – 3 August 2006. The dark colour along the coastline illustrates the area extent covered by the oil-spill (DLR 2006).

Sources: DLR 2006, MOE 2006a, Cyprus Oceanographic Centre 2006a and 2006b, REMPEC 2006

Oil spill clean-up efforts in coastal area north of Jiyeh, Lebanon. *Source: Hassan Partow/UNEP*

the environment and natural resources. Many Lebanese returnees lacked safe drinking water and sanitation. An International Red Cross Committee survey in affected villages found that 55 per cent of households reported cases of diarrhoea (IRC 2006). Tens of thousands of unexploded ordnance, including cluster bombs, pose a continuing threat, resulting in death and injury on a daily basis (UNHCR 2006). Even when these are collected and detonated under controlled circumstances, they can be a source of chemical pollution.

In Iraq, non-violent death rates have increased in the last two years (2005 and 2006) which may reflect deterioration in health services and environmental health threats (Burnham and others 2006). Several years after the ending of major wars, unexploded ordnance and landmines in Iraq are still killing civilians and hampering reconstruction (UNAMI 2005).

Recurrent conflicts have led to considerable political and socio-economic instability in the region. They not only affect the environment directly, but they also drain resources away from conservation and constrain the effective management of natural capital (ESCWA 2005). For instance, the total cost of damages incurred from conflict in the Gaza strip is estimated at US$46 million during July and August alone (UNDP 2006). Once peace and stability have been established in the region, resources may be devoted effectively to rebuilding physical infrastructure.

MANAGEMENT OF CHEMICALS

Chemicals in West Asian countries are mainly imported for use in agriculture, industry, pharmaceutical, and other economic sectors. The petrochemical industry is expanding within the Gulf Cooperation Council (GCC) countries. For example, ethylene production has tripled in GCC countries since 1990 and is expected to double again by 2010 (EMCC 2006). In the Mashriq countries highly polluting industries like mining, cement production, and tanneries continue to operate inefficiently, polluting air, water, and soil resources.

The use of chemicals, especially agrochemicals, is rapidly rising in the region. For example, insecticide use doubled in Syria between 2002 and 2004, when it reached 1.4 million metric tons (Hajjar 2005). The heavy application of these chemicals and the discharge of wastes into soil and aquatic ecosystems present significant hazards to human health and to the environment. Applications of agrochemicals and irrigation with sewage water have increased nitrate in wells in the Gaza strip to levels exceeding the World Health Organization's safe guideline values (UNEP 2003a, Miski and Shawaf 2003, EMWATER 2005).

There are no reliable data on the amount of hazardous waste generated in the region, but some crude estimates indicate that per capita levels could be comparable to those of industrialized countries. So far only a few GCC countries have constructed treatment, disposal, and incineration facilities. Chemical and industrial waste is a problem in Iraq, where remaining stockpiles of hazardous and obsolete chemicals threaten public health and the environment (UNEP 2005). Radioactive materials such as depleted uranium from ammunition are believed to cause clusters of cancer cases and genetic defects recently reported in Basra city, Iraq (Hirschfield 2005, Burnham and others 2006).

There are signs of progress. In 2006 the region hosted the International Conference on Chemicals Management (ICCM) in Dubai, United Arab Emirates, which adopted a Strategic Approach to International Chemicals Management (SAICM) (UNEP 2006c). Prior to the conference, political support for SAICM in the region was demonstrated in the Cairo declaration, in which the sound management of chemicals and hazardous wastes strategy was adopted as a national and regional priority (UNEP 2006d). Recently, seven countries nominated national focal points to the SAICM Secretariat, indicating their commitment to implement ICCM decisions (UNEP 2006e). Moreover, a genuine effort is underway by countries in the region to develop an integrated regional strategy on chemical and waste management (UNEP 2006f).

Most countries in West Asia are parties to the major international agreements on chemicals: the Basel, Rotterdam, and Stockholm Conventions as well as the Montréal Protocol and related regional conventions. Compliance, however, has been modest in some cases, due to a number of factors including illegal shipments of chemicals. Nevertheless, some progress has been achieved towards control and safe handling of chemicals. The phasing out of ozone-depleting substances is a success story in its own right **(Box 2)**.

Laws and regulations need to be updated and strictly enforced by governments, to control the use of chemicals and to reduce associated pollution risks. The key policy challenges to achieving more sound management of chemicals are:

- strengthening coordination mechanisms between institutions at the national level;
- preparing national chemical safety profiles; and
- raising public awareness.

Open dumping of hazardous sodium cyanide in Al-Qadissiya, Iraq.

Source: UNEP/Post Conflict Branch

Box 2: Consumption of ozone-depleting substances slashed

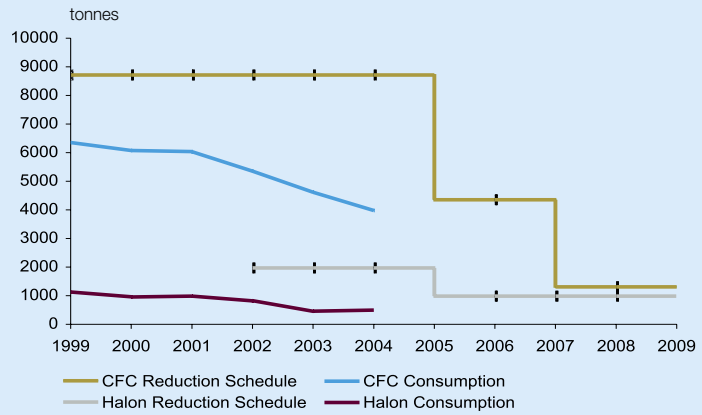
Protection of the ozone layer, and implementation of relevant international treaties, have been given a high level of attention by key governmental and private sector stakeholders in the region. Since 1999 most West Asian countries have made significant progress in phasing out ozone-depleting substances (ODS). The Regional Ozone Network has promoted compliance with the control measures spelled out in the Montreal Protocol through the Compliance Assistance Programme (CAP) of the United Nations Environment Programme.

As of October 2006, only 70 per cent of the parties had reported their official 2005 data to the Ozone Secretariat. However, countries have already reduced consumption by more than the 50 per cent required by the Protocol. Among the reporting countries, total chlorofluorocarbon (CFC) consumption in 2005 was 1 519 tonnes in ozone-depleting potential (ODP), compared to the 1995-1997 baseline of 4 590 ODP tonnes—an average reduction of 67 per cent ranging from a low of 57 per cent in Bahrain to a high of 91 per cent in Jordan. Halon consumption reported for 2005 was 126 ODP tonnes, compared to the baseline of 693 ODP tonnes—an average reduction of 82 per cent with most countries achieving a complete elimination. The remaining countries, although they have not yet officially reported, have followed a similar trend.

In addition to national efforts, the GCC Secretariat in cooperation with CAP approved regional guidelines aimed at strengthening regulations and improving cooperation to ensure a sustainable phase out of ODS.

Source: CAP/UNEP-ROWA 2006

Status of total consumption of ODS in West Asian countries.



Note: 2005 data are not included.

THE FUTURE OF FORESTS AND FOREST POLICY IN WEST ASIA

The forests and woodlands of West Asia cover 43 million hectares (FAO 2006). Dense forests are mainly found in Mashriq countries while open stands are scattered in wadis and high mountains of the Arabian Peninsula. Most of these forests are state owned and managed for multiple purposes including protection services (FAO 2006).

Forest resources in the region are under severe pressure due to water shortage, increasing demand for agricultural land, and accelerated urbanization. There have been no major changes in the total extent of forest areas in the last five years (FAO 2006), but degradation of forest quality is widespread, due to clearing, illicit cuttings, overgrazing, fires, and tourism. For instance, a single major fire in Syria in 2004 destroyed nearly 0.4 per cent of the total forest area in the country (Jbawi 2006). In the Arabian Peninsula, hundreds of hectares of Juniper forests are experiencing die-back (Asiri 2006, PME 2005) **(Box 3)**.

Box 3: The dying juniper of the Arabian Peninsula

Urban development encroaching on Juniper forests, Saudi Arabia

Source: Mohammad S. Abido

The forests of West Asia cover 1.4 per cent of the total area of the region, while other wooded lands account for 10.2 per cent. Over 70 per cent of the forest area is in the Arabian Peninsula. The Juniper (*Juniperis spp.*)—the only coniferous species native to the peninsula—grows in the northern mountains of Oman, the Asir Mountains of Saudi Arabia, and the northwestern mountains of Yemen. Juniper foliage condenses fog into water that drips off the trees during relatively humid periods, creating a microclimate that sustains the growth of other species. The forest has a significant role in supporting rich fauna and flora as well as providing local people with products and services. The woodland of southwestern Arabia is home to a number of threatened endemic birds (Jennings and others 1988, Newton and Newton 1996, Birdlife International 2003). The region is home to many raptors and provides a flyway for migratory birds. As well, the critically endangered Arabian leopard (*Panthera pardus*) and the rare Arabian wolf (*Canis lupus*) are believed to frequent the woodlands. Juniper is the major woody component of agroforestry in the region and is used in traditional medicine.

The Juniper forests of the Arabian Peninsula, especially those at lower altitudes, are now showing signs of decline, with gradual reduction of growth and vigour in trees and progressive death of twigs and branches. These signs are associated with a high rate of tree mortality and poor natural regeneration. In Saudi Arabia, extensive decline has been reported in the last two decades in the Asir National Park (450 000 hectares) and in the Raidah National Park (900 hectares).

The exact cause of the Juniper's dieback is yet to be identified. However, the poor regeneration of the species has been attributed to the infestation of berries by a tortricid moth as well as to human disturbance, overgrazing, atmospheric pollution, drought spells, and continuing climate change. The clearing of juniper forests for agriculture, roadways, housing, and recreation has altered natural watershed drainage systems in many locations. These activities—along with overcutting, overgrazing, and fuelwood and charcoal making—have created microclimates unfavourable for tree growth. The Juniper die-back phenomenon is a serious problem for the affected countries of the region, because it is a silent form of resource degradation that may worsen desertification. New initiatives to overcome the dieback problem are urgently needed.

Sources: FAO 2006, Gardner and Fisher 1996, Fisher and Gardner 1998, Fisher 2005, Herzog 1998, PME 2005 and 2006, Collenette 1989, Jennings and others 1988, Newton and Newton 1996, Birdlife International 2003, Baille and Groombridge 1996, WWF 2001, Hajar and others 1991, NCWCD 2003, Yoshikawa and Yamamoto 2005, Asiri 2006, IUCN 2002, Sigi and others 2005

Countries are now updating forest laws and establishing national policies and strategies for forest management. These policies and strategies need to be harmonized with national plans for biodiversity conservation, combating desertification, and rural poverty alleviation. A framework for the development of new policies must ensure long term conservation and sustainable use of woodlands. This entails defining the socio-economic values and environmental services of forests and woodlands, setting targets and defining indicators for measuring progress, periodically updating forestry laws and regulations, building institutional capacity, and ensuring effective participation of local communities.

CONCLUSION

Frequent conflicts have significantly affected the environment in West Asia. Sustainable development and a healthy environment cannot be fully achieved without peace and security in the region. Although important achievements have been made in certain aspects of chemical management—such as initiating national policy frameworks, building data bases, and regulating the use of certain chemicals—the region still faces challenges to fully implement SAICM and to properly manage and conserve its precious natural forests and woodlands.

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Polar

Observations and new research showed that climate change continued to accelerate, with global consequences. Combined with increasing development pressures, this gives a new sense of urgency to improving international cooperation and governance in the Polar Regions.

Antarctic Ice. *Source: Ben Holt Sr/NASA*

MELTING ICE

Studies from 2006 provided new information about the rates at which warming temperatures are causing the earth's great storehouses of ice to melt and break apart. There are still uncertainties about what will happen with ice sheets in the long term and how quickly global sea levels will rise.

The volume of the Antarctic ice sheet shrank at an annual rate of 152 ± 80 cubic kilometres between 2002 and 2005, according to the first mass balance estimate of the entire ice sheet (Velicogna and Wahr 2006). This would have produced enough meltwater to account for 13 per cent of the sea level rise observed during that period. The volume of the Greenland ice sheet shrank at an annual rate of 101 ± 16 cubic kilometres between 2003 and 2005, according to estimates derived from the same satellite-based methodology (Luthcke and others 2006). Both the Antarctic and the Greenland ice sheets are gaining mass in some areas from increased snowfall while losing ice in other areas from melting and iceberg calving. The rate of ice loss is increasing because glaciers in Greenland and Antarctica are flowing faster (Kerr 2006). For example, Greenland's fastest glacier, Kangerdlugssuaq, increased its speed from 6 km per year in 2000 to 13 km per year in 2005 (Rignot and Kanagaratnam 2006).

Arctic sea ice cover in September 2006 averaged 590 million hectares, the second lowest of the 29 year record of satellite measurements (NSIDC 2006). This continues the pattern of sharply decreasing Arctic sea ice cover, which is now shrinking at the rate of 8.6 per cent per decade. If this rate continues the Arctic Ocean will be ice-free in summer by 2060. Changing Arctic sea ice conditions are opening shipping routes, leading to disputes over borders and jurisdiction, including the waters of the Northwest Passage (Box 1) (Figure 1).

Figure 1: Arctic shipping

As the amount of ice in the Arctic shrinks, sea routes will open up to increased traffic.

Source: UNEP/GRID-Arendal

The ecological impacts of these changing ice conditions include threats to animals such as the polar bear and changes in fish stocks and marine mammals, with economic and social consequences for Arctic residents (ACIA 2005).

INTERNATIONAL COOPERATION AND GOVERNANCE IN A CHANGING WORLD

These changing ice conditions, along with an increase in commercial fi shing, Antarctic economic activity, and Arctic oil and gas development are producing additional challenges for international cooperation and governance (Box 2).

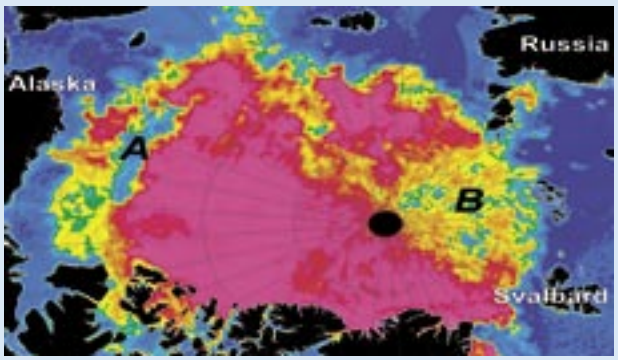
Both the Arctic and the Antarctic have formal means for nations to share information and cooperate on man-

Box 1: Holes in the year-round ice

In late summer 2006 two large areas of open water appeared in regions of the Arctic Ocean that are normally frozen all year round (See Figure). One of these openings, in the Beaufort Sea north of Alaska **(A)** , was a large polynya (a lake-like region of open water surrounded by ice) larger than Ireland. Another unusual open ice area was registered on the European side of the Arctic Ocean **(B)**, a region of fragmented ice and open water the size of the British Isles. At its maximum in late August, a ship could have passed from Svalbard or northern Russia through what is normally pack ice to reach the North Pole without difficulty.

Open water and ice break-up of this magnitude in what is normally permanently-frozen ice have not been observed before. Neither of these unusual events can be directly attributed to climate change and the specific causes are not clear. Unusual wind patterns, thinner ice, and warmer waters rising to the surface may be involved.

Sources: ESA 2006, NSIDC 2006



The image, from 24 August 2006, was produced from microwave radiometer measurements from NASA's Aqua satellite. Pink indicates solid ice cover; yellow, green and orange indicate broken ice; and blue indicates open water.

Source: Polar View/DTU (Leif Toudal Pedersen)

agement and conservation. But they have developed very different cooperative mechanisms. The Antarctic is governed by an international multilateral regime, the Antarctic Treaty System, whose core is the 1959 Antarctic Treaty, currently including 45 state parties. There is no such international regime for the Arctic, but in 1996 the Arctic Council was established as a forum for cooperation, made up of the eight nations around the Arctic Ocean and six Indigenous Peoples' Organizations.

In addition to these regional mechanisms, many multilateral environmental agreements (MEAs) play important roles in polar cooperation and governance. A case in point is the story of stratospheric ozone **(Box 3)**. This example shows that nations can agree to take strong actions to solve environmental problems. It also shows the importance of international cooperation in research and monitoring of ecosystems and their interactions with human activities and in measuring the effectiveness of instruments such as the Montreal Protocol.

2006 saw significant advances in polar science cooperation, in the preparations for the International Polar Year (IPY) 2007-2008. This burst of research, education, and outreach aims to improve understanding and awareness of major issues facing the Polar Regions and the world, especially climate change (IPY 2006).

The Antarctic

In 2006 representatives of the Antarctic Treaty states committed themselves to improve the effectiveness of the Antarctic Treaty System and to increase coordination among its components. As part of the Edinburgh Declaration of the 29th Antarctic Treaty Consultative Meeting (ATCM) held in June, it was recommended that nations champion the importance of the Polar Regions in international forums and that there be increased collaboration with the Arctic Council (ATCM 2006). These recommendations come at a time when the 'Question of Antarctica' has been removed as a regular agenda item before the UN General Assembly **(Box 4)**.

At the 2006 ATCM, New Zealand introduced a working paper proposing stronger links between the ATCM and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), a separate decision-making body. The Antarctic Treaty Consultative parties agreed that there is a need for close synergy and cooperation, especially on Antarctic marine protected areas. CCAMLR stressed the importance of developing a strategic approach to marine protected areas and a harmonized regime to protect the Antarctic marine environment across the Antarctic Treaty System. CCAMLR has initiated a process called bioregionalism, seen as the first stage of a strategic approach to decide where marine protected areas are most appropriate.

The growth of tourism and bioprospecting (collecting biological material for commercial purposes) also has implications for international governance. A resolution was proposed at the 2006 ATCM to limit landings of large tourist vessels, but no consensus was reached; discussion of the issue was deferred until the 2007 ATCM. Three information papers on the topic of bioprospecting were tabled by France, Argentina, and UNEP. However, no substantive discussion took place; parties were urged to continue providing updates on their activities in this field. The meeting considered a third emerging issue: the risk of an increase in alien species of plants, animals, and microbes colonizing the region.

The Arctic

In the Arctic, accelerating changes in sea ice and glaciers, along with the growing pressure to develop

Box 2: The changing Arctic: Responding to global demands for oil and gas

With increasing global demand for secure energy supplies, there is competition for rights related to large-scale Arctic projects on land and in the seas. There are many uncertainties related to market forces and political factors, as disputes arise over boundaries, shipping routes, and ownership of sea bed resources. All of this is taking place in the context of rapid environmental change, and ecological and societal impacts are becoming increasingly difficult to predict.

Some events of 2006:

- Construction continued on the first European export facility for liquefied natural gas, Snøhvit, in the Barents Sea north of Hammerfest, Norway. Export is scheduled to begin in late 2007, sending 70 shipments per year to Europe and the US.
- A public hearing into the construction of the Mackenzie Valley Pipeline began. This proposed 1 200 kilometre natural gas pipeline system would connect northern Canadian onshore gas fields with North American markets.
- In March, one million litres of crude oil spilled onto the Alaskan tundra, the largest leak in the history of Alaska's Arctic production. In August, BP temporarily halted production in Prudhoe Bay following another much smaller leak.
- In September, the Russian Ministry of Natural Resources suspended the permits of the developers of the Sakhalin oil and gas project in the Russian Far East, citing non-compliance with environmental regulations. The estimated US$22 billion project includes offshore drilling platforms and pipelines. Opponents say the project threatens fish and the last population of western grey whales. Onshore infrastructure includes two 800 kilometre pipelines that cross more than 1 000 watercourses and swamps as well as seismic faults, roads, and railways.
- Gazprom, the Russian state-controlled oil company, announced in October that it will be the sole developer of the giant Shtokman gas field in the Barents Sea, 500 kilometres north of the port city of Murmansk. At the same time the Russian government declared that it was dropping plans to ship liquefied natural gas to the US, in favour of a pipeline to European markets.

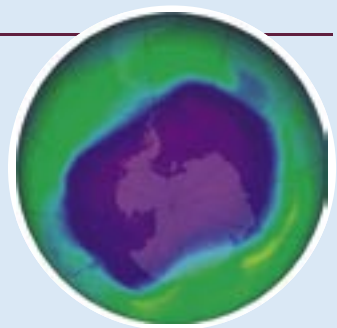
Sources: BP 2006, JSC Gazprom 2006, MGP 2006, Roach 2006, Sakhalin Energy 2006a, Sakhalin Energy 2006b, Statoil 2006

Box 3: Ozone hole reaches record size

The thinning of the protective ozone layer in the earth's atmosphere was discovered by Antarctic researchers in the early 1980s. The 1987 Montreal Protocol has been successful in reducing global emissions of substances that deplete the ozone layer, such as chlorofluorocarbons.

Despite the progress made, in September 2006 the ozone hole over the Antarctic was the largest on record. This was partly due to particularly cold temperatures in the stratosphere, but also due to the stability of these chemicals—it takes about 40 years for ozone-depleting substances to break down. The ozone layer is expected to recover, but it is now predicted to return to its pre-1980s condition around 2060-2070, more than 70 years after the international community agreed to take action and 15 years later than earlier predictions. This illustrates both the effectiveness of coordinated international action on global environmental issues and the need to take action quickly on issues like climate change where improvements happen slowly and changes to the atmosphere have far-reaching global effects.

Sources: NASA 2006, WMO/UNEP 2006



Antarctic ozone hole 24 September 2006.

Source: NASA

the Arctic's vast oil and gas and other resources, raise questions about the adequacy of current governance regimes, especially for the marine environment. Can Arctic countries, within existing international mechanisms, strike the difficult balance between promoting economic development and securing vulnerable Arctic environments? In 2006 this topic was examined through several forums and initiatives (Arctic Centre 2006, UNEP/GRID-Arendal 2006a and 2006b, SCPAR 2006a, Huebert and Yeager 2006). Two sets of issues were under discussion: first, how existing treaties relevant to the Arctic can be made more effective and comprehensive in their coverage of Arctic issues and second, the pros and cons of establishing a binding legal regime for the Arctic marine environment.

In August, at its biennial conference in Kiruna, Sweden, the Conference of Parliamentarians of the Arctic Region called on governments in the Arctic and institutions of the European Union to "initiate, as a matter of urgency, an audit of existing legal regimes that impact the Arctic and to continue the discussion about strengthening or adding to them where necessary" (SCPAR 2006a). The Parliamentarians also proposed that the United Nations should review UN treaties relevant to the Arctic as soon as possible. The recommendation to audit existing legal regimes was presented to the Arctic Council ministerial meeting in Salekhard, Russia in October (SCPAR 2006b).

In September, in Lahti, Finland, the Nordic Council (the forum for parliamentary cooperation among Nordic countries) recommended that their Council of Ministers should consolidate legal research pertaining to Arctic waters and, together with the Arctic Council, aim to create a comprehensive legal system for the Arctic (UNEP/GRID-Arendal 2006b).

Measures proposed and discussed in 2006 for improving the effectiveness of international governance in the Arctic included:

1. Strengthen the Arctic Council to give it more decision-making power.
2. Develop a new Arctic marine treaty, a framework convention, or a regional agreement through the Law of the Sea.
3. Strengthen the Arctic focus and coordination of MEA implementation through joint planning, common reporting, and more extensive stakeholder involvement and outreach.
4. Strengthen and develop new mechanisms to address Arctic priorities such as global regulation of new persistent organic pollutants and mercury.

The work of the Arctic Council currently includes activities related to MEA implementation, especially with respect to pollution (Arctic Council 2006, Huebert and Yeager 2006, Stokke 2006, UNEP/GRID-Arendal 2006b). However there is no consensus among the Arctic states on any expansion of its role, especially in dealing with climate change. Some member states favour a more active policy and decision-oriented role, while others see the Council as restricted to sharing information and cooperating on projects. The Arctic Council has been particularly successful in producing comprehensive Arctic assessments on climate (ACIA 2005), human development (AHDR 2004), and pollution issues (AMAP 2002); it is now working on assessments of Arctic marine shipping and of oil and gas development. At the biennial ministerial Council meeting in October, ministers requested the Council to begin work on an assessment of Arctic biodiversity (Arctic Council 2006).

Box 4: The 'Question of Antarctica'

The 'Question of Antarctica' was brought before the UN General Assembly in 15 of the years since 1983. This arose from the concerns of many developing countries about management of Antarctica, regarding issues such as the fragility of the Antarctic and its importance in the global biosphere; the ability of Antarctic Treaty parties to manage Antarctica on behalf of the global community; contested Antarctic territorial claims; the 'two-tiered' character of the Antarctic Treaty in which Consultative Parties make policy decisions and non-Consultative Parties play a lesser role; and development of a mineral regime, seen by developing countries as an instrument to secure mineral resources solely for Antarctic Treaty parties. In response to these concerns, Malaysia led an argument at the General Assembly that Antarctica should be designated as a Common Heritage of Mankind.

Recently the debate over Antarctica has been tempered by reforms, including the abandonment of the mineral regime in 1989, adoption of the Protocol on Environmental Protection in 1991, and an expansion of the Antarctic Treaty membership from 12 original signatories to 45 countries today. In 2005, at Malaysia's request, the 'Question of Antarctica' was removed from the agenda of the General Assembly's 2008 session and replaced with a direction to keep a watchful eye on the situation. This is likely a signal that Antarctic Treaty states have made progress on the concerns expressed in the 1980s. Some suggest that it may be a step backward in global governance: a global concern as important as Antarctica will no longer be discussed periodically in a global forum.

Sources: Joyner 1998, UN (various years)

Representatives of indigenous peoples and organizations at the October Arctic Council ministerial meeting in Salekhard, Russian Federation

Source: Clive Tesar/Indigenous Peoples' Secretariat of the Arctic Council

ILLEGAL, UNREPORTED AND UNREGULATED FISHING

Illegal, unreported and unregulated (IUU) fishing is a global concern—reducing the resilience of marine ecosystems and making them more vulnerable to environmental change in a time of accelerating loss of marine biodiversity and fisheries resources (Worm and others 2006, Berkes and others 2006). While marine ecosytems become more vulnerable, commercial fisheries are expanding in both Polar regions.

Management regimes exist for both regions. In the Antarctic, fisheries are regulated by the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). The dominant fisheries are for krill (with a catch of about 127 000 tonnes for the 2005/06 season) and toothfish (about 14 000 tonnes) (CCAMLR 2006). Arctic fisheries policies are governed by national and regional bodies according to the jurisdictions of the Arctic Ocean, the North Atlantic and Pacifi c Oceans, and the northern seas. But the management regimes are weakened by inadequate tools for enforcement and because fishing and damage to habitat and marine life occurs outside of their reporting systems or jurisdictions.

In the Antarctic, IUU fishing is not just a threat to fish and krill stocks but also to albatrosses and petrels, which get caught on long-line fishing hooks (Gandini and Frere 2006). Policy responses have included setting up a catch documentation scheme and improved reporting and inspection measures, but the effectiveness of these measures is compromised by issues of jurisdiction. For example, southern bluefin tuna are harvested within the CCAMLR area, authorized by the Commission for the Conservation of Southern Bluefin Tuna rather than by the

CCAMLR (Hemmings 2006). In November, the CCAMLR adopted a significant measure requiring members to take steps against nationals suspected of involvement in IUU activities at any stage of the fisheries supply chain. This is the first time any regional fisheries management organization has adopted such a comprehensive and binding mechanism in the fight against IUU fishing (EC 2006).

IUU fishing is also a problem for Northeast Arctic cod and was the focus of the 11th Conference of North Atlantic Fisheries Ministers in June. The Northeast Arctic cod is threatened by IUU fishing in the Barents Sea: an estimated 137 000 tonnes were fished illegally in 2005, equal to 30 per cent of the total legal fishery for this important fish stock. Governments agreed at the conference on the need for international measures to tackle IUU fishing (FKD 2006a). In November the North East Atlantic Fisheries Commission followed through by adopting binding rules, entering into force in May 2007, including the denial of entry at ports to vessels involved with IUU fishing or transport—effectively prohibiting the landing of illegally-caught fish in the European Union, Russia, Iceland, the Faeroe Islands, Greenland, and Norway (FKD 2006b).

CONCLUSIONS

A host of new issues and challenges are emerging in the Arctic due to pressures from climate change and ongoing development. Currently there are good mechanisms sharing information, producing comprehensive assessments, and cooperating on science. However, the time has arrived to consider the needs and options for improving international governance, especially in the Arctic marine environment.

Although Antarctica has strong protection through an international protocol designating it as a 'natural reserve, devoted to peace and science', the management regime for this protocol needs support to ensure that expanding commercial activities do not undermine this ideal.

There was progress in both regions in 2006 in addressing illegal, unreported and unregulated fishing, including the adoption of binding rules and improvements in surveillance and enforcement through regional fisheries management organizations. In the context of a growing commercial fishing industry in the Polar Regions, continued emphasis on resolution of IUU issues is critical.

Seabird by-catch is a problem associated with illegal, unreported and unregulated fishing.

Source: Graham Robertson/Australian Antarctic Division

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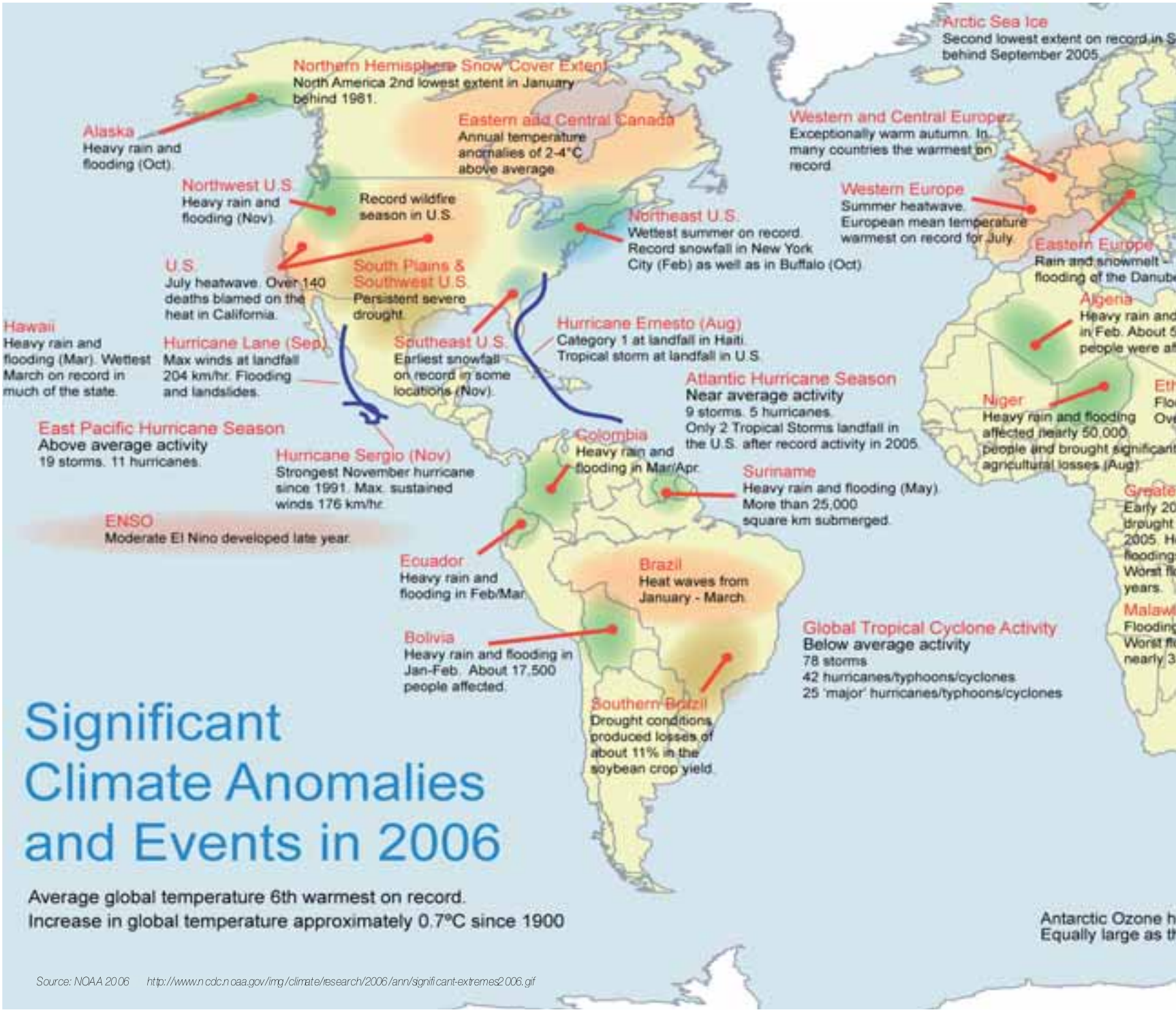
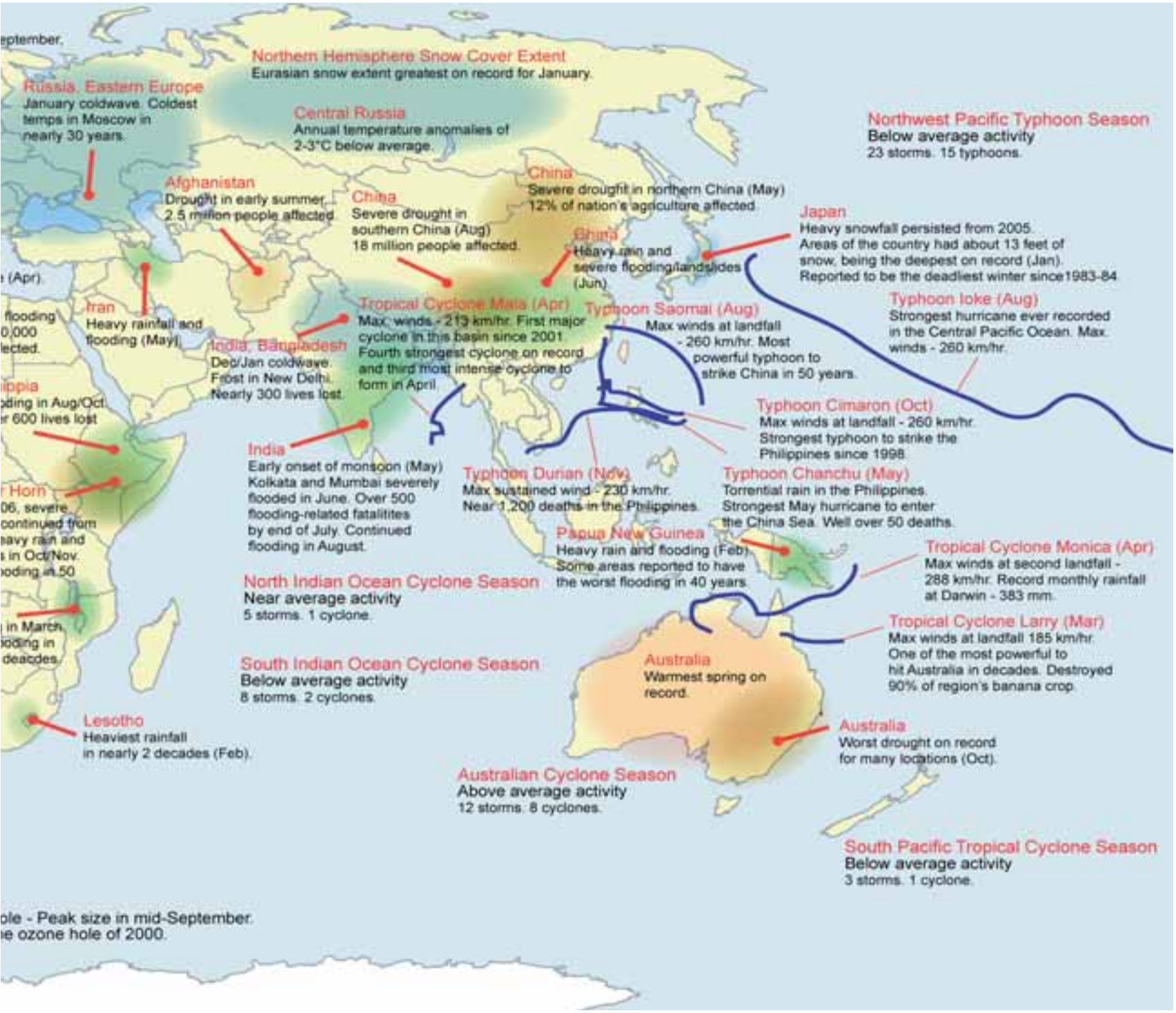
2006 Ongoing trends



Source: NOAA 2006 http://www.ncdc.noaa.gov/img/climate/research/2006/ann/significant-extremes2006.gif


eptember.
Northern Hemisphere Snow Cover Extent
Eurasian snow extent greatest on record for January.
Russia, Eastern Europe
January coldwave. Coldest temps in Moscow in nearly 30 years.
Central Russia
Annual temperature anomalies of 2-3°C below average.
Northwest Pacific Typhoon Season
Below average activity
23 storms. 15 typhoons.
Afghanistan
Drought in early summer. 2.5 million people affected.
China
Severe drought in southern China (Aug)
18 million people affected.
China
Severe drought in northern China (May)
12% of nation's agriculture affected.
China
Heavy rain and severe flooding/landslides (Jun).
Japan
Heavy snowfall persisted from 2005. Areas of the country had about 13 feet of snow, being the deepest on record (Jan). Reported to be the deadliest winter since1983-84
(Apr).
flooding
0,000
ected.
Iran
Heavy rainfall and flooding (May).
Tropical Cyclone Maia (Apr)
Max. winds - 213 km/hr. First major cyclone in this basin since 2001. Fourth strongest cyclone on record and third most intense cyclone to form in April.
Typhoon Saomai (Aug)
Max winds at landfall - 260 km/hr. Most powerful typhoon to strike China in 50 years.
Typhoon Ioke (Aug)
Strongest hurricane ever recorded in the Central Pacific Ocean. Max. winds - 260 km/hr.
India, Bangladesh
Dec/Jan coldwave. Frost in New Delhi. Nearly 300 lives lost.
ppia
ding in Aug/Oct.
r 600 lives lost.
Typhoon Cimaron (Oct)
Max winds at landfall - 260 km/hr. Strongest typhoon to strike the Philippines since 1998.
India
Early onset of monsoon (May) Kolkata and Mumbai severely flooded in June. Over 500 flooding-related fatalities by end of July. Continued flooding in August.
Typhoon Durian (Nov)
Max sustained wind - 230 km/hr. Near 1,200 deaths in the Philippines.
Typhoon Chanchu (May)
Torrential rain in the Philippines. Strongest May hurricane to enter the China Sea. Well over 50 deaths.
Horn
06, severe
continued from
avy rain and
s in Oct/Nov.
ooding in 50
Papua New Guinea
Heavy rain and flooding (Feb). Some areas reported to have the worst flooding in 40 years.
Tropical Cyclone Monica (Apr)
Max winds at second landfall - 288 km/hr. Record monthly rainfall at Darwin - 383 mm.
in March.
ooding in
decades.
North Indian Ocean Cyclone Season
Near average activity
5 storms. 1 cyclone.
Tropical Cyclone Larry (Mar)
Max winds at landfall 185 km/hr. One of the most powerful to hit Australia in decades. Destroyed 90% of region's banana crop.
South Indian Ocean Cyclone Season
Below average activity
8 storms. 2 cyclones.
Australia
Warmest spring on record.
Lesotho
Heaviest rainfall in nearly 2 decades (Feb).
Australia
Worst drought on record for many locations (Oct).
Australian Cyclone Season
Above average activity
12 storms. 8 cyclones.
South Pacific Tropical Cyclone Season
Below average activity
3 storms. 1 cyclone.
ole - Peak size in mid-September.
e ozone hole of 2000.

2007 Ongoing trends

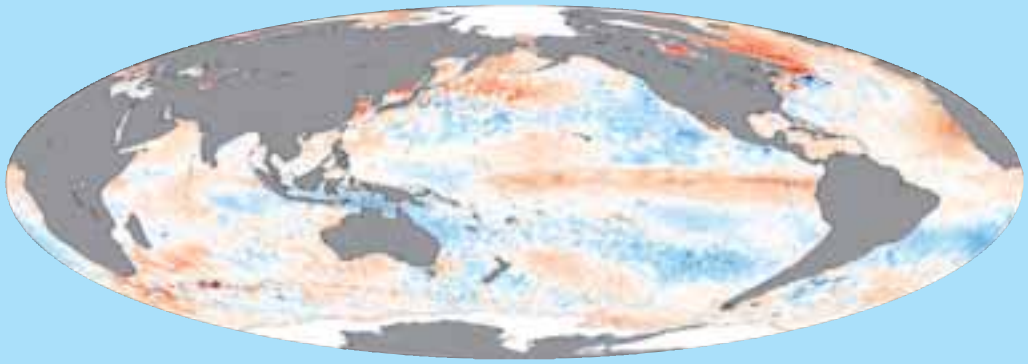
In the tropical Pacific—the section of the ocean between 23 degrees North and 23 degrees South—trade winds blow from east to west. The winds push sun-warmed surface water away from the South American coast that then accumulates in a deep pool of warm water east of Indonesia. Along the South American coast, cold water from the deep rises to the surface like a conveyer, replacing the warm water. As a result, tropical waters in the eastern Pacific are usually cooler than those of the western Pacific.

But every few years, the trade winds grow weak and warm water is no longer pushed west. The western Pacific cools, while the eastern Pacific warms. This distinctive reversal in the Pacific's temperature pattern is called El Nino. The last strong El Nino occurred in 1998 while 2002/3 saw a moderate event that puzzled researchers with its unpredictability (NASA 2006a, NASA 2003).

El Nino Chills the Western Pacific Ocean

Satellite measurements of sea surface temperatures in the tropical Pacific revealed a clear El Niño pattern in November 2006 as seen in the image to the right. Warmer-than-average sea surface temperatures, shown in red, stretch away from the South American coast, while cooler surface temperatures, shown in blue, concentrate around Indonesia and Australia (NASA 2006a).

November 2006



At the end of 2006, East Africa suffered unusually heavy rainfall. Floods swept across the region, affecting up to 1.5 million people in Somalia, Ethiopia, Kenya, and parts of surrounding countries. At the same time, Indonesia and Australia fought back widespread fires, fueled in part by unusually dry conditions. Parts of Australia have been experiencing a severe drought since 2002 and the cumulative effect of the current El Nino weather is enhancing the dry spell.

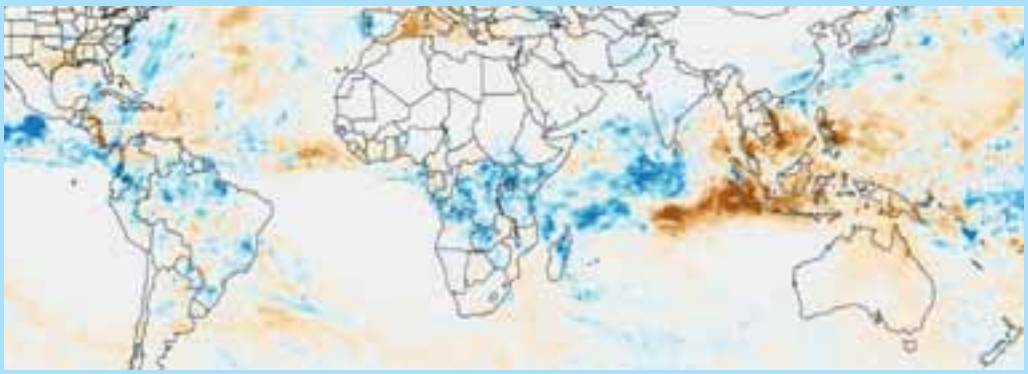
These changes in the atmosphere and the ocean set off a string of unusual weather patterns around the globe that move from east to west over a period of 9 to 24 months. Besides the drought in Australia and Indonesia and the high rainfall in East Africa, the El Nino is expected to eventually bring a low hurricane season to the Atlantic and heavy rainfall to the west coasts of the Americas (IRI 2006).

With the warming trends currently underway, and the last moderate-to-strong El Nino producing the global record-breaking weather of 1998, 2007 will likely be a year of very high temperatures.

El Nino and Rainfall

Measurements taken by the Tropical Rainfall Measuring Mission satellite provide data for the image of the Indian Ocean region. Areas of dark brown over Indonesia and Southeast Asia show that these regions received much less rain than normal during November 2006, while blue over East Africa reveals higher-than-average rainfall totals. Australia is light brown, indicating shortages of a few millimeters per day (NASA 2006b).

November 2006



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FEATURE FOCUS

Environment and Globalization

Minimizing risks, seizing opportunites

Source: ullstein - CARO / Still Pictures

- Introduction
- The Many Faces of Globalization
- Linking Globalization, Ecosystem Services, and Human Well-Being
- Managing Globalization to Protect Ecosystem Services and Human Well-Being
- Conclusion

Environment and globalization: Minimizing risks, seizing opportunities

Globalization is helping to remove hundreds of millions of people from poverty and to provide cheaper goods for many. Yet it also carries great risks for excluded social groups and for the environment. To achieve a 'sustainable globalization' that seizes opportunities and minimizes risks, advances and innovations are needed in governance, civil society, finance, and business at every level from the local to the global.

INTRODUCTION

Globalization in its many dimensions—economic, cultural, environmental, technological, and political—is widely recognized as a defining feature of our times. The United Nations Millennium Declaration, adopted by world leaders in 2000, stated that the central challenge the world now faces "is to ensure that globalization becomes a positive force for all the world's people" (United Nations 2000). Two years later, participants at the World Summit on Sustainable Development (WSSD) in Johannesburg addressed the links between globalization and sustainable development more specifically. They identified trade, investment, capital flows, and advances in technology as opportunities available through globalization. They also considered financial crises, insecurity, continuing ecosystem decline, poverty, socio-economic exclusion, and inequality within and among societies as serious challenges linked to globalization (United Nations 2002).

The challenge of ecosystem decline has become even more evident in subsequent years. The landmark findings of the Millennium Ecosystem Assessment (MA), based on the collective work of over a thousand scientists from around the world, were released in 2005. The MA concluded that over the past half-century humans have altered ecosystems more rapidly and more extensively than in any comparable period of time in human history. The MA noted that while the changes made to ecosystems have contributed substantial net gains in human well-being, they have also led to growing costs, including the degradation of many ecosystem services. The MA concluded that given current trends, the degradation of ecosystem

Earth at Night (27 November 2000). The above image is a composite of hundreds of pictures made by the orbiting DMSP (Defense Meteorological Satellite Program) satellites—Earth Observation Group, National Geophysical Data Data Center, National Oceanographic and Atmospheric Administration (NOAA), USA.

Sources: C. Mayhew & R. Simmon (NASA/GSFC), NOAA/ NGDC, DMSP Digital Archive

services could grow significantly worse during the first half of this century. Importantly, the MA also noted that this degradation of ecosystem services is being borne disproportionately by the poor, is contributing to growing inequities and disparities across groups of people, and is sometimes a principal factor contributing to poverty and social conflict (MA 2005).

It is now well-established that today's multi-faceted globalization trends are intricately linked to both environmental quality and human well-being, and that they pose both large risks and great opportunities for sustainable development (Box 1). But as globalization spreads and deepens alongside growing evidence of serious damage to the world's ecosystems, with grave implications for human well-being, the need to improve our understanding of the complex interactions between these two powerful and converging trends is becoming increasingly urgent.

This Feature Focus seeks to illuminate the risks and the opportunities that globalization poses for efforts to protect the health of the environment, its ecosystems, and the well-being of all who depend on them. It also aims to identify strategies through which governments, international institutions, civil society, and the private sector can effectively work together to harness globalization trends for environmental sustainability and human well-being.

Delegates at the 2002 World Summit on Sustainable Development in Johannesburg identified challenges facing globalization and sustainable development components.
Source: AP Photo/Dario Lopez-Mills

THE MANY FACES OF GLOBALIZATION

The globalization debate of the last few decades has stirred strong passions, with some observers focusing mainly on globalization's dangers and others heralding its benefits. The controversy stems in part from the fact that 'globalization' means different things to different people. For the purposes of this discussion, we consider globalization to be a multifaceted phenomenon, and single out for special consideration its economic, technological, and political dimensions

Box 1: Environment and globalization: costs and benefits

Recent analysis of the environmental costs and benefits of globalization presents "at least eight reasons to suppose that globalization can exacerbate environmental problems":

- expansion of environmentally destructive growth;
- decrease in the ability of national governments to regulate and otherwise cope with environmental management challenges;
- increase in corporate power and reach;
- stimulation of particular sectors such as transportation and energy that have largely negative environmental side effects;
- increased likelihood of economic crises;
- commodification of resources such as water and the decline of traditional local controls on resource use;
- spatial separation of action and impact from responsibility; and
- further ascendancy of the growth imperative.

As well, this analysis presents "a set of factors that suggests that globalization may help environmental quality":

- Global corporations can spread the most advanced environmental management technology and techniques.
- The strengthening of capacities in government to manage economic affairs can have spillover effects, strengthening environmental management.
- Globalization can lead to increased incomes, which in turn can lead to increased government spending on environmental and social programs and to increased public demand for environmental amenities.
- And increasing international trade in resources such as timber could lead to higher prices, more secure property rights, and larger investments in sustaining forest resources.

In summary, "While something can be said for each of these [latter four] forces, their effects are certainly farther down the road than most of the negative effects mentioned earlier. Nor, on balance do they seem as powerful."

Source: Speth 2003

and their implications for ecosystem services and human well-being (Box 2).

Growing economic integration is widely agreed to be a key component of the overall globalization picture. Central features of *economic globalization* include the increasing volume of cross-border transactions in goods and in international capital flows (Figure 1 and Figure 2). Both the volume and the variety of these economic interactions have experienced significant growth over the last two decades.

Economic globalization has had powerful effects on the environment and human well-being, in terms of the scale, patterns, locations, and technologies of production. Both luxury and basic foodstuffs are transported vast distances across the globe. Raw materials such as timber are extracted from forests in one country, processed and manufactured in another, and the final product sold to a consumer in a third country. In many developing countries—especially in Asia—increasing trade and inflows of foreign investment have stimulated economic growth by providing employment for local people, contributing to infrastructure development, increasing incomes, and removing hundreds of millions of people from absolute poverty. Yet in many cases, these gains have led to difficult trade-offs in terms of pollution or increased environmental degradation.

Closely linked with economic globalization is *technological globalization*, which encompasses the technologies used for extraction and production of mineral and agricultural materials, manufacturing, transport, telecommunications, and other services—as well as the increasingly rapid development and diffusion of these technologies. These technologies can benefit or damage the environment, in some cases reducing environmental risk and damage by promoting clean

Box 2: Definitions of globalization

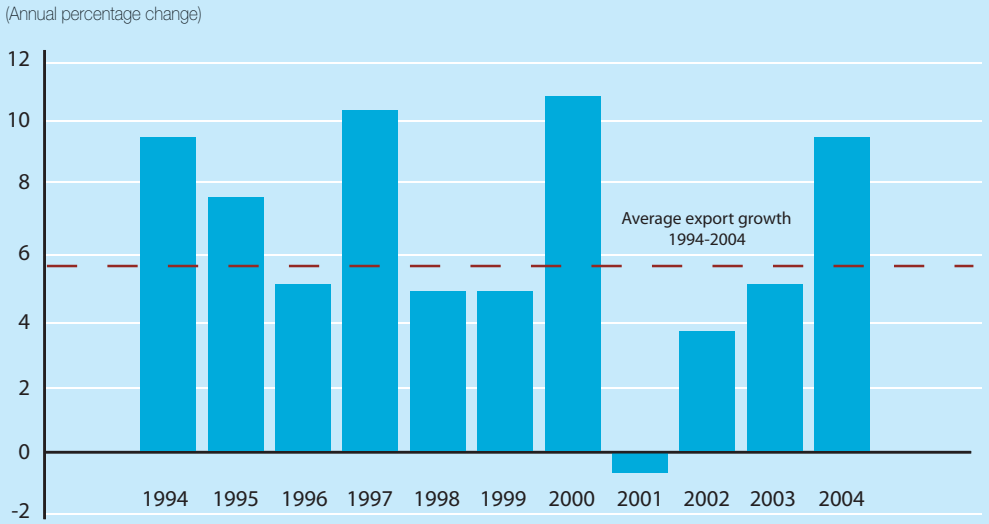
-"…the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa." (Giddens 1990)

-"Shrinking space, shrinking time and disappearing borders are linking people's lives more deeply, more intensely, more immediately than ever before." (UNDP 1999)

-"…a historical process, the result of human innovation and technological progress. It refers to the increasing integration of economies around the world, particularly through trade and financial flows. The term sometimes also refers to the movement of people (labor) and knowledge (technology) across international borders. There are also broader cultural, political and environmental dimensions of globalization that are not covered here." (IMF 2002)

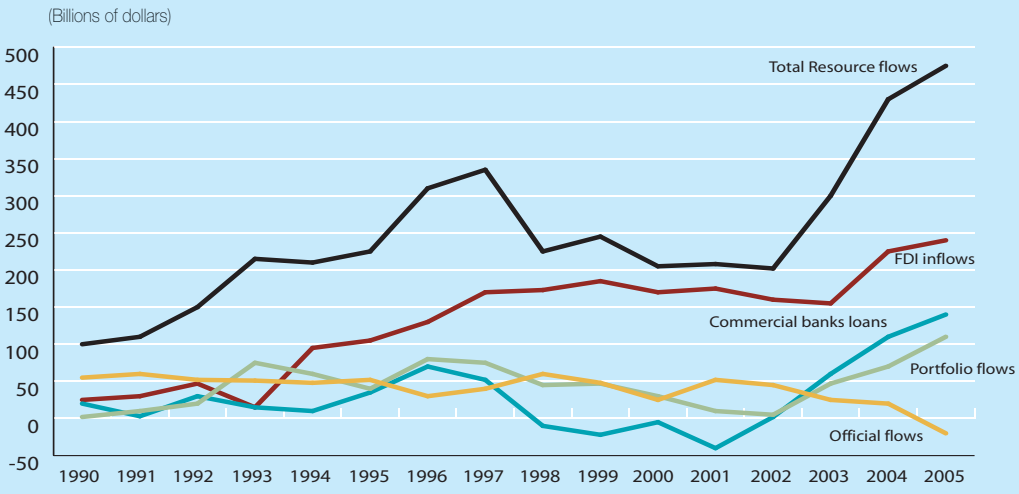
-"Globalization is commonly understood to describe the increasing flow of goods, services, capital, technology, information, ideas and labour at the global level, driven by liberalization policies and technological change" (Annan 2002).

Figure 1: Growth in the volume of world merchandise trade, 1994-2004



Source: WTO 2005

Figure 2: Total net financial resource flows, 1990-2005



Source: UNCTAD 2006

Bangkok pedestrian eyes the cultural offerings of the west.
Source: J. Royan / Still Pictures

energy or efficient production processes while in other cases increasing risk and damage by facilitating diffusion of threats and overexploitation of resources.

Growing international transport for trade and travel, for instance, has made it possible for invasive species to survive and spread to places that were previously out of range, a trend that has become a major source of ecosystem decline worldwide (see Africa section). Ballast water in ships can transport around the world species such as the zebra mussel and the Chinese mitten crab that wreak havoc in lakes and seas (WRI 2006). And growing air travel has provided opportunities for pests to reach new populations. For example, the brown tree snake—a stowaway on flights from New Guinea—wiped out 9 of 11 native bird species in Guam in the late 20th century, severely damaging biodiversity on that island.

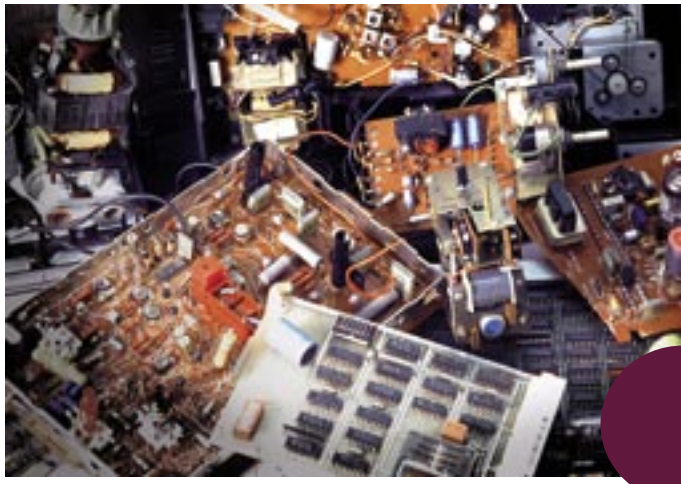
Similar forces are also increasingly at work in the spread of human diseases. The spread of SARS, in March 2003, has been linked to air travel. Other diseases that might spread in a similar way include dangerous influenzas with incubation periods that allow travellers to carry the illness aboard a plane to a new destination before falling ill (CDC 2005, New Scientist 2005).

Rapid advances in communications technologies are one of globalization's most powerful driving forces. These technologies offer substantial environmental benefits, such as reducing the need for physical travel while providing access to an expanding knowledge base.

The number of people with access to that knowledge base is growing. By the end of 2005, global documented Internet usage reached more than one billion people (InterNetStats 2006). Increasing Internet and email use provides widespread availability of useful information for governments and many others to make evidence-based decisions about the environment and to facilitate sustainable resource management. Affordable, reliable, and ubiquitous mobile phone networks are now linking millions of new users—including large numbers of poor people and those in very isolated locations—into systems through which they can gain vital information to benefit their health and wealth **(Figure 3)**.

The rapid growth of information and communications technologies has also brought its own environmental risks and challenges. The growing problem of electronic waste is a case in point. An estimated 50 million metric tons of e-waste replete with toxic materials are generated annually as consumers replace used electronics such as computers and mobile phones with the latest models (Environmental News Service 2006).

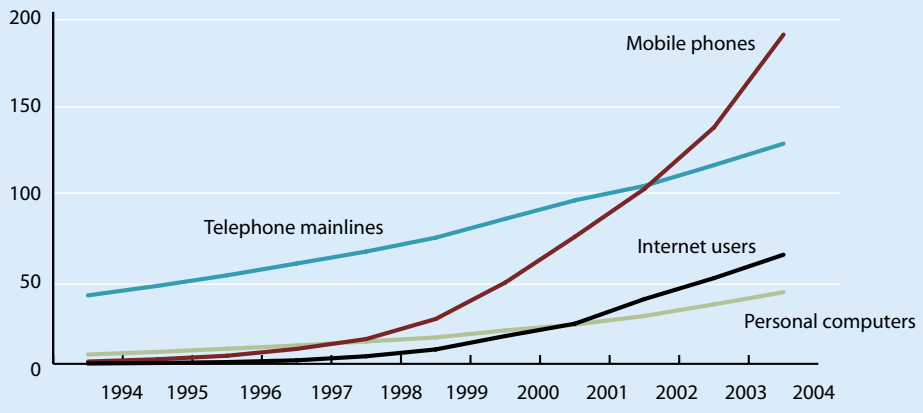
A key challenge related to the globalization of communications and knowledge is the need to respect local, traditional, and indigenous cultures and to promote diversity. Many indigenous cultures emphasize the symbiotic relationship between nature and humans—but they are increasingly challenged by the spread of dominant or homogenized cultures which often do not highly value such relationships.



Electronic waste is becoming a serious environmental issue in both developed and developing countries.
Source: H. Schmidbauer / Still Pictures

Economic globalization and technological globalization have been accompanied by, and have contributed to, some measure of *political globalization*. Since its establishment in 1945, the United Nations (UN) system has been evolving in response to changing global realities. Through the work of a myriad of agreements, arrangements, treaties, and institutions including UN agencies, political globalization has responded to and in turn facilitated the globalization of economics, technology, and governance.

Figure 3: Information and communications users in low and middle income economies (per 1 000 people)



Source: World Development Indicators 2006, The World Bank

Recent decades have seen the development of increasingly specific and legally binding rules on economic policy-making. Notable examples include the many rules and provisions enforced by the World Trade Organization, as well as the economic policy reforms that are often required by the IMF and the World Bank as part of structural adjustment and other policy-based lending programmes. Regional economic treaties and institutions include the European Union, the North American Free Trade Agreement, and the Central American Free Trade Agreement. Many of these have significant implications for the ability of individual governments to address environmental and social challenges related to economic policies.

In many quarters, governance is no longer viewed as the domain of governments alone. Civil society and the private sector are becoming increasingly engaged in international diplomacy and policy issues. The number of international non-governmental organizations (NGOs) grew rapidly over the last century, climbing from 176 in 1909 to nearly 30 000 in 2004 (Union of International Associations 2006) **(Figure 4)**. Prominent among them are groups devoted to human rights, peace, women's rights, environmental issues, and development. The number and scale of transnational corporations has also climbed rapidly in recent decades, rising to an estimated 77 000 today, acoounting for over US$20 trillion in annual sales (UNCTAD 2006).

In the environmental sphere, political globalization has led to numerous environmental treaties over the last several decades. These cover shared environmental resources and concerns including trade in endangered species, the spread of hazardous chemicals, the steady loss of the Earth's biological diversity, the proliferation of air pollutants, management of oceans and fisheries, and the threat of climate change (see Indicators section).

LINKING GLOBALIZATION, ECOSYSTEM SERVICES, AND HUMAN WELL-BEING

The perspective of ecosystem services offers fresh insights into the links among globalization, the environment, and human well-being, as well as the challenges arising from these linkages. A better understanding of these links and challenges can strengthen the design and implementation of responses to maximize the benefits of globalization, while minimizing the negative effects.

The Earth's ecosystems provide humans with essential services, ranging from water purification and waste treatment to the provision of food, fibre, and genetic resources. The Millennium Ecosystem Assessment (MA) is currently the most comprehensive knowledge base on the links between ecosystem services and human well-being. The MA identified four main classes of ecosystem services—provisioning, regulating, supporting, and cultural services—and clearly showed how these are linked to various aspects of human well-being **(Figure 5)**. The MA emphasizes that human well-being involves far more than just material wealth and should be considered as a multi-dimensional concept encompassing health, security, social relations, and the extent to which individuals have the ability and the opportunity to achieve their aspirations.

The MA found that 15 of the 24 major ecosystem services examined in the assessment are being degraded or used unsustainably. The degradation of these services often causes significant harm to human well-being. For instance, environmental degradation affects human health through the spread of vector-borne diseases and the incidence of respiratory illnesses. Human security is threatened by conflicts over natural resources (see Africa section), while conflicts themselves can lead to environmental degradation and the loss of other ecosystem services (see West Asia section). Importantly, the costs of such degradation are often borne disproportionately by the poor and they represent a barrier to the achievement of the Millennium Development Goals.

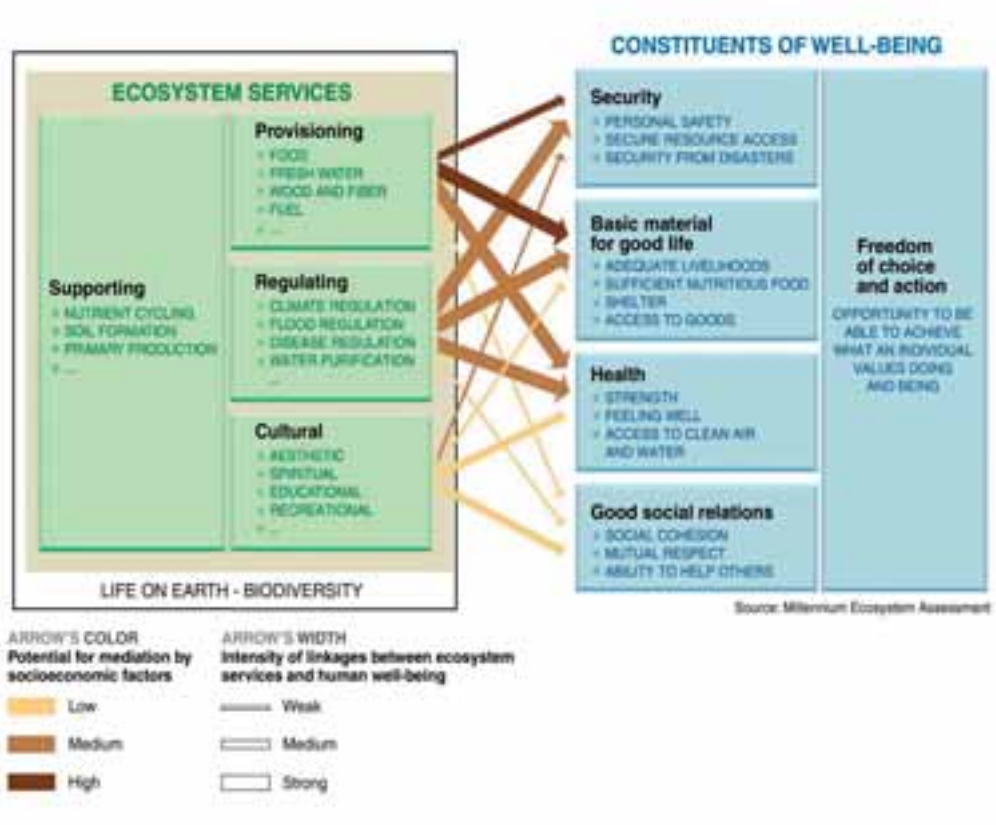
The links among globalization, ecosystem services, and human well-being are complex. The forces of

These minefields in Nicaragua have rendered this land unusable
Source: Jorgen Schytte / Still Pictures

Figure 4: Trends in number of active international organizations: 1900-2004

Source: Union of International Associations

Figure 5: Linkages between ecosystem services and human well-being



The strength of the linkages and the potential for mediation vary in different ecosystems and regions. In addition to the influence of ecosystem services on human well-being depicted here, other environmental (as well as economic, social, technological, and cultural) factors influence the balances. And ecosystems are in turn affected by changes in human well-being.

Source: MA 2005

Shared between Bangladesh and India, the Sundarbans region of the Ganges delta contains the largest mangrove ecosystem in the world.

Source: SHEHZAD NOORANI / Still Pictures

globalization can affect ecosystem services in both beneficial and harmful ways and they can affect different ecosystem services in different ways. It is inadequate to view the environment simply as a natural resource base influenced by globalization through economic growth and material prosperity alone (see Latin America and the Caribbean section).

Globalization trends have increased the provision of some ecosystem services that benefit human well-being, such as crops and livestock. At the same time they have led to declines in other critical ecosystem services including water supply, natural hazard protection, genetic resources, and the biodiversity that underpins all ecosystems. These trade-offs among different ecosystem services affect human well-being—often as gains for some groups of people and losses for others.

These complexities are evident in the case of mangrove ecosystems, which are increasingly threatened by conversion to aquaculture. The increase in aquaculture production from converted mangrove lands has been at the expense of other ecological services provided by intact mangrove ecosystems such as water filtration, soil retention, flood prevention, and sheltering of juvenile fish. In many cases, the trade-offs among these services are not fully assessed when decisions on mangrove conversion are made (Box 3).

Terrestrial ecosystems are also feeling the impact of globalization's reach. Transformation of terrestrial ecosystems, mostly to croplands, accounts for a significant proportion of ecosystem change since 1950. Only landscapes that are inaccessible or relatively unsuited to agriculture have remained comparatively intact (MA 2005a). This global trend in conversion of land for cultivation continues—with a focus now on tropical agriculture.

Large-scale, industrial production of beef, soybeans, cotton, and biofuels is expanding into the tropical latitudes of Latin America and could soon reach tropical Africa. A similar expansion of oil palm cultivation is occurring in Southeast Asia (Figure 6). Together with the spread of agricultural biotechnology, these trends represent what may be the most important agricultural transition since the

Box 3: Aquaculture, mangroves, and ecosystem services

Around 35 per cent of the world's mangrove area has been lost, according to the MA estimate based on data from countries which account for half the global area of mangroves. One reason for the loss has been the rapid growth of the shrimp sector driven by global demand. Many governments in tropical and sub-tropical regions have provided incentives for small and big businesses to move into shrimp farming, notably in India, Sri Lanka, Thailand, and Vietnam—but also in some countries in Latin America and Africa. This combination of a growing global market and government incentives has led to a massive conversion of mangrove lands to shrimp aquaculture.

These changes have mixed effects on human well-being, given the gains and losses in different ecosystem services. In the case of Thailand, the total economic value of an intact mangrove ecosystem offering a suite of ecosystem services has been estimated to be US$1 000 per hectare, compared to only around US$200 per hectare when completely converted to shrimp farming.

Importantly, the distribution of these gains and losses, and the corresponding impacts of human well-being, has been uneven. The well-being of some social groups has improved, particularly those who have benefited through increases in material wealth from aquaculture, such as owners of large farms. Small farms have also benefited, but many of them only in the short run. Once problems emerge due to disease from polluted water—a byproduct of the shrimp farms—many small farmers face financial ruin.

These private economic gains have to be measured against the losses of the ecosystem services provided by intact mangroves. Mangroves provide many provisioning services, including serving as important sources of construction materials and biomass fuels. Mangrove ecosystems host a variety of medicinal plants which are used by local communities and provide nurseries for many fish and shrimp species, including many commercially important fisheries.

Mangroves also provide critical regulatory ecosystem services in terms of shoreline protection. Recent studies of the 2004 tsunami indicate that in Sri Lanka areas with healthy and intact mangrove ecosystems suffered less damage than areas with degraded or destroyed mangrove ecosystems. In these ways, the security and livelihoods of local coastal communities dependent on the services from intact mangroves has been reduced, representing a loss of human well-being.

However, the negative trends observed to date do not need to continue. Numerous studies show that with proper land and water management, including buffer zones of intact mangroves, aquaculture can be sustainable and mangrove ecosystems can continue to deliver other valuable provisioning, regulating, and supporting services.

Sources: MA 2005, Sathirathai and Barbier 2001, Duraiappah 2003, Ellison 2000, UNEP 2006, Hiraishi and Harada 2003

Figure 6: Conversion of forested areas into palm oil plantations in Papua, Indonesia

Indonesia is the second largest producer of palm oil in the world, after Malaysia. The drive to meet the demand for palm oil is resulting in conversion of forested areas into palm oil plantations. These satellite images reveal how a combination of transmigration, logging interests, and palm oil plantation development have transformed an area that was previously tropical lowland rain and forest. The 1990 image shows the first signs of development in this region, with the jagged access road network forming the only break in the forest cover. The 2002 image clearly shows a checkered pattern of plantations in the primary development area, and the extension of the road network to the north, south, and southwest.

Source: USGS

Green Revolution (Nepstad 2006) **(Box 4)**. The main driver of these changes is the growing global demand for agricultural products such as soy for ration-fed livestock and palm oil for both edible and inedible products in China and other emerging economies. The rising price of fossil fuels coupled with growing concerns about climate change are pushing demand for sugar cane, corn, soy, palm oil, and other crops that can be used to make biofuels (Nepstad 2006) (see Latin America and the Caribbean section).

While increasing production from these ecosystem provisioning services continues to improve the well-being of involved groups, this 'tropical agricultural revolution' carries with it important new threats to ecosystems in the tropics. Trade-offs include the loss of biodiversity, carbon sequestration, water regulation, and soil protection from the clearing of tropical landscapes, as well as health impacts such as from the smoke haze from slash and burn forest clearing which envelops much of Southeast Asia periodically (Nepstad 2006).

The global dimensions of the tropical agricultural revolution are perhaps even greater than for mangroves, given the scale of the ecosystem conversion taking place and the global ramifications of the increases in agricultural production with corresponding reductions in other ecosystem services. Again, the trade-offs among these various services and the distribution of consequences for

human well-being among different groups of people are often not fully considered in the decisions being made. However, the management of affected ecosystems can be improved— and in some cases those improvements are already being made.

MANAGING GLOBALIZATION TO PROTECT ECOSYSTEM SERVICES AND HUMAN WELL-BEING

The mismatch between ecological imperatives and prevailing economic practice must be reconciled if the world is to enjoy the benefits of globalization, while avoiding a further unravelling of critical ecosystem services in the decades ahead. Fortunately, diverse actors are already responding to globalization's challenges for ecosystem health and human well-being in innovative ways and in multiple realms.

In Brazil crops are grown to produce biofuels for use in vehicles.
Source: Joerg Boethling / Still Pictures

Box 4: Managing the 'tropical agricultural revolution'

The tropical agricultural revolution brings with it new opportunities for sustainable ecosystem management and poverty reduction. The rising environmental and social standards sought by many importers and consumers of agricultural commodities can offer a strategy for reducing the negative ecological and social impacts of this transition.

Motivated by corporate risk aversion, consumer demand, and other factors, the higher standards for environmental and social performance that are emerging within the commodity marketplace are felt by producers even in the agricultural hinterlands of the Amazon rainforest through a variety of channels. When the International Finance Corporation extended a US$30 million loan to one of the world's largest soy producers, the Brazilian Grupo André Maggi, it came with conditions attached. The five hundred Amazon and Cerrado soy producers who received pre-harvest financing through the loan to Maggi were required to demonstrate their compliance with environmental and social legislation and their steps towards the implementation of responsible agricultural practices.

In response to such requirements, the Round Table on Responsible Soy culminated its initial stakeholder consultations with the creation of an institution that will develop international social and environmental standards for the responsible production of soybeans. This initiative already enjoys commitments from major buyers of soy who will buy only from 'responsible' soy producers once the certification system is in place. These buyers include the European Union's animal ration industries, purchasers of 40 million metric tons of soy each year (three quarters of the Brazilian harvest). Similar pressures are being felt in the global palm oil industry, particularly in Southeast Asia, with the Round Table on Sustainable Palm Oil now growing in prominence.

There are some important obstacles to transforming these global pressures for improved environmental and social performance of food commodity producers into large-scale improvements in the protection of ecosystem services, the observance of sound labour practices, and the provision of social benefits through the tropical agriculture revolution. Since compliance with legislation is one of the cornerstones of responsible production systems, the costs of socio-environmental certification can become prohibitively high to aspiring producers. For example, when Brazil increased the mandatory forest reserves from 50 per cent to 80 per cent of private properties in the Amazon in 1998, it may have raised the environmental bar too high for current market realities. For many producers, compliance with this legislation was not economically viable in the absence of sharp increases in the prices of their products.

Despite these obstacles, the elements of a strategy are emerging for defending services provided by natural ecosystems and promoting greater social benefits within the new agro-industrial landscapes of the tropics. It is possible to imagine a future in which diverse agricultural regions are competing among themselves to produce soy, palm oil, beef, sugar cane, and other products with the highest environmental and social standards.

Source: Nepstad 2006

Developing markets for ecosystem services

Creative economic instruments can help manage ecosystem services threatened by globalization forces. Creating markets for ecosystem services is increasingly recognized as one such tool. These instruments can generate financial resources, channel funds to environmentally sound technologies, create incentives for investment, and increase the involvement of the private business sector in environmental management.

Some eminent economists argue that the carbon sequestration value alone of tropical forests may be worth tens if not hundreds of billions of dollars a year (FSC 2006). Currently the countries and communities whose forests provide this service are left uncompensated for the pollution they remove and the economically damaging climate change they avert.

Payments could take various forms, depending on whether they are part of a publicly funded programme, the result of a self-organized private deal, a trade under a regulatory cap, or part of an eco-labelling or carbon offset programme. The scale of implementation of payments schemes varies according to the services under consideration. Transactions in water-related services such as sediment control are found at local and regional levels while carbon sequestration mitigation arrangements, such as those to be channelled through the Kyoto Protocol's Clean Development Mechanism, apply at the global level.

For example, in Costa Rica, hydro-electric companies pay communities upstream not to cut down trees. It makes economic sense because deforestation destabilizes the soil and can trigger the siltation of

dams. There may be opportunities to extend current payments for ecosystem service systems to manage other natural resources in a more sustainable manner.

One example of an effort to ensure payment for ecosystem services involves the Panama Canal, through which 278.8 million metric tons of internationally traded goods moved between the Atlantic and Pacific Oceans in 2005 (Panama Canal Authority 2006). The canal uses water from upland reservoirs to buoy ships up and over the isthmus cordillera. The dams that create the reservoirs also serve as power generators for the region. Over the last few decades deforestation around the high reservoirs has led to a number of problems for the Panama Canal system—especially a shortage of water in some seasons.

Environmentalists, scientists, and concerned governments agree that the watersheds should be reforested but funding is a problem. A creative solution to reforesting the slopes surrounding the Canal's reservoirs comes from a forestry reinsurance company. To pay for the reforestation the reinsurance company proposed a financial market for shippers that depend on the canal. In this scheme, insurance and reinsurance partners underwrite a 25-year bond to pay for the reforestation and ask their clients to buy the bond in exchange for reduced premiums. Firms that insure against the huge losses they would suffer if the canal were closed are paying for reforestation through the 25-year forest bonds and compensate on their books with lower insurance premiums (UNEP 2005).

A container ship moves through the Miraflores locks of the Panama Canal which are supplied with fresh water from upland reservoirs to float the ships.

Source: Rainer Heubeck / Still Pictures

In the light of the deteriorating trend in ecosystems highlighted by the MA, efforts to create markets for ecosystem services will take on a greater role in the future in providing incentives for conservation and sustainable use of ecosystem services. This is largely a welcome development, but it is important to note that traditionally markets are not designed to address issues of poverty and inequality. Therefore, when designing markets for ecosystem services, equity issues must be specifically examined and addressed.

Promoting environmentally sound technology

Many countries are seeking another opportunity offered by globalization: that of becoming leaders in the global marketplace for cutting-edge green technologies (see Nanotechnology section). China, for example, has become the world's largest manufacturer of energy-efficient compact fluorescent light bulbs, in part through joint ventures with lighting firms based in Hong Kong, Japan, and the Netherlands (French 2006). Solar energy has also become a growth industry in China, so successful that the seventh richest man in the country is a manufacturer of silicon photovoltaic solar cells (Friedman 2006). And India has become a major manufacturer of advanced wind turbines for use both domestically and in overseas markets (Bradsher 2006).

Many people in countries with unreliable or unavailable power grids are installing small-scale independent energy sources to meet their needs. Renewable energy technologies have evolved, costs have come down, and small-scale solutions—such as solar photovoltaics, solar hot water, and biogas digesters—have been successfully commercialized in some parts of the world. But broad uptake of these technologies is still modest. The International Energy Agency (IEA) has projected that by 2030—in the absence of vigorous new policies—1.6 billion people will still be without access to electricity and 2.6 billion will continue to cook and heat with traditional and polluting forms of biomass supply (IEA 2002). To address the energy access challenge, more needs to be done to incorporate renewable technologies into the energy mix, including the introduction of new financing instruments (Box 5).

Box 5: Financing renewable energy technologies

If renewable energy technologies are to be widely adopted even in poorer countries, bold new approaches will be needed to overcome financial constraints and policy inertias. One way of facilitating adoption of new technologies is for lending institutions to offer loans for small-scale investments in the technologies.

To advance the use of renewable energy sources, credit support programmes are being piloted which help local banks build their first clean energy loan portfolios in countries where the growth of such schemes has been constrained. In addition to scaling up use of renewable energy technologies at local and national levels, these projects aim to build experience and transfer best practice across countries and regions, as well as to influence national policy-makers.

In 2003 a partnership was established, including two of India's largest banking groups, to provide consumer financing for solar home systems at preferential interest rates. The programme provides these banks with an interest rate subsidy, marketing support, and a vendor qualification process. In three years the programme has financed 17 310 solar home systems which together supply energy to over 100 000 people. In 2003 the solar home sector was largely a cash-only business but in 2006 over half of sales were financed through the original partners and other banks that have now entered the market. A similar loan programme is underway in Tunisia for solar water heaters.

An interesting lesson from these programmes is that there can be an effective feedback loop from the actions of the banking community to policy makers. When banks begin to scale up lending to the renewable energy sector it sends a positive signal to policy makers that the technology is mature and ready to play a significant role in the country's energy mix. This contradicts the conventional wisdom that investment only engages once the right policies are in place. Instead, financing and policy development can evolve in parallel, with each institution influencing the decisions and actions of the other.

Source: UNEP 2003

Women in India walk past power generation installation driven by winds from the Bay of Bengal.
Source: Joerg Boethling / Still Pictures

Utilizing information, communications, and monitoring technologies

Information and communications technologies are a key component of globalization, offering substantial opportunities to promote environmental quality and human well-being through capacity building and electronic networking.

Civil society organizations have learned to use the new tools of the information age to organize themselves into effective cross-border alliances. The Climate Action Network, for instance, has been a tenacious player in the international climate negotiations for more than a decade (CAN 2006). The Third World Network has helped developing-country NGOs to gain a voice in international deliberations in diverse arenas, from the annual World Economic Forum held at Davos, Switzerland to the United Nations and the WTO (TWN 2006).

Information and communications technologies also have the potential to save countless lives as they become increasingly used to disseminate disaster alerts and early warnings. Similarly, new environmental monitoring technologies and processes offer promising pathways to a better understanding of the environment and wiser management of the Earth's resources. Remote sensing satellites now provide a continuous stream of data. They are capable of rapid and effective detection of environmental hazards such as transboundary air pollutants, wildfires, deforestation, changes in water levels, and the extent of natural and anthropogenic disasters. Satellite tracking systems can also be used as part of enforcement to help reduce illegal logging, for example.

Within the last decade new observing systems have emerged that integrate data collected in the field with satellite-based observations for modeling and analysis of components of the Earth system. These include the observing systems dedicated to climate, ocean, terrestrial, and atmospheric phenomena. More recently, in February 2005, the Group on Earth Observations was established with the purpose of building a coordinated, comprehensive, and sustained Global Earth Observation System of Systems by the year 2015. With rapid advances in data collection, analysis, visualization, and dissemination techniques, it is now relatively inexpensive to deliver useful environmental information on a regular basis to a global audience.

A family in Pakistan uses a solar/windup radio to stayinformed after the 8 October 2005 earthquake.
Source: Mark Edwards / Still Pictures

One example is Brazil's National Institute for Space Research (INPE), which has been applying satellite technology to observe and monitor the state of the Amazon forests for many years. As the technology continues to advance, scientists and decision makers can more accurately and quickly assess the deforestation rate in the Amazon. Building on the results of a research partnership with the University of Maryland-College Park and South Dakota State University, INPE has developed a new monitoring application for detection of deforestation in the Amazon known as the Real Time Deforestation Monitoring System, based on data from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) **(Figure 6)**.

Although these new initiatives are promising on many levels, some hurdles remain before they can be used to maximum effect. Key challenges include technological capability gaps between developed and developing countries; issues related to ownership, intellectual property rights, and acceptance of the new technologies; and questions about incorporation of traditional knowledge, sustainability of observing systems and networks, and equity of access to them.

Strengthening environmental governance

Globalization in its many guises poses enormous challenges to governance structures at the local, national, and global levels. Key issues include:

- market failures such as externalities (benefits or costs to third parties that are not included in the market price of goods or services);
- policy shortcomings such as perverse incentives (subsidies, tax structures, and grants that have the side-effect of encouraging environmentally damaging activities); and
- institutional failures such as weak property rights (applying to commons like traditional pastures, the open seas, and the atmosphere).

Students in Sumatra map out community borders using a global positioning system.
Source: Mark Edwards / Still Pictures

Figure 6: Use of satellites to monitor Amazonian deforestation

One example of the benefits delivered by globalized observation and communications technology is the use of satellite data to monitor environmental change. Here, detection of deforestation in northeastern Mato Grosso, Brazil, is shown in yellow for 2002, blue for 2003, and red for 2004. Remaining forest cover in 2004 is shown in green. Background values for non-forested regions are Normalized Difference Vegetation Index (NDVI) values from the MODIS 16-day composite from 8-23 May 2004. Data from NASA's Moderate Resolution Imaging pectroradiometer (MODIS) aboard the Terra and Aqua satellites and high resolution Landsat satellite.

Source: Doug Morton, University of Maryland-College Park

Recognition is growing among many people and governments that an overarching cause of these threats is the lack of integration and coherence between different policy frameworks reflecting diverse societal objectives.

National governments by themselves are ill-suited for managing environmental problems that transcend borders, whether by air and water currents or through global commerce. Yet effective international environmental governance is still in its infancy. The treaties and institutions that governments turn to for global management are often too weak to respond adequately to the problems (Speth 2003). Nonetheless, recent decades have seen a steady expansion in the number of countries that are party to Multilateral Environmental Agreements (MEAs) (see Indicators section). And, despite their shortcomings, the MEAs and their progressive adaptations collectively form one of the best opportunities available today for managing some of the world's most widely recognized but poorly addressed global and trans-boundary environmental issues.

The 1987 Montreal Protocol on Substances that Deplete the Ozone Layer is often cited as one of the most effective of the MEAs. The story of its implementation provides pointers to several criteria which have contributed to its success—many of them closely linked with globalization **(Box 6)**.

In addition to the MEAs, several international institutions are key actors in the current system of global environmental governance, including the United Nations Environment Programme (UNEP), the United Nations Development Programme, the Global Environment Facility, and the World Bank. There has been a lively debate in recent years about how to make international environmental governance work as effectively as possible. Current attention is particularly focused on the important recommendations contained in *Delivering as One*, the report of the Secretary-General's High-level Panel on UN System-wide Coherence in the Areas of Development, Humanitarian Assistance, and the Environment. The Panel's report, issued in November 2006, recommended that the system of international environmental governance should be strengthened and made more coherent; the UN Environment Programme should be upgraded with real authority as the UN's 'environment policy pillar', multilateral environmental agreements should continue to pursue efficiencies and coordination among themselves, and there should be an independent assessment of international environmental governance within the UN system (UN 2006).

In recent years, nations have granted significant and growing powers to global economic institutions such as the World Trade Organization (WTO), the World Bank, and the International Monetary Fund (IMF). The World Bank and the IMF in particular were strongly identified with the so-called 'Washington Consensus' of the 1980s and early 1990s, which held that economic policies such as trade and capital market liberalization were the best path to economic and social development (Gray 1988). Joseph Stiglitz, a former World Bank Chief Economist, voiced the widespread opinion that these policies concentrated "too much on just an increase in GDP, not on other things that affect living standards." Stiglitz also argued that international financial policies "focused too little on sustainability—on whether growth could be sustained economically, socially, politically, or environmentally" (Stiglitz 2006).

Steps have been taken at each of these organizations in recent years to incorporate environmental issues and sustainable development concerns into their activities. The World Bank, for instance, adopted a new Environment Strategy in 2001 that has the goal of integrating sound principles of environmental sustainability in all investment policies, projects, and programmes (World Bank 2001). With the objective of minimizing clashes between trade and environmental rules and to promote synergies between them, in November 2001 governments agreed in Doha, Qatar, to hold talks on selected environmental issues as part of the Doha Round of world trade talks. Among the issues on the table are:

- the trade implications of environmental labelling requirements;
- the relationship between WTO rules and trade measures contained in multilateral environmental agreements;
- the effect of environmental measures on market access;
- efforts to reduce fishing subsidies; and
- tariff and non-tariff barriers to trade in environmental goods and services.

To date there has been little substantive progress on any of these issues, except fisheries subsidies (Box 7).

Involving civil society and the private sector

Recent years have seen growing recognition of the importance of involving relevant stakeholders in international policymaking and governance. The right of various major groups of non-governmental and other organizations, including indigenous peoples, the private sector, trade unions, and women's groups to participate in international policymaking was formally recognized at the 1992 Rio Earth Summit and has since been institutionalized at the UN Commission on Sustainable Development, at UNEP, and in many other environmental policy arenas (UN 2002). Efforts are underway at the World Bank, the IMF, and the WTO to promote greater engagement with civil society and other actors.

International institutions are also increasingly taking steps to involve the private sector in their work.

Box 6: Protecting the ozone layer

The stratospheric ozone layer protects ecosystems and all life on earth from the damaging effects of solar ultraviolet radiation. When scientific evidence showed that certain man-made chemicals were depleting this layer the global community responded rapidly by adopting the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987. The Montreal Protocol provides cradle-to-grave management of these ozone depleting chemicals by requiring Parties to phase out their production and consumption according to agreed timetables. Providing countries fully meet their Montreal Protocol obligations, the ozone layer is expected to repair itself through natural processes and return to its pre-Montreal Protocol level by 2049 over mid-latitudes and around 2065 over the Antarctic (see Polar section).

Ozone-depleting substances (ODS) are ubiquitous, having long been manufactured, used, and traded as part of the global economy. Chlorofluorocarbons, halons, carbon tetrachloride, and methyl bromide have been used in applications as diverse as refrigeration, foam blowing, industrial cleaning, fire extinguishing, soil fumigation, and cosmetic and pharmaceutical products. To phase them out, the Protocol is driving a global shift in consumption and production habits to more ozone-neutral equipment, chemicals, and practices through the support and active participation of multiple actors in industry, government, scientific bodies, and civil society.

Political support for the phase-out of ODS has been overwhelming. As of December 2006, the Montreal Protocol has been ratified by 191 countries and the European Community. Their collective effort has resulted in a total phase-out of nearly 95 per cent of all ODS by 2006 (see Indicators section).

The Protocol has accomplished this shift through various means. For example, the treaty controls ODS trade through mandatory national import/export licensing systems and bans or restrictions of ODS trade with non-Parties. In addition, the Protocol indirectly created a new international market for technologies that replace ODS, encompassing chemical products, equipment, and related services.

International support for developing countries has also proven to be critically important. Recognizing that countries have a common but differentiated responsibility to protect the global ozone commons, the Parties established the Multilateral Fund in 1991. This enables developing countries to comply with their obligations under the treaty by meeting agreed incremental costs. The assistance provided by the Fund, amounting to over US$2 billion as of April 2006, has enabled 139 developing countries to undertake over 5 250 ozone protection projects and activities.

Source: UNEP 2006

Box 7: Fisheries subsidies reform—an opportunity for the WTO

Seventy-five per cent of commercially exploited fish stocks worldwide are either depleted or threatened by over-fishing. Scientists predict that the world will run out of seafood by 2048, if marine fish stocks continue to decline at current rates. This would create serious threats to global food security, coastal water quality, and ecosystem stability, endangering the livelihoods of current and future generations (see Global overview section).

Nearly 40 per cent of fish and fish products enter world trade and over half of this amount originates from developing countries. Estimates suggest that around 30 million people derive their income directly from fishing activities, 95 per cent of them located in the developing world. Net revenues from fish exports earned by developing countries reached US$18.3 billion in 2003—more than the combined developing country net total for other food commodities.

Despite the importance of conserving fish stocks, there are immediate economic incentives to catch as many fish as possible. Available estimates suggest that commercial fishing fleets' overcapacity is as high as 250 per cent. Government subsidies to preserve shipbuilding and fishing jobs have been blamed for generating this overcapacity and the resultant over-exploitation of fish stocks.

Total fisheries subsidies worldwide have been estimated at US$20 billion per year, representing nearly 20 per cent of fishing industry revenue. This degree of support distorts patterns of production and international trade and artificially enhances the competitive advantage of subsidized fleets in regions of common fisheries resources. Non-subsidized fleets cannot compete against such odds. UNEP analysis has shown that under most real-world conditions—less than perfect management schemes and fully utilized fish stocks—subsidies have harmful and potentially irreversible environmental effects.

Developing countries have suffered disproportionately from the negative effects of subsidies, due to the sector's importance for income generation, employment, and food security. The damage is often compounded where local artisanal fisheries face competition with subsidized fleets from major and distant fishing powers.

At the 2002 World Summit for Social Development, heads of state placed international action on fisheries subsidies among the top eight priorities needed to achieve sustainable fishing and they singled out the WTO as the key forum for international action. Now there is broad agreement that reforming fisheries subsidy policies in the WTO provides a clear opportunity to deliver gains for the international trading regime while fostering sustainable development and protection of the environment.

The 2001 Doha Ministerial Conference first integrated fisheries subsidies into the negotiating mandate with instructions to 'clarify and improve' the WTO rules on fisheries subsidies. This mandate was solidified at the Hong Kong Ministerial Conference in December 2005. For the first time in the history of the WTO, the correlation between fisheries subsidies and problems of over-fishing and over-capacity was formally recognized—placing environmental concerns at the heart of trade negotiations. Ministers called for the prohibition of such subsidies. They also acknowledged that 'appropriate and effective special and differential treatment' should form an integral part of the negotiations, highlighting the sector's importance to poverty reduction, livelihoods, and food security concerns.

Substantial progress has been made since Hong Kong. Delegations have submitted a number of concrete proposals that clearly tackle the relationships among trade, environment, and development and suggest ways of prohibiting the most harmful subsidies.

However, considerable political and technical challenges still remain. First, negotiations must give more attention to the unique challenges faced by developing countries, including their over-exploited waters and their heavy dependence on income and employment in fisheries, as well as on international revenue from fisheries trade and fisheries access agreements. Second, governments must be required to disclose their fisheries subsidies, since the effectiveness of regulation depends on reliable enforcement, reporting, and transparency provisions. Finally, the actual rules must incorporate sustainability indicators such as the health of a fishery and the effectiveness of management systems. This will require drawing on available data and expertise outside the WTO and collaborating with bodies such as the FAO, Regional Fisheries Management Organizations, and UNEP.

Meeting these challenges will require WTO to go beyond its most familiar practices. In developing subsidies rules, the WTO will have to link with issues of sustainability without pushing its mandate beyond its limits. WTO fisheries negotiations offer a unique opportunity for the organization to realize the sustainable development objective contained in the WTO preamble. It is an opportunity to demonstrate that outcomes benefiting trade, environment, and development are not just rhetoric—they are realistic and attainable.

Sources: Worm 2006, FAO 2004 and 2006, UNEP 2002, 2004 and 2005.

For example, UN Secretary-General Kofi Annan unveiled the Global Compact in 2000, which calls on participating companies to "embrace, support, and enact" within their operations ten core values related to human rights, labour standards, environmental protection, and anti-corruption. Three principles guide participating businesses in regard to the environment—to take a precautionary approach to environmental challenges, to adopt initiatives to promote greater environmental responsibility, and to encourage the development and diffusion of environmentally sound technologies. By mid-December 2006, 2 400 companies had signed on, along with 600 other labour, academic, and non-governmental organizations (United Nations Global Compact 2006).

In many cases, corporations are acting independently to factor sustainability into their operations. In recent years there has been rapid growth, especially in developed countries, in the reporting of large corporations' social, environmental, and corporate responsibility performance. Environmentally sound standards like the International Standards Organization's ISO 14000 and new ones like the ISO 26000 on sustainability management are being adopted in growing numbers (ISO 2006) (see Indicators section).

Private financial institutions have taken important steps in recent years to integrate environmental considerations into their lending and investment. For example, in 2003, 17 leading banks from 12 countries adopted the Equator Principles, a set of voluntary guidelines for managing environmental and social risks in national and international lending operations. Participating Equator Banks agreed to require clients

Box 8: Forest certification

Natural forest ecosystems are of primary importance to human well-being and planetary health. Forests provide raw material for fuel and shelter. Forest ecosystems also supply watershed services (water quality, quantity, and rate of supply), soil stabilization and runoff control, air quality, climate regulation, carbon sequestration, biological diversity, recreation, non-timber products, and aesthetic values.

All these benefits are under threat. Between 1960 and 1990, 20 per cent of the world's tropical rainforest was destroyed. There have been long-standing efforts to reverse these trends. During the 1992 Environment and Development Conference in Rio de Janeiro many stakeholders worked to establish an international convention to control and reduce the rampant deforestation documented by researchers. A convention was never agreed but alternative approaches to managing forests and forest products in a sustainable manner have emerged, including the International Tropical Timber Agreement and its new successor agreement, the Intergovernmental Forum on Forests, as well as Forest Law Enforcement and Governance initiatives.

One of the most intriguing management tools is forest certification. Discussions about the possibility of certification and accreditation of forest products began seriously in 1990 and in 1993 the Forest Stewardship Council was founded to establish a programme to certify particular timber commodities as products of sustainable forests and sustainable forest practices.

Forest certification is an international market-based tool and relies on 'ethical consumers' exercising a preference for products labelled as sustainably produced. Forests certified under the scheme have to comply with the FSC's Principles and Criteria to demonstrate responsible forest management. To address the circumstances of small forestry managers and owners, especially those in tropical and less developed countries, the FSC established specific procedures which reduce costs of certification and streamline procedures for Small and Low Intensity Managed Forests.

Another approach that reduces costs and streamlines procedures for smaller producers is group certification, combining a number of small forest areas under a single group manager who follows the certification process. This scheme also provides benefits to individual group members by allowing assessments based on samples, thus reducing auditing costs.

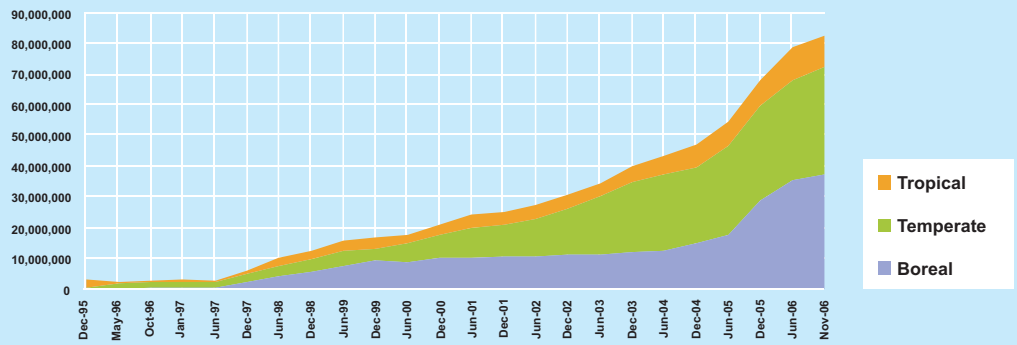
While the original driver for certification might have been uncontrolled deforestation in the tropics, its adoption has generally been most successful in the northern hemisphere in the temperate and boreal regions of the developed world. However, close to 13 per cent of total FSC certified forest area is now tropical forest, surpassing 10 million hectares in 2006.

In 2006, approximately 270 million hectares—7 per cent of the world's total forested area—are covered by certification schemes indicating that they are under a sustainable forest management regime. This is very significant growth since the Forest Stewardship Council issued that first certification in 1993. Today, FSC certification covers 28 per cent (approximately 75 million hectares) of the total area of certified sustainable forests. Over the last year alone, FSC certification has increased by one third, amounting to an additional 20 million hectares.

Forest certification is also practiced by the Canadian Standards Association, which covers 26 per cent of the total area of certified sustainable forests, and the Programme for Endorsement of Forest Certification covering 23 per cent.

Sources: UNECE and FAO 2006, FSC 2006

Increase of FSC Endorsed Forest over Time (Dec '95 – Nov '06)



The timber from this certified forest in Brazil is destined for the Faber Castell pencil production plant in Sao Carlos.
Source: Joerg Boethling / Still Pictures

borrowing money for large projects, such as dams and power plants, to adhere to the World Bank's environmental and social standards, which are rapidly developing into widely accepted international baselines for both public and private investments (French 2004). The number of signatories to the Equator Principles has since risen to 45 (Equator Principles 2006).

In a somewhat similar initiative aimed at private equity investors, UNEP helped broker the Principles for Responsible Investment (PRI), which were publicly launched in April 2006 by the UN Secretary-General at the New York Stock Exchange. As of December 2006, 54 institutional investors and 52 investment management companies, together controlling more than US$5 trillion in assets for potential investment, have endorsed the PRI, which promote the integration

of environmental, social, and corporate governance considerations into their investment activities (UNEP 2006, PRI 2006).

Recognition is growing that innovative partnerships between diverse stakeholders—including businesses, labour unions, NGOs, and inter-governmental institutions—can help to bring about concrete results. This approach was endorsed at the 2002 World Summit on Sustainable Development, which generated more than 230 partnership agreements dedicated to achieving the sustainable development targets that were agreed in in Johannesburg (UN DSD 2003).

A related concept is the notion of 'global public policy networks'—joint initiatives involving NGOs, businesses, national governments, and international institutions in which some or all of the parties come together to forge international guidelines or standards for specific activities in which they have relevant knowledge and a large stake in the outcome (Reinicke and Deng 2000) These transnational networks are by definition flexible and loose gatherings of experts rather than formally-negotiated intergovernmental treaties and institutions. Examples include the World Commission on Dams, the Millennium Ecosystem Assessment, and the REN 21 network formed in 2005 to promote the development of renewable energy worldwide (REN21 2006, Worldwatch Institute 2005).

Certification programmes are another important form of multi-stakeholder initiative. These schemes harness consumer power through the use of market-based tools aimed at improving the management of ecosystems, while creating additional markets for environmentally sound goods and services. The pioneer was the Forest Stewardship Council (FSC), an independent body established in 1993 to set standards for sustainable forest production through a cooperative process (Box 8).

A Marine Stewardship Council (MSC) modelled on the FSC was created a few years later. So far, 19 fisheries have been certified for meeting the MSC's environmental standard of being well-managed

Box 9: Sustainable tourism in Southern Africa

As well as the movement of goods and services, a significant aspect of globalization is increasing human movement across the globe in migration and tourism, with significant environmental impacts. New initiatives are emerging to harmonize tourism with sustainable development.

Africa has become a prime destination for tourists from around the world. In 2004 tourism brought more than 33 million people to Africa who spent nearly US$19 billion (UNWTO 2005). Sustainable tourism—a type of tourism that strives to preserve the landscapes, biodiversity, and cultures that draw the tourists in the first place—is on the economic agenda of most countries on the continent.

After a multinational signing in December, the establishment of the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) will allow a number of initiatives to progress, linking protected areas within the region and increasing tourism potential and related development (see Africa section). The initiative will support micro, small, and medium enterprises to increase local benefits from conservation. The Kavengo-Zambezi TFCA is one of seven current TFCAs linking nine Southern African countries in an effort to maximize tourism opportunities.

Transfrontier Conservation Areas of Southern Africa could form nodes for planned tourist corridors.
Source: Peace Parks Foundation 2006

This new effort provides a keystone for the Southern African Development Community (SADC) effort to preserve transfrontier conservation areas. SADC's 1999 Protocol on Wildlife Conservation and Law Enforcement describes a TCFA as "the area or component of a large ecological region that straddles the boundaries of two or more countries, encompassing one or more protected areas as well as multiple resource use areas."

The Peace Parks Foundation and the government of South Africa are promoting 'The TFCA Route'—a trail linking the Atlantic and Indian Oceans that traverses the conservation areas. The initiative plans to prepare a development corridor for visitors attending the 2010 Football World Cup in South Africa, creating jobs and building capacities within adjacent communities while upgrading accommodation and other services. Southern Africa anticipates facilitation of travel routes between countries through use of a single SADC regional visa by 2008.

Certification of sustainable tourism or ecotourism services is not a unified or centralized process in 2006, although discussions are underway to establish standards and benchmarks for a global system. National Geographic's Center for Sustainable Destinations provides documentation on various initiatives, reports, and services.

Sources: UNWTO 2005, Suich and others 2005, Peace Parks Foundation 2006, National Geographic 2006

and sustainable, including the Alaska salmon fishery, the New Zealand hoki fishery, the Western Australian rock lobster fishery, and the South African Hake fishery (MSC 2006). Hundreds of seafood companies working with fish from these sources have achieved Chain of Custody certification that guarantees traceability of MSC-labelled seafood, ensuring that it has been separated from non-certified product at every stage from boat to table. In the last ten years, programmes that certify the sustainability of practices and products have extended from goods to services, including a certification programme for eco-tourism sites (see LAC regional report) **(Box 9)**.

A priority for the future is to broaden such schemes to cover other natural resources that are traded internationally, such as minerals and biofuels, and to do so in a way that ensures developing country producers have equal opportunities to secure this type of certification and the additional market shares or price premiums that may result from them.

CONCLUSION

Globalization is unfolding alongside growing evidence of serious degradation of the world's ecosystems. It is becoming increasingly urgent for policy-makers, leaders in business, and civil society—and all other decision-makers whose deliberations affect the management of ecosystems—to consider the implications of these converging trends. Yet, the evolving rules and practices of the global economy do not as yet pay sufficient regard to reversing trends which are negatively affecting the global environment.

The many promising examples and initiatives discussed above show that there are numerous ways to influence the forces of globalization to **protect valuable ecosystem services** and **enhance the well-being** of all who depend upon them. In many cases, there will be **trade-offs**—gains in some ecosystem services or for some groups of people, offset by losses in other services or for other groups. Innovative solutions can create **mutual benefits** where there are gains to be had all round. But often, **hard decisions** will have to be made with regard to choosing a particular set of benefits along with the costs that they entail. The key is to understand that there are **real choices** to be made, and to be fully cognizant of the **consequences and ramifications** of each decision.

Given the powerful forces of economic globalization, instruments such as **markets for ecosystem services** can be designed and implemented to achieve economically efficient outcomes for managing ecosystems. Such instruments will need to take into account the limitations of markets, as well as the equity and distributional aspects of market outcomes.

Technological globalization also offers many opportunities for introducing and promoting **environmentally sound technologies**. Technology can improve the quality of available information and make that information more easily accessible for decision-making. Significant challenges remain with regard to building capacity to develop and use new technologies. At the same time, precautionary approaches may be warranted when uncertainties remain on the effects of the introduction and widespread use of new technologies.

Furthering the use of markets and technologies would most effectively proceed hand in hand with **strengthening environmental governance** in the context of political globalization. Success stories on tackling global environmental problems exist, but much progress remains to be made with respect to putting environment at the centre of the sustainable development agenda. At all levels and across all sectors, recognition of the importance of ecosystem services for human well-being is critical. **Partnerships including civil society and business and industry** are an essential complement to strengthened governance.

What is needed, ultimately, is an intelligent globalization path—grounded in the will to transform innovative ideas into practical realities and predicated on the respect for nature and common humanity that unites us all.

Tourists enjoying a bike ride take in the sunset at Mashatu Game Reserve Botswana
Source: Still Pictures

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EMERGING CHALLENGES

Nanotechnology and the environment

Source: Donna Sheppard/ Light up the World Foundation

- Introduction
- The environmental benefits of nanotechnology
- The environmental risks of nanotechnology
- Looking ahead

Nanotechnology and the environment

Nanotechnology has enormous potential for social, economic, and environmental benefits—from innovative medical techniques to savings on materials and energy, as well as advances in detection and remediation of pollution. However, with environmental impacts as yet largely unknown and public controls largely absent, more systematic research and sector-specific policies are necessary.

INTRODUCTION

Nanotechnology is a field of applied science concerned with the control of matter at dimensions of roughly 1 to 100 nanometres—one nanometre is one-billionth of a metre **(Box 1)**. The appeal of nanoparticles is that they can be engineered to function in ways that naturally occurring materials do not. Their large surface area per unit volume and enhanced chemical reactivity can be exploited in novel applications.

Reseacrhers in nanotechnology anticipate that it will have profound effects on industry and technology, human health, social and economic development, and the environment. Public and private investments in nanotechnology are significant and increasing because of its potential to transform sectors as diverse as medicine, manufacturing, energy, water supply, and transportation.

Nanotechnology is poised to become a major element in the global economy. In 2004, nanotech products accounted for less than 0.1 per cent of revenue from manufacturing. By 2014 they are projected to account for 14 per cent, totaling US$ 2.6 trillion—a figure that will match the information technology and telecommunication industries combined (Lux Research 2004).

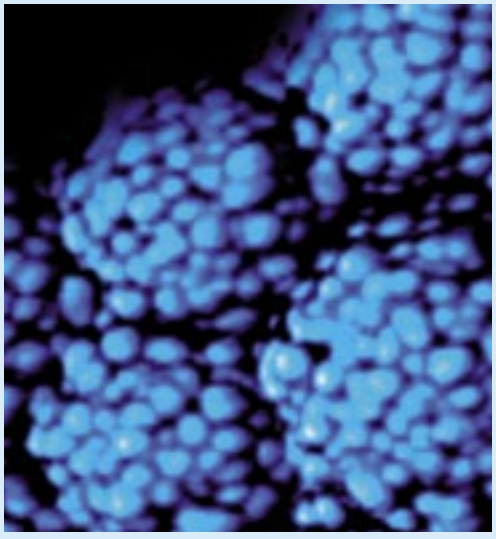
Currently the private sector funds about half the research expenditures in nanotechnology. To date, the majority of nanotechnology research is being carried out by countries belonging to the Organization for Economic Co-operation and Development (OECD). However, a growing number of emerging economies such as Brazil and Thailand are making it a priority (Millennium Project 2005).

As with most new and evolving technologies, there is a great deal of emphasis on the potential benefits of nanotechnology, but much less is known about the potential for harm. In 2005, more than US$10 billion was spent on nanotech research **(Figure 1)**. Yet the United States and European Union were estimated to be spending only US$39 million per year on research on the effects of nanoparticles on human health and the environment (Service 2005).

It is essential to correct this imbalance by directing more resources to investigating the impacts of nanomaterials, minimizing the health and environmental risks, and supporting sustainable development.

Although it may be appropriate to approach the subject of nanotechnology and the environment with enthusiasm, policy makers need to develop science-

Box 1: Defining features of nanotechnology



Nanotechnology is a generic and evolving term that encompasses the development of a wide range of materials and products. Definitions vary, but the essential characteristic is the deliberate exploitation of particles or structures that are measured on the nanometre (nm) scale.

A nanometre is one-billionth of a metre; by comparison, a human hair is 80 000 nm thick. There are three types of nanoparticles:

- **Natural** (such as tiny particles generated from volcanic eruptions),
- **Incidental** (such as emissions from engine combustion), and
- **Engineered** (purposely manufactured).

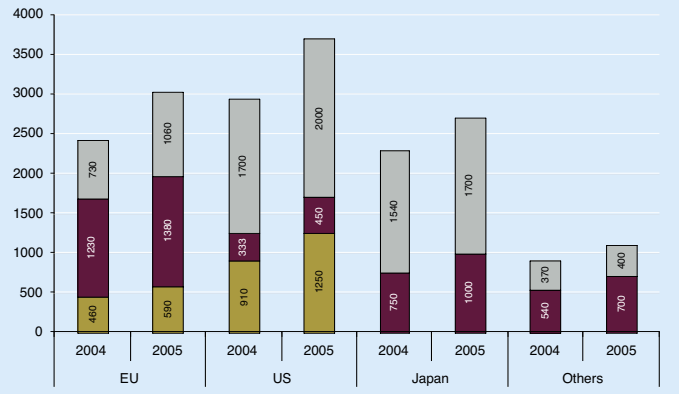
Nanoparticles may be divided into soluble and insoluble, the latter being of greater potential toxicological concern when released.

Engineered nanoparticles are usually developed by scaling commonly used materials (e.g., carbon, metal oxides, and precious metals) from large particles to small. Others are built atom-by-atom to create completely new compounds that have no large-size counterpart. Some are 'fixed' (embedded in materials); others are 'free' and could be released into the environment.

Due to nanotechnology, researchers are developing new materials with extraordinary characteristics. Many materials combine the advantages of inorganic nanoparticles (hardness and breathability) and organic polymer particles (elasticity and water repellency). One example is a new generation of 'binders' developed by BASF, known by the brandname COL9TM. When included in exterior paints, these binders provide extreme durability; resistance to soiling, chalking and cracking; and color tone stability.

Source: BASF Aktiengesellschaft

Figure 1: Research & Technological Development Expenditures (in millions of US dollars)



Sources: European Commission (2005) and Lux Research (2006).

based frameworks to manage the uncertainties and risks. Increased international cooperation is also needed to address transboundary issues involving the development and use of nanomaterials and products. Several international initiatives are being undertaken including the Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks, the International Risks Governance Council, and the International Council for Nanotechnology. Additional support programmes are sponsored by the European Commission, the USA, and other authorities **(Box 2)**.

THE ENVIRONMENTAL BENEFITS OF NANOTECHNOLOGY

Nanoparticles have the potential to deliver environmental benefits both in production processes and in products. Nanomaterials can substitute for conventional materials that require more raw material, are more energy-intensive to produce, or are known to be environmentally harmful (Masciangioli and Zhang 2003). New nanotechnologies seem poised to enhance environmental protection and improve pollution detection and remediation.

A growing number of nanoparticles are 'functionalized', meaning that their surfaces are designed to trigger specific chemical or biological reactions **(Table 1)**. This offers novel mechanisms for targeted delivery of drugs in humans and animals or of pesticides and fertilizers for crops. Targeted delivery facilitates more effective use of substances in far lower amounts—it has potential to reduce use of chemicals and materials, particularly those with negative environmental impacts such as pesticides.

Improved monitoring

One way in which advances in nanotechnology may benefit the environment (both indoor and outdoor) is through detection devices that are less expensive and more sensitive—in some cases thousands or millions of times more sensitive—than existing devices. For example, new protein-based nanotech sensors can detect mercury at concentrations of approximately one part in 10^{-15} or one-quadrillionth, a task previously impossible (Bontidean 1998). Using nanoparticles of europium oxide, a highly sensitive method has been developed to measure the pesticide atrazine, a frequent groundwater contaminant (Feng and others 2003).

Box 2: Nanotechnology and the UN Millennium Development Goals

Children in Sri Lanka display 0.1-watt white LED bulbs, produced using nanolayers of semi-conductor material on a sapphire substrate. This technology is transforming daily life in some of the world's poorest and most remote villages. It may be possible to light entire villages with less energy than a standard 100-watt bulb.

Source: Light Up The World Foundation/University of Moratuwa

Nanotechnology has the potential to contribute to the targets set for achieving the UN Millennium Development Goals, particularly in the areas of affordable energy, clean water,human health, and the environment.

Various nanotechnologies show promise for providing cleaner, more affordable, and more efficient ways to harness renewable energy. This can help to reduce dependency on conventional energy sources and support greater energy self-sufficiency, an important goal for developing nations.

Nanofiltration may improve access to safe and affordable drinking water and basic sanitation, with direct implications for sanitation and public health.

To bring these promises to fruition, public research programmes have an important role to play in providing greater incentives and encouragement for nanotechnologies that support sustainable development.

Sources: Hillie and others 2006, Global Dialogue on Nanotechnology and the Poor 2006, Zhang 2003, Yavuz and others 2006, Yean and others 2005

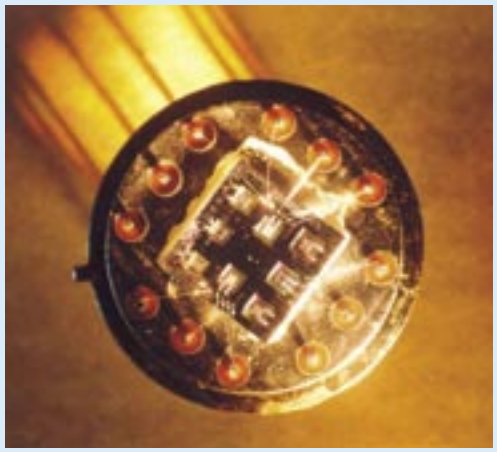
Table 1: Nanomaterials 'made-to-order'

The ability to manipulate nanoparticles allows scientists to fine-tune the properties of materials so the resulting product serves specific purposes.

Properties	Examples
Chemical	Higher surface-to-volume ratio makes particles highly reactive, increasing their efficiency as catalysts for desired chemical reactions.
Electrical	Increased electrical conductivity in ceramics and magnetic nanocomposites, increased electrical resistance in metals
Mechanical	Improved hardness and toughness of metals and alloys, ductility and superplasticity of ceramics.
Optical	Increased conversion efficiency of light to electrical charge in photoelectronic devices such as solar panels
Sterical	The spatial arrangement of atoms in a substance affects chemical reactions and facilitates increased selectivity. For example, hollow spheres can be used to tranport and control the release of specific drugs.
Biological	Increased permeability through biological barriers (membranes, blood-brain barrier, etc.), improved biocompatibility (i.e., the quality of NOT having toxic or injurious effects on biological systems).

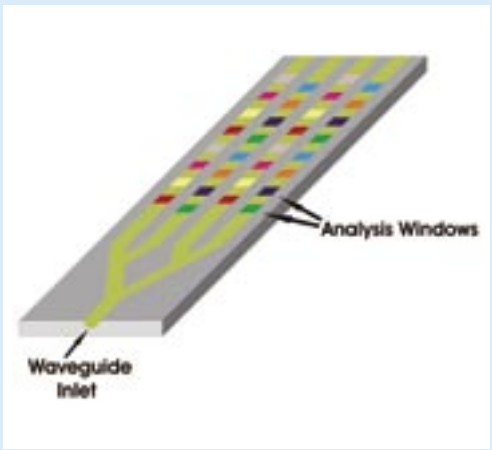
Source: Luther, 2004.

Box 3: Environmental monitoring with nanotechnology



Monitoring Air Pollution Hot Spots
Thin layers of nanocrystalline metal oxide are the key component of solid-state gas sensors for air quality monitoring.

Source: Instituto de Fisica Aplicada, CISC Madrid



Detecting Water Contaminants
Water enters the waveguide inlet and passes over biochemical sensors, making it possible to simultaneously test for more than 30 contaminants.

Source: Eberhard-Karls-University Tuebingen, Institute of Physical and Theoretical Chemistry

Nanotechnology can be used to improve monitoring of air and water quality. For example, miniaturized air quality monitoring devices selectively detect carbon monoxide (CO) and nitrogen dioxide (NO_2) by measuring changes in electrical conductivity that occur when these gas molecules are present on the surface. Other gases such as methane, ozone, and benzene can also be detected.

In some applications, nano-based sensors outperform conventional air pollution monitoring devices (left-hand image, above). They provide faster response with real-time analytical capability, greatly improved geographical resolution, simplified operation, and lower running costs. They are ideal for monitoring localized pollution peaks in urban areas.

To verify the safety of drinking water, it is necessary to monitor pollutants (pesticides, antibiotics, natural toxins, carcinogens, industrial waste, etc.) down to the level of one nanogram (i.e., one-billionth of a gram) per litre. A new biochemical sensor uses an integrated optical chip to analyze water from various sources by means of a miniaturized immunoassay system (right-hand image, above). In approximately 20 minutes, the sensor can detect and provide data on more than 30 different substances. The device can be re-used up to 500 times before the surface chemistry needs to be regenerated.

Sources: Rickerby and others 2000, Comini and others 2001, Graf and others 2004, Tschmelak and others 2005, Proll and others 2005, Hua and others 2005

Box 4: Windows that save energy

Windows are inefficient from an energy standpoint. In hot seasons, sun shining through glass increases indoor temperatures and the need for cooling. In cool seasons, windows leak a significant portion of the indoor heat, wasting heating energy. Depending on the country, a significant amount of energy may be used to heat or cool buildings.

Nanoscale window coatings show promise for reducing energy consumption and CO_2 emissions. Coatings tailored to warm climates allow visible light to pass through glass but block infrared wavelengths. In cool climates, coatings make more efficient use of light and heat by hindering their radiation back to the outside world. Other coatings still in development can respond to changes in the weather or the angle of the light.

At present, reflective coatings are expensive to produce. Although they are less effective, so-called 'absorptive coatings' provide a more affordable alternative. A coating that contains nanoparticles of the compound lanthanum hexaboride (LaB_6) is already on the market and is used to make more cost-effective solar glazing.

Sources: Muir 2004, Schelm 2003

Many new nanotechnology-based monitoring devices operate on site and in real-time, simultaneously measuring a broad range of pollutants and toxic agents. Rapid detection allows for swift response, thereby minimizing damage and reducing remediation costs **(Box 3)**.

Remediating pollution

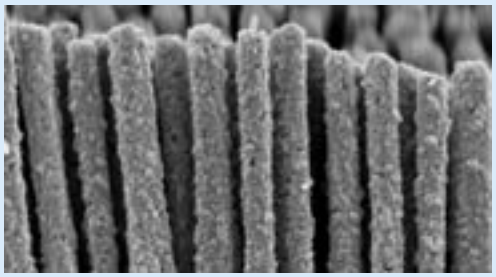
Nanotechnology-based solutions may also help reduce or prevent pollution and toxic emissions at source. Nanostructured catalysts based on metal oxides or metal nanoparticles show promise in reducing industrial and vehicle emissions (Rickerby and Morrison 2006). For example, a variety of precious metal nanoparticles have the ability to oxidize poisonous carbon monoxide (CO) in vehicle exhausts, transforming them into less harmful carbon dioxide (CO_2).

At the nanoscale, various particles demonstrate impressive capabilities to remediate pollutants. Nanoparticles of titanium dioxide (TiO_2) absorb energy from light and then oxidize nearby organic molecules; this property of photocatalysis is exploited to make coatings that attract and oxidize pollutants, such as vehicle and industrial emissions (Strini and others 2005). These properties can be exploited to create self-cleaning surfaces (e.g., self-cleaning glass or walls that can trap particles of air pollution).

Wood coated with a nanoparticle surface becomes extremely water repellant or 'superhydrophobic.' Surfaces treated in this way become self-cleaning and require little maintenance.

Source: BASF Aktiengesellschaft

Box 5: Nanotechnology and better energy options



Scanning electron microscope image of the nanostructured electrode architecture used in an advanced lithium ion battery. The individual columns are approximately 200 nanometres in diameter.

Source: Université de Picardie Jules Verne, Amiens

Lithium batteries increase safety and last longer

The power output of rechargeable lithium batteries can be increased by 50 per cent by using nanostructured electrodes containing lithium cobalt oxide. These batteries are intrinsically safer: they have faster charge/discharge rates and better accommodate the expansion caused by migrating lithium ions during charging. Lithium batteries are already being used to power a wide range of devices, many of which operate in remote locations and extreme environments – from oceans to outer space.

Nanomaterials are improving the efficiency of existing solar energy technologies.

Source: Audio Visual Library of the European Commission

Nanomaterials trap and transform solar energy

Various nanomaterials such as nanostructured cadmium and copper indium diselenide are proving effective in solar energy technologies, including photovoltaic cells. Thin layers of semiconductor materials can be applied to inexpensive bases, such as glass, plastic, or metal, to create photovoltaic cells. Compared to conventional silicon solar cells, less semiconductor material is required and manufacturing costs are significantly reduced.

New vehicles powered by hydrogen fuel produce zero greenhouse gas emissions. Nanotechnology can facilitate hydrogen gas storage.

Source: Daimler-Chrylser

Better storage for emission-free fuels

New vehicles in development operate by converting hydrogen fuel into electrical energy, producing water as a byproduct. Thus, they offer the promise of eliminating greenhouse gas emissions in the transportation sector. However, hydrogen gas is highly flammable and presents considerable storage and transport problems. Nanomaterials that facilitate storage include metal hydrides (chemical compounds formed when hydrogen gas interacts with metals). Some metal hydrides react at near room temperature and at pressures only a few times greater than that of the Earth's atmosphere, making them suitable candidates for hydrogen storage. However, they have relatively slow absorption and desorption rates. Nanostructured materials can reduce this problem by providing fast diffusion paths for hydrogen.

Sources: Baughman and others 2002, Oelerich and others 2001, Rosi and others 2003, Poizot and others 2000, Tarascon and Armand 2001,Bruce and others 2005, Stalmans and others 1998, Pizzini and others 2005

New nanomaterials are being developed that can bind pollutants and then be mopped up, much as one uses a sponge to mop up spilled water. This might be particularly useful, for example, in countries such as Bangladesh where arsenic in groundwater is at levels above safety limits set by the World Health Organization and is responsible for various health problems.

Source: Still Pictures

Several nanostructured materials show promise for cleaning water and groundwater. Nanoporous membranes that filter pathogens and other undesirable material are now commercially available. Some scientists propose to remediate ground water pollution by using nanoparticles of iron as a chemical reductant; in the process the iron oxidizes and becomes rust, a naturally occurring substance. Taking advantage of the high surface area of nanoparticles, magnetic iron nanocrystals are used to remove arsenic from drinking water. This method reportedly reduces, by more than 100-fold, the amount of waste produced by standard techniques. Another innovative approach involves coating the surface of iron oxide particles with molecules that selectively bind to pollutant molecules or ions. Introduced into water, the coated particles attract the pollutant and then a magnetic field is used to concentrate and recapture the bound pairs.

Saving energy and resources

Some new nanocatalysts can be used at room temperature. This is a huge advantage over traditional catalysts, which typically operate at high temperatures and require greater energy input. Capacity to function at room temperature paves the way for broad application of nanostructured materials in small-scale consumer and domestic products.

Nanotechnology may transform energy production, storage, and consumption by providing environmentally sound alternatives to current practices (Box 5). Severaltechnologies can enhance the efficiency of current energy sources and reduce carbon dioxide (CO_2)

emissions–including nanostructured catalysts for fuel cells, improved electrode materials in lithium ion batteries (Tarascon and Armand 2001), and nanoporous silicon and TiO_2 in advanced photovoltaic cells (Stalmans and others 1998, Pizzini and others 2005). Nanoscale optically selective coatings for windows can reduce energy consumption while also improving indoor air quality (Box 4).

Nanotechnology also shows significant potential in terms of saving resources. At the production stage, it offers opportunities to reduce the use of materials that have a large 'environmental footprint' by substituting others that have less impact, thereby promoting more efficient use of raw materials. Some effort is being made to produce nanostructured materials using renewable or abundant sources (such as substituting carbon-based nanoproducts for precious metals). This should be further supported by robust strategies for recovery or recycling of nanomaterials.

The use of high strength and lightweight nanomaterials may extend the lifespan of conventional materials such as plastics and save energy in transportation and other areas. For example, carbon nanotubes are molecular-scale cylinders of carbon that exhibit novel properties such as extraordinary strength, unique electrical properties, and highly efficient heat conductivity. This makes them potentially useful in electronics, optics, and other applications of materials science. They will likely become widely used in common consumer products.

Public and private organizations have been quick to recognize the apparent benefits of nanotechnology, but there is a corresponding need to assess the full costs of this emerging field, including the life cycle costs of products. For example, many nanostructured materials save energy while being used but their manufacture may be very energy-intensive.

Cost-benefit analyses must take into account the true environmental impact of these materials—and the fate and transport of nanoparticles released in the environment must be more fully investigated.

THE ENVIRONMENTAL RISKS OF NANOTECHNOLOGY

Most new technologies are produced without full investigation of their long-term effects in the real-world environment—but nanotechnologies may present special potential risks which demand careful assessment. Although the quantity is less, the particle sizes are much smaller—small enough even to pass through skin or the blood-brain barrier. A large proportion of their atoms lie on the surface and could be highly reactive (Service 2005) (Box 6).

Scientists have been quite successful in characterizing and predicting the behaviour of nanoparticles in the laboratory. Foreseeing the environmental impact of their widespread use is much more difficult because of the complex physical, chemical, and biological interactions that come into play under real-life conditions.

To date, the potential environmental effects of engineered nanoparticles, in any quantity, are largely unknown. Three of the most pressing questions are:

i) how nanoparticles might change over time once present in the environment;
ii) what effect they might have on organisms; and
iii) what effect they might have on ecosystems.

Fate and transport of nanoparticles in the environment

Study of the fate and transport of nanoparticles is largely concerned with determining how their properties and behaviour change over time, particularly after release into the environment. At present, little is known about how nanomaterials might behave in different environments, including whether they remain relatively stable or change in ways that alter their anticipated impact.

The potential impacts of nanomaterials in all media should be fully investigated and compared to the impacts of conventional materials. This includes direct environmental impacts and also those that may ultimately affect human health. The answers will depend on the unique characteristics of each environmental medium. As with any compound, the potential impact (which might be positive, neutral, or negative) is linked to characteristics such as toxicity, bioavailability, mobility, stability, solubility, and reactivity.

Box 6: Small quantities, large effects

The quantity of nanomaterials currently generated, or predicted in the near future, is very much smaller than conventional commercial compounds. For example, the UK Royal Society and Royal Academy of Engineering (2004) estimate that total annual production of engineered nanomaterials will be approximately 58 000 tonnes/year for the period of 2011-2020. Such figures might be misleading. Nanoparticles may be produced in small volumes, but each cubic metre represents an enormous number of particles. Moreover, at the nanoscale the key characteristic is surface area rather than volume or mass. The net result is many tiny particles that are highly reactive. By contrast, according to the US Environment Protection Agency, millions of tonnes of carbon black are produced annually (EPA 2000). This nanoscale byproduct of the petroleum industry is commonly used for color or as reinforcement in rubber and plastic products.

Major types of nanoparticles anticipated to be commercially available in 2006-14

Product	2006-07	2008-10	2011-14
		Tonnes/year	
Nickel (carbon-coated) (Ni-C) powders	3 500	7 500	15 000
Poly (L-lactic acid) (PLLA) nanofibres	500	2 500	5 000
Yttrium Oxide (Y_2O_3) nanopowders	2 500	7 000	7 500
Ceria (CeO_2) nanoparticles, coatings	N/A	10 000	N/A
Fullerenes	N/A	300	N/A
Graphite Particles	1 000 000	N/A	N/A
Silica (SiO_2) nanoparticles, coatings	100 000	100 000	>100 000
Titania (TiO_2) nanopowders, thin layers	5 000	5 000	>10 000
Zinc Oxide (ZnO) nanopowders, thin films	20	N/A	N/A
		USD/year	
Carbon black	~ 8 billion	10 billion	12 billion
Carbon nanotubes	700 million	3.6 billion	13 billion

Source: NanoroadSME, a research project funded by the European Commission, 2006.

Air

Engineered nanoparticles can remain airborne over a long period because of their small size and light weight (Biswas and Wu, 2005). This may increase the likelihood that they will travel long distances, cross borders, and interact with gases and other airborne particles.

The properties of naturally occurring and incidental ultrafine particles (i.e., those having a diameter of ~100 nm) in the air are relatively well known and may serve as a basis for studying engineered nanoparticles that become airborne.

Water

There is a serious lack of data on bioavailability, biodegradation, and biotransformation of water-soluble nanoparticles. Natural small particles suspended and dispersed in water tend to aggregate, eventually becoming large and stable enough to precipitate out. The tendency and degree to which engineered nanoparticles aggregate in water is still under investigation, as are the mechanisms of precipitation. Even if they follow expected behaviour, it is not known what consequences this might have for bioavailability, toxicity, or exposure. Thus, little is known about how they might interact with organisms and affect the functioning of aquatic ecosystems.

Some studies are in progress. Scientists have begun investigating how current wastewater treatment processes affect and are affected by nanomaterials, as well as how the nanomaterial's solubility influences its toxicity, bioavailability, and mobility (Westerhoff and others 2006).

Many questions remain, such as how various aqueous conditions (salinity, phosphate levels, etc.) affect the stability of nanostructured materials that have been coated or functionalized to reduce or eliminate potential toxicity and exposure.

Soil

The fate of nanoparticles in soil is largely unknown. They may be 'partitioned' in ways that could influence where they reside and how they get there. Some may bind chemically to a soil particle; others may remain separate, residing either on the surface of soil particles or in the pore space between particles.

Scientists are attempting to map interactions between nanomaterial on soil particles and nanomaterial found in pores (Wan and others 2005). Biodegradability is a particularly important question: it is not yet known whether natural soil microbial populations will be able to efficiently and adequately degrade nanoparticles.

Addressing the knowledge gap

Life cycle analysis is one of the effective means of approaching the complex question of how nano-structured materials might affect the environment. It involves mapping fate and transport at every step, from production inputs to final disposal or dispersal. Currently available approaches to life cycle analysis should be modified in consideration of the lack of data for nanostructured materials.

The ability to measure and detect engineered nanoparticles, and to differentiate them from other nanomaterials, is vital to developing accurate fate and transport models for nanomaterials. Existing models, together with computer simulations, need to be explored further and systematically validated to determine their efficacy and accuracy for predicting where, when, and in what forms nanoparticles will ultimately be found in the environment, including whether or not they remain in the environmental medium into which they were initially released. Evaluating the potential environmental impacts of engineered nanomaterials prior to their mass production is essential to address environmental and human health concerns and to develop sustainable nanotechnologies. Even preliminary analyses can provide practical information that can be used to design or optimize processes that are more environmentally sound (Olsen and Jørgensen 2005).

Toxicology and health risks

So far, ecotoxicological studies on nanoparticles have been limited to a very small number of materials and target organisms. Data are lacking on the impact of nanoparticles on flora. Thus it is impossible to say with any certainty whether nanomaterials, which can be constructed from virtually any chemical structure, are similar to natural nanoparticles (which are mostly neutral or mildly toxic) or vastly different and therefore cause for concern.

The limited research done to date shows that certain nanoparticles may have ecotoxicological effects. For example, under laboratory conditions, fluorescent latex nanoparticles suspended in water were absorbed and accumulated into virtually all of the organs of the medaka fish (*Oryzias latipes*) and were taken up into medaka eggs. Toxicity to the eggs and uptake into

Box 7: Policy considerations for nanotechnology

The rapid emergence of nanotechnology creates a need for swift action by policy makers. Specific initiatives and programmes are needed together with appropriate financial and human resources, to achieve the following:

- Standardize nomenclature and test protocols to ensure maximum comparability of test results and to facilitate generalization of findings
- Foster cooperation between public and private sectors, between developed and developing countries, and among developing countries
- Sensitize national regulatory and environmental agencies to the potential opportunities and risks of nanotechnology (environmental, human health, and socio-economic)
- Support research and development of nanotechnology applications that contribute to sustainable development
- Evaluate the potential environmental and human health impacts of engineered nanomaterials, giving priority in this to materials that are already being mass produced and potentially released into the environment
- Identify, evaluate, and share private sector risk management methods and best practices for nano-scale materials (including worker safety and material handling procedures)
- Mobilize the existing knowledge of and lessons learned from chemical policies related to environmental and health issues, to help address nanotechnology challenges
- Educate the public about the benefits and risks of nanotechnology, raise awareness, and provide access to information about health and environmental impacts
- Encourage co-operation between governments and intergovernmental organizations to address and share information on the impact of nanotechnologies on the environment and human health.

the body of the adult fish depended upon the size of the nanoparticles and on external factors such as the salinity of the water (Kashiwada 2006).

The toxicological behaviour of nanomaterials that come into contact with cells depends on properties such as chemical composition, quantity, solubility, shape, and characteristics such as area and charge. The effects may also be influenced by factors such as persistence (how long a nanoparticle remains intact) and bioaccumulation (how many nanoparticles accumulate within a biological system) (SCENIHR 2005). Impurities that result from production processes also affect the toxicity of a given nanoparticle. The means of exposure also plays a significant role. Additional features, such as translocation and accumulation of particles within particular organs, must be considered (Oberdörster and others 2004).

Some air pollution studies have examined incidental (non-engineered) nanoparticles, mainly from combustion exhausts. However, research to date suggests that it is not possible to generalize about the toxicological behaviour of nanoparticles. They do not always mirror the characteristics of the bulk material from which they derive nor can existing data on one product be extrapolated to all nanoparticles.

Moreover, different species of plants and animals exhibit different sensitivities. For example, titanium dioxide (TiO_2) is frequently used in surface coatings and cosmetics, including sunscreen products. Studies indicate that cellular absorption of TiO_2 particles through healthy skin is very limited (Schulz and others 2002). However, in laboratory tests, when TiO_2 particles were released in aquatic environments (as might occur through swimming or washing), they were potentially harmful for algae and water fleas (*Daphnia spp.*) (Hund-Rinke and Simon 2006).

Other studies show that carbon nanotubes have toxic properties when absorbed through the skin (Monteiro-Riviere and others 2005). More controversial is whether inhalation or ingestion of carbon nanotubes, or of impurities associated with their production, cause lung damage in experimental animals (Lam and others 2004, Donaldson and others 2006, Shvedova and others 2005, Wörle-Knirsch 2006). Further research and testing is needed in this area to provide a scientific basis for policy frameworks to deal with the uncertainties and risks.

Fullerenes are a particular type of nanoparticle, composed entirely of carbon atoms in the form of a hollow sphere, ellipsoid, or tube. Fullerenes show strong toxicity to bacteria (Lyon and others 2005). Among fish species, studies on fullerene exposure show contradictory results—ranging from no negative impacts to 100 per cent mortality (Oberdorster 2004, Zhu 2006). Again, further investigation is needed, using appropriate methodologies.

Titanium dioxide is a nanomaterial used in sunscreensbecause it blocks ultraviolet radiation with only limited absorption by healthy skin.

Source: AP Photo/Mary Godleski

Further reseacrh

Additional studies are needed to clarify whether existing methodologies for assessing ecotoxicological effects are adequate for nanomaterials or if alternatives need to be developed.

It is widely accepted that the traditional methods of measuring dose exposure are of little use for predicting the toxicological effects of nanoparticles. Standard monitoring instruments cannot always detect nanoparticles in environmental samples. Thus, characterizing their behaviour and novel properties, and tracing their impacts, presents a real scientific and technical challenge.

To assess the health risks for human beings and other terrestrial mammals, toxicity test data on rats, mice, and other species can be useful. Existing literature contains contradictory data, but a growing body of evidence suggests that some nanoparticles may represent an additional challenge, since they have an enhanced capability to reach internal organs that are not normally exposed to larger particles.

In addition, there is a need for studies that examine the long term effects of nanoparticles on different environments and their resident organisms.

Experience so far shows that exhaustive assessment of existing data and new, carefully designed research are required to establish the ecotoxicity of nanoparticles, including how each differs from conventional forms of the same substance. Assessing the ecotoxicity of novel nanoparticles that have no naturally occurring counterpart may require a different approach.

LOOKING AHEAD

Nanotechnology is no longer 'on the horizon'; it is fast becoming a facet of daily life. The nanoproducts now available came onto the market with limited public debate and with limited additional regulatory oversight that is specifically aimed at their novel features. Current research and development seek to rapidly exploit the novel applications of nanomaterials.

Considering the large-scale investments in product development, public authorities have an important role in assessing and addressing the complex

implications, both short and long term, of broad dissemination of nanotechnology. This is particularly true in relation to nanoparticles that might be released, intentionally or unintentionally, into the environment.

It may be possible to regulate nanotechnology products under some of the existing laws against pollution. For example, late in 2006 the US Environmental Protection Agency (EPA) announced that it would require manufacturers using nanosilver to provide scientific evidence that such usage will not harm waterways or public health. Nanosilver is used to kill germs in shoe liners, food-storage containers, air fresheners, and washing machines (Heilprin 2006).

It is not clear whether current regulatory frameworks are adequate to deal with the special characteristics of nanotechnology. To date, no government has developed a regulatory framework specific to nanotechnology. Some governments are making considerable efforts to determine whether existing regulatory frameworks are sufficient for addressing issues associated with nanotechnology and its potential societal impacts, or whether modified or completely new risk management approaches are needed. As an example, the US EPA is developing a white paper on nanotechnology policy (US EPA 2006).

A number of complementary measures will be needed, ranging from carefully conducted laboratory experiments and computer simulations to small-scale field trials. It will also be necessary to develop standards and instrumentation that can accurately characterize and monitor the effects of these novel materials. As many unforeseen and unintended consequences on the environment are long term, it may be necessary to adapt existing protocols for traceability and life cycle analysis of products—or to devise new ones.

Governments and international organizations should work together with scientists and the private sector to establish scientifically and ethically sound, risk-based standards for new nanotechnology-based products, and to promote 'best practices' to avoid potential health and environmental threats. Standard nomenclature is also needed to eliminate ambiguity when communicating differences between nanomaterials and bulk materials, as well as in reporting for regulatory purposes.

Today's globalized world offers an unprecedented opportunity to develop, disseminate and share the benefits of technical innovation to more users, more rapidly. It will be important to avoid the development of a 'nano-divide' between nations with advanced nanotechnology programmes and those without (Balbus and others 2005).

Scientific understanding of environmental processes is increasing, as is general awareness of environmental issues. However, policy makers, industry, non-governmental organizations, and scientists need to work together to raise public awareness of the specific opportunities and risks associated with nanotechnology. They also need to inform the public on steps being undertaken to assess the potential consequences of nanomaterials before they reach the marketplace.

Nanotechnology creates many new possibilities for social and economic development, both in the short and long terms. The enhanced capacities to monitor the environment, to increase energy efficiency, and to reduce the impact of human activities on the environment are clear potential benefits in the adoption of nanomaterials. A balanced approach is required to maximize benefits while minimizing risks.

Research and development of nanotechnologies are science policy priorities in some developing countries, resisting traditional technological divides between developed and developing countries.

Source: Joerg Boethling / Still Pictures

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GEO INDICATORS

Source: Joerg Boethling/ Still Pictures

- Environmental trends in 2006
- Energy
- Climate change
- Stratospheric ozone depletion
- Forests
- Fisheries
- Biodiversity
- Water and sanitation
- Environmental governance

GEO Indicators

Data published in the course of 2006 illustrate the continued overuse of the Earth's ecosystems and the negative impact on the environment, as well as some progress in global policies to address major environmental issues.

Various sets of core environmental indicators, as well as highly aggregated indices combining several indicators, have been developed and have gained importance throughout the years in various parts of the world and in international fora. They differ in their scope and purpose—from tracking impacts of individual economic activities and supporting direct policy action, to framing global sustainable development. The GEO Indicators aim to provide a comprehensive overview of the headline environmental trends at the global and regional levels. They simplify and focus information for decision-makers in national, regional, and global policy-making processes as well as for the public at large. However, the challenge remains to find good time-series data on the environment necessary for credible individual and aggregate indicators (UNESCO-SCOPE 2006).

The following selection from the core set of GEO indicators provides a graphic snapshot of key global environmental trends. The indicators support and complement findings of the Year Book's global and regional overviews and its special sections. They highlight trends of importance to policy makers, in the areas of energy, climate change, stratospheric ozone depletion, forests, fisheries, biodiversity protection, water and sanitation, and environmental governance.

The UNEP GEO Data Portal

The core indicators are continuously reviewed, refined, updated, and made avaiable on the internet. They provide the most recent trends and the latests developments up to the current year—or the most recent year for which data are available. The overall core indicator set—as well as the underlying detailed data base—can be accessed directly at http://geodata.grid.unep.ch/.

ENVIRONMENTAL TRENDS IN 2006

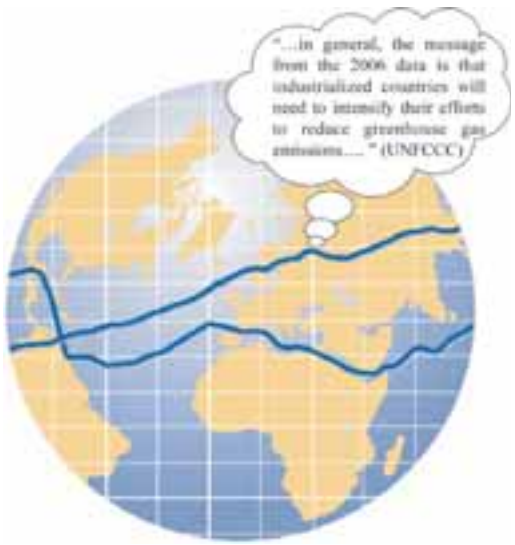
The most recent data provide more evidence of growing pressures that damage the ecological systems supporting all life on the planet. The overall trend is towards continued overuse of the Earth's ecosystem resources. The Ecological Footprint index suggests that humanity's resource consumption and waste production exceeded the Earth biocapacity by about 25 per cent in 2003 (WWF 2006). The 2005 Millennium Ecosystem Assessment estimated that 15 of the 24 major ecosystem services that support humanity—through provision of fresh water, replenishment of fertile soil, or regulation of the climate for example—are being pushed beyond their sustainable limits or are already operating in a degraded state (Millennium Ecosystem Assessment 2005).

Some key trends can be identified. Total energy consumption continues to increase despite a continuing trend towards energy efficiency. The share of fossil fuels in energy use has not changed significantly since the mid-1990s. Carbon dioxide (CO_2)emissions from fossil fuel use are one of the main factors behind climate change. Data show that total CO_2 emission continue to rise while global CO_2 emissions per capita have remained at the same level over the last few years. The downward trend for consumption of chlorofluorocarbons and hydrochlorofluorocarbons is expected to result in the full recovery of the stratospheric ozone layer over the long term.

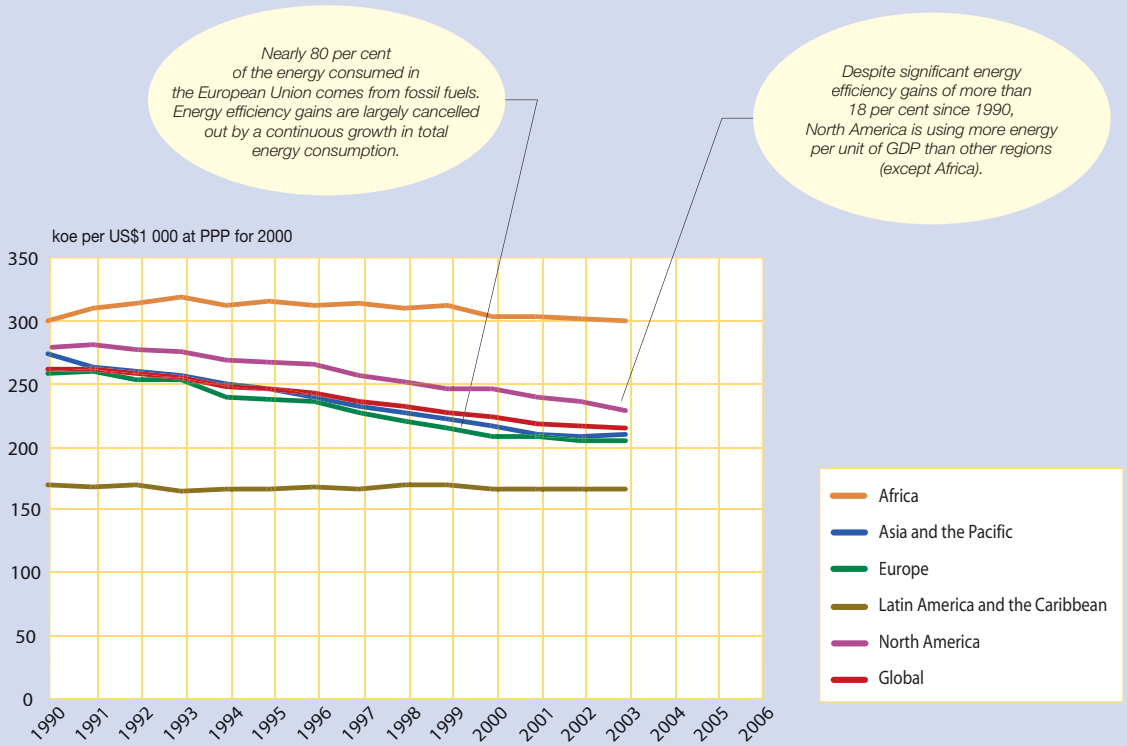
In terms of pressures on natural resources, the total marine fish catch shows signs of stabilizing (though its current level may not be sustainable), while marine aquaculture is increasing. The forest harvest rate indicates an increasing demand for wood, in particular in Africa and in Asia and the Pacific. There is also a trend towards establishing more land and sea areas to protect and maintain biological diversity.

In the area of governance, the ratification process of various Multilateral Environment Agreements has advanced further in most regions in 2006. At the same time, certification programmes in forestry (Forest Stewardship Council) and environmental management systems (ISO-14001), among others, are attracting more companies and organizations.

Some progress is being made towards achieving the overall Millennium Development Goals (MDGs) set for 2015, but there is still a long way to go to ensure environmental sustainability (Goal 7). For example, while the world is on track to reach the drinking water target, it seems unlikely that the basic sanitation target will be reached (United Nations 2006). Indicators referring to the targets set under the MDGs have been clearly marked in the following pages.



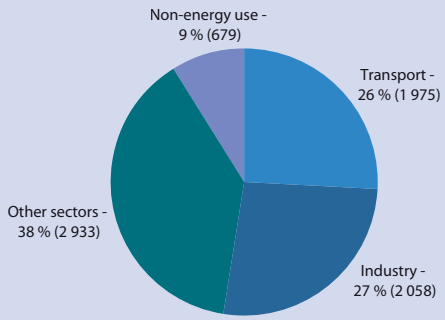
Indicator: **Energy use per unit of GDP (MDG indicator 27, under Target 9, Goal 7)**



Note: Insufficient data for West Asia.

The **intensity of energy use** continues to decrease gradually in most regions of the world—while recently stabilizing in others. This means that, on average, energy is used more and more efficiently in economic production, although there are significant differences in energy use between regions due to factors such as general economic structure and availability of natural resources. The overall trend towards more efficiency is cancelled out by a continued rise in total economic production, leading to an increase in energy consumption for the world as a whole from 5 559 million tonnes of oil equivalent (Mtoe) in 1990 to 7 645 Mtoe in 2004.

World energy consumption by sector, 2004



Units of measurement: *Million tonnes of oil equivalent*
Definition: *'Other sectors' comprises agriculture, commerical,, public service, residential, and non-specified. 'Non-energy use' includes substances used as raw material in industrial processes such as propylene, benzene, and naphthalene.*

Source: *IEA 2006*

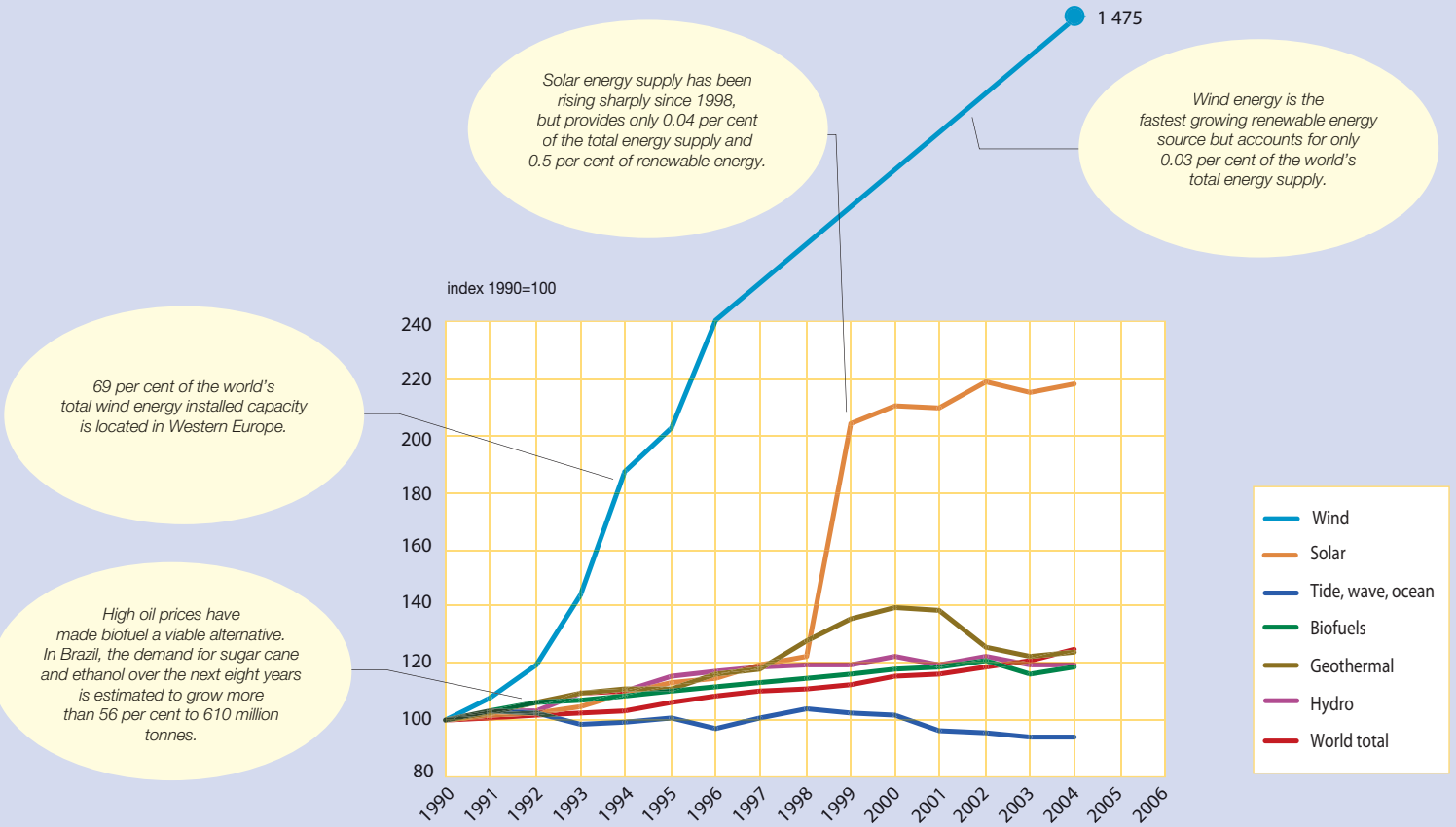
Between 1973 and 1990 the share of the transport sector in total energy consumption has increased from 23 per cent to 26 per cent, but in absolute terms more than doubled (from 967 to 1 975 Mtoe). During the same period total energy consumption increased more than 65 per cent (from 4 608 to 7644 Mtoe). Even with technological efficiency gains, the transport sector is becoming an increasingly important source of greenhouse gas (GHG) emissions as demand for transport services continues to grow.

Units of measurement: *Kilogram of oil equivalent (koe) per US$1 000 of GDP, converted from national currencies using purchasing power parity (PPP) conversion factors for the year 2000.*

Definition: *Energy use is calculated by the International Energy Agency as the production of primary energy, plus energy imports minus energy exports, minus energy delivered to international marine bunkers, and plus or minus stock changes that happened during the year.*

Source: GEO Data Portal, compiled from UNSD 2006

Indicator: **Renewable energy supply index**



The share of fossil fuels in energy sources has been more or less stable since the mid 1990s at around 86-87 per cent of total energy use. The **share of renewable energy sources** for 2004 was slightly down, at 13.0 per cent from 13.2 per cent in 2003 (1990: 12.9 per cent). Among renewables, wind and solar energy have very small shares but are rising fast, illustrated by the growth index shown in the graph. Combustible renewables (such as biofuels and mostly traditional biomass of wood and waste) and hydro-electricity remain the biggest renewable energy sources with 10.3 per cent and 2.2 per cent respectively of total energy supply in 2004. More sustainable energy production and consumption patterns can be achieved through a reduction of total fossil fuel energy use, further improvement of energy efficiency, and a continued increase in the share of renewable energy sources.

Key challenges to the promotion of renewable energy are reducing costs and improving integration of renewable sources in the energy system, improved technology uptake, and increasing purchases leading to economies of scale. Costs are declining faster for renewable energy sources because renewable technologies are less mature than fossil fuel technologies. Between 1980 and 1995, the cost of electricity produced in Europe decreased by 88, 84, and 50 per cent for solar energy, wind, and biomass, respectively, while the cost of electricity produced from coal was more or less unchanged (IEA 2003).

Units of measurement: *none (index with 1990=100)*

Definition: *Renewable energy data refer to Total Primary Energy Supply, originally expressed in million tonnes of oil equivalent (Mtoe), for all the countries of the world from 1990 to 2004.*

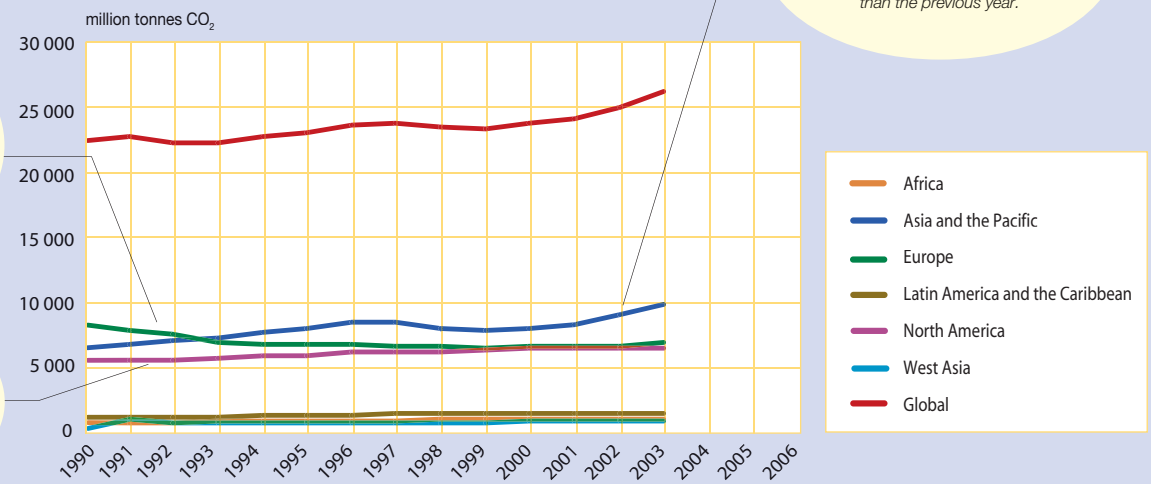
Source: GEO Data Portal, compiled from IEA 2006

Indicator: **Carbon dioxide emissions, total and per capita (MDG Indicator28a under Target 9, goal 7 [Carbon dioxide emissions])**

Globally, Asia and the Pacific have seen the biggest increase in GHG emissions—a 760 million tonne increase of CO_2 equivalent in 2003, 8.5 per per cent more than the previous year.

For 2003, the total amount of GHG emissions in the entire European region was 7 218 million tonnes of CO2 equivalent, up from 7 094 in 2002 (1990: 9 838 million tonnes). For the new EU-25, total emissions fell by 7.3 per cent between 1990 and 2004, mainly due to economic decline in the 1990s—but they are on the rise again.

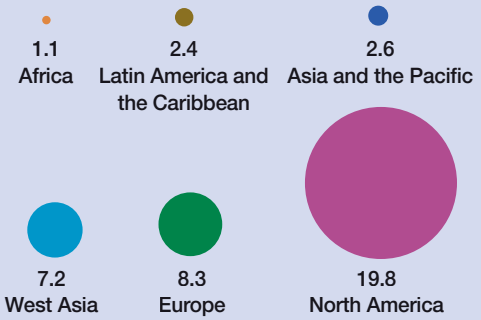
For 2003, the amount of GHG emissions in North America rose to 7 094 million tonnes from 6 768 million tonnes (1990: 5 488 million tonnes).



The Earth's climate is changing rapidly. During the last century, the global average surface temperature rose by around 0.6°C. It is projected to rise by a further 1.4 to 5.8°C by the end of this century (IPCC 2001). Noticeable world-wide effects include sea level rise, the reduction of glaciers and ice massess, and changing vegetation and biodiversity patterns. For example, the average mass balance of mountain glaciers around the world continues to decrease, with the latest available data indicating a further thickness reduction of 0.5 metre in 2005. This confirms the trend in accelerated ice loss during the past two and a half decades and brings the total loss since 1980 to about 9.5 metres. Underlying rapid climate change are greenhouse gas (GHG) emissions from fossil fuel use, as well as land-use and forestry changes. Total anthropogenic **CO_2 emissions** continue to rise, although in most regions the increase is relatively small. The world total CO_2 emissions, including those from forestry and land use changes, are estimated to have just passed 26 billion tonnes in 2003, up from 24.8 in 2002 (1990: 22.2). In the period 1990–2004, the overall anthropogenic **emissions of greenhouse gases** (CO_2, N_2O, CH_4, HFCs, PFCs, and SF_6 , among others) in industrialized countriesdecreased by 3.3 per cent. However, this was mostly due to a 36.8 per cent decrease in emissions from transition economies in eastern and central Europe.

In the more recent period 2000-2004, this group has seen an emission increase of 4.1 per cent (UNFCCC, GHG Data 2006).

CO_2 emissions per capita by region, 2003



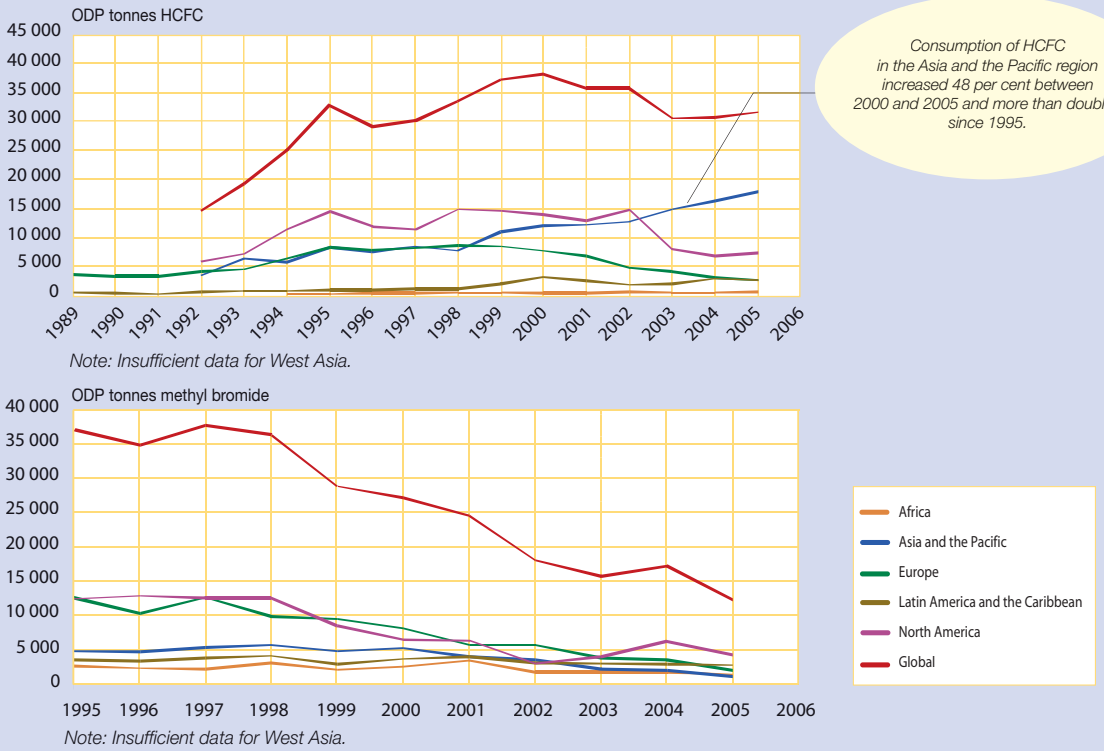
Units of measurement: *Tonnes per capita*
Definition: *Emission of CO_2 per capita is the total amount by a region divided by the region's population.*
Source: *GEO Data Portal, compiled from UNFCCC 2006, Marland and others 2006 and UN Population Division 2005. The global and regional data are compiled from national data submitted to the UN Framework Convention on Climate Change (UNFCCC) for countries listed in its Annex 1 and from estimated country data from the Carbon Dioxide Information and Analysis Center (CDIAC) for the rest of the world.*

In comparison **CO_2 emissions per capita** have remained near the same level over the last years. The global average for 2003 was estimated at 4.1 tonnes per capita, up from 4.0 the year before. Differences among regions are considerable, with the highest figure for North America (19.8 tonnes per capita in 2003) and the lowest for Africa (1.1 tonnes per capita). The key challenge is to limit GHG emissions and stabilize concentrations of CO_2 and other gases in the atmosphere by strengthening local, national, and international strategies and initiatives for reducing GHG emissions and fossil energy use.

Units of measurement: *Million tonnes of CO_2 equivalent*
Definition: *Emission of CO_2 is the total amount emitted as a consequence of human production and consumption*

Source: GEO Data Portal, compiled from UNFCCC 2006 and Marland and others 2006.

Indicator: **Consumption of CFC, HCFC, and MeBr (MDG 28b under Target 9, Goal 7 [CFC consumption])**

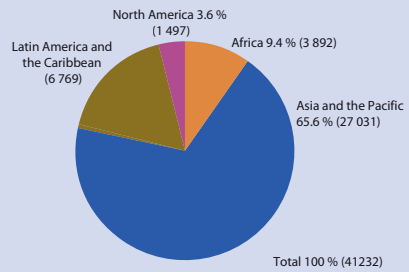


The use of hydrochlorofluorocarbons (HCFCs) as substitute for chlorofluorocarbons (CFCs) had been decreasing modestly since the year 2000, but recent years show a small increase to 31 700 tonnes tonnes ozone-depleting potential (ODP) in 2005, mainly due to increased consumption in the Asia and the Pacific region.

The **use of methyl bromide**, a substance with a high ODP mainly used as a fumigant, especially of soils before planting tomatoes, strawberries, and other crops, was banned under the Montreal Protocol by 2005 except for uses deemed critical. The use of methyl bromide continues to decline and in 2005 stood at 12 450 tonnes ODP for the world as a whole. Exemptions granted to certain industrialized countries for the phase out have decreased from 14 132 metric tonnes for 2005 to 5 122 for 2008. Developing countries are to complete their phase out by 2015.

The **consumption of CFCs** further decreased in 2005 and was reported at about 41 000 tonnes ODP for the world as a whole, down from 66 000 tonnes the year before. However, despite the considerable and swift phase out of CFCs over the last two decades, stratospheric ozone depletion remains a source of concern due to its long term impacts on human health, agriculture, and the environment. Full recovery of the ozone layer is currently expected to take longer than earlier projected (WMO/UNEP 2006). At the same time ozone depleting substances and some of their substitutes such as HCFCs are also greenhouse gases—and so reductions in ozone-depleting substances can also help to mitigate climate change.

Consumption of CFCs by region, 2005



Note: Europe has a negative consumption of CFC (-187 tonnes) in 2005 due to destruction of export for feedstock use.

Over the last decade global consumption of CFCs has decreased from 28 3870 (1995) to 41232 (2005) ODP tonnes.

Definition: *Tonnes of ozone-depleting potential (ODP) by region in per cent.*

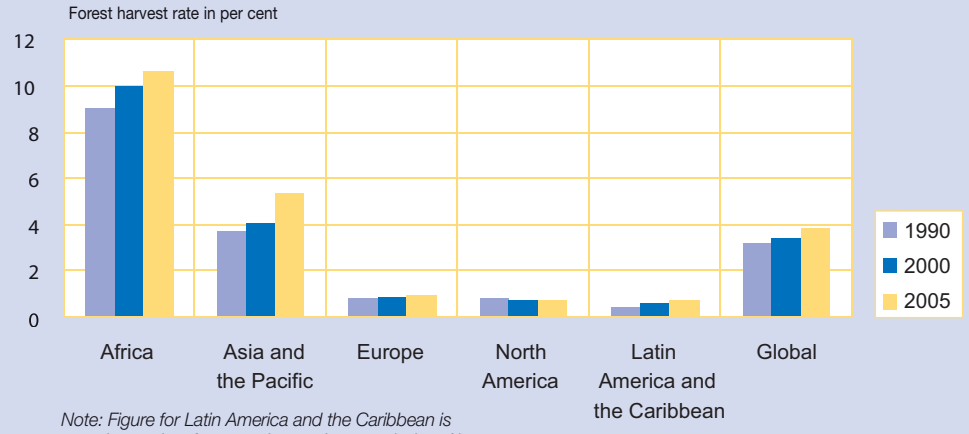
The key challenges are to further reduce the production and use of CFCs, HCFCs, and methyl bromide; to reduce international movements and illegal trade of these substances; and to support developing countries in reducing their use of ozone-depleting substances.

Units of measurement: *Tonnes of ozone-depleting potential*

Definition: *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. The HCFCs to be phased out are HCFC-22, HCFC-123, HCFC-124, HCFC-133a, HCFC-141b, HCFC-142b, HCFC-225ca, and HCFC-225cb. Methyl bromide, MeBr or CH_3Br, is to be phased out by 2005 in developed countries and by 2015 in developing countries (except for critical uses).*

Source: GEO Data Portal, compiled from UNEP Ozone Secretariat 2006.

Indicator: **Forest harvest rate and total FSC certified forest area**

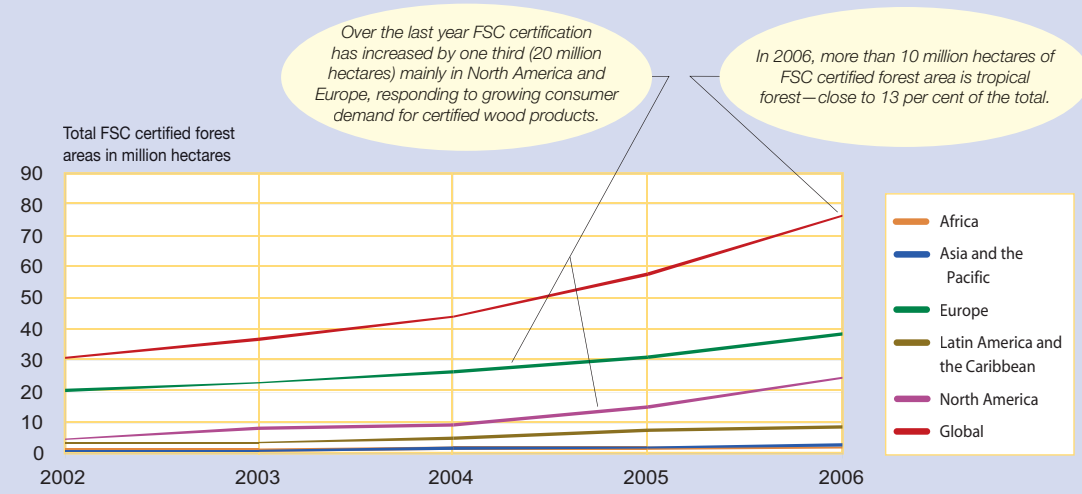


Note: Figure for Latin America and the Caribbean is tentative as data for several countries are missing. All data are approximations only, due to methodological differences in calculations and definitions.

Units of measurement: *Per cent*

Definition: *Forest harvest rate is the amount of timber production divided by the total forest volume or 'growing stock'. Roundwood is wood in its natural state as felled, or otherwise harvested, with or without bark, round, split, roughly squared, or other forms (such as roots, stumps, or burls). The roundwood volume is measured in tonnes/m^3 under bark, while the forest volume is measured in m^3 over bark; an increase of 10 per cent bark has been applied to roundwood production volume for harmonization purposes. Roundwood volume also includes production of wood in areas outside forests ('other wooded land'). The wood density has been set at an average of 0.57 tonnes/m^3 for all regions.*

Source: GEO Data Portal, compiled from FAO 2005 and FAO 2006a.



Note: Insufficient data for West Asia

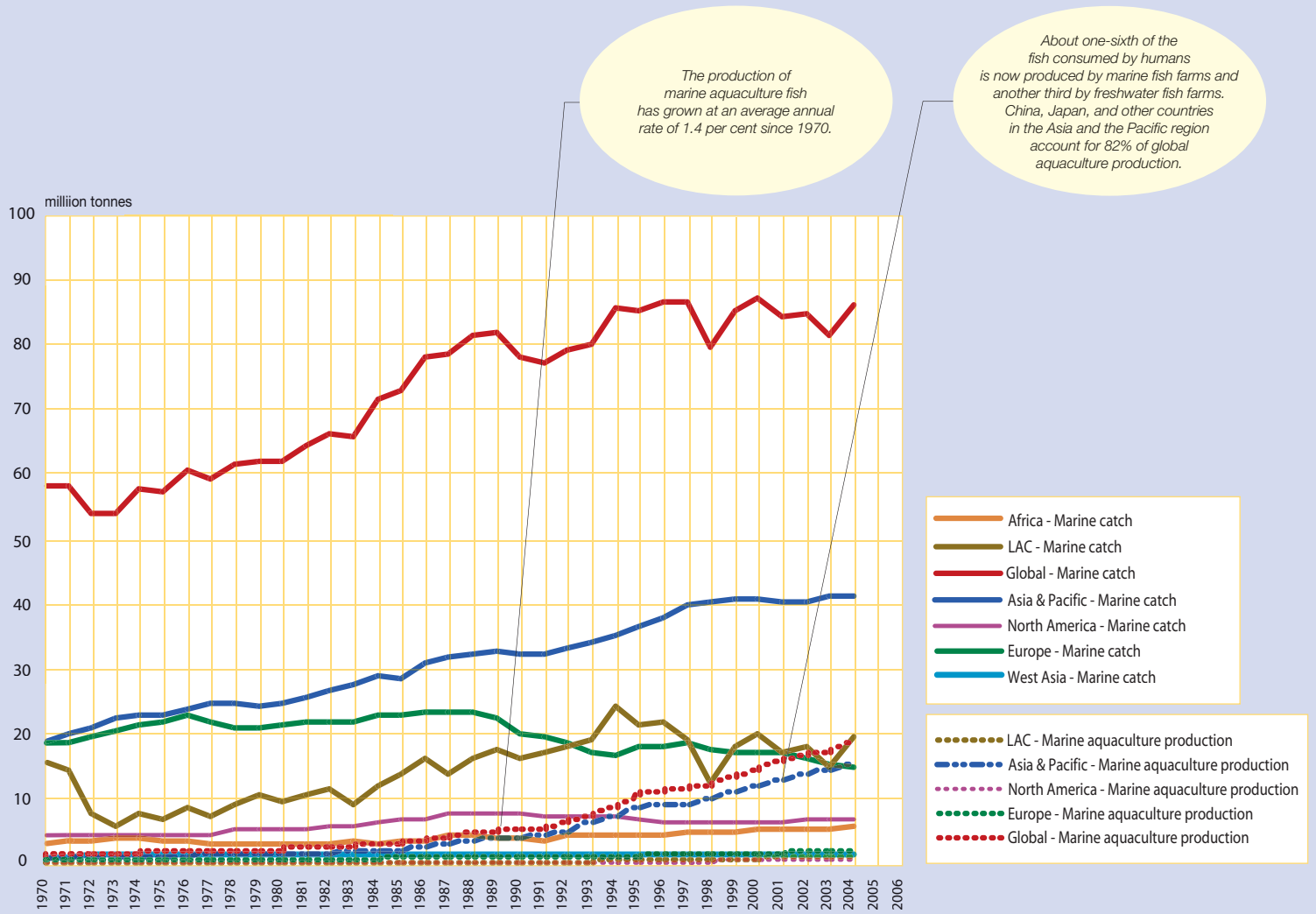
Units of measurement: *Million hectares*

Definition: *FSC certified forest area gives the area of forest that has received a FSC Forest Management Certificate. The certification is undertaken by an independent body to check that the forestry complies with the internationally agreed FSC Principles of Responsible Forest Management. Certified forest operations can claim the forest products they produce come from a responsibly managed forest. Before a certified forest operation can sell their products as FSC certified, they must also obtain 'chain of custody' certification (FM/COC). The data for 2006 ends at the beginning of July.*
Source: GEO Data Portal, compiled from FSC 2006.

The increasing demand for wood products can pose a threat to the total forest cover around the world. Although there are not many reliable and comparable times-series data available on forest volume and wood production, the available information points to increasing **forest harvest rates** in most parts of the world, in particular in Africa and Asia and the Pacific. It has been estimated that the global forest harvest rate has increased to 3.8 per cent in 2005, based on data from the latest FAO Global Forest Resources Assessment.

In the last decade, about 80 million hectares in more than 80 countries have been certified according to sustainable management standards of the Forest Stewardship Council (FSC), while several thousand products are now produced using FSC certified wood and carrying the FSC trademark. **FSC certification** is carried out by independent bodies. The consumer demand for certified products is continuing to increase in all regions, particularly North America and Europe, with a doubling in the last two years.

Indicator: **Annual marine fish catch and aquaculture production**



The total **catch of fish, crustaceans, and molluscs** in marine areas has remained within the range of 80-87 million tonnes since 1994. For 2005, the latest reported year, the catch was 86 million tonnes. The reported figures are not always fully reliable and illegal catch is difficult to assess. However, it seems clear that the limits of natural fish stocks are being challenged more and more, resulting in tighter rules and regulations in the area of fish quotas, fish types, and seasonal catch.

While the overall marine fish catch is levelling off, the **production of marine aquaculture fish** is rising significantly, particularly in the Asia and the Pacific region—posing more threats to existing coastal ecosystems.

The key challenge is to achieve a more sustainable management of marine fish resources in all parts of the world through effective international cooperation—recognizing the importance of fish for nutrition and economic development while trying to avoid negative impacts on fish stocks and habitats.

Units of measurement: *Million tonnes*

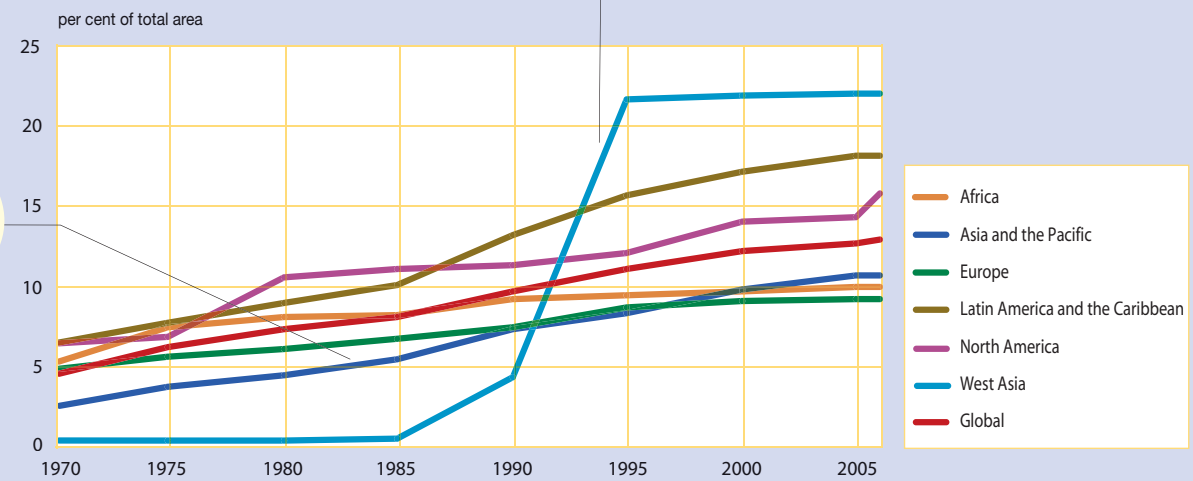
Definition: *Marine capture is the nominal catch of fish, crustaceans, and molluscs in marine areas and excludes production from fish farming. Aquaculture marine production includes all fish, molluscs, crustaceans, aquatic animals, and animal products cultivated in marine and brackish environments; it excludes production figures for marine mammals, corals, sponges, and aquatic plants. The data are based on official country reports.*

Source: GEO Data Portal, compiled from FAO 2006b.

Indicator: **Ratio of area protected to maintain biological diversity to surface area (MDG Indicator 26, under Target 9, Goal 7)**

The jump for West Asia between 1990 and 1995 is due to the declaration of one the largest protected areas in world, the 64 million hectare Ar-Rub'al-Khali Wildlife Management Area, Saudi Arabia, in 1994.

In the Asia and the Pacific region, the ratio of protected area to surface area increased from 7.4 per cent in 1990 to 10.6 per cent in in 2006—mainly forest areas. Marine protected areas grew only modestly, from 1.6 per cent of the territorial area in 1990 to 2.2 per cent in 2006.



Continuing pressures on natural areas pose major challenges for conservation efforts to protect ecosystems and other areas of significance. Although in many parts of the world the protection of natural areas is expanding, their management improving, and protection is better integrated into urban, forestry, agricultural and fisheries policies, society's overall impact on the natural environment and biodiversity remains a major issue of concern.

In the last decades, the number and area of registered protected areas in the world—both those classified under the system established by the World Conservation Union (IUCN) and others—has been steadily growing. By the end of 2006, registered protected areas amounted to almost 13 per cent of the surface area of land and territorial waters. In reality this number is a little higher, because the figures presented here exclude protected areas for which no starting data are known and the number of marine protected areas is likely to be underestimated.

The upward trend has been levelling off somewhat in recent years in some regions. The most significant increase in the last decade was noted in the North America region: from 11.9 per cent in 1995 to 14.4 per cent in 2005 and now up to 15.6 per cent in 2006.

The indicator does not provide a measure for effectiveness of protection of biological diversity in the protected areas. Protected areas invariably require active management interventions if they are to fulfill their role in maintaining biological diversity. Such measures include protection from adverse human activities such as encroachment, poaching, or over-harvest of particular resources and intervention to maintain ecological processes or populations of species. A key challenge for many protected areas is that they do not have adequate resources invested in them to allow for such management (UNEP-WCMC 2007).

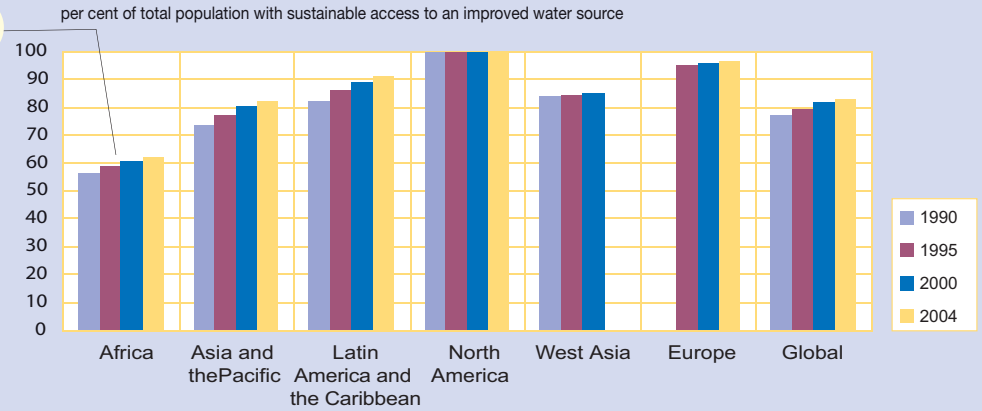
Units of measurement: *Per cent*

Definition: *Protected area is the area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, of natural and associated cultural resources, and managed through legal or other effective means. The data include both the areas classified under the six IUCN management categories and other protected areas. They include terrestrial and marine protected areas, but exclude all areas for which no starting data are known. Data for 2006 end at the beginning of November.*

Source: GEO Data Portal, compiled from UNEP-WCMC 2006.

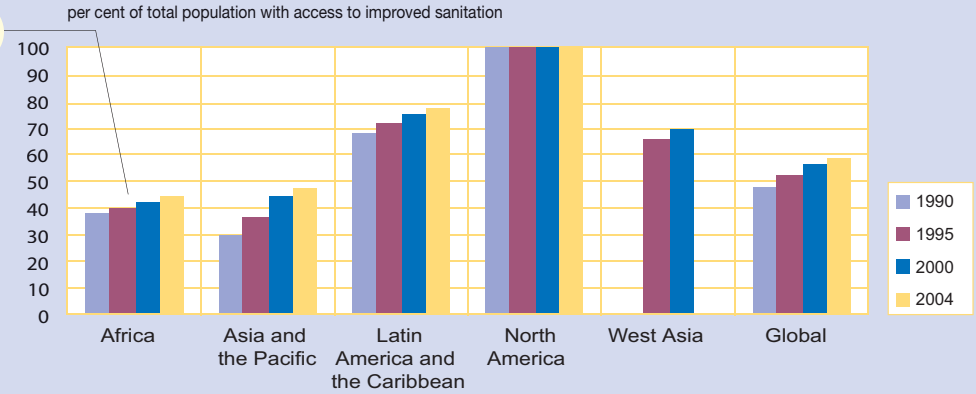
Indicator: **Proportion of population with sustainable access to an improved water source and proportion of population with access to improved sanitation (MDG indicator 30 & 31, under Target 10, Goal 7)**

Despite improvements in Africa as a whole from 1990 to 2004, the total number of people without access to drinking water in Sub-Saharan Africa increased by 23 per cent.



Note: Insufficient data for Europe in 1990 and West Asia in 2004

Despite improvements in Africa as a whole from 1990 to 2004, the number of people without sanitation in Sub-Saharan Africa increased by over 30 per cent.



Note: No data available for Europe and insufficient data for West Asia 1990 and 2004

Safe drinking water, sanitation, and good hygiene are fundamental to human health and development. Access to improved water supply and sanitation continues to increase—in 2004, 83 per cent and 59 per cent of the world's population had access to improved water supply and sanitation, respectively. Despite this progress, the world is not on track to achieve the sanitation target set by the Millennium Development Goals (MDGs).

These basic necessities are still a luxury for many of the world's poor people. Currently over 1.1 billion people do not use drinking water from improved sources, while 2.6 billion lack basic sanitation. These figures have not changed much during recent years. Migration from rural to urban areas poses major challenges for governments and urban planners, requiring extension of basic drinking water and sanitation services to peri-urban and slum areas to reach the poorest people (WHO/UNICEF 2006).

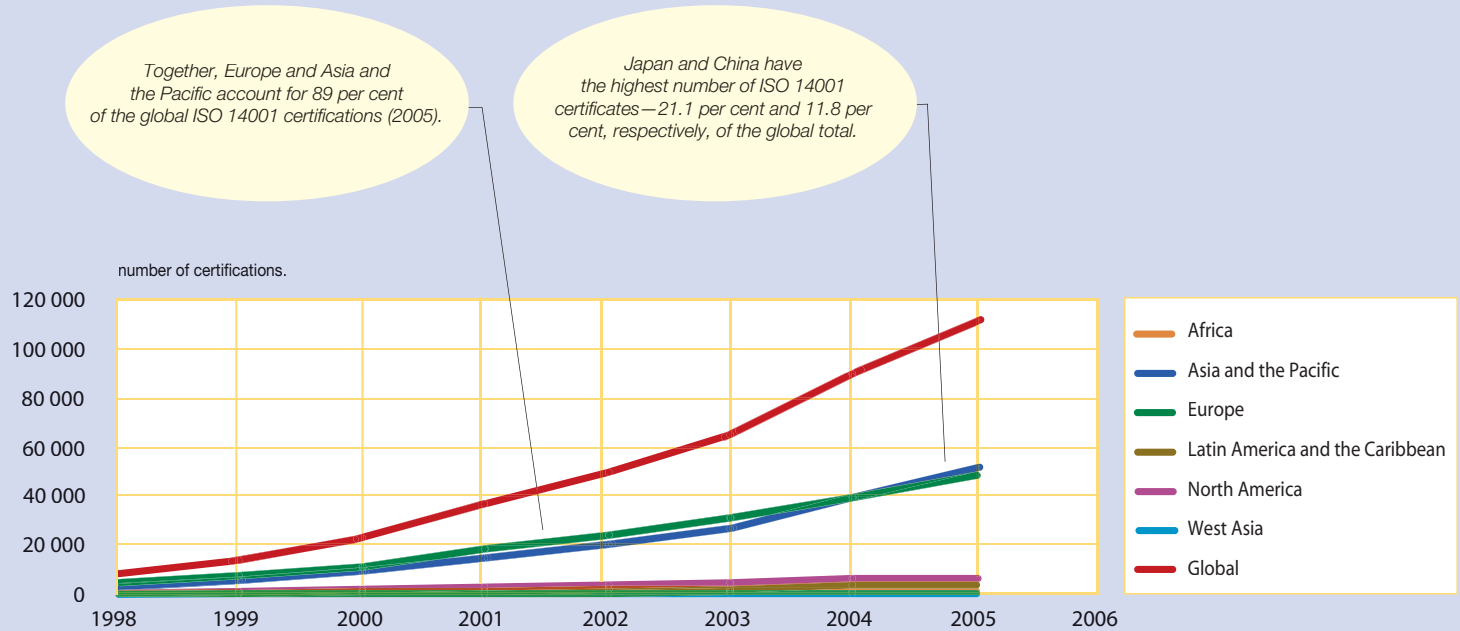
Units of measurement: *Per cent*

Definition: *The proportion of the population with access to safe drinking water is expressed as the percentage of people using improved drinking water sources or delivery points (piped water into dwelling, plot or yard; public tap/standpipe; tubewell/borehole; protected dug well; protected spring; rainwater collection). Improved drinking water technologies are more likely to provide safe drinking water than those characterized as unimproved.*

The proportion of the population with access to basic sanitation is expressed as the percentage of people using improved sanitation facilities (flush or pour-flush; ventilated improved pit; latrine; pit latrine with slab; composting toilet). Improved sanitation facilities are more likely to prevent human contact with human excreta than unimproved facilities.

Source: GEO Data Portal, compiled from WHO/UNESCO 2006.

Indicator: **ISO 14001 certifications**



The International Organization for Standardization (ISO) is the world's largest developer of voluntary international standards for business, government, and society. The most widely known standards related to the environment field are ISO 9001 for quality management and **ISO 14001 for environmental management systems**. The standards are used worldwide by businesses and organizations, large and small, in public and private sectors, by manufacturers and service providers, in all sectors of activity. ISO does not undertake any certification or auditing itself—instead many companies and organizations decide to have their management systems independently audited and certified as conforming to the standards. Certification is not a requirement of the standards themselves but many organizations have chosen certification because of the perception that an independent confirmation of high standards is important and worthwhile. By the end of December 2005, a total of at least 111 000 ISO-14001 certificates had been issued in 138 countries. The 2005 total represents an increase of 24 per cent over 2004, when the total stood at about 90 000 in 127 countries (ISO 2006).

Units of measurement: *Number of certifications*

Definition: *Number of certifications of ISO14001 standards gives the number of organizations (enterprises, institutions) that have received the ISO 14001certificate. ISO 14000 is a series of international standards on environmental management, of which ISO 14001 is the cornerstone standard. ISO 14001 specifies a framework of control for an Environmental Management System against which an organization can be certified by a third party. Data for 2006 end at the beginning of November.*

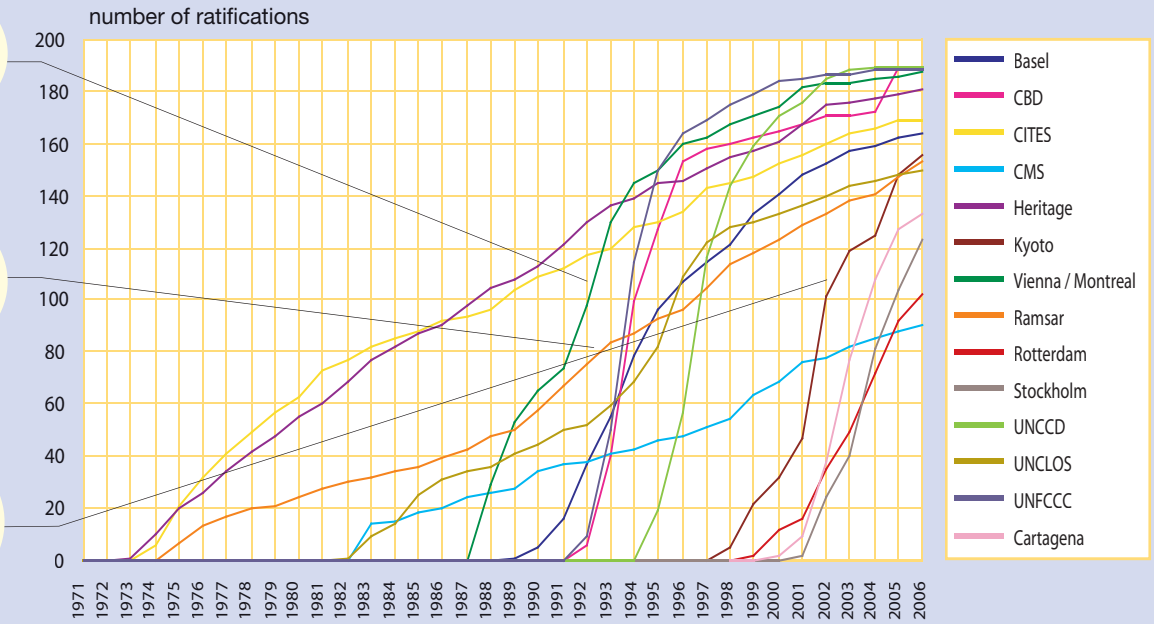
Source: GEO Data Portal, compiled from ISO 2006.

Indicator: **Ratification of multilateral environmental agreements (MEAs)**

Several MEAs play important roles in the Polar Regions such as Vienna / Montreal, CBD, Stockholm, UNCLOS, and UNFCCC.

In November 2006, the Parties to the Basel Convention agreed to increase efforts to address electronic waste issues. Some 20 to 50 million metric tonnes of e-waste are generated worldwide every year, comprising more than 5% of all municipal solid waste.

Among countries with commitments to cut emissions under the Kyoto Protocol, only Denmark, France, Iceland, the UK, Germany, and Norway reported lower emissions (excluding activities related to land use change and forestry) in 2004 than in 1990 along with ten countries with economies in transition.



	Vienna / Montreal	UNFCCC	Kyoto	CBD	Cartagena	CITES	CMS	UNCCD	Heritage	UNCLOS	Ramsar	Basel	Rotterdam	Stockholm
Africa (53)	53	52	39	53	39	52	32	53	48	39	47	44	32	38
Asia + Pacific (45)	44	44	38	47	29	31	10	45	40	34	27	33	20	28
Europe (49)	48	47	38	46	38	45	37	46	48	40	46	46	27	28
LAC (34)	33	33	31	32	23	32	8	33	32	27	27	30	15	21
North America (2)	2	2	1	1	0	2	0	2	2	1	2	1	1	1
West Asia (12)	11	10	9	10	4	7	3	10	11	9	4	10	7	7
Global (195)	**191**	**188**	**156**	**189**	**133**	**169**	**90**	**189**	**181**	**150**	**153**	**164**	**102**	**123**
Global (% ratified)	**98%**	**96%**	**80%**	**97%**	**68%**	**87%**	**46%**	**97%**	**93%**	**77%**	**78%**	**84%**	**52%**	**63%**
Change in number of parties from 2005 to 2006	**+5**	**-**	**+8**	**+3**	**+6**	**-**	**+2**	**-**	**+2**	**+3**	**+7**	**+2**	**+10**	**+19**

Units of measurement: *Number of parties*

Definition: *Number of parties to Multilateral Environmental Agreements (MEAs) 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 14 MEAs presented here. Data for 2006 are up to November.*

Source: GEO Data Portal, compiled from various MEA secretariats.

The ratification process of various Multilateral Environment Agreements (MEAs) advanced in 2006 in almost all regions. It is estimated that there are 700 or more different international agreements that govern some aspect of the environment (UNEP 2006b). For the 14 key agreements selected here, 86 per cent of the potential signatories were formal parties at the end of 2006 (up from 83 per cent in 2005). Many of the conventions are now approaching their maximum in terms of number of parties. However, this does not necessarily mean that all parties undertake immediate and adequate measures nor that the environmental problems are properly addressed. Strengthening and streamlining reporting mechanisms and further integration into national policies are important challenges for many of the international agreements.

Even the more recent conventions have seen their number of parties quickly increasing, such as the Stockholm Convention on Persistent Organic Pollutants (POPs), the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC), as well as the Kyoto Protocol to the UN Framework Convention on Climate Change. Negotiations are underway to develop commitments by industrialized nations and major developing countries for the 2012 post-Kyoto era.

Environmental conventions' websites

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel): http://www.basel.int/ratif/convention.htm

Cartagena Protocol on Biosafety to the Convention of Biological Diversity (Cartagena): http://www.biodiv.org/biosafety/default.aspx

Convention on Biological Diversity (CBD): http://www.biodiv.org/world/parties.asp

Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage): http://whc.unesco.org/en/statesparties/

Convention on the Conservation of Migratory Species of Wild Animals (CMS): http://www.cms.int/about/intro.htm

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): http://www.cites.org/eng/disc/parties/index.shtml

Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar): http://www.ramsar. org/key_cp_e.htm

Kyoto Protocol to the UN Framework Convention on Climate Change (Kyoto): http://unfccc.int/essential_background/kyoto_protocol/status_of_ratification/items/2613.php

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/reference_files/chronological_lists_of_ratifications.htm#The United Nations Convention on the Law of the Sea

UN Framework Convention on Climate Change (UNFCCC): http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer (Vienna/Montreal): http://ozone.unep.org/Ratification_status/index.asp

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Acronyms and abbreviations

ASEAN	Association of South East Asian Nations
ATCM	Antarctic Treaty Consultative Meeting
Basel Convention	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
BASF	Badische Anilin und Soda Fabrik (German chemical products company)
BP	Beyond Petrolem (formerly British Petroleum)
BTC	Baku-Tbilisi-Ceyhan (oil pipeline)
CAP	Compliance Assistance Programme
Cartagena Protocol	Cartagena Protocol on Biosafety to the Convention of Biological Diversity
CBD	Convention on Biological Diversity
CCAMLR	Convention on/ Commission for the Conservation of Antarctic Marine Living Resources
CDM	Clean Development Mechanism
CeO_2	ceria
CEWARN	Conflict Early Warning and Response Mechanism
CFC	chlorofluorocarbon
CH_4	methane
CI	Conservation International
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CO	carbon monoxide
CO_2	carbon dioxide
CONAMA	Comisión Nacional del Medio Ambiente
COREMA	Comisión Regional del Medio Ambiente
DMSP	Defense Meteorological Satellite Program
EIA	Environmental Impact Assessment
EMEP	Environmental Monitoring, Evaluation and Protection Programme
E/MSY	extinction per million species per year
ENCE	Empresa Nacional de Celulosa España
EPA	Environmental Protection Agency (of the United States)
ESA	Endangered Species Act
ETS	Emissions Trading Scheme (European Union)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FIFA	Fédération Internationale de Football Association (International Federation of Football Association)
FSC	Forest Stewardship Council
GCC	Gulf Cooperation Council
GEF	Global Environment Facility
GEO	Global Environment Outlook (of UNEP)
GHG	Greenhouse gas
GMS	Greater Mekong Sub-region
HCFC	hydrochlorofluorocarbon
Heritage Convention	Convention Concerning the Protection of the World Cultural and Natural Heritage
IAS	Invasive alien species
ICCM	International Conference on Chemicals Management
ICJ	International Court of Justice
ICLEI	Local Governments for Sustainability
IEA	International Energy Agency
IGAD	Intergovernmental Authority on Development
IGCP	International Gorilla Conservation Programme
IMF	International Monetary Fund
IMO	International Maritime Organization
INPE	Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research of Brazil)
IPY	International Polar Year
ISO	International Organization for Standardization
ITPGR	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	The World Conservation Union
IUU	Illegal, Unregulated and Unreported (fishing)
IWC	International Whaling Commission
IWRM	Integrated Water Resources Management
IYDD	International Year of Deserts and Desertification
KAZA TFCA	Kavango-Zambezi Transfrontier Conservation Area
Kengen	Kenya Electricity Generating Company
Kyoto Protocol	Kyoto Protocol to the UN Framework Convention on Climate Change
LaB6	lanthanum hexaboride
LAC	Latin America and the Caribbean
LED	Light Emitting Diodes
MA	Millennium Ecosystem Assessment
MDGs	Millennium Development Goals
MEA	Multilateral Environmental Agreement
MeBr	methyl bromide
MERCOSUR	Mercado Común del Sur (Southern Cone Common Market)
MIKE	Monitoring of Illegal Killing of Elephants
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	Marine Protected Area
MSC	Marine Stewardship Council
Mtoe	million tonnes of oil equivalent
NAP	National Allocation Plans
NASA	National Aeronautics and Space Administration (of the United States)
NDVI	Normalized Difference Vegetation Index
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
Ni-C	nickel (carbon-coated)
NO_2	nitrogen dioxide
N_2O	nitrous oxide
NOAA	National Oceanographic and Atmospheric Administration (of the United States)
ODS	ozone-depleting substance
ODP	ozone-depleting potential
OECD	Organization for Economic Co-operation and Development
OPT	Occupied Palestinian Territory
PIC	Prior Informed Consent
PLLA	Poly (L-lactic acid)
PM	particulate mattersmaller than x micrometres
POP	Persistent Organic Pollutant
ppm	parts per million
PPP	purchasing power parity
PRI	Principles for Responsible Investment
Ramsar Convention	Convention on Wetlands of International Importance Especially as Waterfowl Habitat
REACH	Registration, Evaluation and Authorization of Chemicals
Rotterdam Convention	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
SADC	Southern African Development Community
SAICM	Strategic Approach on International Chemicals Management
SARS	Severe Acute Respiratory Syndrome
SiO^2	silica
Stockholm Convention	Stockholm Convention on Persistent Organic Pollutants
TiO^2	titania
TiO_2	titanium dioxide
UAE	United Arab Emirates
UK	United Kingdom
UN	United Nations
UNCCD	UN Convention to Combat Desertification In Those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa
UNCLOS	UN Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
US	United States
Vienna Convention/ Montreal Protocol	Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer
WfW	Working for Water (Programme)
WHO	World Health Organization
WMO	World Meteorological Organization
World Bank	International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA)
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWF	World Wide Fund for Nature
Y203	yttrium oxide
ZnO	zinc oxide

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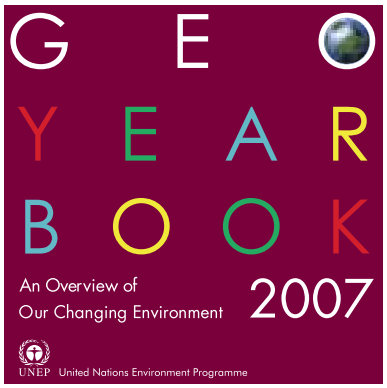
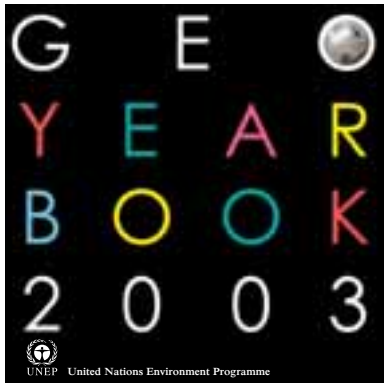


Year Book 2007
The opportunities and risks examined in the Feature Focus of GYB 2007 on the interface between Environment and Globalization are considered from a dynamic and interactive approach. With responsible management, risks can be defused or even transformed into opportunities. With no management or with mismanagement, opportunities can all too easily degrade into risks. The impact of nanotechnologies on the environment and human health are examined in the Emerging Challenges chapter.

Year Book 2004/5
The Feature Focus of the 2004/2005 Year Book looks at the links among gender, poverty, and environment. The Emerging Challenges section explores how environmental change can trigger the emergence or re-emergence of infectious diseases, demonstrating the role of good environmental management in minimizing adverse trends. It also presents an overview of recent changes in ocean salinity and a step-by-step explanation of why this could have serious consequences.

Year Book 2006
The GYB's 2006 Feature Focus elaborates on the environmental, socio-economic and public health impacts of energy-related air pollution. Associated with the energy consumption that contributes to air pollution are increasing global concerns over climate change and energy security and access. The chapter on Emerging Challenges addresses two topics of policy interest related to food security. The first topic explores the issue of crop production in a changing climate, while the second identifies environmental effects and best practices related to fish and shellfish farming in marine ecosystems.



Year Book 2003
Water is the topic of the Feature Focus in the Year Book 2003. Water plays an important role 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 Governments convened in 2000. The section on Emerging Challenges focuses on science and research findings related to the nitrogen cycle and marine fisheries.

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The GEO Year Book 2007 is the fourth annual report on the changing environment produced by the United Nations Environment Programme in collaboration with many world environment experts.

The 2007 Year Book includes **global and regional overviews** of significant developments over the past year. It highlights linkages among ecosystem health, human well-being, and economic development; examines new thinking on the value of ecosystem services and the threat from ecosystem degradation; and describes recent research findings and policy decisions that affect our awareness and response to global change.

A special feature focus analyzes the intersection between **environment and globalization** where ecosystem services–and the human well-being that depends on those services–are affected by natural resource exploitation in response to global demands. The chapter also explores some of the innovative policy mechanisms that link global supplies of goods and services with sustainable development objectives.

The emerging scientific and policy challenges of **nanotechnology** are examined from an environmental perspective. Nanotechnology will bring environmental benefits but it is vital that we adopt appropriate assessment and legislative processes to address the unique challenges presented by nanomaterials and their life cycles.

The GEO-indicators chapter provides an **up-to-date graphic representation of key trends** and growing stresses on the environment that supports all life on the planet.

The 2007 GEO Year Book is essential, informative, and authoritative reading for anyone with a role or an interest in our changing environment.

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