

Global Environment Outlook

# GEO<sub>4</sub>

*environment for development*

## SUMMARY FOR DECISION MAKERS



United Nations Environment Programme

First published by the United Nations Environment Programme in 2007

Copyright © 2007, United Nations Environment Programme

This publication may be reproduced in whole or in part and in any form for educational or non-profit services without special permission from the copyright holder, provided acknowledgement of the source is made. UNEP would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme.

Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, DCPI, UNEP, P.O. Box 30552, Nairobi, 00100, Kenya.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of UNEP concerning the legal status of any country, territory or city or its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of a commercial company or product in this publication does not imply endorsement by the United Nations Environment Programme. The use of information from this publication concerning proprietary products for publicity or advertising is not permitted.

Printed and bound in Malta by  
Progress Press Company Limited  
Strickland House, 341 St Paul Street,  
Valletta VLT1211, Malta

UNEP promotes  
environmentally sound practices  
globally and in its own activities.

This publication is printed on  
chlorine free, acid free paper made of wood  
pulp from sustainably managed forests.

Our distribution policy aims to  
reduce UNEP's carbon footprint.

Global Environment Outlook

**GEO<sub>4</sub>**  
*environment for development*

# **SUMMARY FOR DECISION MAKERS**



United Nations Environment Programme

## The GEO-4 assessment process

Since 1997, UNEP has produced *Global Environment Outlook* (GEO) reports providing assessments of the interactions between environment and society. With its core mandate of “keeping the global environment under review,” UNEP coordinated a series of scientific assessments that included extensive consultations and participatory processes, resulting in the production of GEO reports in 1997, 1999 and 2002.

The fourth assessment, *Global Environment Outlook: environment for development (GEO-4)*, is the most comprehensive GEO process to date. It was designed to ensure synergy between science and policy, while maintaining its scientific credibility and making it responsive to policy needs and objectives. The launch in 2007 of the GEO-4 report coincides with the 20th anniversary of the launch of the report of the World Commission on Environment and Development, *Our Common Future*. GEO-4 uses it as a reference to assess progress in addressing key environment and development issues. GEO-4 highlights the vital role of the environment in development and, more importantly, for human well-being.

GEO-4 is more than a report: it is also a comprehensive consultative process which began in 2004. In February of that year, *an intergovernmental consultation on strengthening the scientific base of UNEP*, which involved more than 100 governments and 50 partner organizations, called for a further strengthening of the GEO process. The global consultation was followed by *regional consultations* in September-October 2004, which identified key regional and global environmental issues. Building on these consultations, the scope, objectives and process of the GEO-4 were finalized and adopted by the *First Global Intergovernmental and Multistakeholder Consultation* in February 2005.

The assessment was carried out by 10 chapter expert groups consisting of *coordinating lead authors* and *lead authors* supported by *chapter coordinators* provided by the UNEP secretariat. The draft outputs from the expert groups were subjected to an additional round of *regional consultations* and two rounds of extensive *expert and government peer review*. The review process was overseen by *chapter review*

*editors*. The assessment was also guided and supported by a *High-level Consultative Group* of senior government policy-makers, funding partners, scientists and academics as well as representatives of some UN agencies, international organizations, the private sector, GEO collaborating centres and civil society.

In 10 chapters, the GEO-4 assessment provides: an overview of environmental issues; state-and-trends of the environment between 1987 and 2007; human dimensions of environmental change; an outlook for the future using four scenarios; and the policy options available to sustain our common future:

Chapter 1: Environment for Development

Chapter 2: Atmosphere

Chapter 3: Land

Chapter 4: Water

Chapter 5: Biodiversity

Chapter 6: Sustaining a Common Future

Chapter 7: Vulnerability of People and the Environment:  
Challenges and Opportunities

Chapter 8: Interlinkages: Governance for Sustainability

Chapter 9: The Future Today

Chapter 10: From the Periphery to the Core of Decision  
Making – Options for Action

The *Summary for Decision Makers (SDM)* was prepared by UNEP with technical inputs from the coordinating lead authors and inputs from the members of the High-level Consultative Group. It underwent two rounds of extensive expert and government peer review. Finally, the SDM was subject to in-depth consideration by the *Second Global Intergovernmental and Multistakeholder Consultation* in September 2007. The consultation adopted a statement which endorsed the SDM.

The basis for this *Summary for Decision Makers* can be found in the GEO-4 chapters. Reference sources for graphics used in this report are provided at the end of the report.

**This Summary for Decision Makers synthesizes the findings of the main report: *Global Environment Outlook: environment for development (GEO-4)* and is prepared by UNEP with:**

***Inputs from members of the High-Level Consultative Group***

Agnes Kalibbala (co-chair), Jacqueline McGlade (co-chair), Ahmed Abdel-Rehim, Svend Auken, Philippe Bourdeau, Preeti Bhandari, Nadia Makram Ebeid, Idunn Eidheim, Exequiel Ezcurra, Peter Holmgren, Jorge Illueca, Fred Langeweg, John Matuszak, Toral Patel-Weynand, Jaco Tavenier, Dan Tunstall, Judi Wakhungu, Vedis Vik (alternate member)

***Technical inputs from the Coordinating Lead Authors***

John Agard, Russell Arthunton, Neville Ash, Sabrina Barker, Jane Barr, Ivar Baste, Bradnee Chambers, David Dent, Asghar Fazel, Habiba Gitay, Jill Jager, Peter King, Marcel Kok, Johan Kuylenstierna, Marc Aaron Levy, Clever Mafuta, Diego Martino, Trilok Panwar, Walter Rast, George Varughese, Zinta Zommers

and

***the following Lead and Regional Authors***

Waleed K. Al-Zubari, Ahmed Fares Asfary, Samuel Ayonghe, Álvaro Fernández-González, Murari Lal, Frank Murray, Washington Odongo Ochola, Irene Pisanty-Baruch, Salvador Sánchez-Colón, Tunnies Srisakulchairak, Marc Sydnor

**It was considered and endorsed on 26 September 2007 by:**

The Second Global Intergovernmental and Multistakeholder Consultation on the fourth Global Environment Outlook Report

Afghanistan, Argentina, Azerbaijan, Bahrain, Bangladesh, Belgium, Burundi, Canada, Chile, China, Colombia, Cuba, Czech Republic, Denmark, Democratic Republic of Congo, Djibouti, Egypt, Estonia, Finland, Gambia, Georgia, Germany, Greece, Holy See, Honduras, Hungary, India, Indonesia, Iran, Iraq, Italy, Japan, Kenya, Liberia, Libya, Madagascar, Mauritius, Mexico, Morocco, Myanmar, The Netherlands, Nigeria, Norway, Oman, Pakistan, Panama, Philippines, Portugal, Republic of Korea, Russian Federation, Saudi Arabia, Spain, St. Kitts and Nevis, Sweden, Sudan, Switzerland, Syria, Tanzania, Thailand, Togo, Uganda, United Kingdom, United States of America, Uzbekistan, Venezuela, Viet Nam, Yemen, Zambia, and Zimbabwe

Arab Media Forum for Environment and Development, Egypt; Centre for Environment and Development for the Arab Region & Europe, Egypt; Charles University of Prague, Czech Republic; Council for Development, Environmental Studies & Conservation (MAUDESCO), Mauritius; Department of Environment, Housing and Sustainable Development, Egypt; Environmental Assessment Agency (MNP), The Netherlands; Environment Liaison Centre International (ELCI), Kenya; Environment Liaison Centre International (ELCI), Switzerland; European Environment Agency, Denmark; Food and Agriculture Organization of the United Nations, Italy; Institute for Global Environment Strategies, United States; International Council for Science (ICSU), France; International Conference on Philanthropy, Switzerland; IUCN-The World Conservation Union, Switzerland; Maoni Network, Kenya; National Environment Management Authority (NEMA), Uganda; Organización Juvenil Ambiental (OJA), Colombia; Scientific Committee on Problems of the Environment (SCOPE), France; Secretariat of the United Nations Forum on Forests, United States; Society for Conservation and Protection of Environment (SCOPE), Pakistan; Stakeholder Forum for a Sustainable Future, United Kingdom; Secretariat of the Convention on Biological Diversity (CBD), Canada; Secretariat of the United Nations Convention to Combat Desertification (UNCCD), Germany; Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), Germany; Tilburg University (IGSP), The Netherlands; United States Geological Survey (USGS), United States of America; World Health Organization (WHO), Switzerland; World Meteorological Organization WMO Sub-regional Office for Eastern and Southern Africa, Kenya; World Wide Fund for Nature-Kiunga MNRC&D Project (WWF), Kenya; and World Resources Institute (WRI), United States of America

**The UNEP team included:**

Adel Abdel-Kader, Joana Akrofi, Ivar Baste, Marion Cheatle, Jacquie Chenje, Munyaradzi Chenje, Thierry de Oliveira, Volodymyr Demkine, Salif Diop, Silvia Giada, Peter Gilruth, Robert Hoft, Christian Lambrechts, Marcus Lee, Elizabeth Migongo-Bake, Patrick M'mayi, Neeyati Patel, Charles Sebukeera, Nalini Sharma, Gemma Shepherd, Ashbindu Singh, Linda Starke (consultant), Jaap Van Woerden, Ron Witt, and Jinhua Zhang

# KEY MESSAGES FOR DECISION MAKERS

**Humankind depends on the environment**, which is critical for both development and human well-being. Natural resources – compared to financial, material and human resources – are the foundation for much of the wealth of countries. Environmental change can affect people's security, health, social relations and material needs.

## **There is evidence of unprecedented environmental change at global and regional levels:**

- **The Earth's surface is warming. This is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.** Other major impacts, include changes in water availability, land degradation, food security, and loss of biodiversity. The projected increase in frequency and intensity of heat waves, storms, floods and droughts would dramatically affect many millions of people including those in small island states and Polar regions. While in the past century the global average temperature increased by 0.74°C, the best estimate of the Intergovernmental Panel on Climate Change (IPCC) for additional warming over the current century is projected to be from 1.8 to 4.0°C. Climate change may further exacerbate the loss of biodiversity and degradation of land, soil, forest, freshwater and oceans.
  - **More than 2 million people globally die prematurely every year due to outdoor and indoor air pollution.** Although air pollution has decreased in some cities due to technological and policy measures, increasing emissions in other cities are intensifying the challenges. Indoor air pollution due to the improper burning of solid biomass fuels imposes an enormous health burden.
  - **The "hole" in the stratospheric ozone layer over the Antarctic – the layer that protects people from harmful ultraviolet radiation – is now the largest it has ever been.** Due to decreased emissions of ozone depleting substances and assuming full Montreal Protocol compliance, the ozone layer is expected to recover, but not until between 2060 and 2075 as a result of long lag times.
  - **Unsustainable land use and climate change are driving land degradation**, including soil erosion, nutrient depletion, water scarcity, salinity, desertification, and the disruption of biological cycles. Poor people suffer disproportionately from the effects of land degradation, especially in the drylands, which support some 2 billion people, 90 per cent of whom live in developing countries.
  - **The per capita availability of freshwater is declining globally, and contaminated water remains the greatest single environmental cause of human sickness and death.** If present trends continue, 1.8 billion people will be living in countries or regions with absolute water scarcity by 2025, and two-thirds of the people in the world could be subject to water stress. The decline of quantity and quality of surface and groundwater is impacting aquatic ecosystems and their services.
  - **Aquatic ecosystems continue to be heavily exploited, putting at risk sustainability of food supplies and biodiversity.** Global marine and freshwater fish catches show large-scale declines, caused mostly by persistent overfishing.
  - **The great majority of well-studied species are declining in distribution, abundance or both.** Although the decline in the area of temperate forest has been reversed, with an annual increase of 30 000 km<sup>2</sup> between 1990 and 2005, deforestation in the tropics continued at an annual rate of 130 000 km<sup>2</sup> during the same period. More than 16 000 species have been identified as threatened with extinction.
- These unprecedented changes are due to human activities in an increasingly globalized, industrialized and interconnected world**, driven by expanding flows of goods, services, capital, people, technologies, information, ideas and labour, even affecting isolated populations. The responsibility for global environmental pressures is not equally distributed throughout the world. For instance, in 2004, United Nations Framework Convention on Climate Change Annex 1 countries with 20 per cent of world population produced 57 per cent of gross

world product based on purchasing power parity and accounted for 46 per cent of greenhouse gas emissions. Industrial development, natural resource extraction and carbon-intensive industrial production, may have significant environmental consequences, which need to be addressed. Responses include the use of the best available technologies and practices as appropriate.

**Environmental change affects human development options, with poor people being the most vulnerable.** For example, in the period between 1992 and 2001, floods were the most frequent natural disaster, killing nearly 100 000 people and affecting more than 1.2 billion people. More than 90 per cent of the people exposed to disasters live in the developing world.

**Biophysical and social systems can reach tipping points, beyond which there are abrupt, accelerating, or potentially irreversible changes.** The four *GEO-4* scenarios show an increasing risk of crossing tipping points, even as some global environmental degradation trends are slowed or reversed at different rates towards the middle of the century. Changes in biophysical and social systems may continue even if the forces of change are removed, as evidenced in the stratospheric ozone depletion and the loss of species.

**The transition towards sustainable development needs to be pursued more intensively by nations and the international community, including through capacity building and technological support to developing countries.** Actions to reduce the drivers of environmental change by all stakeholders, including the private sector and consumers, require trade-offs, which may involve hard choices, among different values and concerns.

**Decision-makers can promote timely action by integrating prevention, mitigation and adaptation efforts into the core of decision-making through sustained efforts which include:**

- **Reducing people's vulnerability to environmental and socio-economic changes** by decentralization, strengthening resource rights of local people, improving access to financial and technical support, improving capacities to cope with natural disasters, and empowering women and vulnerable groups;

- **Integrating environmental activities into the broader development framework**, including by ascertaining the environmental impacts of proposed public spending, identifying sectoral and inter-sectoral environmental targets, promoting best practices, and monitoring long-term achievements;
- **Enhancing treaty compliance** by overcoming administrative costs and the heavy reporting burden of Parties, improving monitoring and compliance, and enhancing coordination, particularly at national level;
- **Creating enabling environments for innovations and emerging solutions** by using economic instruments, new and existing technologies, empowerment of stakeholders, and more adaptive approaches which break away from the traditional segmented institutional management and production systems, and result in more sustainable consumption and production patterns;
- **Strengthening environmental knowledge, education and awareness** by making the best-available scientific research and data accessible through improved monitoring, assessments and knowledge infrastructure, building on the rapid developments in information and communication technologies;
- **Mobilizing financial resources to address environmental problems** through innovative approaches, including payments for ecosystem services while achieving an open, non-discriminatory and equitable multilateral trading system as well as meaningful trade liberalization benefiting countries at all stages of development.

**Knowledge on the interlinkages between environment and development, and the impacts on human well-being, gained since the release of *Our Common Future*, the report of the World Commission on Environment and Development, can be used effectively for the transition towards sustainable development.** Concerns about the global environment may have reached a tipping point of their own, with the growing realization that, for many problems, the benefits of early action outweigh the costs. **Now is the time to pursue the transition towards sustainable development supported by well-governed, innovative and results-oriented institutions.**

# 1 INTRODUCTION

In 1987, the World Commission on Environment and Development (WCED) presented its report, *Our Common Future*. The Brundtland Commission, as it was known, brought international attention to the concept of sustainable development – a challenge to meet today's development needs without compromising the ability of future generations to meet their own needs. Twenty years on, the challenges as set out in the Millennium Development Goals (MDGs) are even more profound, and the importance of the environment in sustaining development is becoming ever clearer.

# 2 ENVIRONMENT FOR DEVELOPMENT

Development depends on the environment while its impacts on the environment affect human well-being. The world has changed radically over the past two decades. Significant changes to geopolitical borders have occurred. Global population has grown from 5 billion to 6.7 billion. There has been a net annual rise in gross domestic product (GDP) per person of almost 2 per cent and continued increases in trade volume, CO<sub>2</sub> emissions and agricultural land (see **Figure 1**). Technological innovations have improved livelihoods and health. Low transportation costs, coupled with market liberalization and the rapid development of telecommunications have fuelled globalization and altered trade patterns, expanding the flow of goods, services, capital, people, technologies, information, ideas and labour. While millions have worked their way out of poverty and have access to improved services, such as healthcare, there are still more than 1 billion poor people in the world. They lack essential services such as clean water, adequate nutrition, shelter and clean energy, making them especially vulnerable to environmental and socio-economic changes.

The responsibility for the mounting global environmental pressures is not equally distributed throughout the world. For instance, in 2004, United Nations Framework Convention on Climate Change Annex 1 countries with 20 per cent of world population, produced 57 per cent of gross world product based on purchasing power parity and accounted for 46 per cent of greenhouse gas emissions. Changing drivers and pressures, including the large-scale movement of people from rural to urban areas, the widening gap between the richest and the poorest, and growth in demand for energy, among other factors, have led to a deepening disparity in consumption patterns and in outsourcing of environmentally damaging production processes.

Long term sustainable development aimed at improving human well-being entails:

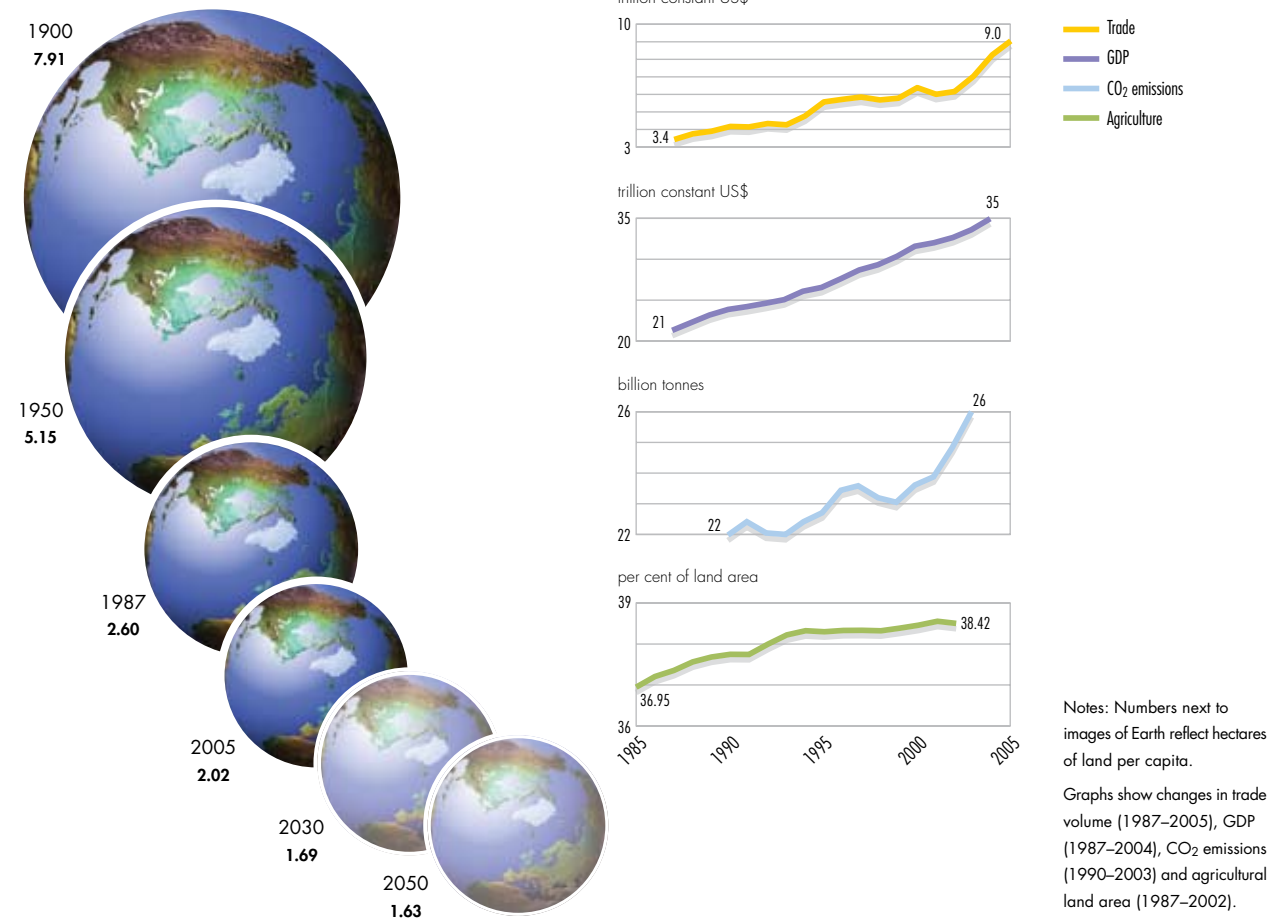
- increasing the asset base and its productivity;
- empowering poor people and marginalized communities;

- reducing and managing risks; and
- taking a long-term perspective with regard to intra- and inter-generational equity.

Ecosystems provide the natural resources capital needed for development. Natural resources, account for more than a quarter of the wealth of low-income countries and somewhat less in higher income countries. Changes in ecosystem services can affect natural resources as well as financial, material, and human assets. All people – rich and poor, urban and rural – rely on natural resources through a complex web of interactions. The GEO conceptual framework (see back page) illustrates many of the links between environmental change and people's security, health, social relations and material needs, all of which are components of human well-being. Sectors such as agriculture, fisheries, forestry, tourism and mining are instrumental in utilizing natural resources and ecosystem services.



**Figure 1: Our “shrinking” Earth**



Changing drivers, such as population growth, economic activities and consumption patterns, have placed increasing pressure on the environment. Since 1987 the world population has increased by almost 34 per cent, and world trade has increased 2.6 times. The illustration above shows how the land available to each person on Earth has been figuratively “shrinking” since 1900, from 7.91 ha then to 2.02 ha in 2005 and is projected to further drop to 1.63 ha by 2050. The figure also shows that global economic output has grown by 67 per cent, also increasing the average per capita income in the same period. The graphs highlight some of the pressures and environmental changes from human activities.

The normative framework for human development is reflected in the internationally agreed development goals in the Millennium Declaration. Environmental sustainability is one of the development goals critical to achieving the other targets. The eradication of extreme poverty and hunger, for example, is dependent on sustainable agriculture which, in turn, relies on soils, water and ecological processes.

Increasingly, there is evidence that investment in environmental management results in increased income generation for the rural poor. It can also result in income generation for industries in developed countries

that produce environmental remediation equipment; for example, the environmental industry is Denmark’s second largest export.

It is estimated that 80 per cent of people in developing countries rely on traditional medicines, and more than half of the most frequently prescribed drugs in developed countries derive from natural resources. Worldwide, more than 1.3 billion people depend on fisheries, forests and agriculture for employment. Communities in resource dependent countries are, therefore, especially vulnerable to environmental degradation, climate change, and the loss of services from ecosystems. In the Adagon watershed in India, for example, the

annual days of employment rose from 75 to 200 after ecosystem restoration was undertaken. Traditional management in Fiji to promote recovery of fisheries through a *no-take* area in a marine coastal zone resulted in a 35–43 per cent increase in income over three years.

Knowledge about the value of ecosystem services and the role of environment in supporting development has improved over the last two decades. A further enhancement of such knowledge can facilitate the transition to sustainable development. This transition will require trade-offs, and hard choices, among different values and concerns in society.

## 3 ENVIRONMENTAL CHALLENGES AND OPPORTUNITIES

### Changes in the Earth's environment

We now have evidence of unprecedented environmental changes at global and regional levels. These unprecedented changes are due to human activities in an increasingly globalized, industrialized and interconnected world, driven by expanding flows of goods, services, capital, people, technologies, information, ideas and labour, even affecting isolated populations. The key changes and associated challenges and opportunities are presented below.

#### Atmosphere

Atmospheric changes have major implications for human well-being. Since *Our Common Future* considered the topic of **climate change**, there has been a sharp and continuing rise in greenhouse gas (GHG) emissions and in the concentration of these gases in the atmosphere. Climate change (including global warming) is under way, and an average temperature increase of 0.74°C over the past century has been recorded. This trend, in which 11 of the last 12 years (1995–2006) rank among the 12 warmest years since 1850, is virtually certain. Impacts are already evident and include changes in water availability, spread of waterborne disease vectors, food security, sea-level and ice cover as exemplified by melting of the Greenland ice sheet (see **Figure 2**). Anthropogenic GHG emissions (principally carbon dioxide, CO<sub>2</sub>) are the main drivers of change. The projected increase in

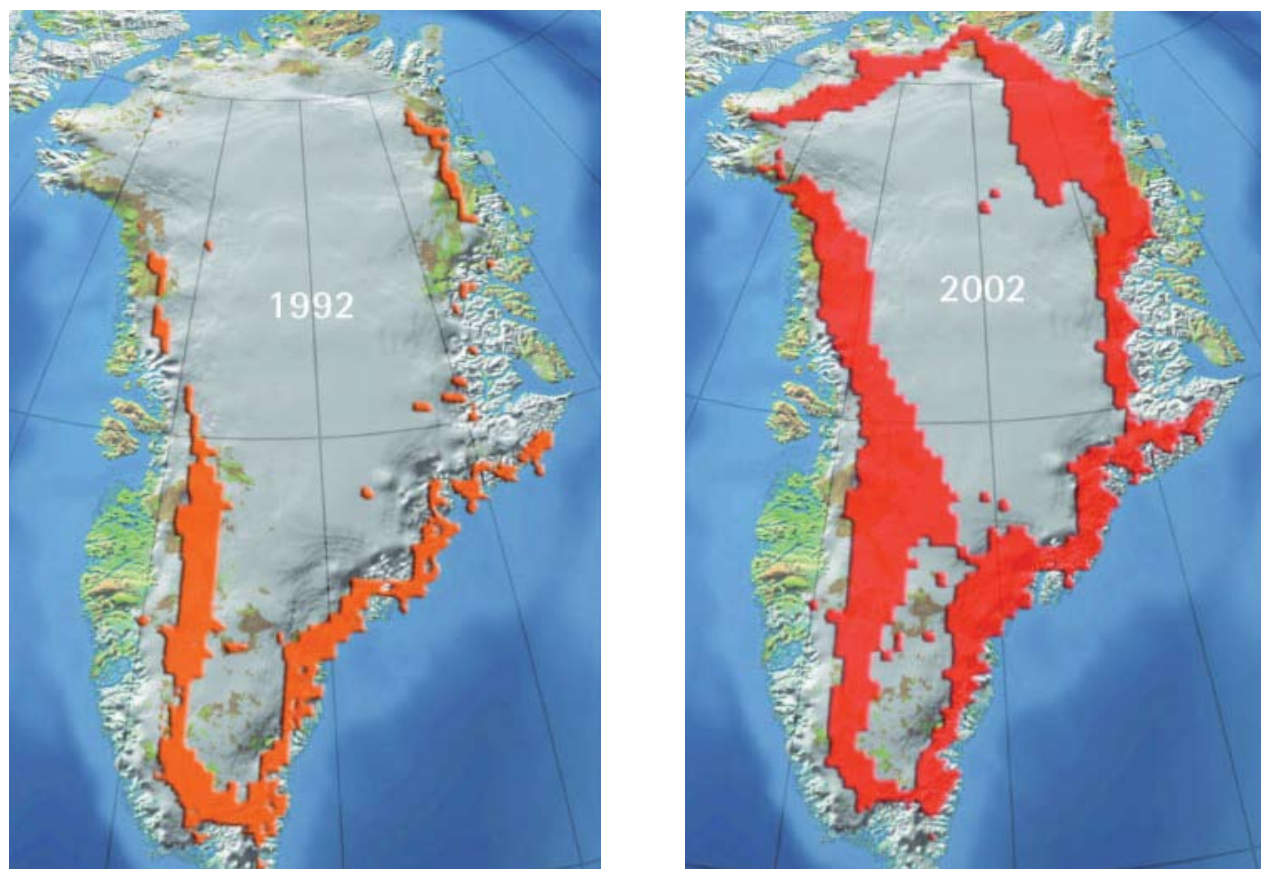
frequency and intensity of heatwaves, storms, floods and droughts would dramatically affect many millions of people. The Intergovernmental Panel on Climate Change (IPCC) projects an increase in the global temperature of 1.8–4°C by the end of this century. This will lead to potentially massive consequences, especially for the most vulnerable, poor and disadvantaged people who contribute to climate change to a lesser extent. Even if atmospheric concentrations of GHGs were to be stabilized today, land and ocean temperatures would increase for decades and sea levels would rise for centuries.

Adaptation to climate change is necessary even if major mitigation measures are rapidly implemented. The array of potential adaptive responses available to human societies is very large, ranging from purely technological (such as sea defences), through behavioural (such as altered food and recreational choices) to managerial (such as modified farm practices), and policy (such as planning regulations). However, there are formidable barriers to adaptation. For developing countries, availability of resources and building adaptive capacity are particularly important.

Mitigation and adaptation to climate change can be integrated into development policies by pursuing innovative and emerging solutions, which will also create new opportunities and jobs. The use of economic policy instruments and public and private sector investments in new technologies, clean and renewable energy, energy efficiency, nuclear energy and carbon sequestration are some of the many options already being used.

More than 2 million people are estimated to die prematurely each year due to **indoor and outdoor air pollution**. Severe indoor air pollution occurs in many poor communities when biomass and coal are used for cooking and heating in enclosed places without adequate ventilation. Outdoor air pollution (see **Figure 3**) arises from many sources, including industrial processes, motor vehicles, energy generation, and wildfires. Although air quality has improved dramatically in some cities, many areas still suffer from excessive air pollution, resulting in severe health impacts.

**Figure 2: Seasonal melting of the Greenland Ice Sheet**

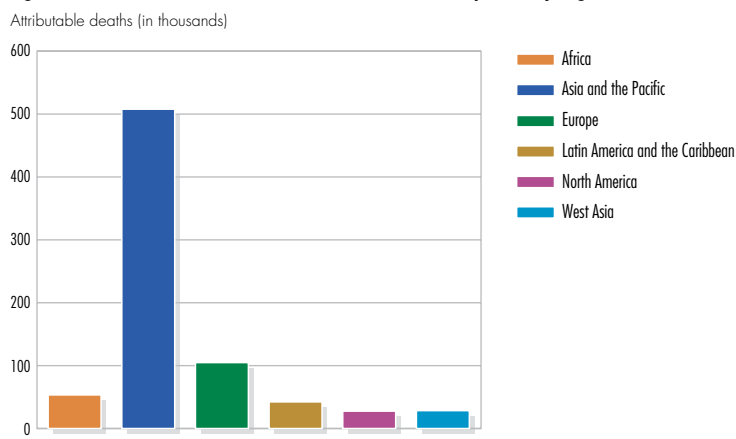


The areas in orange/red are the areas where there is seasonal melting at the surface of the ice sheet. The total melt extent in 2005 exceeded the previous record of 2002.

Long-range transport of a variety of air pollutants also remains an issue of concern for human and ecosystem health.

The “hole” in the **stratospheric ozone layer** over the Antarctic – the layer that protects people from harmful ultraviolet radiation – is now the largest it has ever been. Due to decreased emissions of ozone depleting substances (ODS), the ozone layer is expected to recover, assuming full Montreal Protocol compliance, but not until between 2060 and 2075 as a result of long lag times. Early precautionary action on stratospheric ozone depletion was taken before the impacts were fully evident. In 1987, the international community, through cooperation among developing and developed countries, agreed to phase out production and consumption of chlorofluorocarbons and other ODS, through the Montreal Protocol on

**Figure 3: Premature deaths due to outdoor urban PM<sub>10</sub> exposure by region in 2000**



Human and environmental exposure to air pollution is a major challenge, and an issue of global concern for public health. The World Health Organization (WHO) estimates that about 2.4 million people die prematurely every year due to inhaling fine particles. This figure shows the annual mortality that is attributable to outdoor air pollution for different world regions. The highest number of estimated annual premature deaths occurs in developing countries of Asia and the Pacific.

Substances that Deplete the Ozone Layer. These substances have undergone a massive phase-out over the last 20 years. Consequently, by 2004 the emissions of ODS are about 20 per cent of their 1990 level. As ODS were also GHGs, the treaty has simultaneously contributed to mitigating climate change. The protocol represents a global success story brought about, among others, by use of economic incentives, increased private investments, and enhanced public awareness.

## Land

Unsustainable land and water use, and the impacts of climate change are driving land degradation, including soil erosion, nutrient depletion, water scarcity, salinity, chemical contamination and disruption of biological cycles. The cumulative effects of these changes threaten food security, biodiversity, and carbon fixation and storage. Poor people suffer disproportionately from the effects of land degradation, especially in the drylands, which support some two billion people, 90 per cent of whom live in developing countries.

One example of long-term success in combating land degradation is in the Great Plains of the United States, where a comprehensive package of measures was first introduced in the 1930s. As a result, natural, social, institutional and financial capital has been rebuilt and maintained to the present day. The Land Care programme in Australia

is another successful example. In Africa and other developing regions, many countries have embarked on national action programmes to combat desertification within the framework of the UN Convention to Combat Desertification (UNCCD).

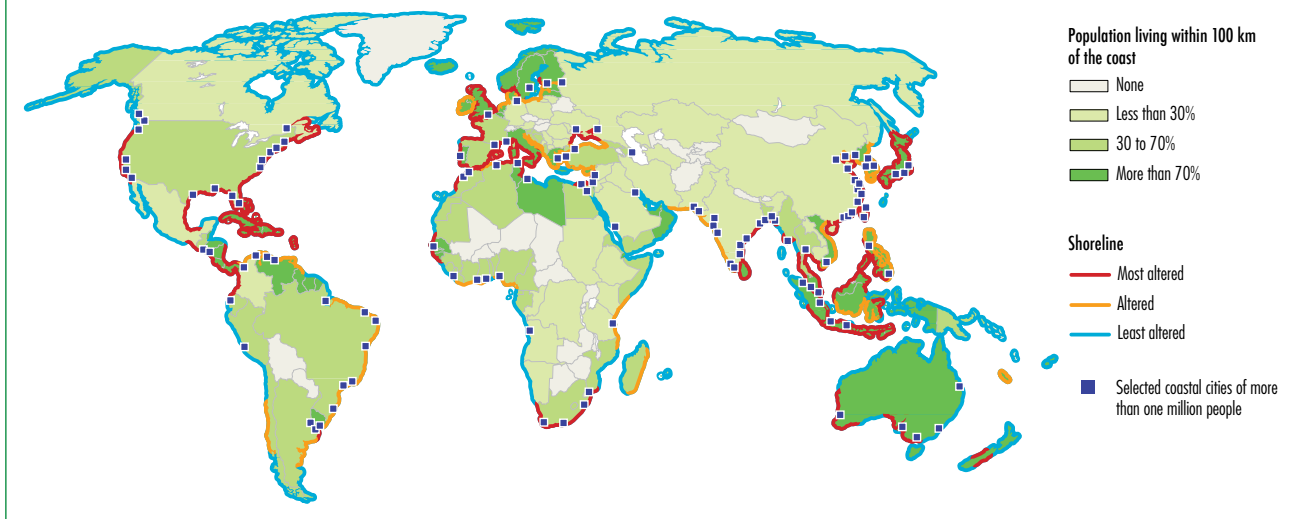
The decline in the area of temperate forest has been reversed with an average annual increase of 30 000 km<sup>2</sup> between 1990 and 2005. However, deforestation in the tropics has continued at an average annual rate of 130 000 km<sup>2</sup>, with serious implications for GHG gas concentrations and biodiversity loss. Declines in natural forest area are partially countered by ecological restoration efforts, investment in planted forests, and more efficient use of wood products. More forest is being designated for ecosystem services but effective management is required to maintain and restore ecosystems.

The release of harmful and persistent pollutants, such as heavy metals and organic chemicals, from mining, manufacturing, sewage, energy and transport emissions, the use of agro-chemicals, and from leaking stockpiles of obsolete chemicals and products, remains a problem for terrestrial and aquatic ecosystems. Although there has been progress in dealing with pollution in the industrialized countries, mainly through regulation, achieving an acceptable level of safety worldwide requires strengthening of institutional and technical capacities in all countries.

Unsustainable land-use contributes to land degradation, including soil erosion and nutrient depletion, which adversely affect human health, food security, and limit livelihood options.



**Figure 4: Coastal population and shoreline degradation**



Rapid and poorly planned urbanization in ecologically sensitive coastal areas increases vulnerabilities to coastal hazards and climate change impacts.

The average population density in coastal areas is now twice as high as the global average. More than 100 million people live in areas no more than one metre above mean sea-level (see **Figure 4**); 21 of the world's 33 mega-cities are located in coastal areas, with most of them in developing countries. Poor planning and the loss of key ecosystems such as wetlands, mangroves and coral reefs, and sea level rise due to climate change, are increasing the risk of flooding and reducing coastal protection from storms, tsunamis and erosion.

## Water

Contaminated water remains the greatest cause of human sickness and death on a global scale. The per capita availability of freshwater is declining, in part because of excessive withdrawals of surface and groundwater. If present trends continue, many countries will not meet their MDGs relating to water. About 1.8 billion people will be living in countries or regions with absolute water scarcity by 2025 and two-thirds of the people in the world could be subject to water stress, with the *GEO-4* scenarios indicating that there could be more than 5.1 billion people living under such conditions in 2050.

Since agriculture accounts for more than 70 per cent of global water-use, it is a logical target for conservation management. Development and

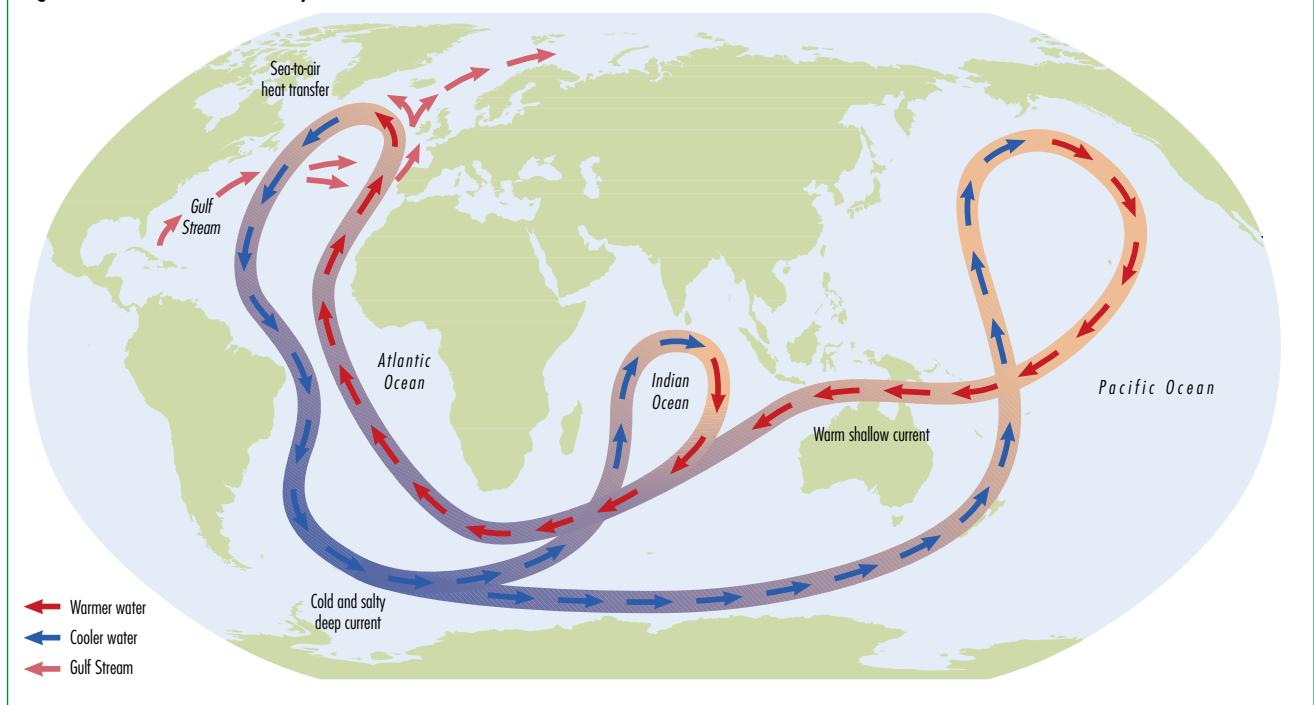
implementation of Integrated Water Resources Management (IWRM) has enhanced many aspects of human well-being and ecosystem health, through improved water availability and quality both in catchments and in their respective coastal zones.

The world's oceans are the primary regulator of global climate and an important sink for GHGs (see **Figure 5**), leading, for example, to ocean acidification. At watershed, regional and ocean basin scales, the water cycle is being affected by long-term changes in climate, altering precipitation patterns. Climate changes are also causing major reductions in Arctic sea ice cover, and the accelerated melting of permafrost and mountain glaciers, and Arctic land ice. These in turn have serious impacts on the security of communities in the Arctic, in glacier-fed river basins and deltas, and in low-lying coastal areas, including Small Island Developing States (SIDS) worldwide. Concerted global actions are needed to address the root causes, while local efforts can reduce human vulnerability.

Eutrophication of inland and coastal waters caused by excessive nutrient loads from sources such as agricultural fertilizer causes sporadic major fish kills, and threatens human health and livelihoods. The deterioration of inland and coastal water quality is being exacerbated by other pollutants from land-based sources,



Figure 5: The Global Ocean Conveyor



Ocean circulation – the global ocean conveyor – is driven by differences in seawater density, determined by temperature and salt content. This circulation is of enormous significance to the world, carrying carbon dioxide (CO<sub>2</sub>) to the deep ocean, distributing heat and dissolved matter, and strongly influencing climate regimes and the availability of nutrients to marine life.

particularly, municipal wastewater, and urban run-off.

Aquatic ecosystems continue to be heavily exploited, putting at risk sustainability of food supplies and biodiversity. Global marine and freshwater fish catches show large-scale declines, caused mostly by persistent overfishing. Total marine catches are being sustained only by fishing ever further offshore and deeper in the oceans and progressively lower down the food chain. Freshwater stocks suffer from habitat degradation and altered thermal regimes related to climate change and water impoundment.

### Biodiversity

**Biodiversity decline and loss of ecosystem services** continue to be a major global threat to future development. The reduction in distribution and functioning of land, freshwater and marine biodiversity is more rapid than at any time in human history. Ecosystems such as forests, wetlands, and drylands are being transformed and, in some cases, irreversibly degraded.

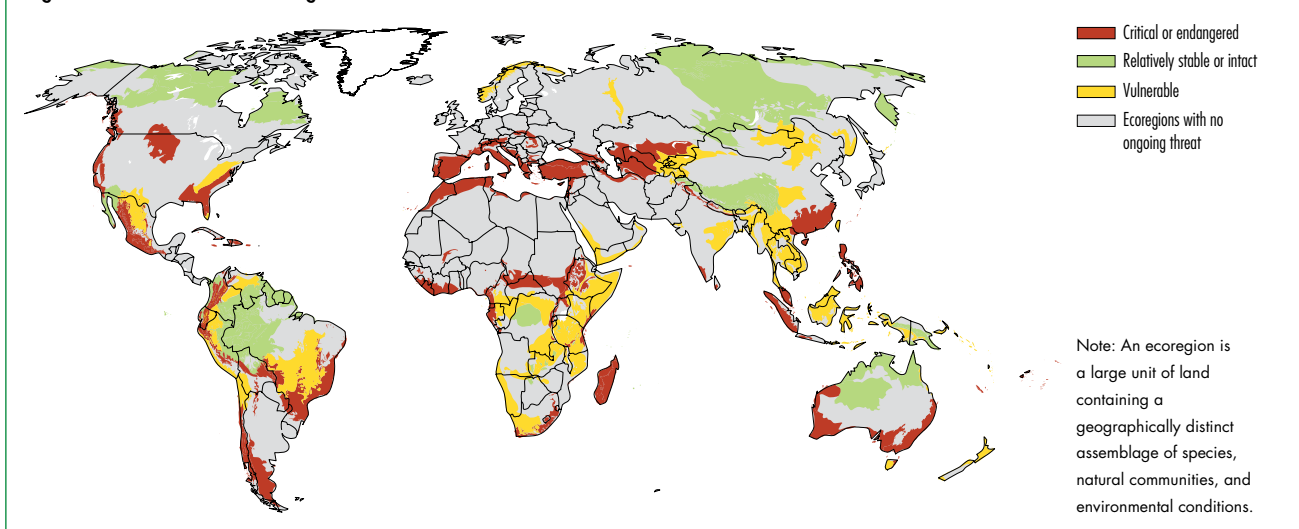
Rates of species extinction are increasing.

The great majority of well-studied species, including commercially important fish stocks, are declining in distribution or abundance or both. Genetic diversity of agricultural and other species is widely considered to be in decline.

Despite the importance of terrestrial and aquatic ecosystems, they are being modified in extent and composition by people at an unprecedented rate, with little understanding of the implications this will have in terms of their ability to function and provide services in the future. **Figure 6** highlights the status of terrestrial ecosystems.

Biodiversity plays multiple roles in the daily lives of people through the **supply of ecosystem services**. In agriculture, biodiversity contributes to regulating and supporting services through soil formation, nutrient cycling, and pollination. Biodiversity is the basis for cultural services through spiritual and aesthetic benefits, and amenity values from ecotourism. Some economic estimates are available, for example, the value of the regulating services provided

Figure 6: Status of terrestrial ecoregions



Despite the importance of terrestrial and aquatic ecosystems, they are being modified in extent and composition by people at an unprecedented rate, with little understanding of the implications this will have in terms of their ability to function and provide services in the future.

by honeybees as pollinators for crops has been estimated at well over US\$2 billion per year, and the annual world fish catch is valued at US\$58 billion.

In recognition of the importance of biodiversity and the fact that poor people in rural and remote areas tend to be the most directly affected by the deterioration or loss of ecosystem services, many governments have established and adopted the **2010 biodiversity target** to reduce the rate of loss of biodiversity at global, regional and national scales. The target was adopted by the Convention on Biological Diversity (CBD), and endorsed by the 2002 World Summit on Sustainable Development (WSSD).

There have been local success stories with the conservation and sustainable use of biodiversity, particularly where economic incentives have been made available, such as for ecotourism, biodiversity-friendly agricultural practices, certification schemes and various initiatives on payments for ecosystem services. However, at a global level, and in most regions of the world, biodiversity continues to be lost because current policies and economic systems do not incorporate the values of biodiversity effectively in either the political or the market systems, and many policies that are already in place are yet to be fully implemented.

## 4 REGIONAL PERSPECTIVES

The UNEP regions share common concerns about a number of critical environmental and sustainability issues, yet face tremendous differences in their challenges. Strong interdependencies exist and are reinforced by globalization and trade, with growing demand on resources in and across the regions.

Significant improvements in human well-being have been achieved globally over the last 20 years. However, there are still more than 1 billion poor people who lack essential services and who are not buffered against environmental and socio-economic changes. Many countries will not meet the 2015 targets of the MDGs. Addressing vulnerability provides opportunities to meet these goals.

Throughout the world, recurring patterns of vulnerability can be found, including in industrialized and developing regions, and urban and rural areas. Examples of these include contaminated sites, drylands, energy security and, urbanization in coastal zones. The most vulnerable groups include the poor, indigenous populations, women and children in both developed and developing countries. Analysis of representative patterns of vulnerability in different regions shows the

unequal distribution of risks for specific groups of people. Although vulnerability is context- and site-specific, certain common elements can be observed across regions, scales and contexts. **Table 1** lists the environmental issues which were identified by regional consultations in September-October 2004.

**Table 1: Key regional priority issues selected for GEO-4**

Africa	Land degradation and its cross-cutting impacts on forests, freshwater, marine and coastal resources, as well as pressures such as drought, climate variability and change, and urbanization
Asia and the Pacific	Transport and urban air quality, freshwater stress, valuable ecosystems, agricultural land use, and waste management
Europe	Climate change and energy, unsustainable production and consumption, air quality and transport, biodiversity loss and land-use change, and freshwater stress
Latin America and the Caribbean	Growing cities, biodiversity and ecosystems threats, degrading coasts and polluted seas, and regional vulnerability to climate change
North America	Energy and climate change, urban sprawl and freshwater stress
West Asia	Freshwater stress, land degradation, degrading coasts and marine ecosystems, urban management, and peace and security
Polar Regions	Climate change, persistent pollutants, the ozone layer, and development and commercial activity

The following sections highlight environmental challenges and opportunities of the regions.

**Africa's** land is under pressure from a growing population, natural disasters such as drought and floods, desertification, the inappropriate use of technology and chemicals, and poverty. In addition to threatening the livelihoods of the rural poor, land degradation has widespread effects on Africa's river catchments, forests and agricultural land, and ecosystem services. Per capita access to land is declining even as the region struggles to increase food production per unit area. Per capita agricultural production declined by 0.4 per cent between 2000 and 2004. Climate change and more frequent droughts and floods in Africa, are exacerbating land

degradation. Africa is one of the regions most vulnerable to climate change and has the least adaptive capacity. Water and sanitation are also priority issues for most African countries. Despite an overall improvement in the coverage of water supply between 1990 and 2002, the regional projection to 2015 still falls below the MDG target of 75 per cent coverage.

The region continues to be at risk from hazardous and electronic waste dumping due to inadequate monitoring capacities and institutional mechanisms to manage such waste. Africa holds at least 50 000 tonnes of obsolete pesticides which threaten both people and the environment. Lack of environmentally friendly technology is a major problem in Africa that should be dealt with through technology transfers, taking into consideration the preservation of cultural heritage. Although there are efforts to manage the environment through the African Ministerial Conference on the Environment (AMCEN), initiatives such as the New Partnership for Africa's Development (NEPAD) environment action plan, land and agrarian reforms, and integrated land and water management programmes, policy shortcomings still exist, and so do unfair agricultural subsidies in developed regions which undermine the profitability of farming and livelihoods of small landholders in Africa.

In **Asia and the Pacific**, environmental change is driven by rapid population growth, changing consumption patterns accompanying higher incomes, and burgeoning industrial and urban development. Various factors have led to an increase in urban air pollution: a highly urbanized population; poorly planned municipal development and transport services; a 2.5 times increase in the use of passenger cars over the last two decades (see **Figure 7**); and haze pollution from forest fires and peri-urban industries in Southeast Asia. Air pollution causes the premature deaths of about 500 000 people annually. Many countries have, in recent years, initiated a switch from conventional fossil fuels to cleaner renewable forms of energy. Excessive and





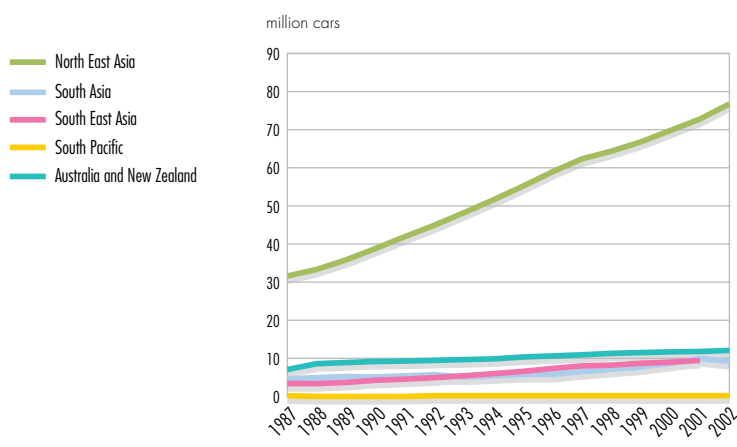
Soil erosion is widespread in Africa, affecting food production and food security. In addition to threatening the livelihoods of the rural poor, land degradation has widespread effects on Africa's river catchments, forests and agricultural land, and ecosystem services.

inefficient use of water, industrial pollution, climatic variability and natural disasters are major causes of water stress. Although there has been remarkable progress in the provision of improved drinking water over the last decade, some 655 million people in the region (17.6 per cent) still lack access to safe water.

The population pressure on marginal land and climate-related extremes in the past few decades pose a risk to terrestrial and marine biodiversity in the region. Rapid changes in consumption patterns have led

to the generation of large quantities of electric and electronic waste, and toxic and hazardous waste. The illegal traffic in these wastes poses new, growing challenges. Although most countries have developed extensive domestic laws, regulations and standards related to the environment and participate in global action through multilateral and bilateral agreements, the challenging task is to implement those laws and regulations. Rapid introduction of innovative and energy efficient technology should improve environmental conditions in the region.

**Figure 7: Trend in use of passenger cars**



The exploding growth in motorized vehicles is the key factor in both traffic congestion and the levels of urban air pollution in many cities in the region. Between 1987 and 2003, the use of passenger cars increased about 2.5 times.

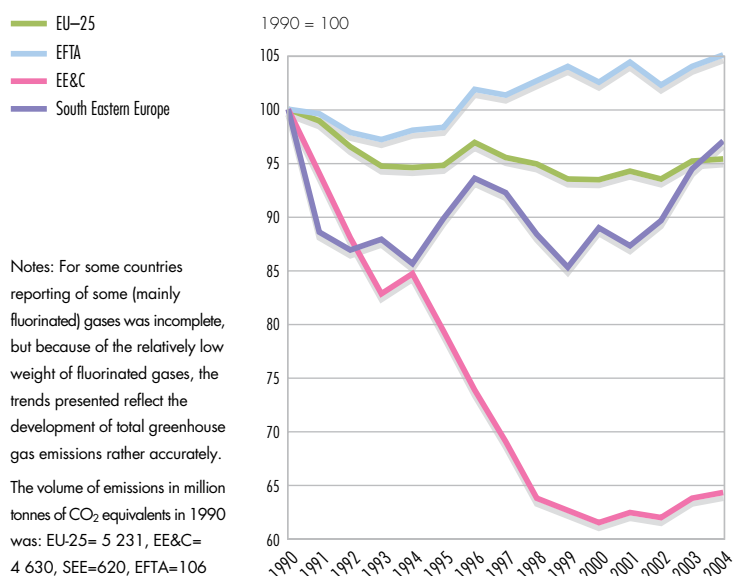
**Europe** is a region of great environmental and socio-economic diversity. Economic recovery in the past two decades has resulted in an increase of national income in many countries across the region. This, together with the growing number of individual households, is driving environmental change. The region has made progress in decoupling economic

growth from resource use, although per capita household consumption is steadily increasing. Recently, growing public awareness underpinned by rising prices, has given new political momentum to climate change policies. Since 1987, GHG emissions (see **Figure 8**) from the energy sector have been reduced in some countries in Western Europe, although they have increased across the region as a whole. Emissions of air pollutants are largely driven by the demand for greater mobility, including increasing use of private transport and deterioration of public transport systems in many countries.

Despite much progress, poor water and urban air quality still cause substantial problems in some parts of Eastern and Southern Europe. Intensification and land abandonment are the two major trends in agriculture having impacts on biodiversity, as well as increasing the risk of land degradation and desertification, especially in southern parts of the region. Transport infrastructure is fragmenting landscapes and reducing biodiversity.

With its many action plans, environmental institutions and legal instruments, the region has extensive experience with environmental cooperation. Easier to manage environmental problems (e.g., point-source air and water pollution) have been effectively addressed in much of Central and Western Europe, but remain challenges in many Eastern European countries. The use of market-based instruments in environmental policy has gained ground substantially in Europe, especially in the area of taxes, charges and tradeable permits. Comprehensive systems of pollution charges for air and water are being implemented and resource use and waste taxes are being introduced. More efficient production and consumption patterns need to be established, and good governance mechanisms and lessons learned exchanged within the region, to achieve sustainable development.

**Figure 8: Trends in total greenhouse gas emissions**



While greenhouse gas emissions from the energy sector have been reduced in Western Europe since 1987, the trend since the end of the 1990s shows that these emissions have increased across the European region. This is partly because of increasing natural gas prices which have re-established coal as a key fuel.

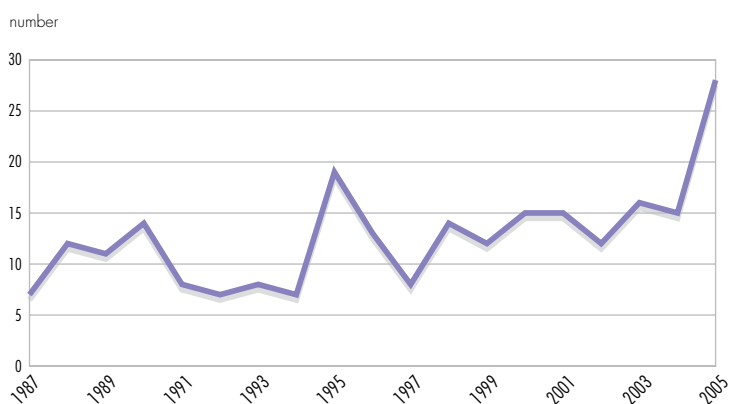
The **Latin America and the Caribbean** region is the most urbanized in the developing world, with 77 per cent of the total population living in cities, and urbanization rates are still

increasing. The challenge for developing and implementing urban environmental policies is, therefore, considerable. There has been relative success in improving the quality of fuels, public transport systems (Bogotá, Colombia, and Curitiba, Brazil), air quality management (major Mexican cities), water law reforms (Chile), and community-based solid waste management schemes. Nevertheless, urban air pollution is high and increasing in smaller cities, untreated and domestic and industrial waste and waters are a growing problem, and domestic waste is generally not treated, contributing to water pollution.

The rich biodiversity in the region is threatened by forest conversion to pastures, infrastructure and urban areas. These threats are contributing to habitat loss and fragmentation, as well as the loss of indigenous cultures and knowledge. Land degradation, resulting from deforestation, overgrazing and inappropriate irrigation is affecting 15.7 per cent of the region. Integrated prevention and control programmes are helping to decrease annual deforestation rates in some areas, and protected areas have almost doubled over the last two decades now covering 10.5 per cent of the land base. New efforts are being made to conserve terrestrial and marine corridors, such as the Meso-American Biological Corridor and those in the Amazon.

Although Latin America is responsible for only 5 per cent of the global GHG emissions and represents 8 per cent of the total world population, climate change is projected to significantly affect the region. The impacts include rising sea levels, more hurricanes and storms (see **Figure 9**), more pronounced droughts and floods associated with El Niño events, decline in water supplies stored in glaciers and declines in crop and livestock productivity. Particularly vulnerable are tropical rain forests, mangroves and coral reefs, mountain ecosystems, coastal wetlands and SIDS. Extreme climatic events have increased over the past 20 years. The development of national climate change strategies is critical in this regard. Declining water quality, climate change and algal blooms have contributed to the rise in water-borne diseases in some coastal regions.

**Figure 9: Number of storms in the North Atlantic basin**

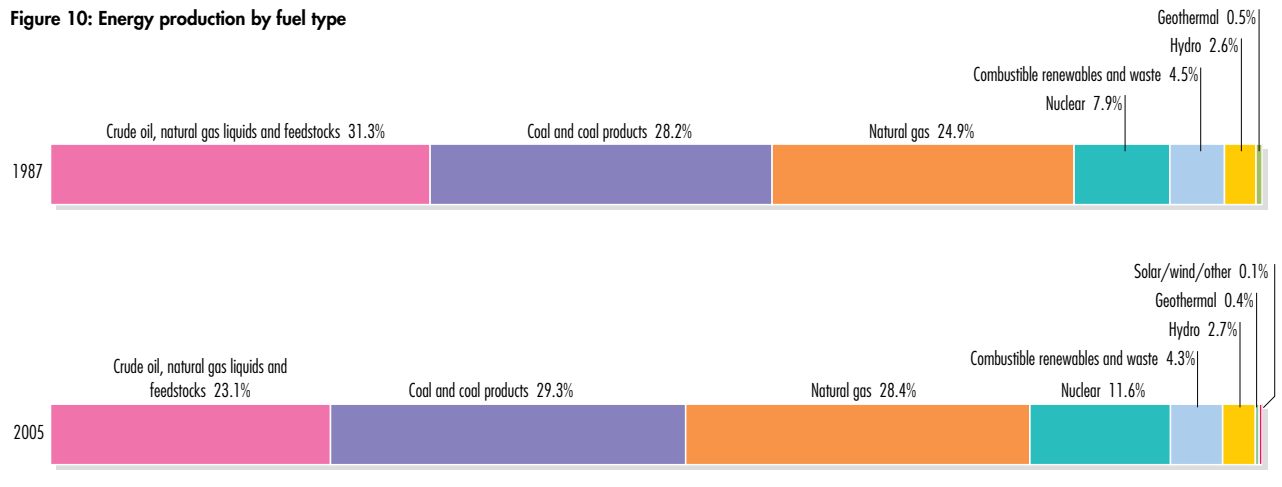


Extreme climate events affecting the region have already increased over the last 20 years. The number, frequency, duration and intensity of tropical storms and hurricanes in the North Atlantic Basin have increased since 1987. The 2005 season was the most active and the longest on record, with 27 tropical storms, 15 of which became hurricanes.

Most successful responses to environmental issues in the region have involved command-and-control measures. However, emerging policies have combined these approaches with economic instruments (including application of the polluter-pays-principle). Payments for ecosystem services are being implemented in several countries (such as Costa Rica, Brazil, Ecuador and Mexico) to protect biodiversity. The use of economic instruments and effective compliance with environmental law need coupling with participatory and ecologically oriented urban planning as the strategic basis for sustainability.

In **North America**, the multi-stakeholder process identified energy and climate change, freshwater stress, and sprawl as major environmental issues facing the region. North America's growing economy and population contribute to the ongoing environmental challenges. The region is a leader in research in environmental science and reporting, integrating the public into environmental decision making, providing timely access to information on environmental conditions, and the production of goods-and-services that mitigate or prevent environmental damage. A solid foundation of legislation from the 1970s, and newer innovative market-based programmes and modes for paying for ecosystem services, provide incentives for controlling pollution and conserving natural resources. Canada has signed the Kyoto

**Figure 10: Energy production by fuel type**



The past two decades have seen a marked shift in energy production in North America, with crude oil, natural gas liquids and feedstocks declining, and coal and coal products, natural gas and nuclear production increasing.

Protocol and produced a plan to become more energy-efficient.

As a measure of progress, energy use per unit of GDP has declined; however, in absolute terms, energy use and associated GHG emissions have increased. **Figure 10** shows trends in energy production in the region over the past two decades. With only 5.1 per cent of world population, North America consumes just over 24 per cent of global primary energy. Increasing domestic energy exploration is leading to new threats from air pollution, the potential for additional releases of oil to the environment and the fragmentation of landscapes, with impacts on biodiversity.

Continued urban sprawl and growing exurban development are leading to pressures on water quality, biodiversity, and air pollution. In response, many states, provinces and municipalities have implemented smart growth and other strategies to manage sprawl, preserve farmland and green space, and protect ecosystem services. For example, the master plans of most Canadian cities include the control of sprawl, and in the US, 22 states have enacted laws to curb sprawl.

Water quality and availability vary across the region. Per capita water consumption is the highest in the world; however, this includes significant water contained in food exports;

agriculture use accounts for 41 per cent of annual water withdrawals in the US and 12 per cent in Canada. Excessive groundwater withdrawal in the US remains a challenge. Steps are being taken to improve water use efficiency through conservation programmes in agriculture and for household use. Overall water quality in the region is the cleanest in the world. However, there is significant variability and approximately 20 per cent of US watersheds face serious water quality challenges. Significant gains have been made in point-source pollution, but non-point source pollution remains a major difficulty and has become a priority for both countries. Excess nutrient run-off is an important problem, contributing to eutrophication of many US estuaries. Both countries are responding to water problems with national and transboundary Integrated Water Resource Management (IWRM) approaches to improve policy measures for these complex water issues. The human health consequences of environmental impacts are an emerging issue.

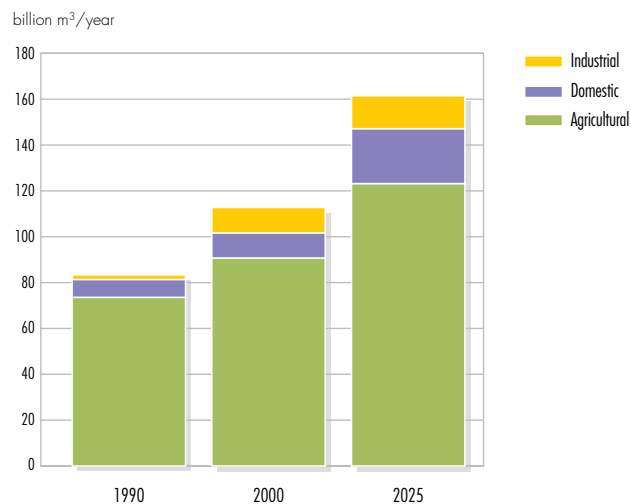
**West Asia** has made strides in environmental governance since *Our Common Future*, including establishing environmental institutions, enacting environmental regulations, developing environmental and sustainable development strategies, such as the sustainable development initiative in the Arab Region, and joining many of the MEAs. Nevertheless, continued population growth, military conflicts, and rapid development have resulted in a significant increase in



environmental challenges and pressures on natural resources. The region is one of the most water-stressed in the world. Per capita freshwater availability is decreasing, while consumption is increasing. Water resources are overexploited with 80 per cent used for agriculture (see **Figure 11**). Institutional and policy reforms have been emphasizing a shift from water supply to demand management. An additional major challenge that impacts planning is the absence of agreements regulating shared water resources.

Unsustainable agricultural practices, overgrazing and rangeland cultivation, recreational activities, and urbanization have degraded vast land areas. Measures to mitigate land degradation and to protect threatened areas are well defined in national action plans to combat desertification. However, in many countries these plans are ineffective because they are not mainstreamed into national socio-economic development policies. Marine and coastal areas are threatened by urbanization, tourism infrastructure, industry, oil pollution, chemical contamination, invasive alien species and overfishing. Efforts to introduce Integrated Coastal Zone Management (ICZM) should be reinforced with strict protection and conservation measures to meet the fast-paced development. The urban environment is facing escalating challenges related to increased air pollution and increased wastes. Policies and successful measures have been implemented in several countries, such as phasing-out leaded gasoline, adopting zero-flaring policies, enhancing the use of natural gas as energy, and introducing effective waste management systems. Armed conflict has harmed human well-being, expanded the number of refugees, and resulted in the degradation of natural resources and ecological habitats. Regional cooperation in transboundary environmental problems and environmental management are undertaken by the Council of Arab Ministers Responsible for the Environment (CAMRE). However, strengthening of institutions, capacity building, environmental legislation and enforcement are urgently required. Finally, peace and stability are essential for sustainable development in the region.

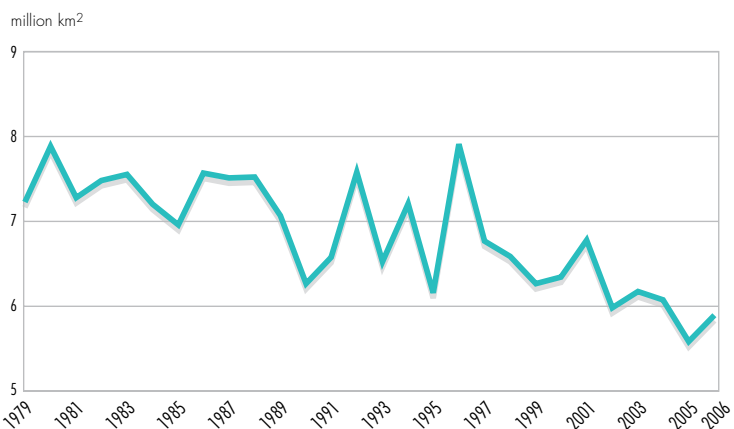
**Figure 11: Current and projected water demand in West Asia**



Although urban demand for water is high in the region, the agricultural sector consumes most water, accounting for more than 80 per cent of total water used. During the past few decades, economic policies favouring food self-sufficiency and socio-economic development have prioritized the development and expansion of irrigated agriculture.

The **Polar** regions influence major environmental processes, and have direct impacts on global biodiversity and human well-being. The regions are interlinked with global climate change impacts, such as altered ocean currents and rising sea levels. The Arctic is warming twice as fast as the world average, causing shrinking sea ice (see **Figure 12**), melting of glaciers as well as changes in vegetation. The Greenland and Antarctic ice sheets are the largest contributors

**Figure 12: Summer Arctic sea ice is shrinking at a rate of 8.9 per cent per decade**



The Arctic is warming almost twice as fast as the world average, and most increases occurred in the past 20 years.

to the sea level rise from melting land ice. Persistent organic pollutants, although banned in most industrialized countries, are still used elsewhere and persist and accumulate in polar regions where they enter marine and terrestrial ecosystems, and accumulate in food chains. These toxic substances pose a threat to the integrity of the traditional food system and the health of indigenous peoples in the Arctic. Mercury from industrial emissions can pose a similar threat because it can be transported over long distances and transformed into methyl mercury, a Persistent Organic Pollutant (POP). Ozone depletion has resulted in increased ultraviolet radiation, with impacts on ecosystems and human health.

## 5 LESSONS AND PROGRESS FROM THE PAST TWO DECADES

Environmental changes affect human development options, with poor people being the most vulnerable. Environmental changes impact human well-being, human vulnerability, and people's ability to cope or adapt. For example, conflicts, violence and persecution displace large civilian populations, forcing millions of people into marginal ecological areas within countries and across international boundaries. This undermines, sometimes for decades, sustainable livelihoods, economic development, and the capacity of ecosystems to meet an increased demand for resources.

More than 90 per cent of the people exposed to disasters live in the developing world. Millions are also affected in developed countries. Over the past 20 years, natural hazards (see **Figure 13**) such as earthquakes, floods, droughts, storms, tropical cyclones and hurricanes, wildfires, tsunamis, volcanic eruptions and landslides have claimed more than 1.5 million lives and affected more than 200 million people annually. Between 1992 and 2001, floods were the most frequent natural disaster, killing nearly 100 000 and affecting more than 1.2 billion people worldwide. The capacity to adapt to and withstand hazards in some parts of the world is being eroded through reduced state protection schemes, the undermining of informal safety nets, poorly built or maintained infrastructure, conflict, and chronic illness.

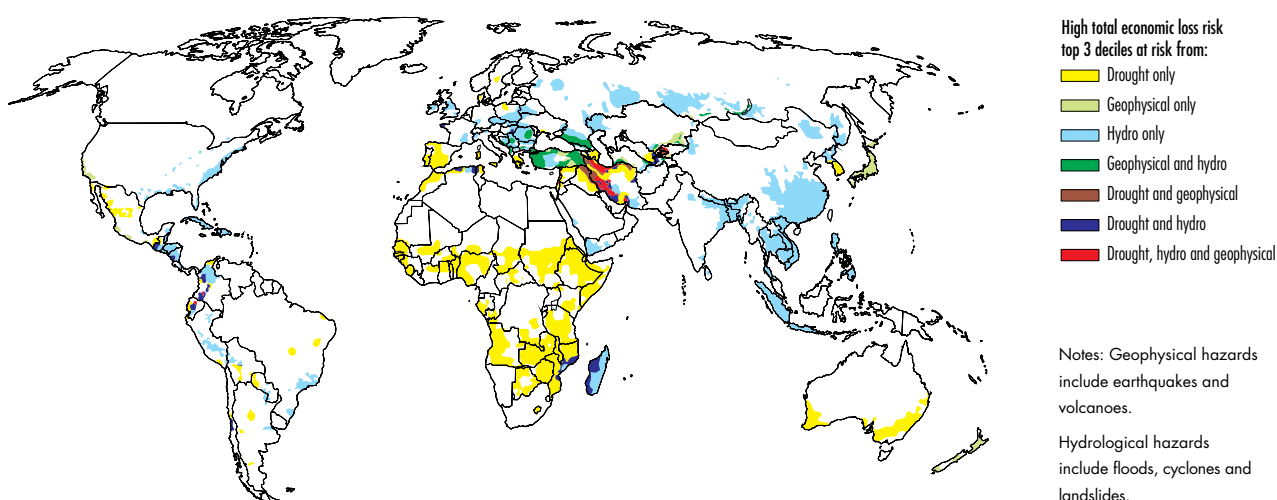
However, progress has been made on several fronts over the last 20 years. The historical decline of the temperate forests has reversed, some regional air pollution problems, such as acid rain in Europe and North America, have been successfully addressed, major research advances have been made in agriculture on innovations for integrating conservation and development to ease biodiversity loss, reverse land degradation and foster environmental sustainability and, in some cities, environmental quality is better today than when *Our Common Future* was published in 1987.

There are also many cases in which problems persist even though proven solutions are known. In these cases, progress requires concerted, focused implementation of best practices, as in the example of recent initiatives to extend the leaded-petrol ban to countries where it is still used. There is substantial experience with a wide range of policy instruments that can be transferred, adapted and implemented (**Table 2**).

At the global level, strengthening UNEP and better cooperation among United Nations bodies and other institutions to make environment and sustainable development governance more efficient and effective has long been a goal of the international community. These efforts are ongoing in UNEP in follow-up to the Cartagena agreement on International Environmental Governance (IEG). Discussions on how to strengthen environment and sustainable development are also underway through the United Nations General Assembly (UNGA). Various secretariats of MEAs and United Nations bodies have signed Memoranda of Understanding. Environmental cooperation also provides opportunities to create pathways for peace by promoting sustainable resource use between countries.

Regional environmental cooperation has also been strengthened since 1987. A number of regional environmental ministerial fora have been established, including the African

**Figure 13: Highest risk hot spots by natural hazard type**



Natural hazards, such as earthquakes, floods, droughts, storms, tropical cyclones and hurricanes, wildfires, tsunamis, volcanic eruptions and landslides threaten people around the world. Two-thirds of all disasters are hydrometeorological events, such as floods, windstorms and extreme temperatures. More than 90 per cent of the people exposed to disasters live in the developing world, and more than half of disaster deaths occur in countries with a low human development index.

Ministerial Conference on the Environment (AMCEN), and Conference of Europe Environment Ministers (CEEM), the Forum of Ministers of the Environment of Latin America and the Caribbean, the Association of Southeast Asian Nations (ASEAN), and Council of Arab Ministers Responsible for the Environment (CAMRE). The North American Free Trade Agreement (NAFTA) has an environmental accord that is overseen by the Commission for Environmental Cooperation (CEC). The European Union (EU) provides a good example of the added value of strong political cooperation among nations,

especially in establishing environmental regulations on a wide range of issues.

Coordination on environment and sustainable development issues is equally important at the national level. Here, coordination among MEA focal points and among ministries representing governments in various fora on development, finance, foreign affairs and environment needs to be encouraged.

Direct regulation plays a major role in achieving progress and is likely to continue doing so, even if the use of market forces

**Table 2. Classification of environmental policy instruments**

Command-and-control regulations	Direct provision by governments	Engaging the public and the private sectors	Using markets	Creating markets
<ul style="list-style-type: none"> <li>Standards</li> <li>Bans</li> <li>Permits and quotas</li> <li>Zoning</li> <li>Liability</li> <li>Legal redress</li> <li>Flexible regulation</li> </ul>	<ul style="list-style-type: none"> <li>Environmental infrastructure</li> <li>Eco-industrial zones or parks</li> <li>National parks, protected areas and recreation facilities</li> <li>Ecosystem rehabilitation</li> </ul>	<ul style="list-style-type: none"> <li>Public participation</li> <li>Decentralization</li> <li>Information disclosure</li> <li>Eco-labelling</li> <li>Voluntary agreements</li> <li>Public-private partnerships</li> </ul>	<ul style="list-style-type: none"> <li>Removing perverse subsidies</li> <li>Environmental taxes and charges</li> <li>User charges</li> <li>Deposit-refund systems</li> <li>Targeted subsidies</li> <li>Self-monitoring (such as ISO 14000)</li> </ul>	<ul style="list-style-type: none"> <li>Property rights</li> <li>Tradeable permits and rights</li> <li>Offset programmes</li> <li>Green procurement</li> <li>Environmental investment funds</li> <li>Seed funds and incentives</li> <li>Payment for ecosystem services</li> </ul>

and *soft instruments*, such as the provision of information and technology transfer, play a more important role than before. By compiling successful experiences from global, regional, sub-regional, national and local initiatives the GEO process can provide some valuable lessons learned on general principles for public policy formulation and implementation.

Effective diffusion of innovative policies often results from governments and other actors learning from each other. Best practices are spread most effectively when there is monitoring and reporting of policies and outcomes. Almost all successful policy initiatives from the past two decades have been supported by robust environmental monitoring programmes. Such programmes are lacking in regard to many of the high priority problems identified in *GEO-4*.

Civil society and the private sector are also playing a growing role in decision-making and in the delivery of solutions through extended opportunities for environmental technology and innovation in some regions. The growing awareness of environmental problems, and better education programmes have also led to a broadening of corporate social responsibility (CSR). CSR and corporate financing of certain social and environmental activities have been encouraged by global initiatives that have stimulated companies to report not only on their economic activities but, also, on their social and environmental performance. The Principles for Responsible Investment (PRI), launched at the New York Stock Exchange in April 2006, had after six months been accepted by 94 institutional investors from 17 countries representing US\$5 trillion in investments.

Through the *GEO-4* scenario exercise, stakeholders explored the interplay between some of the environmental issues in atmosphere, land, water and biodiversity. The scenarios are based on assumptions related to institutional and socio-political effectiveness, demographics, economic demand, trade and markets, scientific and technological innovation, value-systems

and social and individual choices, and highlighted those areas of uncertainty in the coming decades. The following are the main elements of the four scenarios:

- *Markets First*: the private sector, with active government support, pursues maximum economic growth as the best path to improve the environment and human well-being for all.
- *Policy First*: the government sector, with active private- and civic-sector support, implements strong policies intended to improve the environment and human well-being, while still emphasizing economic development.
- *Security First*: the government sector and the private sector vie for control in efforts to improve, or at least maintain, human well-being for mainly the rich and powerful in society.
- *Sustainability First*: the civic, government and private sectors work collaboratively to improve the environment and human well-being for all, with a strong emphasis on equity.

There is an increasing understanding of how the environmental changes being recorded around the world are linked through time and space via a complex set of biophysical and social processes. These changes may continue even if the forces of change are removed, as evidenced by the stratospheric ozone depletion and the loss of species. Such time lags have implications for the formulation and implementation of policy interventions. Biophysical and social systems can also reach tipping points, beyond which there are abrupt, accelerating, or potentially irreversible changes. The four *GEO-4* scenarios show an increasing risk of crossing tipping points, even as some global environmental degradation trends are slowed or reversed at different rates towards the middle of the century.



## 6 GOING FORWARD

The pressing environmental issues facing decision-makers today can be mapped along a continuum from those where *proven* solutions are available, to those where both the understanding of the problem and its solutions are still *emerging*. In all cases, science has a key role to play in providing the best available information to enable informed decision-making. The long-term knowledge base of indigenous peoples in providing such knowledge should also be considered.

Existing institutions are vital in *creating the right conditions for change*. Further achievements can be brought about by following a two-track, complementary approach (see Figure 14):

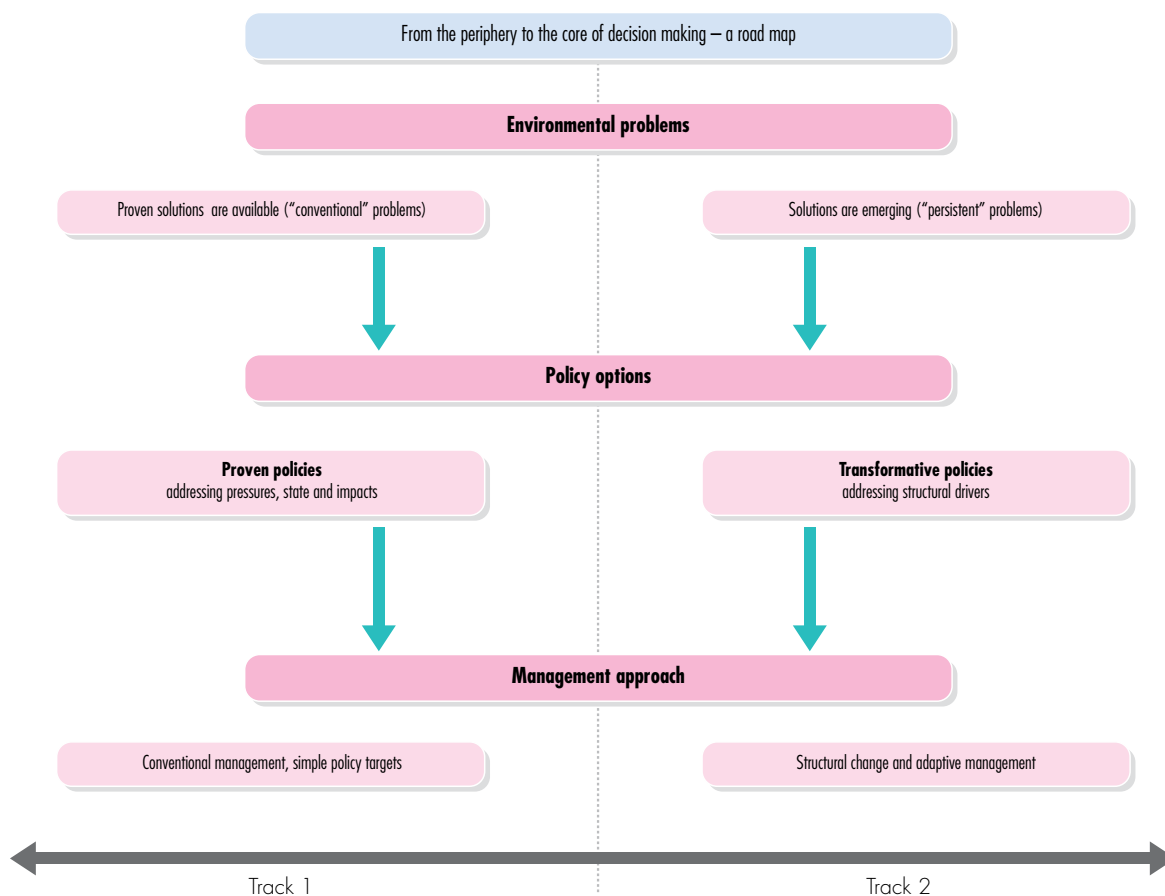
- Expanding institutions and adapting policies that have already worked effectively for conventional problems into areas lacking such policies, especially in developing regions, and financing this endeavour;

- Supporting innovation that pursues new and emerging solutions for persistent environmental problems by using economic instruments and more adaptive approaches.

### Building on recent gains

Over the last 20 years, the range of institutions and policy options for dealing with environmental problems has expanded

Figure 14: Two tracks to address environmental problems with proven and emerging solutions



The two tracks are expected to merge over time as the environmental policy agenda is progressively moved from the periphery to the core of economic and social development decision making. Both tracks need greater focus to address underlying societal and cultural values, increased education, empowerment of citizens and decentralized governance structures.

and diversified. Investing in results-based management of existing environmental institutions can help strengthen capacities for determining environmental risks and trade-offs, promoting timely action, reducing the costs of inaction and integrating environment with development. **Table 2** summarizes a simple categorization of environmental policies, which have evolved over the last two decades from command-and-control regulations to the creation of markets.

Direct regulation still plays a major role and is likely to continue doing so, even if the use of market forces and *soft instruments* (such as providing information) play a more important role than before. An effective toolbox would include a wide variety of instruments, often used together, that are customized to specific institutional setups, as well as the prevailing social and cultural situations.

When a new approach works well – whether in forest management, irrigation techniques or the protection of threatened species – the lessons learned during the process can help establish what becomes a new standard for best practices in that sector. Even if these practices do not provide the whole solution to an environmental problem, they are important incremental steps along the way towards solutions. Experiences from global, regional, national and local initiatives that address complex environmental issues across sectors have also provided some valuable lessons on general principles for public policy formulation and implementation. To increase the chance of success, policy-makers may:

- Stimulate political will, through public awareness, education, and conflict-mediation systems;
- Create the necessary legislative basis and environmental judiciary, minimize delays between policy decisions and implementation, and ensure sustainable financing systems are safeguarded from corruption;
- Strengthen and reinforce the capacity of agencies and staff operating at local, national and international level;
- Decentralize power to the lowest level

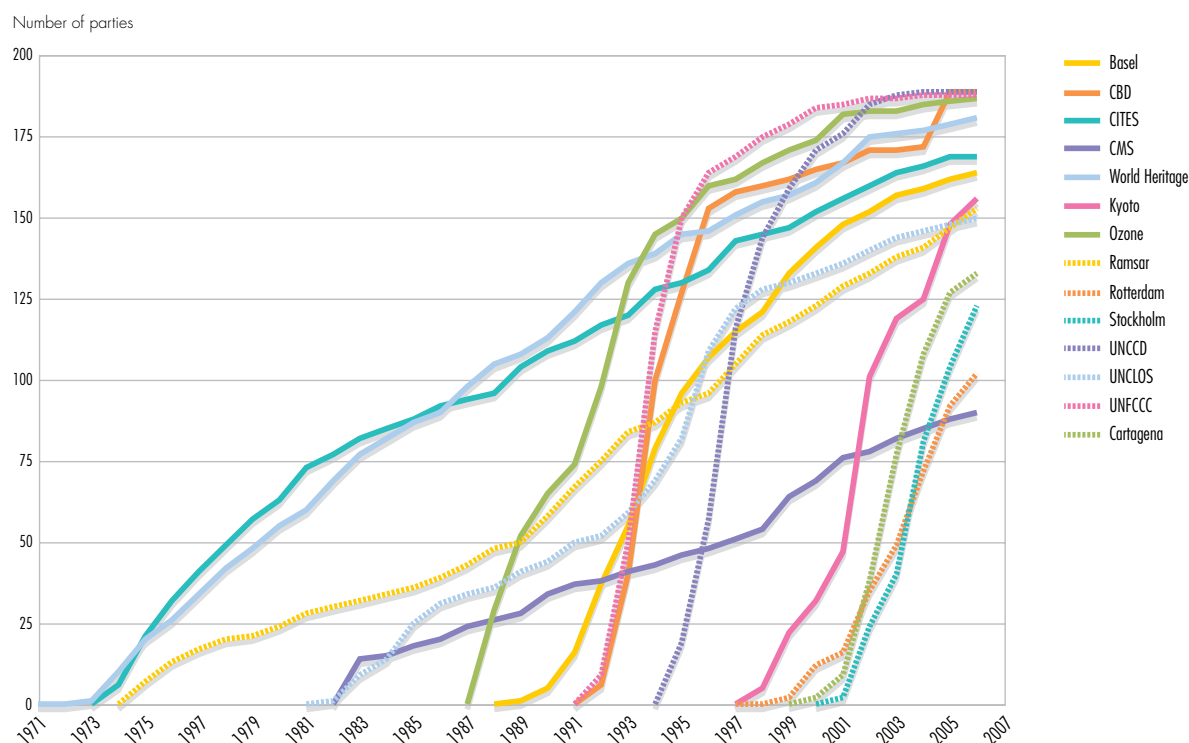
appropriate for the decision, where it is usually more timely and meaningful;

- Involve relevant stakeholders, such as through formal or informal partnerships, and transfer authority to stakeholders who have a relative advantage, stake and competence in assuming the responsibility;
- Support and facilitate the active participation of women, local communities and marginalized and vulnerable groups in decision making;
- Support research, monitoring, and information networking and develop specific management objectives, selecting appropriate and measurable indicators, and monitoring and assessing progress against these objectives.

Strong organizations are crucial for effective implementation of public policy. Since 1987, there has been an overabundance of organizational arrangements, especially at the global level. Significant opportunities for increased effectiveness are offered by the **UN reform process** initiated by the 2005 World Summit. The process identified the need for more efficient environmental activities within the UN, and is consistent with the IEG initiative. **Coordination** within the UN can be enhanced through joint programming and practical cooperation between UN agencies, such as UNEP and UNDP, and within the “One UN” approach at the country level. Calls for a UN or World Environment Organization (UNEO or WEO) have been made since the early 1970s. There is still much debate about whether there is a need for such an organization, however, and what form it could take.

**Better treaty compliance** can be achieved by overcoming the material limitations for Parties to meet their obligations, including administrative costs and the heavy reporting burden. There are now more than 500 international treaties and other agreements related to the environment, of which 323 are regional, and 302 date from the period between 1972 and the early 2000s (see **Figure 15** on ratification of MEAs). Improved monitoring and compliance mechanisms,

**Figure 15: Ratification of major multilateral environmental agreements**



As a result of various global and regional conferences and assessments, a diversity of multilateral environmental agreements (MEAs) has been adopted, providing the legal and institutional framework to tackle various environmental challenges. One of the agreements that has drawn significant attention during the last 20 years is the Montreal Protocol to the Vienna Convention on Substances that Deplete the Ozone Layer. The Montreal Protocol, which became effective in 1989 and had 191 parties at the beginning of 2007, has helped decrease or stabilize atmospheric concentrations of many of the ozone-depleting substances, including chlorofluorocarbons. The protocol is regarded as one of the most successful international agreements to date.

such as the establishment of a voluntary peer-review mechanism on compliance, can also contribute. Identified interlinkages and synergies between environmental challenges can serve as areas for cooperation among the treaties and for more effective implementation and capacity building at the national level.

#### ***The integration of environmental activities into the broader development framework***

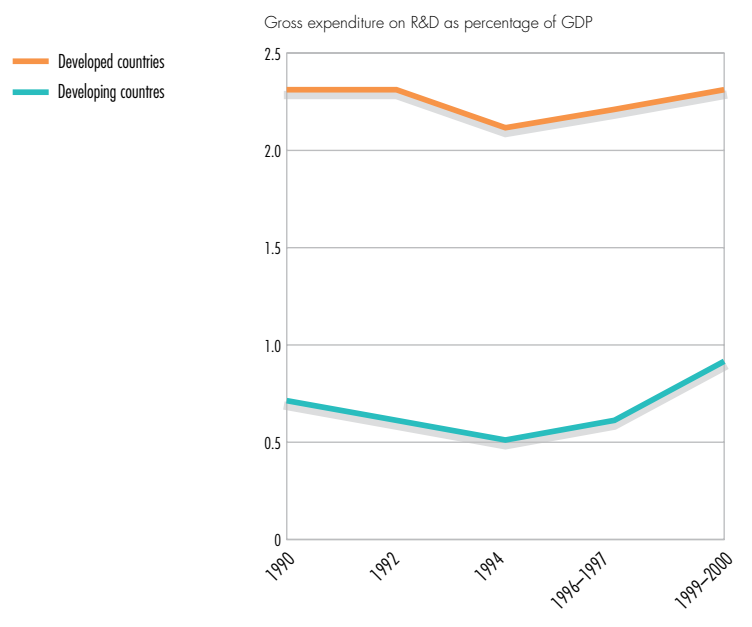
is at the heart of the MDG on achieving environmental sustainability. Improved efficiency and coherence can be achieved by integrating environmental mitigation and adaptation efforts into development policies. A key role for environmental institutions to achieve this goal is to provide knowledge and promote awareness; identify targets, policies, regulations, tools and best practices; and monitor long-term achievements.

Striving to ensure more sustainable patterns of consumption and production is a key approach to mainstreaming the environment. Opportunities exist in the implementation of the multi-stakeholder Marrakech process, which supports regional and national initiatives to promote the shift towards such patterns. Efforts to link environmental policies with major public budgets represent another effective option for integration. A relatively small number of countries, including Canada and Norway, for example, review their budgets to ascertain the environmental impacts of proposed public spending. The EU requires an environmental impact assessment for spending on national projects from structural and regional funds.

#### ***Strengthened environmental knowledge***

about interactions between people and the environment at all scales, based on the best-

**Figure 16: Research and development (R&D) intensity**



The potential for science and technology to enhance our understanding of environmental and social processes and to reduce vulnerability remains very unevenly distributed worldwide. There is great need to strengthen research and development and to improve technology transfers between regions.

available scientific research (see **Figure 16**) and data, can be achieved by improving knowledge infrastructure and capacities, promoting interoperability of data systems and tools, and information networking, particularly in developing regions. Effective implementation of the Bali Strategic Plan on Technology Support and Capacity Building, adopted in February 2005 by the UNEP Governing Council, **will strengthen the capacity of states on environmental issues** at all levels. It calls for a bottom-up approach in identifying specific objectives, strategies and activities that need support. It also stresses the importance of, and national ownership and South-South cooperation for assessing overall needs and setting priorities. Learning about best practices can be facilitated, for instance, through web-based learning platforms and networks. These incremental gains should not be forgotten in pursuing solutions to all pressing environmental problems at the same time.

There is considerable scope for **mobilizing financial resources to address environmental problems**. Building intergovernmental

partnerships and implementing outcomes of the Monterrey Conference on Financing for Development can provide much-needed support. There may also be environmental and economic benefits in phasing out some subsidies. For instance, an International Atomic Energy Agency study of energy subsidies in eight developing countries, mostly in Asia, concluded that their annual economic growth would increase by over 0.7 per cent, while their CO<sub>2</sub> emissions would go down by nearly 16 per cent, if the subsidies were eliminated. Green budgeting, the creation of conservation funds and economic instruments, such as user fees and charges, are among the tools that have been applied in various countries. Financing plans that allow local resource conservation to pay for itself over time can be developed, but local communities or domestic financial sources are often unable to make the initial seed investment. Liberalization of trade in goods-and-services of interest to developing countries could generate additional financial flows totalling about US\$310 billion yearly. Realizing this potential, however, will depend on success in achieving an open, non-discriminatory and equitable multilateral trading system, which benefits countries at all stages of development. It will also depend on meaningful trade liberalization which takes into account impacts on the environment, and which does not compromise effective management of the environment.

**Reducing people's vulnerability** to environmental and socio-economic changes is one component of protecting and extending recent gains. This can involve strengthening local rights by, for example, developing institutional forms that are more inclusive of local concerns or strengthening resource tenure to give people secure access to their livelihood assets and increased control over how local resources are used. Reducing vulnerability includes access to better financial and technical support and information, and investing in the capacity to cope with natural disasters and adapt to climate change.

**Empowering women** not only contributes to the widely shared objective of equity and

justice, but also makes good economic, environmental and social sense. Evidence shows that finance schemes that target women can have higher-than-usual payoffs and more sustainable outcomes. Better access to education improves maternal health, creating a better starting point for the next generation.

### Innovations and emerging solutions

For many problems, the benefits from early and ambitious action outweigh the costs. Scenarios on future global environmental changes suggest that implementing determined action in the present is cheaper than waiting for better solutions to come along. Delayed action also unfairly shifts the burden of paying such costs onto future generations, contradicting the principle of inter-generational equity. In particular, recent IPCC reports about the costs of inaction on climate change have raised the alarm about the need for action, and suggest that immediate measures are affordable for many countries. Innovative approaches are needed for society to make the necessary transition to a sustainable, low-carbon economy.

A number of structural innovations could form the basis of a more ambitious global policy agenda to enable such a transition. Contemporary approaches are moving, for example, towards *collective learning* and adaptive management. Effective **adaptive governance** depends on leadership and *bridging organizations*. Leaders are imperative for establishing a vision, building trust, generating knowledge, initiating partnerships among relevant actors, managing conflicts, and mobilizing broad support for change. Bridging organizations are often at the interface of scientific knowledge and policy or of local experience and research and policy. They reduce the cost of collaboration significantly and often perform important conflict resolution functions.

Adaptive governance approaches are well placed to manage uncertainty and periods of change. The rising price of oil, for example, has led to increased interest in other energy sources. Broad-based energy policies may

benefit from an integrated multisectoral approach that addresses both the need to maintain biodiversity and vital ecosystem services, and the need to mitigate and adapt to climate change.

Greater emphasis is also being placed on **economic instruments** (see **Table 3** for different types of instruments and applications). Natural resources – compared to financial, material and human resources – are the foundation for much of the wealth of countries. Managing this natural resources portfolio to maximize its returns and benefits over time is good investment.

The policy options available to influence economic drivers include green taxes, the creation of markets for ecosystem services, and environmental accounting. Governments are beginning to gain experience in implementing these instruments, although typically only at relatively small scales. *Learning by doing* can help develop new policy approaches to move development decisions in a sustainable direction.

Used properly, economic instruments provide market corrections, promote production efficiency or cost minimization, and facilitate flexible responses to changing circumstances. They can help economic development to foster environmental protection and vice-versa. Economic instruments may provide signals concerning resource scarcity and environmental damage which, in turn, can trigger more-efficient resource use and waste minimization. Instruments such as green taxes can raise revenues that may be used to improve environmental quality or reduce income taxes for the poor. **Table 3** provides some examples of various economic instruments being applied to different environmental sectors.

In *ecological tax reform* and *tax shifting*, taxes on energy use and the consumption of other resources are increased, and corresponding reductions are often made on income tax. Although this has encountered stiff resistance from vested interests, ecological tax reforms have

**Table 3 Examples of economic instruments and applications**

	Property rights	Market creation	Fiscal instruments	Charge systems	Financial instruments	Liability systems	Bonds and deposits
<b>Forests</b>	Communal rights	Concession building	Taxes and royalties		Reforestation incentives	Natural resource liability	Reforestation bonds, forest management bonds
<b>Water resources</b>	Water rights	Water shares	Capital gains tax	Water pricing Water protection charges			
<b>Oceans and seas</b>		Fishing rights, Individual transferable quotas Licensing					Oil spill bonds
<b>Minerals</b>	Mining rights		Taxes and royalties				Land reclamation bonds
<b>Biodiversity and wildlife</b>	Patents Prospecting rights	Transferable development rights Access fees		Charges for scientific tourism		Natural resource liability	
<b>Water pollution</b>		Tradeable effluent permits	Effluent charges	Water treatment fees	Low-interest loans		
<b>Land and soils</b>	Land rights, use rights		Property taxes, land-use taxes		Soil conservation incentives (such as loans)		Land reclamation bonds
<b>Air pollution</b>		Tradeable emission permits	Emission charges		Technology subsidies, low-interest loans		
<b>Hazardous waste</b>				Collection charges			Deposit refund systems
<b>Solid waste</b>			Property taxes		Technology subsidies, low-interest loans		
<b>Toxic chemicals</b>			Differential taxation			Legal liability, liability insurance	Deposit refund
<b>Climate</b>	Tradeable emission entitlements Tradeable forest protection obligations	Tradeable CO <sub>2</sub> permits Tradeable CFC quotas CFC quota auction Carbon offsets	Carbon taxes BTU tax		CFC replacement incentives Forest compacts		
<b>Human settlements</b>	Land rights	Access fees Tradeable development quotas Transferable development rights	Property taxes, land-use taxes	Betterment charges Development charges Land-use charges Road tolls Import fees			Development completion bonds

proved to be a stimulus for innovation and new employment opportunities. When introduced gradually and in ways that are revenue-neutral and easy to administer, these reforms may encourage environmentally conscious consumption patterns without having significant negative social distribution effects. Certain instruments, such as carbon taxes, that have a potentially significant impact on industry and national competitiveness, have been used by some countries. To date, however, carbon taxes have been introduced in only 12 countries, and their diffusion has been very slow.

A relatively new approach called payments for environmental or ecosystem services (PES) attempts to address the overexploitation of ecosystems by paying the individuals and communities that secure the supply of ecosystem services; the beneficiaries must pay for the services themselves. Costa Rica, Brazil, Ecuador, Mexico and other developing countries have pioneered PES schemes for the preservation of freshwater ecosystems, forests and biodiversity. Many PES schemes have originated in developed countries, particularly in the US, where it is estimated that the government spends at least US\$1.7 billion a year to induce farmers to protect land. While the conservation goals may be laudable, the trade-distorting nature of some agricultural subsidies also needs to be considered.

Three main markets are emerging for payments for ecosystem services:

- Watershed management, which may include control of floods, erosion, access to nutrients, sedimentation and water quality, as well as maintenance of aquatic habitats and dry season flows;
- Biodiversity protection, which includes eco-labelled products, ecotourism and payments for conservation of wildlife habitat;
- Carbon sequestration, in which, for example, international buyers pay to plant new trees to absorb carbon, offsetting carbon emissions elsewhere.

Indicative of the growing interest in market mechanisms, the period from 1 January 2005

to 31 March 2006 witnessed a booming global carbon market worth over US\$10 billion, 10 times the value of the previous year and more than the value of the entire US wheat crop in 2005 (US\$7.1 billion).

Market failures are, however, not necessarily solved solely through market solutions. A combination of market-based mechanisms and regulatory structures is often needed. The cap-and-trade model, in the case of carbon emissions, is an example of a regulatory framework defining overall emission limits before a market for emission credits can be established.



Experiences from global, regional, national and local initiatives that address complex environmental issues across sectors have provided some valuable lessons on general principles for public policy formulation and implementation.



## 7 CONCLUSION

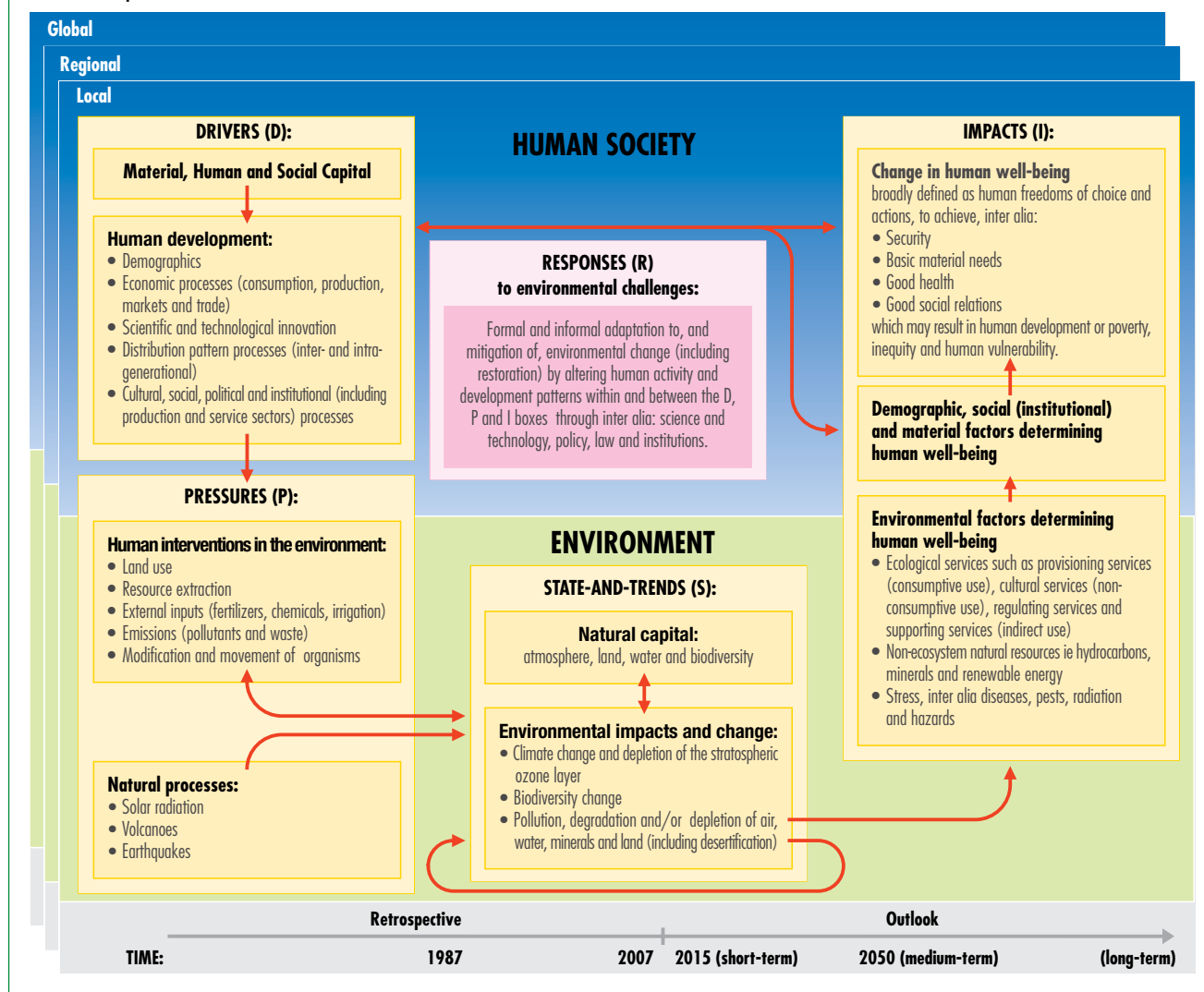
The intertwined environmental and developmental challenges that *Our Common Future* warned about in 1987 still exist, as do the associated policy challenges. Knowledge of the interlinkages between environment and development, and the impacts on human well-being, gained in the past two decades, can be used effectively for the transition towards sustainable development. Concerns about the global environment may have reached a tipping point of their own, with the growing realization that for many problems, the benefits of early action outweigh the costs. Now is the time to pursue the transition towards sustainable development supported by well-governed, innovative and results-oriented institutions, which can effectively respond to environmental challenges, particularly persistent ones.



The complexity, magnitude and the interconnectedness of environmental change do not mean that decision-makers are faced with the stark choice of “doing everything at once in the name of integrated approaches or doing nothing in the face of complexity.” Identifying interlinkages offers opportunities for more effective responses at national, regional and global levels. Current gaps and needs relating to existing national and international infrastructure and capacities for integrating environment into development should be identified and addressed.



# GEO-4 conceptual framework



The GEO-4 conceptual framework is based on the drivers-pressures-state-impacts-responses (DPSIR) concept. It draws on different types of assessments that have taken place over the years, including previous GEO reports, the Intergovernmental Panel on Climate Change (IPCC) and the Millennium Ecosystems Assessment (MA), especially with regard to the concepts of human well-being and ecosystem services. The framework reflects the key components of the complex chain of cause-and-effect, taking place in space and time that characterizes the interactions between society and environment. Environmental changes are induced by drivers and caused by pressures, but they do also affect each other. These changes interact with demographic, social and material factors in determining human well-being. Responses include measures by society for mitigating and adapting to environmental changes. These processes take place at all spatial scales, from the global to the local.

## Reference sources:

### Figure 1: Our “shrinking” Earth

FAOSTAT (2006). FAO Statistical Databases. Food and Agriculture Organization of the United Nations, Rome; <http://faostat.fao.org/faostat/> (last accessed 10 July 2007); WTO (2007). Statistics Database. World Trade Organization, Geneva; [http://www.wto.org/english/res\\_e/statistics\\_e.htm](http://www.wto.org/english/res_e/statistics_e.htm) (last accessed 9 July 2007); GEO Data Portal. UNEP's online core database with national, sub-regional, regional and global statistics and maps, covering environmental and socio-economic data and indicators. United Nations Environment Programme, Geneva; <http://www.unep.org/geo/data> or <http://geodata.grid.unep.ch> (last accessed 10 July 2007); UNPD (2007). World Population Prospects: the 2006 Revision Highlights. United Nations Department of Social and Economic Affairs, Population Division, New York, NY (in GEO Data Portal); World Bank (2006). World Development Indicators 2006. The World Bank, Washington, DC (in GEO Data Portal); UNFCCC-CDIAC (2006). Greenhouse Gases Database. United Nations Framework Convention on Climate Change, Carbon Dioxide Information Analysis Centre (in GEO Data Portal); FAOSTAT (2004). FAO Statistical Databases. Food and Agriculture Organization of the United Nations, Rome (in GEO Data Portal) <http://faostat.fao.org/faostat/> (last accessed 10 July 2007)

### Figure 2: Seasonal melting of the Greenland Ice Sheet

Steffen, K. and Huff, R. (2005). Greenland Melt Extent, 2005 <http://cires.colorado.edu/science/groups/steffen/greenland/melt2005> (last accessed 11 April 2007)

### Figure 3: Premature deaths due to outdoor urban PM<sub>10</sub> exposure by region in 2000

Cohen, A. J., Anderson, H. R., Ostro, B., Pandey, K., Krzyzanowski, M., Künzli, N., Gutschmidt, K., Pope, C. A., Romieu, I., Samet, J. M. and Smith, K. R. (2004). Mortality impacts of urban air pollution. In Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factor Vol. 2, Chapter 17. World Health Organization, Geneva

### Figure 4: Coastal population and shoreline degradation

Adapted from: Vital Water Graphics. Coastal population and shoreline degradation. UNEP/GRID-Arendal Maps and Graphics Library <http://maps.grida.no/go/collection/CollectionID/70ED5480-E824-413F-9B63-A5914EA7CCA1> (last accessed 27 April 2007); based on: Harrison, P. and Pearce, F. (2001). AAAS Atlas of Population and Environment. American Association for the Advancement of Science. University of California Press, California <http://www.ourplanet.com/aaas/pages/about.html> (last accessed 27 April 2007); Burke L., Kura Y., Kassem K., Revenga C., Spalding M.D. and McAllister D., Pilot Analysis of Global Ecosystems: Coastal Ecosystems, 2001. World Resources Institute, Washington DC

### Figure 5: The Global Ocean Conveyor

IPCC (1996). Climate change 1995: Impacts, adaptations and mitigation of climate change: scientific-technical analyses. Contribution of Working Group II to the Second Assessment Report. Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

### Figure 6: Status of terrestrial ecoregions

WWF (2006). Conservation Status of Terrestrial Ecoregions. World Wide Fund for Nature, Gland; [http://www.panda.org/about\\_wwf/where\\_we\\_work/ecoregions/maps/index.cfm](http://www.panda.org/about_wwf/where_we_work/ecoregions/maps/index.cfm) (last accessed 8 May 2007)

### Figure 7: Trend in use of passenger cars

GEO Data Portal. UNEP's online core database with national, sub-regional, regional and global statistics and maps, covering environmental and socio-economic data and indicators. United Nations Environment Programme, Geneva <http://www.unep.org/geo/data> or <http://geodata.grid.unep.ch> (last accessed 1 June 2007); UNSD (2005). UN Statistics Division Transport Statistics Database, UN Statistical Yearbook. United Nations, New York, NY (in GEO Data Portal)

### Figure 8: Trends in total greenhouse gas emissions

EEA (2007). Europe's Environment: the Fourth Assessment. European Environment Agency, Copenhagen; Adapted from: UNFCCC-CDIAC (2006). Greenhouse Gases Database. United Nations Framework Convention on Climate Change, Carbon Dioxide Information Analysis Centre (in GEO Data Portal); [http://unfccc.int/ghg\\_emissions\\_data/items/3800.php](http://unfccc.int/ghg_emissions_data/items/3800.php) (last accessed 16 May 2007)

Note:

**EU-25** (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, the United Kingdom, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)

**EFTA**: (Iceland, Liechtenstein, Norway and Switzerland)

**EE&C**: (Armenia, Azerbaijan and Georgia, Belarus, Republic of Moldova, The Russian Federation and Ukraine)

### Figure 9: Number of storms in the North Atlantic Basin

Unisys Corp. (2005). Atlantic Hurricane Database. Atlantic Oceanographic and Meteorological Laboratory, US National Oceanic and Atmospheric Administration <http://weather.unisys.com/hurricane/atlanctic/1987/index.html> (last accessed 10 May 2007)

### Figure 10: Energy production by fuel type

IEA (2007). Energy Balances of OECD Countries and Non-OECD Countries: 2006 edition. International Energy Agency, Paris (in GEO Data Portal)

### Figure 11: Current and projected water demand in West Asia

UNESCWA (2003). Updating the Assessment of Water Resources in UNESCWA Member Countries. Report No. E/UNESCWA/ENR/1999/13. United Nations Economic and Social Commissions for Western Asia, New York, NY

### Figure 12: Summer Arctic sea ice is shrinking at a rate of 8.9 per cent per decade

NSIDC (2006). Arctic sea-ice extent. National Snow and Ice Data Center News Release, 28 September 2005; [ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/Sep/N\\_09\\_area.txt](ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/Sep/N_09_area.txt) (last accessed 15 May 2007)

### Figure 13: Highest risk hot spots by natural hazard type

Dilley, M., Chen, R., Deichmann, U., Lerner-Lam, A.L. and Arnold, M. (with Agwe, J., Buy, P., Kjekstad, O., Lyon, B. and Yetman, G.) (2005). Natural Disaster Hotspots: A Global Risk Analysis. Synthesis Report. The World Bank, Washington, DC and Columbia University, New York, NY

### Figure 14: Two tracks to address environmental problems with proven and emerging solutions

GEO-4 Chapter authors

### Figure 15: Ratification of major multilateral environmental agreements

GEO Data Portal. UNEP's online core database with national, sub-regional, regional and global statistics and maps, covering environmental and socio-economic data and indicators. United Nations Environment Programme, Geneva <http://www.unep.org/geo/data> or <http://geodata.grid.unep.ch> (last accessed 1 June 2007)

### Figure 16: Research and development intensity

Adapted from UIS (2004). A Decade of Investment in Research and Development (R&D): 1990-2000. In UIS Bulletin on Science and Technology Statistics 1. UNESCO Institute for Statistics, Paris <http://www.uis.unesco.org/template/pdf/S&T/BulletinNo1EN.pdf> (last accessed 26 June 2007)

### Photo on page 10

Credit: Ngoma Photos

### Photo on page 15:

Credit: Christian Lambrechts

### Photo on page 29:

Credit: Munyaradzi Chenje

### Photo on page 30:

Credit: ullstein-Hiss/Mueller/Still Pictures



Delegates consider the Summary for Decision Makers during the Second Global Intergovernmental and Multistakeholder Consultation held in Nairobi in September 2007.

*Rapid environmental change is all around us. This assault on the global environment risks undermining the many advances human society has made in recent decades. It is undercutting our fight against poverty. It could even come to jeopardize international peace and security.*

**Ban Ki-moon, Secretary-General, United Nations**

*GEO-4 underlines the choices available to policy-makers across the range of environmental, social and economic challenges – both known and emerging. It underlines not only the enormous, trillion-dollar value of the Earth's ecosystems and the goods-and-services they provide, but also underscores the central role the environment has for development and human well-being.*

**Achim Steiner, Executive Director, United Nations Environment Programme**



**[www.unep.org](http://www.unep.org)**

United Nations Environment Programme  
P.O. Box 30552 - 00100 Nairobi, Kenya  
Tel.: +254 20 762 1234  
Fax: +254 20 762 3927  
e-mail: [unep@unep.org](mailto:unep@unep.org)  
[www.unep.org](http://www.unep.org)

