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Disasters

Global overview

Disasters can occur as a consequence of the impact of a natural or a human-caused hazard. Natural hazards comprise phenomena such as earthquakes, volcanic activity, landslides, tsunamis, tropical cyclones and other severe storms, tornadoes and high winds, river and coastal flooding, wildfires and associated haze, drought, sand and dust storms, and infestations. Human-caused hazards may be intentional, such as the illegal discharge of oil, or accidental such as toxic spills or nuclear meltdown. All of these can expose people, ecosystems, flora and fauna to threats. The poor are the most vulnerable to disasters because they have fewer resources and capacity to prevent or cope with the impacts.

'A disaster is a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope on its own resources.' — *Source: UNDHA 2001*

Natural disasters

People and the environment are increasingly suffering from the effects of natural disasters. There are a number of reasons for this such as high population growth and density, migration and unplanned urbanization, environmental degradation and possibly global climate change. The sheer scope of the socio-economic impacts of natural disasters has brought about a shift in the political approach to dealing with the concept of risk in modern societies.

Comparing the past two decades, the number of people killed in natural and non-natural disasters was higher in the 1980s (86 328 annually) than in the 1990s (75 252 annually). However, more people were affected by disasters in the 1990s — up from an average of 147 million a year in the 1980s to 211 million people a year in the 1990s. While the number of geophysical disasters has remained fairly steady, the number of hydrometeorological disasters (those caused by water and weather) has increased (see figure on page 271). In the 1990s, more than 90 per cent of those killed in natural disasters lost their lives in hydrometeorological events such as droughts, windstorms and floods. While floods accounted for

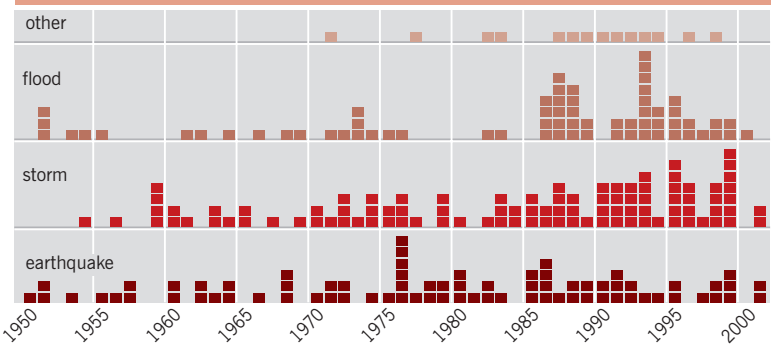
more than two-thirds of people affected by natural disasters, they are less deadly than many other types of disaster, accounting for only 15 per cent of deaths (IFRC 2001).

The social and economic costs of disasters vary widely and are difficult to estimate on a global basis. Insurance claims tend to be misleading as an estimate of the economic impact of disasters. Considering insured damage claims for the 1999 floods in Austria, Germany and Switzerland, at least 42.5 per cent of damage was covered by disaster insurance. But in Venezuela the same year, only 4 per cent of flood damage was covered (CRED-OFDA 2002). There is a need for reliable and systematic data on disasters to help assess their socio-economic and environmental impacts in both the short and the long term. But although communities in developing countries suffer from numerous local-scale disasters such as wildfires, small floods, droughts and pest infestations, these are often not reflected in disaster statistics.

The most expensive disasters in purely financial and economic terms are floods, earthquakes and windstorms but events such as drought and famine can be more devastating in human terms. While earthquakes accounted for 30 per cent of estimated damage, they caused just 9 per cent of all fatalities due to natural disasters. In contrast, famine killed 42 per cent, but accounted for just 4 per cent of damage over the past decade (IFRC 2001). In 1999, global financial losses from natural catastrophic events were estimated to exceed US$100 billion — the second highest figure on record. A total of 707 large events were recorded compared to 530 to 600 events in previous years. It is even more striking that the number of major catastrophic events over the past decade has increased threefold in comparison with the 1960s, while the rate of economic losses has increased by a factor of almost nine over the same period (Munich Re 2001).

Between 1995 and 1997, the impacts of natural hazards cost the United States at least US$50 billion a year, or the equivalent of about US$1 billion a week (IDNDR 1999a). The economic losses of the United States because of the 1997-98 El Niño event were estimated at US$1.96 billion or 0.03 per cent of GDP. Ecuador suffered equivalent financial losses but this represented 11.4 per cent of its GDP. The floods in China in 1991, 1994-95 and 1998 caused losses ranging from US$20 to 35 billion (CNC-IDNDR 1999).

Numbers of great natural disasters per year, 1950–2001



Graph shows increasing trend in frequency of 'great' natural disasters. Catastrophes are classed as great if the ability of the region to help itself is overtaxed, making inter-regional or international assistance necessary, as is usually the case when thousands of people are killed, hundreds of thousands made homeless or when a country suffers substantial economic losses

Source: Munich Re 2001

Recent disasters caused by extreme natural events

The year 2000

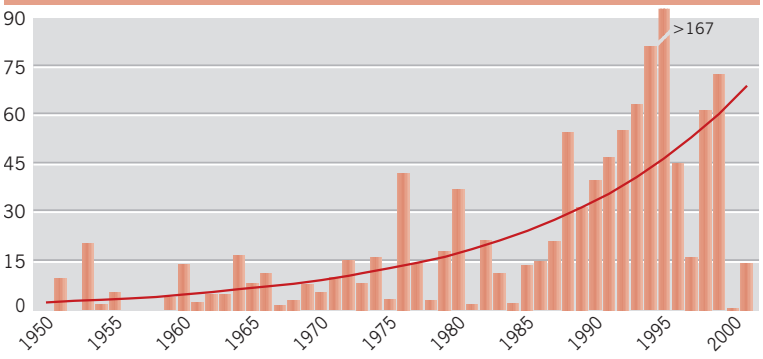
- Mongolian herders had their hardest winter for 30 years — 2.4 million livestock died and 45 per cent of the country's population was affected.
- In February and March, floods killed 650 people and left more than half a million homeless in Mozambique. Heavy rains also affected Botswana, Swaziland and Zimbabwe.
- Cyclones Eline (mid-February) and Gloria (early-March) left 184 000 people in need of immediate relief support out of the total of 737 000 affected in Madagascar. In early April, a third cyclone, Hudah, hit the north of the island.
- Floods in September and October in Southeast Asia, especially Viet Nam and Thailand, killed approximately 900 people and left 4 million homeless or with insufficient shelter. Losses estimated at US$460 million.
- Hurricane Keith in October killed eight and affected 62 000 people in Belize. Direct losses estimated at US$520 million.
- In mid-October, heavy rains caused floods in the Italian and Swiss Alps killing 38 people and causing economic losses estimated at US$8.5 billion.
- Similar floods killed six people and caused US$1.5 billion loss in the United Kingdom in November.

The year 2001

- In mid- to late January, heavy rains over Zambezia Province caused the Licungo River to flood in Mozambique. Nearly 500 000 people were affected by the floods.
- In March, floods devastated a wide area of northeastern Hungary, northwestern Romania and western Ukraine. Tens of thousands of people were forced to move.
- Flash floods unexpectedly struck parts of Pakistan on 23 July. The cities of Islamabad and Rawalpindi were the worst affected. 132 people were killed.
- In mid-November, as many as 576 Vietnamese had been killed by natural disasters, mainly floods and typhoons. Material losses amounted to more than US$200 million.
- A persistent multi-year drought in Central and Southwest Asia had affected about 60 million people by November 2001.
- After several months of drought, devastating floods tore through the Algerian capital Algiers on 10 November, killing 751 people. Thousands were injured, and about 40 000 people were left homeless.

Source: ReliefWeb (2002), Munich Re 2001

Economic costs of great natural disasters (US$billion), 1950–2000



In comparison with the 1960s, economic losses during the 1990s increased by a factor of almost nine

Note: chart shows only the cost of 'great' natural catastrophes — see figure on page 271 for definition

Source: Munich Re 2001

The annual loss from natural disasters over the period from 1989 to 1996 is estimated to range from 3 to 6 per cent of China's GDP, averaging 3.9 per cent. In December 1999, the Anatol, Lothar and Martin storms generated losses in northern Europe amounting to US$5–6 billion (Munich Re 2001). Less developed countries with limited economic diversity and poor infrastructure must not only rely mostly on external relief if a disaster happens but their economies need more time to recover. In developed economies, governments, communities and individuals have greater capacities to cope with disasters, the economic losses are to some extent absorbed by a diversified economy, and most assets are insured.

Among the least developed countries, 24 of the 49 face high levels of disaster risk; at least six of them have been affected by between two and eight major disasters per year in the past 15 years, with long-term consequences for human development (UNDP 2001). Since 1991, more than half of all the disasters reported occurred in countries with medium levels of human development (see 'Socio-economic background'). However, two-thirds of those killed came from countries with low levels of human development, while just 2 per cent came from highly developed countries. The effect of development on disasters is dramatic: on average, 22.5 people die per reported disaster in highly developed countries, 145 die per disaster in countries with medium human development, and 1 052 people die per disaster in countries with low levels of development (IFRC 2001).

A number of experts link the current trend in extreme weather events with an increase of the global mean temperature. Many parts of the world have suffered major heat waves, floods, droughts and other extreme weather events. While individual events, such as El Niño-related phenomena (see box), cannot be directly linked to human-induced climate change, the frequency and magnitude of these types of events are predicted to increase in a warmer world. The changes in the global mean temperature are 'very likely' to affect parameters such as precipitation patterns, wind velocities, soil moisture and vegetation cover which appear to influence the occurrence of storms, hurricanes, floods, drought and landslides (IPCC 2001). For example, the extent of damage from storm surges can be directly linked to sea level variations.

Climate change and variability alone do not explain the increase in the impacts related to disasters. 'Natural' can be a misleading description for disasters such as the droughts, floods and cyclones which afflict much of the developing world. Identifying human-induced root causes, and advocating structural and political changes to combat them, is long overdue (IFRC 2001). For example, destruction of the natural environment because of logging or inappropriate land uses for short-term economic gain is one of the major

Socio-economic effects of the 1997–98 El Niño

The 1997-98 El Niño event affected virtually every region: Eastern Africa suffered drought and unusually high rainfall; Southeast Asia and North America, abnormally warm periods; South Asia, drought; Latin America and the Caribbean, unusually high rainfall and drought; and the Pacific Islands unusually high rainfall. The global socio-economic impacts were varied:

- More than 24 000 people died because of high winds, floods or storm tides that occurred during intense storms.
- More than 110 million people were affected and more than 6 million people were displaced as community infrastructures, including housing, food storage, transport and communications, were lost during storms.
- Direct economic losses exceeded US$34 billion.
- Waterlogging of fields reduced agricultural production in many regions; in others, the absence of storms and rain led to prolonged dry spells, loss of crops and reduction in water supplies.
- Wildfires were more frequent and widespread during extended dry periods.
- Increased incidence of disease followed the prolonged disruption to weather and rainfall patterns that resulted in contamination of water supplies or a more favourable environment for disease-carrying insect vectors.

Sources: WMO 1999, UNU 2001

factors promoting floods or mudslides such as those that hit Venezuela in December 1999. Similarly, the migration of population to urban and coastal areas increases human vulnerability as population densities increase, infrastructure becomes overloaded, living areas move closer to potentially dangerous industries, and more settlements are built in fragile areas such as floodplains or areas prone to landslides. As a result, natural catastrophes affect more people and economic losses are increased. For example, despite the fact that seismic activity has remained constant over recent years, the effects of earthquakes on the urban population appear to be increasing.

Human-induced disasters

A number of major accidents involving chemicals and radioactive materials have drawn attention worldwide to the dangers of mismanagement, particularly in the transport, chemical and nuclear power sectors. These events often have impacts that transcend national boundaries; they also emphasize the fact that issues of technological safety concern more than just the developed countries.

Some disasters have resulted in the introduction of voluntary or mandatory regulations designed to prevent similar occurrences. Public concern following the explosion in 1976 at a pesticide plant in Seveso, Italy, with the release of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), led to the introduction in 1982 of a European Directive on the major-accident hazards of certain industrial activities. Similarly, other major accidents, such as the methyl isocyanate leak at Bhopal, India, in 1984 and the Switzerland-Sandoz warehouse fire in Basel in 1989, stimulated legislation in many countries to prevent and control chemical incidents. Influenced by the Bhopal accident, in particular, the International Labour Office developed in 1993 the Convention Concerning the Prevention of Major Industrial Accidents No. 174 and the Prevention of Major Industrial Accidents Recommendation No. 181. These documents call for an international exchange of relevant information, development of policies aimed at addressing the major accident risks, hazards and their consequences, and recognition that a major accident could have serious impacts on human life and the environment.

Major nuclear accidents such as those at Three Mile Island in the United States in 1979 and at Chernobyl in 1986 have not only catalysed action to strengthen nuclear safety and emergency preparedness but also forced many countries to

The 1999 earthquake in Izmit, Turkey

On 17 August 1999, an earthquake with a magnitude of 7.4-7.8 on the Richter scale hit the city of Izmit, Turkey, and the surrounding areas. Damage from the earthquake was estimated at more than US$13 billion. More than 15 000 people were killed, 25 000 others were injured and 600 000 people were left homeless. The earthquake was blamed for increasing the national account deficit of some US$3 billion in 1999-2000 (equivalent to about 1.5 per cent of the GNP).

A significant part of the damage could have been avoided had local building codes been effectively implemented. Many new buildings had not been properly designed, had not been built on foundations strong enough to resist earthquakes, and had not been sited in areas where the effects of earthquakes would have been diminished.

Source: ISDR 1999

Apartment block split in two by the 1999 earthquake in Izmit, Turkey

Source: Alexander Allmann, Munich Re

abandon or severely restrict development of the nuclear power sector. Following the Chernobyl accident, two major international treaties were adopted — the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency and the Convention on the Early Notification of a Nuclear Accident. Most recently, the 1994 Convention on Nuclear Safety, committing parties to a higher level of nuclear safety, and the 1997 joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management were adopted.

The 1989 *Exxon Valdez* oil spill in Alaska resulted in enormous environmental and economic damages and catalysed the development of the 'Valdez Principles' — a voluntary code of conduct for corporate behaviour towards the environment — by the Coalition for Environmentally Responsible Economics (CERES). The 'Valdez Principles' guide corporations in the establishment of environmentally sound policies and require the raising of corporate environmental safety standards and the taking of responsibility for environmental harm that may be caused by them (Adams 1994).

International policy responses

Until the 1970s, the international community considered disasters as exceptional circumstances, when local coping capacities were exhausted and external emergency relief was required. The term disaster management was generally equivalent to disaster response and tended to be within the exclusive competence of organizations such as the Red Cross and Red Crescent Societies or national civil defence institutions.

In 1971, the United Nations Disaster Relief Office, now the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), was established to mobilize and coordinate relief activities from all sources in times of disaster. The concept of disaster preparedness was developed during the 1970s and 1980s, and included training and some cross-sectoral activities to increase capacity for rescue, relief and rehabilitation during and after a disaster. But even the most pessimistic forecasts could not have foreseen the upward spiral in negative socio-economic consequences of natural disasters in the closing decades of the 20th century.

The 1990s was declared the International Decade for Natural Disaster Reduction (IDNDR), one of the principal goals of which was to inculcate a culture of disaster prevention through the wider application of known scientific and technological mechanisms by a better-informed population. In the words of United Nations Secretary-General Kofi Annan, 'We must, above all, shift from a culture of reaction to a culture of prevention. The humanitarian community does a remarkable job in responding to disasters. But the most important task in the medium and long-term is to strengthen and broaden programmes which reduce the number and cost of disasters in the first place. Prevention is not only more humane than cure, it is also much cheaper' (IDNDR 1999b). The IDNDR successfully placed risk reduction higher on the political agenda, as well as setting out a number of priorities to be undertaken by countries and regions in the 21st century.

An increasing number of governments and international organizations are promoting risk reduction as the only sustainable solution for reducing

China committed to risk reduction

The Chinese government is shifting the focus of its disaster policies from improving response capabilities to reducing hazards and risks. During the past ten years, national coordination has been vested in the Chinese National Committee (CNC) for the IDNDR, an inter-ministerial organization composed of representatives from 28 ministries, departments and commissions. Since 1989, CNC has been working on the National Natural Disaster Reduction Plan of the People's Republic of China (1998-2010). It has also helped to develop and coordinate policies and plans for national and local disaster reduction activities.

Motivated by the seriousness of the 1991 floods in China, the Chinese authorities recognized the need 'to integrate disaster reduction into the comprehensive plan for national economy and social development'. The Chinese National Centre for Natural Disaster Reduction has now been established within the Chinese Academy of Sciences. The centre compiles and analyses data on disasters, and passes the results to the State Council for decision-making responsibilities.

China experienced its worst floods in more than 100 years in 1999, which affected more than 300 million people. The floods galvanized more political commitment for the integration of risk and disaster prevention programmes into national social and economic planning. However, China believes that there were fewer losses during the 1999 floods in the Yangtze River Valley, despite higher water levels, because of the US$7.6 billion invested in water conservancy measures since the costly 1998 floods.

Source: CNC-IDNDR 1999

the social, economic and environmental impacts of disasters. Risk reduction strategies include:

- vulnerability mapping;
- identification of areas that are safe for settlement and development;
- adoption of building codes based on disaster resilient engineering and on local hazard risk assessments; and
- enforcing these plans and codes by economic and other incentives.

At the global level, the UN has established an International Strategy for Disaster Reduction (ISDR), a global platform aimed at helping all communities to become resilient to the effects of natural disasters and to proceed from protection against hazards to the management of risk through the integration of risk prevention into sustainable development. The strategy — based on the IDNDR experience and developments such as the 1994 Yokohama Strategy and Plan of Action for a Safer World and the 1999 Strategy 'A Safer World in the 21st Century: Disaster and Risk Reduction' — reflects a cross-sectoral and interdisciplinary approach to disaster reduction.

Implementation of the strategy, which is based on the establishment of partnerships between governments, non-governmental organizations, UN agencies, the scientific community and other stakeholders in the disaster reduction community, is an integral part of efforts aimed at promoting the overall goal of sustainable development. It is also an indispensable element in the search for solutions designed to counter the increasing threat posed by natural hazards (ISDR 1999).

Prevention and preparedness to reduce the costs of disasters

The fundamental goal of the UNEP disaster management programme is to reinforce the centrality of environmental concerns in disaster management. The other cornerstone is the adoption of preventive strategies and practical measures to reduce the potential loss of human lives and property, as well as destruction of the environment.

The success of this approach depends on increasing public awareness of the risks that natural, technological and environmental hazards pose to societies, and on educating people about the value of existing approaches for prevention and preparedness. UNEP contributes to this process through its programmes on environmental law, early warning and assessment, and Awareness and Preparedness for Emergencies at Local Level (APELL).

UNEP's APELL programme, developed in conjunction with governments and industry, recognizes that the incidence and effects of environmental disasters can be reduced by prevention and preparedness initiatives at the local level. The APELL concept has been successfully introduced to more than 30 countries and in more than 80 industrial communities worldwide. The UNEP strategy includes the promotion of cleaner production processes and technologies, and helping countries establish cleaner production centres.

A major objective of the UNEP early warning and assessment programme is to evaluate the increasing vulnerability of human society due to widespread environmental and climatic change in order to emphasize the need for sound integrated environmental management, and to provide early warning of emerging threats for preparedness and response.

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Disasters: Africa

Extreme hydrometeorological events such as flooding and drought are common across Africa, while geophysical events such as earthquakes occur predominantly in Northern Africa, along the Atlas mountain range, and in the African Rift Valley, which also experiences volcanic activity. The El Niño Southern Oscillation causes significant climatic disturbances in most parts of Africa, either inducing drought or flooding, or increasing sea temperatures leading to cyclones.

These natural events become disasters where large numbers of people or infrastructure are affected, as has occurred over the past 30 years due to high population growth rates, especially in urban centres and drought-prone areas — 34 per cent of Africa's population lives in arid areas compared to just 2 per cent of Europe's population (Findlay 1996).

Impacts of disasters include loss of lives and livelihoods, damage to infrastructure and communications, interruption of economic activities, and increased risk of disease outbreaks. In many places, these impacts are worsened by poverty and marginalization, and overcrowding. Inadequate, old and deteriorating infrastructure and lack of economic security to provide for times of hardship also compromise people's coping capacities and therefore magnify the impacts of disasters. There is growing concern that the frequency and severity of disasters are increasing at a time when early warning systems are inadequate and disaster management is weak (DMC 2000).

Some of the worst disasters in Africa, 1972–2000

			number killed	*number affected*
1972	famine	Ethiopia	600 000	no data
1973	drought	Ethiopia	100 000	no data
1974	drought	Ethiopia	200 000	no data
1980	drought	Mozambique	no data	6 000 000
1982	famine	Ghana	no data	12 500 000
1983	drought	Ethiopia	no data	7 000 000
1984	drought	Ethiopia	300 000	7 750 000
1984	drought	Sudan	150 000	8 400 000
1985	drought	Mozambique	100 000	2 466 000
1987	drought	Ethiopia	no data	7 000 000
1990	drought	Ethiopia	no data	6 500 000
1991	drought	Ethiopia	no data	6 160 000
1991	drought	Sudan	no data	8 600 000
1993	drought	Malawi	no data	7 000 000
1993	famine	Ethiopia	no data	6 700 000
1999	famine	Ethiopia	no data	7 767 594
2000	drought	Ethiopia	no data	10 500 000

Source: CRED-OFDA 2002

Natural disasters

Africa has experienced some of the worst droughts and famines in terms of number of people killed or number affected (see table), with particularly severe droughts in 1972-73 and 1984-85, affecting much of Northern, Southern, Eastern and Sahelian Africa (Gommes and Petrassi 1996). Countries most regularly affected include Botswana, Burkina Faso, Chad, Ethiopia, Kenya, Mauritania and Mozambique (FAO 2001), where the impacts of famine are exacerbated by inadequate transport facilities to receive and distribute food and medical aid (Ehrlich and Ehrlich 1990). There are some indications that droughts are becoming more prolonged and their impacts more severe (DMC 2000, FAO 2000).

The risk of damage from heavy rain is greater in drier areas than in those that usually receive higher rainfall because there is less vegetation cover to absorb the water and stabilize soils. Expansion of informal settlements into the flood zone is putting many more people at risk of flooding, as illustrated in South Africa's Alexandra Township, Johannesburg, during the floods of 2000 when approximately 3 000 families living in shacks below the floodline were subjected to flooding and outbreaks of cholera (Kim 2000, World Bank 2001a).

Disasters can have severe economic impacts which are difficult to calculate. The Western Indian Ocean islands typically experience ten cyclones a year, between November and May, which bring strong winds and heavy rainfall. This causes destruction of infrastructure, particularly in low-lying areas and where settlements have encroached into flood-prone areas. Huge costs are incurred due to destruction of income-generation activities, including tourism revenues, and rehabilitation and replacement of damaged infrastructure and crops.

Globally, Africa suffers the least damage from disasters in purely financial terms but the significance of such losses may actually be greater in terms of impact on economic development. Africa's people and economies are heavily dependent on rainfed

agriculture, and are therefore vulnerable to rainfall fluctuations. It is usually the poor who suffer most from flood or drought-induced crop failure, because they often cultivate areas that are climatically marginal for crop production and they cannot accumulate reserves for times of hardship.

Both droughts and floods can result in malnutrition and famine, and the associated food imports and dependency on food aid can affect the economic growth potential of affected countries. In Kenya, low reservoir levels resulting from drought and siltation linked to deforestation led to reductions in hydropower generation, necessitating water and power rationing which devastated the country's economy in 1999 and 2000. Losses from power rationing alone were estimated at US$2 million per day, and the cost of unmet electricity demand was estimated at US$400-630 million, equal to 3.8-6.5 per cent of GDP (World Bank 2000). In Mozambique, the costs of floods in 2000 were estimated at US$273 million in physical damage, US$247 million in lost production, US$48 million in lost exports and US$31 million in increased imports (Mozambique National News Agency 2000).

Human-caused disasters

Although climatic variability is a natural phenomenon, the increasing frequency and severity of extreme events can be in part attributed to human activities such as deforestation and inappropriate management of land and water resources. For example, clearing of tropical forests in Central and Western Africa has altered the local climate and rainfall patterns, and increased the risk of drought. Clearing of vegetation may also increase run-off and soil erosion. Damming of rivers and draining of wetlands reduces the environment's natural ability to absorb excess water, enhancing the impacts of floods. For example, countries in Southern Africa experienced devastating floods in 1999 and 2000 which affected more than 150 000 families (Mpofu 2000). Degradation of wetlands such as the Kafue wetlands in Zambia, damming of rivers, deforestation and overgrazing lowered the environment's ability to absorb excess water and magnified the impact of the floods (Chenje 2000, UNDHA 1994).

Over the past three decades, millions of Africans have sought refuge from natural and human-made disasters with both environmental and socio-economic impacts. At the end of 2000, there were 3.6 million refugees in Africa, 56 per cent of whom were under 18 years of age (UNHCR 2001b). Often refugees are settled in fragile ecosystems where they exert considerable pressure on the natural resources, as they have no other means of survival (see box). Refugee populations also sometimes experience further conflicts with neighbouring communities, through competition for resources.

Environmental impacts of refugees in Africa

Environmental rehabilitation of refugee camps in Africa alone could cost as much as US$150 million a year. Visible evidence of environmental degradation is most obvious in long-standing asylum countries such as Kenya and Sudan. Land surrounding the refugee camps has been stripped clean of trees and vegetation. In such situations, refugees may have to walk up to 12 km in search of water and firewood.

In the early 1990s, an estimated 20 000 ha of woodlands were cut each year in Malawi to provide firewood and timber for the various camps hosting Mozambican refugees, while in 1994, at the height of the refugee crisis near the Virunga National Park in the Democratic Republic of Congo (formerly Zaire), refugees were removing some 800 tonnes of timber and grass each day from the park — an amount far in excess of a possible sustainable yield. Despite efforts to restrict the impact on the park, almost 113 km^2 have been affected, of which more than 71 km^2 have been completely deforested. At another site in South Kivu, almost 38 km^2 of forest were lost within three weeks of the arrival of refugees. In December 1996, more than 600 000 refugees from Burundi and Rwanda were housed in the Kagera region in northwest Tanzania. More than 1 200 tonnes of firewood were consumed each day — a total of 570 km^2 of forest were affected, of which 167 km^2 were severely deforested.

Source: UNHCR 2001a

Disaster responses

There have been no concerted regional efforts to manage disasters, and disaster responses in Africa have tended to focus on national and sub-regional levels. Efforts have also concentrated on responses rather than mitigation through improved environmental management and agricultural practices.

The unpredictable nature of extreme events, and the weak economic performance of most African countries, makes preparation for, and relief from, disasters all the more difficult. There have however been some successes in preventing famine resulting from drought, such as the Famine Early Warning System (FEWS) project, the implementation of a new efficient seed distribution system in Niger and promotion of more drought-resistant crop varieties.

In Northern Africa, efforts to respond to economic hardship during droughts include financing

employment-generating projects to keep farmers from abandoning lands where productivity is declining, while in Eastern Africa afforestation and reforestation projects are being implemented to lessen the impact of future environmental changes, particularly climate change. In Southern Africa, the SADC Regional Early Warning Unit, the Regional Remote Sensing Project, the Drought Monitoring Centre and the FEWS Project advise governments on drought preparedness (see Chapter 3). A drought fund is also in place to mitigate the effects of poor rainfall (UNDHA 1994).

In some areas, including parts of West Africa, long-term measures such as urban planning regulations which prohibit developments along watercourses have been promulgated although resource constraints often prevent them from being strictly enforced. Additional responses include the development and implementation of early warning or forecasting mechanisms such as ENSO forecasting, which has been implemented in Southern Africa and the Western Indian Ocean area. While this has the potential to alert relief organizations and evacuate communities ahead of time, it has been limited by poor communications services (Dilley 1997). For example, only 152 of every 1 000 people in Africa had radios by 1997 (World Bank 2000b).

With global warming, the incidence of drought is likely to increase in many parts of Africa. The frequency and intensity of cyclones and floods in some areas are also likely to increase, adding to the stresses on water and food security, and possibly contributing to outbreaks of disease (IPCC 2001). For example, Seychelles is currently outside the cyclone zone but sea temperature rise could cause an increase in cyclone intensity and expansion of the cyclone zone to include the islands (UNEP 1999).

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Disasters: Asia and the Pacific

About 75 per cent of the world's major natural catastrophes between 1970 and 1997 occurred in the Asia and the Pacific region, mostly in poverty-ridden developing countries (UNESCAP and ADB 2000). There has been a general upward trend in the number of natural disasters due to hydrometeorological events (such as cyclones and flooding) in the region, while geophysical disasters such as volcanic eruptions, earthquakes and tsunamis have remained fairly steady (see figure).

Natural disasters

Vulnerability to disasters is closely linked with population density and economic resources. The impact of natural disasters in the region is severe, with more than 1.4 million people killed, almost 4 000 million affected and US$438 million in damage over the past three decades (see table). During 1991-2000 alone, the total number of deaths caused by natural disasters in the region exceeded 550 000 or 83 per cent of the global total (IFRC 2001), the majority of them in Asian countries with low or medium levels of human development.

The highest number of deaths occurred in South Asia (the sub-region with the highest population density and the lowest per capita income) and the lowest number in Australia and New Zealand, the sub-region with the lowest population density and a high per capita income (UNPD 2001, World Bank 2001).

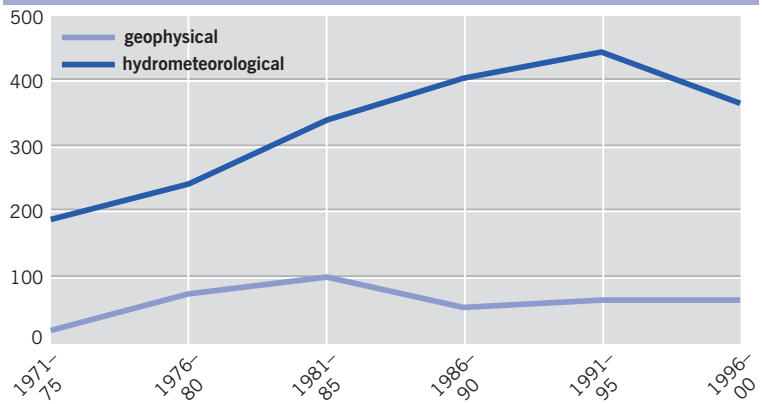
China experienced more than 300 natural disasters and recorded more than 311 000 deaths during 1971-2000; India with more than 300 disasters suffered more than 120 000 deaths; the Philippines, with nearly 300 events, lost about 34 000 people; Indonesia experienced about 200 disasters with more than 15 000 lives lost; and Bangladesh experienced 181 events and more than 250 000 people killed.

Some areas are more exposed to natural hazards because of location (on the coast, near a volcano or geological fault). Cyclones occur most frequently over the Northwest Pacific, over the southern end of the Bay of Bengal, east of India and south of Bangladesh (UNESCAP and ADB 1995, Ali 1999, Huang 1999, Kelly and Adger 2000). Bangladesh, China and India are the most flood-prone countries of the region (Mirza and Eriksen 1996, Ji and others 1993). Hilly and mountainous areas (China, India, Nepal, Philippines and Thailand) are most prone to landslides, which are aggravated by deforestation and cultivation that destabilizes slopes. Countries along or adjacent to seismic zones (Afghanistan, China, India, Iran, Nepal, Philippines and the Pacific Islands) are more vulnerable to seismic events, while countries along the Pacific Rim are at risk from volcanic eruptions, particularly Indonesia, Japan and the Philippines (UNESCAP and ADB 1995). The El Niño phenomenon has significant impacts over large areas in the region, the most affected being Indonesia (Glantz 1999, Salafsky 1994, 1998).

Other disasters

Environmental degradation and change are becoming increasingly important in relation to both the occurrence and impact of natural disasters. Deforestation, for example, is now frequently linked to severe flood events and landslides. Overexploitation of

Trends in disasters (number/year): Asia and the Pacific



Disasters caused by water and weather (hydrometeoro-logical disasters) have become more frequent while the number of geophysical disasters remains fairly constant

Source: CRED-OFDA 2002

Impact of natural disasters in Asia and the Pacific, 1972–2000

	number killed (thousands)	*number affected (thousands)*	*damage (US$1 000)*
South Asia	761	2 164 034	60 881
Southeast Asia	73	284 074	33 570
Northwest Pacific and East Asia	606	1 447 643	317 174
Central Asia	3	4 895	986
Australia and New Zealand	1	15 761	21 900
South Pacific	4	4 061	3 139
total	**1 447**	**3 920 467**	**437 649**

Note: Central Asia figures are for 1992/93–2000

Source: CRED-OFDA 2002

Selected natural disasters: Asia and the Pacific

- July 1976: an earthquake in China took 242 000 lives
- April 1991: a cyclone in Bangladesh accompanied by a storm surge caused 138 866 deaths
- February 1990 and December 1991: cyclones in Samoa caused losses of US$450 million, about four times the country's GDP
- January 1995: an earthquake in Kobe, Japan, became one of the costliest natural disasters in history — 5 502 people were killed and more than 1 800 000 affected, with damage estimated at US$131.5 billion
- October 1999: the Super Cyclone in the eastern state of Orissa in India caused more than 10 000 deaths, while 15 million people were rendered homeless, left without food, shelter or water and their livestock population devastated — the cyclone damaged 1.8 million ha of agricultural land and uprooted more than 90 million trees
- January 2001: an earthquake of magnitude 7.7 on the Richter scale rocked the state of Gujarat in India, causing more than 20 000 deaths and 167 000 injuries — economic losses estimated at US$2.1 billion

Sources: ADPC 2001, CRED-OFDA 2002, DoAC India 2002

water resources has already resulted in sub-regional environmental disasters such as the drying up of the Aral Sea in Central Asia (see box below and feature on page 296).

Most of the countries in the Northwest Pacific and East Asia sub-region and the Pacific Island countries will be particularly vulnerable to climate change and associated sea-level rise because so many human settlements and so much industrial infrastructure are located in coastal or lowland areas. For the small island developing states, climate change and extreme weather events may also have dramatic impacts on terrestrial biodiversity, subsistence cropping and forest food sources (IPCC 1998).

Rapid population growth, urbanization and weak land-use planning are some of the reasons why poor people move to fragile and high risk areas which are more exposed to natural hazards. Moreover, the rapid growth of industries in urban areas has induced rural–urban migration. This has sometimes led to more people being exposed to technological hazards such as the disaster in Bhopal, India, in 1984, in which escaping methyl isocyanate from an industrial plant killed more than 3 000 and affected more than 200 000 others (Robins 1990).

Disaster responses

Asian countries are at different stages of institutional development with respect to disaster reduction. Some, such as Japan, have a long-established system of disaster management. Stimulated by the International Decade for Natural Disaster Reduction (IDNDR), other countries (such as Viet Nam, see box page 281) have either strengthened existing frameworks or are formulating new ones (UNESCAP and ADB 1995).

Despite some recent achievements, significant

The Aral Sea: a human-induced environmental and humanitarian disaster

The destruction of the Aral Sea is now a well-known example of unsustainable development. Atlases used to describe the sea as the world's fourth largest lake, with an area of 66 000 km^2 and a volume of more than 1 000 km^3. Its waters supplied local fisheries with annual catches of 40 000 tonnes, while the deltas of its tributaries hosted dozens of smaller lakes and biologically rich marshes and wetlands covering 550 000 ha.

In the 1960s, planners in the former Soviet Union assigned Central Asia the role of supplier of raw cotton. Irrigation was imperative, and the Aral Sea and its tributaries seemed a limitless source of water. Irrigated land was expanded from about 4.5 million ha in 1960 to almost 7 million ha in 1980. The local population also grew rapidly, from 14 million to about 27 million in the same period, while total water withdrawal almost doubled to an annual 120 km^3, more than 90 per cent of it for agriculture.

The result was the collapse of the prevailing water balance in the basin. Waterlogging and salinization eventually affected about 40 per cent of irrigated land. Overuse of pesticides and fertilizer polluted surface water and groundwater, and the delta ecosystems simply perished: by 1990, more than 95 per cent of the marshes and wetlands had given way to sand deserts, and more than 50 delta lakes, covering 60 000 ha, had dried up.

The surface of the Aral Sea shrank by one-half and its volume by three-quarters. The mineral content of the water has increased fourfold, preventing the survival of most of the sea's fish and wildlife. Commercial fishing ended in 1982. Former seashore villages and towns are now 70 km from the present shoreline.

Communities face appalling health problems. In Karakalpakstan, Uzbekistan, drinking water is saline and polluted, with a high content of metals that causes a range of diseases. Over the past 15 years, there has been a 3 000 per cent increase in chronic bronchitis and in kidney and liver diseases, especially cancer, while arthritic diseases have increased 6 000 per cent. The infant mortality rate is one of the world's highest.

Five newly independent Central Asian states have now established a joint commission for water coordination. Several international organizations and bilateral agencies are providing assistance, and an International Fund for the Aral Sea and the Interstate Council for the Aral Sea Problem have been set up to coordinate initiatives.

The Central Asian republics have decided to focus on demand management, aiming to reduce water withdrawal by raising irrigation efficiency. The primary objective is to satisfy crop water requirements. Total water withdrawal in the basin has now stabilized at 110-120 km^3/year but environmental degradation continues.

Source: FAO 1998

measures and actions still remain to be taken at the regional and national levels to reduce risks and losses due to disasters, namely:

- the impact of environmental degradation needs to be examined — raising awareness about the dangers of environmental degradation among the governments and people is of utmost importance;
- deforestation should be stopped;
- mitigation and preparedness measures already undertaken must be strengthened;
- actions are needed to reduce poverty levels with a view to maintaining the resource base and protecting biodiversity; and
- rural development is a prerequisite for reducing the migration of people to cities and coastal areas.

Being prepared: Viet Nam's disaster reduction programme

Viet Nam has a long tradition of disaster mitigation. When the United Nations General Assembly designated the 1990s as the International Decade for Natural Disaster Reduction, Viet Nam responded by organizing a National Committee and strengthening the role its Central Committee for Flood and Storm Control (CCFSC) plays in disaster mitigation. The CCFSC has developed programmes, plans and measures for disaster reduction in coordination with other relevant organizations, directed the implementation of disaster mitigation activities and coordinated actions with relevant international organizations.

In the late 1990s, Viet Nam experienced a number of extreme events, including Typhoon Linda (1997) in the southern coastal area. Although the human and economic losses were tragic, agencies at all levels strengthened their search and rescue capacities, resulting in tens of thousands of evacuations. More than 5 000 people were saved by these efforts. Once the typhoon abated, the government provided assistance to the local fishing communities. As a result of this and other disasters, the government took policy decisions for each part of the country, including improving flood resistance and protecting populated areas, by strengthening the system of dykes and flood diversion structures in northern Viet Nam, policies to prevent and mitigate flood damage in central Viet Nam, and the Mekong River Delta policy which is designed to prepare measures for living with floods and minimizing their damage.

In recognition of these achievements, the United Nations awarded Viet Nam the Certificate of Distinction for Disaster Reduction on 11 October 2000, the International Day for Disaster Reduction.

Source: UNEP 2001

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Disasters: Europe

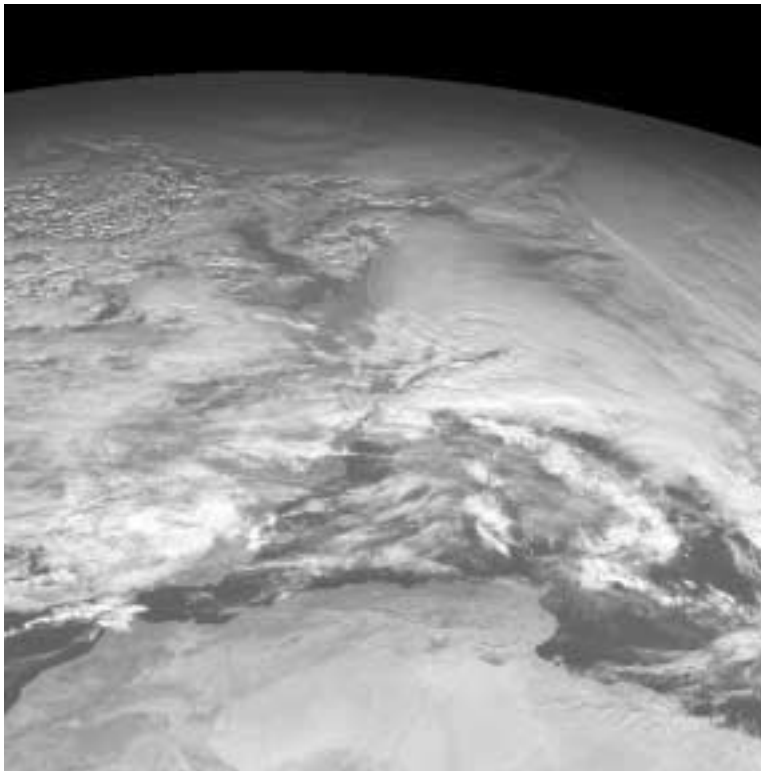
Disasters resulting from natural and human-caused hazards occur throughout Europe, often leading to significant environmental damage, economic loss, human injuries and premature mortality. The overall consequences depend on both the magnitude of the event and on factors such as population density, disaster prevention, preparedness and response measures and emergency planning. Europe generally suffers less from disasters than many developing countries, due to a higher level of 'coping capacity' in terms of government ability to prepare and respond to disasters.

Natural disasters

In Europe, the most common natural disasters are storms and floods, although earthquakes do occur in some countries. Storms and floods are also the most costly in terms of economic and insured losses. The windstorms Lothar and Martin that occurred in December 1999 caused an estimated €5 billion damage to crops, forests and infrastructure while the cost of flood damage between 1991 and 1995 has been estimated at €99 billion. One of the worst years ever in terms of flood damage was 2000, accounting for almost one-quarter of the total US$10.6 billion insured costs (Swiss Re 2001). In recent years, many European countries have experienced abnormally high precipitation intensity and duration, especially in winter months, which has led to floods in the Czech Republic, France, Germany, Hungary, Italy, Portugal, Switzerland, Ukraine and the United Kingdom. Between 1971 and 1996, 163 major floods occurred in Europe. The main factors that induce or intensify floods and their impacts include climate change, land sealing, changes in the catchment and floodplain land use, population growth, urbanization and increasing settlement, roads and railways and sometimes hydraulic engineering measures (EEA 2001a).

Forest fires and droughts are a problem in the southern countries along the rim of the Mediterranean (Croatia, France, Greece, Italy, Slovenia and Spain) and fires are also common in the Siberian region of the Russian Federation where economic recession has caused a severe decline in the response capacity of local authorities and forest fire teams. Each year, hundreds of thousand of hectares of taiga forest are lost due to fires. Around 80 per cent of forest fires are a result of people's ignorance of fire safety rules.

The average annual number of natural disasters appears to be increasing and since the late 1980s there has also been an increase in the impacts of these



Lothar, the first of two severe storms that passed over Western Europe on 26–27 December 1999, caused severe damage. This image shows the storm passing over Europe at 12.00 UTC on 26 December, with the northern African coast outlined below

Source: copyright EUMETSAT 2002

The Rhine Action Plan on Flood Defence

In January 1998, the 12th Conference of Rhine Ministers adopted an Action Plan on Flood Defence to be implemented over 20 years. The most important aims of the plan are to reduce damage by up to 10 per cent by the year 2005 and by up to 25 per cent by 2020. Extreme flood levels downstream of the regulated Upper Rhine are to be reduced by up to 30 cm by 2005 and by up to 70 cm by 2020. These ambitious targets are likely to be reached only through an integrated managerial approach at local, national, regional and international levels.

Over the past two centuries, the Rhine has lost more than 85 per cent of its natural floodplains to buildings and agriculture. There were severe floods in 1993 and 1995. The assets that could be affected in areas at flood risk may amount to €1 500 billion. Countermeasures, such as the preservation and expansion of floodplains, and improved water storage in the entire catchment area, must aim at the ecological improvement of the Rhine, its valley and catchment area.

Source: ICPR 2001

disasters and their related economic losses — at least in the European Union (EEA 1999). For example, at the French–German border, the floodwaters of the Rhine rose more than 7m above flood level about once every 20 years between 1900 and 1977. Since 1977, that level has been reached on average once every other year (UWIN 1996). Actions and measures are taken at both national and regional level to reduce the impacts of natural disasters (see box left), though there is no targeted policy. Integrated land-use planning can, to some extent, prevent impacts on humans. Emergency response plans have been produced throughout the European Union to react to various natural disasters, but these appear to be ad hoc, generally not tested, and are considered unlikely to work well in practice (EEA 1999).

Major human-caused disasters

Human-caused disasters cause more human fatalities and economic losses than natural disasters in Europe. Despite overall higher technological and safety levels in Europe, the number of industrial accidents in the European Union continues to rise (EC undated). In 1997, there were 37 major industrial accidents — the highest annual number since records began in 1985 (EEA 1999). In contrast to accidents in fixed installations, major oil spills from marine transport and offshore installation accidents have shown a downward trend (ITOPF 2000) although the total number of oil spills appears to be increasing (EEA 2001b).

It is likely that the overall risk from nuclear accidents increased in the 1970s as more plants were commissioned but declined in the 1990s as older plants were taken out of service and the building of new ones either slowed or was completely abandoned due to public pressure. However, quantifying the risk from accidental releases of radionuclides is not possible due to lack of sufficiently detailed, comparable information. A widespread campaign on increasing the safety of new and already functioning civil nuclear reactors, especially in CEE countries, was catalysed by the 1986 nuclear accident at Chernobyl in the former Soviet Union. Significant resources have been allocated to increasing nuclear safety at nuclear processing plants (for example, €838 million was spent by the European Commission between 1991 and 1998 (EC 2001)). However, a complicating factor is the increasing deterioration of the older nuclear power plants in the Russian Federation and Lithuania built to a similar design to the Chernobyl reactor.

Helicopter sprays water on one of the forest fires that periodically plague southern European countries such as Croatia, France, Greece, Italy, Slovenia and Spain; fires are also common in the Siberian region of the Russian Federation

Source: UNEP, Rougier, Topham Picturepoint

Analyses of major industrial accidents indicate that component failure and operator error are the two most common immediate causes but the dominant underlying causes identified were poor safety and environmental management (Drogaris 1993, Rasmussen 1996). The age of process plants is a further factor as the probability of 'wear-out' failure increases with age (M&M Protection Consultants 1997). Lack of expenditure on safety and environmental management, and operating plants past their design life, are often a result of pressure from

Baia Mare: analysis of a mining accident

At 22:00 on 30 January 2000, a dam wall failed at a mine tailings reclamation facility at Baia Mare in northwestern Romania, spilling 100 000 m^3 of wastewater polluted with cyanide into the Tisa river and then the Danube, eventually entering the Black Sea, by which time it had become significantly diluted. The spill devastated large numbers of plant and wildlife species in the river systems.

The Baia Mare Task Force, set up to investigate, reported that faults in the design of the operating plant, including inadequate construction of the dams, contributed to the accident. The key problem was believed to be the ineffectiveness of the permitting and enforcement authorities. The permitting process was over-complex and the Task Force concluded that the original environmental impact assessment was flawed. Furthermore, no measures were established to deal with an emergency, and monitoring of the water level in the tailings pond where the dam broke was inadequate.

Source: BMTF 2000

shareholders wishing to increase profitability, although this may result in major losses in the long run. However, they also reveal gaps in regulation and monitoring. The mining accident at Baia Mare, Romania, in January 2000 served as a rather sobering reminder of the shortcomings in enforcement of environmental regulations in the countries of Eastern Europe (see box on page 283).

Policy responses

For many technological disasters, holistic approaches are becoming more prevalent, with increasing attention to reducing the risk of long-term environmental impacts as well as reducing acute health and property damage from accidents (EEA 1999). The European Commission's directive on the control of major-accident disasters involving dangerous substances (often referred to as the 'Seveso II Directive'), now also incorporated into the legal systems of most CEE countries, is important in this respect. Its Major Accident Reporting System (MARS) database and the Seveso Plants Information Retrieval System database are practical tools helping countries make decisions related to risk management.

Information on the extent and location of technological hazards is generally improving. Emergency response plans can now be made for technological accidents but further efforts are still necessary to reduce risks (EEA 1999).

Since pollution does not stop at political boundaries, one of the most important multilateral agreements in this respect is the 1992 Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes, which entered into force in 1996. This convention includes requirements to conduct environmental impact analyses (EIAs), to notify downstream states of accidents and it enforces the 'polluter pays' principle. The 1991 Convention on Environmental Impact Assessment in the Transboundary Context, which entered into force in 1997, requires parties to notify and consult each other on all major potentially dangerous ongoing projects (ECE 1991). An innovative approach is under consideration with respect to a proposed joint protocol on liability under the Helsinki Convention and the Convention on the Transboundary Effects of Industrial Accidents (REC 2000).

Most European countries are parties to these multilateral treaties, and international cooperation under their provisions helps governments improve national policies in respect of human-caused disaster prevention and mitigation.

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Disasters: Latin America and the Caribbean

In Latin America and the Caribbean, the main natural hazards are droughts, hurricanes, cyclones, tropical storms, floods, tidal waves, avalanches, landslides and mudslides, earthquakes and volcanoes. Mining and oil spill accidents represent the main human-caused disasters in the region.

A total of 65 260 deaths due to natural disasters were reported in the region during the 1990s. The deaths were mainly a result of floods (54 per cent), epidemics (18.4 per cent), storms, cyclones and hurricanes (17.7 per cent), earthquakes (5.2 per cent) and landslides (3.2 per cent) (CRED-OFDA 2002). Considering that floods and landslides are often associated with storms and hurricanes, this means that three-quarters of total human losses due to natural disasters in the region have a hydrometeorological origin.

The number of deaths due to disasters declined markedly between 1972 and 1999, coinciding with the global trend. Total fatalities in the 1990s were less than one-third of those in the 1970s while the number of people injured fell by almost one-half (after rising by nearly 30 per cent in the 1980s) (CEPAL 1999). This trend can be explained by fewer severe earthquakes in densely populated or highly vulnerable areas and by the establishment of early warning systems and disaster-preparedness measures in some countries over the past 30 years (PAHO 1998). Economic losses caused by disasters increased by almost 230 per cent between the 1960s and the 1990s (CEPAL 1999), again reflecting a global trend.

Hydrometeorological events

The best known hydrometeorological event is the El Niño phenomenon, the impacts of which can be severe. For example, after the El Niño of 1983, Peru's GDP fell by 12 per cent, mostly because of a reduction in agricultural output and fishery. The national economy took a decade to recover. Damage in the Andean Community countries (Bolivia, Colombia, Ecuador, Peru and Venezuela) due to the 1997/98 El Niño was estimated at more than US$7 500 million (CEPAL 1999).

Most countries in Central America and the Caribbean are within the hurricane belt, on both the Atlantic and Pacific coasts. Hurricane Mitch, which struck the region in 1998, affecting mostly Honduras and Nicaragua, killed more than 17 000 people and left three million homeless with damage estimated at US$3 000 million. The hurricane also caused fatalities and serious environmental and economic damage in Costa Rica, Dominican Republic, El Salvador and Guatemala (CRED-OFDA 2002).

The 1999 floods on the northern coast of Venezuela also had a strong impact, with damage estimated at more than US$ 3 200 million or 3.3 per cent of the country's GDP (World Bank 2000). In the state of Vargas, the hardest-hit area, more than 230 000 jobs were lost. The state of Miranda was also badly hit: the El Guapo dam collapsed, causing water shortages and 60 per cent of crops were reported lost (MoPD Venezuela 2000). It is estimated that there were 30 000 deaths, 30 000 families left homeless and more than 81 000 dwellings destroyed (IFRC 2002).

El Niño and epidemic diseases

Cyclical temperature and rainfall variations associated with El Niño are particularly important since they can favour the development and proliferation of vectors of epidemic diseases such as malaria, dengue fever, yellow fever and bubonic plague (WHO 1999). In South America, the most severe outbreaks of malaria generally occur a year after the beginning of an El Niño event, whether associated with an increase in rainfall (as in 1983 in Bolivia, Ecuador and Peru) or with a reduction in rainfall and run-off (as in Colombia and Venezuela).

A similar link has been suggested between the warming of superficial oceanic waters by El Niño, the proliferation of marine algae, and the appearance of cholera in South America in 1992. The impact of extremes in precipitation (both too much and too little) is also important in the transmission of water-borne diseases such as cholera, gastrointestinal infections and various types of diarrhoea. There were outbreaks of cholera in 1997–98 in Honduras, Nicaragua and Peru related to the increase in precipitation, associated with El Niño (WHO 1999, PAHO 1998).

Ecological and social impacts of earthquakes in El Salvador

The series of earthquakes that shook El Salvador in early 2001 began with one of 7.6 on the Richter scale that was initially considered an isolated event. However, it was only part of a series that spanned weeks and demonstrated the complex social and ecological implications of such events. Besides the loss of life and infrastructure during the original series of earthquakes, there has been a long-lasting impact on people and ecosystems. For example, the artisanal fishery lost an essential part of its docking infrastructure as well as service infrastructure for processing fish and transporting it to the market on land. A total of 30 772 farms were damaged and farmers were forced to wait for three months for the rains because they did not have the funds to repair their damaged irrigation systems. The destruction of 20 per cent of the country's coffee processing plants severely affected the jobs and income of thousands of rural families in a country that was also affected by Hurricane Fifi in 1974, civil conflict between 1978 and 1992, the 1986 earthquake and Hurricane Mitch in 1998.

Source: UNICEF 2001

Geological events

Seismic and tectonic activities are particularly intense along the Pacific Ocean coast and in the Caribbean basin due to pressures generated between oceanic and continental plates. Such activity creates a relatively high risk of earthquakes, tsunamis and volcanic eruptions which in some areas add to the already high risk of hurricanes and floods. Between 1972 and 1999, extreme geological events killed 65 503 people and affected 4.4 million others (CRED-OFDA 2002).

Vulnerability to natural hazards of Caribbean countries

	hurricanes	*earthquakes*	*volcanoes*	*floods*	*drought*
Antigua and Barbuda	●	●	●	●	●
Bahamas	●	●	●	●	●
Barbados	●	●	●	●	●
Belize	●	●	●	●	●
Cuba	●	●	●	●	●
Dominica	●	●	●	●	●
Dominican Republic	●	●	●	●	●
Granada	●	●	●	●	●
Guyana	●	●	●	●	●
Haiti	●	●	●	●	●
Jamaica	●	●	●	●	●
Saint Kitts and Nevis	●	●	●	●	●
St Lucia	●	●	●	●	●
St Vincent and the Grenadines	●	●	●	●	●
Surinam	●	●	●	●	●
Trinidad and Tobago	●	●	●	●	●

● = high vulnerability ● = medium vulnerability ● = low vulnerability

Human-caused disasters

Certain disasters such as spills of hazardous chemicals and oil products have a technological origin. In the Orinoco River delta and neighbouring regions of Venezuela, for example, the use of cyanide and mercury for gold extraction has increased by 500 per cent over the past decade with the growth in the exploitation of the mineral. In the Caroni Basin alone, 3 000 kg of mercury have been dumped and a spill of 1.5 million litres of cyanide-polluted waste has been reported in the Omai and Esequibo rivers in neighbouring Guyana (Filártiga and Agüero Wagner 2001, AMIGRANSA 1997). The largest regional oil spill was an underwater oil blow-out of the Ixtoc well in Campeche Bay in 1979, the second largest in world records at more than 500 000 tonnes (Cutter Information Corp 2000).

Policy responses

Many countries, especially those located on islands, are vulnerable to natural disasters (see table). The major concerns with regard to policy include the following (UNEP 1999):

- deficiencies in disaster prevention, including the lack of zoning of vulnerable areas during the development planning process;
- weak mitigation mechanisms;
- deficiencies and limited use of anti-seismic building measures, as well as inadequate administrative arrangements and human resources for enforcement;
- lack of insurance policies for low-income households; and
- inadequate support systems for affected communities.

Improving management is critical to disaster reduction, especially non-structural mitigation actions using natural mechanisms. For example, wetlands reduce floods, woodlands reduce landslides and mangroves lessen the effect of coastal storms and extreme tides. In general, good land use maintains healthy ecosystems, provides resources and facilitates non-structural mitigation action. This strategy is particularly attractive in countries where risk insurance and structural mitigation come at a high price.

Given the enormous economic, social and environmental burden of disasters, considerable attention has been paid during the past decade to disaster preparedness, assessment and mitigation. Many of the actions took place in the context of the International Decade for Natural Disaster Reduction (IDNDR). At the regional level, its mandate for promoting international cooperation in this field was supported by the Inter-American Conference on Natural Disaster Reduction held in Cartagena, in March 1994.

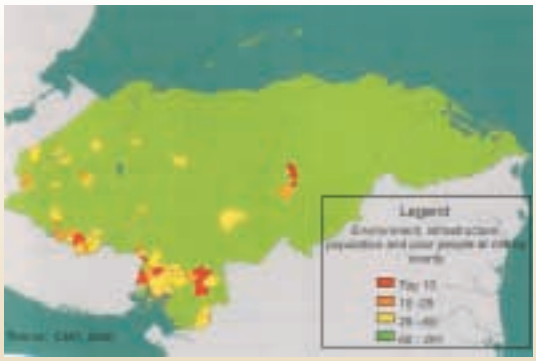
Vulnerability to natural hazards: a geo-referenced index for Honduras

Pre-existing conditions in the environment, demography, social system and infrastructure are among the major factors of vulnerability. The Centro Internacional de Agricultura (CIAT)-UNEP-World Bank rural sustainability indicators have generated a geo-referenced index of vulnerability that combines geographic information from four maps.

The environmental vulnerability map highlights areas at risk from landslides and flooding using data on forests, rivers, topography, slopes, soil permeability and vegetation. The population vulnerability map displays the population density per county and the social vulnerability map adds data on incomes and poverty. The infrastructure vulnerability map adds data on electricity lines and roads.

These four maps are then combined (see map right) to show the 60 counties of highest priority for disaster prevention and rehabilitation (top 10 in red, next 15 in orange and the other 35 in yellow). The information provided by the maps answers major questions such as why are some counties more vulnerable than others, what can be done about it and where should interventions be focused?

Source: Segnestam, Winograd and Farrow 2000



Several countries in the region — such as Brazil, Costa Rica, Cuba, Chile, Colombia, Guatemala, Nicaragua and Panama — have created and strengthened national institutional frameworks in the area of disaster management. These include the Centre for Coordination of the Prevention of Natural Disasters in Central America, established in 1988, and the Caribbean Disaster Emergency Response Agency, established in 1991. Under the auspices of the Organization of American States, the Inter-American Convention to Facilitate Disaster Assistance was adopted in 1991 and entered into force in 1996 (PAHO 1998).

Experience has shown the positive effects of planning and building institutional capacities. A fundamental element is to strengthen and standardize data production methods at a regional level, not only to prevent inconsistencies during emergencies but also to assess losses. Also important are efforts to identify the vulnerability of the territories and populations when faced with natural and human-made hazards (see box). The prevailing disaster response is directed towards risk management. It has a growing component of local and community participation, and makes non-centralized use of non-governmental organizations and citizen groups. Within this framework, a new vision is emerging: the development process must reduce risk by lessening populations' and territories' social, economic and environmental vulnerability.

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Disasters: North America

Natural hazards such as earthquakes, volcanic eruptions, tornadoes, hurricanes, ice storms, droughts, dust storms and other extreme events threaten different parts of North America. Floods and forest fires are also priority concerns. North American governments have put in place many response mechanisms to prevent and alleviate the harm caused by such factors. Despite strong regulations governing the handling of hazardous material, occasionally serious accidents occur, prompting further preventive legislation.

Floods and climate change

The disruption and intensification of the Earth's water cycle is believed to be one of the most fundamental effects of climate change (White House 2000). Changes may already be occurring in North America's hydrological conditions, as demonstrated by the increase in average annual precipitation over the past 30 years (see figure). In the United States, the average amount of moisture in the atmosphere increased by 5 per cent per decade between 1973 and 1993 (Trenberth 1999). Most of the increase has been due to heavier precipitation events resulting in floods and storms (O'Meara 1997, Easterling and others 2000).

During the 1960s and 1970s, more than 90 per cent of the natural disasters in the United States were the result of weather or climate extremes (Changnon and Easterling 2000). Flooding is natural and essential to the health of watersheds but floods can also be destructive and cause economic damage (see box right). In response to these events, the United States introduced the National Flood Insurance Act of 1968 and the 1974 Disaster Relief Act. Many of the separate and fragmented responsibilities of parallel state and local level disaster programmes were merged in 1979 under the Federal Emergency Management Agency (FEMA 1999). In 1975, Canada introduced the Flood Damage Reduction Program (FDRP) and, in 1988, it established Emergency Preparedness Canada (EPC) (EC 2000). These programmes provided better flood mitigation, preparation, response and recovery measures.

Evidence shows that deaths and damage from floods have increased sharply since the early 1970s (USGRP 2000). More people and their settlements are exposed to floods because of population increase and concentration, and increasing affluence (Easterling and others 2000). A tendency to settle in flood-prone areas is also influenced by a perception that risk has been lowered by protective structures such as dams, dykes and diversions, and because of the availability of disaster relief (Brun and others 1997, Bruce and others 1999).

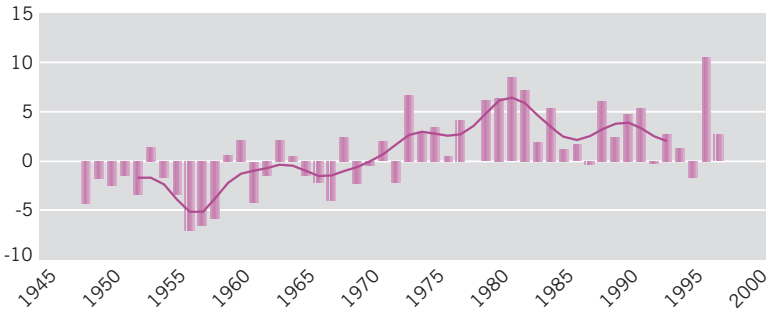
Structures that prevent rivers from flooding often provoke extremely damaging floods when water eventually overflows (see box above). In the 1990s, the United States, which is subject to more frequent and severe weather events than Canada, began to encourage non-structural approaches to flood prevention such as resettlement projects and wetland

Major floods over the past 30 years

The 1993 Mississippi flood, which submerged 75 towns and killed 48 people, cost US$10–20 billion, surpassing all previous US floods in terms of economic losses, area, duration and amount of flooding (Dalgish 1998, USGCRP 2000). It was the result of record-breaking spring rains in the midwest, a larger than usual snow cover, and high soil moisture content — but levees and dykes also confined the river to its channel, helping increase the flood crest (Dalgish 1998). In 1996, Canada experienced its most destructive and costly flood in the Saguenay River valley in Quebec. Nearly 126 mm of rain fell in 48 hours, resulting in 10 deaths and about US$750 million in damages (EC 1998b, Francis and Hengeveld 1998, EC 2001). In 1997, the Red River, which flows north from the United States into Canada, experienced its worst flooding in 150 years, incurring costs of almost US$5 billion (IJC 2000).

Floods can have significant environmental consequences. The Mississippi flood, for example, damaged much of the midwest's fertile farmland and altered the natural ecosystems of the region's rivers and their floodplains (Dalgish 1998). Human modifications over the past century led to the loss of some 85 per cent of the river basin's wetlands, and changes in riparian and in-stream habitat. Wetlands and temporary lakes act as storage areas for excess water and their loss increases the vulnerability of the watershed to flooding (Searchinger and Tripp 1993).

Annual average precipitation departures from mean (mm): Canada



In Canada (as in the United States), annual precipitation (running mean, solid line) has recently been above the 1951–80 mean

Source: EC 1998a

restoration. In Canada, settlement in flood-prone areas has been discouraged through mapping and the designation of more than 320 flood risk areas (EC 1998b). Canada established the Office of Critical Infrastructure and Emergency Preparedness (OCIPEP) in 2001 to develop and implement a more comprehensive approach to disaster prevention (OCIPEP 2001).

According to some climate change models, the magnitude, frequency and cost of extreme hydrological events in some regions of North America are forecast to increase (USGCRP 2000). Projected effects of climate change include changes in the El Niño. An uncommonly strong El Niño in 1997–98 is believed to account for heavy floods in Florida, California, some midwest states and parts of New England (Trenberth 1999). Where rainstorms intensify and flooding increases, there is greater potential for damage to low-lying settlements and dock and port facilities as well as for problems with water distribution and sewage systems that can have health implications (EC 1999a).

The International Joint Commission assists both governments in managing their shared waters. In a report on the 1997 Red River flooding, it cautioned that, given impending increased flooding due to climate change, a comprehensive, binational strategy should be developed and implemented (IJC 2000).

Forest fires

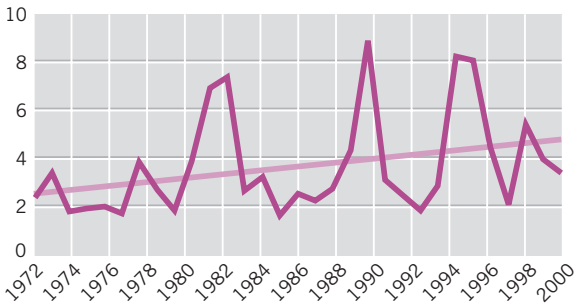
Forest fires are a natural part of North America's landscape and play an important role in maintaining and regenerating some types of forests (NIFC 2000). Wild fires ignited by lightning are useful for clearing out old and dead trees which are then quickly replaced by robust new trees (CCFM 2000). Such fires open spaces for new seedlings, help increase diversity, clear debris and increase the availability of nutrients (Jardine 1994).

Since the 1970s, the annual area burned by forest fires has grown (see figure). The increase has been due to a number of factors: fuel build-up from past fire protection programmes; changes in policy related to prescribed burning; and increased public access to forests. Climate change has also been implicated. The relative importance of these factors is controversial.

The United States has long had an aggressive policy of fire suppression and, by the 1970s, fires were kept to about 2 million ha a year in the lower 48 states compared to the 16 million ha burned every year in the 1930s (Booth 2000, CEQ 2000, H. John Heinz III Center 2001).

As a result, species normally eliminated by fire became dominant. Dead trees accumulated during periods of drought, creating excessive fuel loads. Fire suppression prevented natural low-intensity fires from burning this accumulated fuel. The result was increasingly large and disastrous fires (CEQ 2000).

Forest area burnt (million ha/year): North America



Since forest authorities decided to let more natural fires burn themselves out, the area of forest burnt each year has been increasing

Source: CCFM 2000, CIFCC 2001 and NIFC 2000

The importance of periodic natural fires began to be recognized in the 1970s. US policies of suppressing all fires before they reached 4 ha in size by 10 am the next day ceased in the late 1970s (Gorte 1996). Decisions were taken not to interfere with fires in wilderness areas or national parks unless people or neighbouring land was threatened (COTF 2000, Turner 2001). In addition, prescribed burning and 'let burn' policies to reduce built-up fuels and protect settlements and businesses were introduced. Such fires are either purposefully lit or are lightning fires that are allowed to burn. Annually, more than 2 million ha are treated by prescribed fire in the United States (Mutch 1997).

These policies have not been without controversy, however. In 1988, parts of Yellowstone — the largest National Park in the United States — were allowed to burn after being struck by lightning. The fires spread quickly because of severe summer drought and high winds. Eventually a decision was made to suppress the fires. At the cost of US$120 million, this was the costliest fire-fighting event in US history (NPS 2000).

The challenge of managing wildfires has been exacerbated by population increases close to fire-prone areas. It is estimated that in the 1990s wildfires damaged six times as many homes as in the previous decade (Morrison and others 2000). Wildfires also create smoke hazards and some highways, airports and recreation areas periodically have to close because of

reduced visibility. Smoke also constitutes a health hazard, due to the toxic chemicals it contains.

Changes in climate that may bring drier conditions and more severe storms may also play a role in changing fire patterns. In 1989, for example, record fires burned in western Canada and the areas east of James Bay. They were caused by unusual weather conditions and an unprecedented heat wave in the Arctic (Jardine 1994, Flannigan and others 2000). The severity of Canada's 1995 fire season, which burned 6.6 million ha of forestland, was also due in part to extremely dry conditions (EC 1999b).

In the future, North America's annual fire severity rating may well increase due to climate change, which is predicted to increase the number of lightning strikes and the intensity and frequency of windstorms (Jardine 1994). Research into the links between climate and forest change is being intensified.

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Disasters: West Asia

West Asia is arid and vulnerable to drought, with rainfall scanty and variable (ACSAD 1997). Nearly 80 per cent of the region is classified as semi-desert or desert (AOAD 1995). Drought is the most important natural disaster in the region.

Drought

Rainfall appears to be declining in some countries bordering the Mediterranean Sea. Over the past 100 years, precipitation has decreased by more than 5 per cent over much of the land bordering the Mediterranean with a few exceptions such as Libya and Tunisia (IPCC 1996). The region suffered droughts during the 1930s, 1960s and the 1990s. In the winters of 1991–92 and 1992–93, snowfall was rare in many areas of the eastern Mediterranean (WMO and UNEP 1994). Cycles of drought have become intense and more frequent. The 1998–99 drought affected many countries and Syria was the worst hit, suffering its worst drought in 25 years (FAO 1999).

The most direct effects of the drought were crop failures and a decline in cereal and livestock production. In Iraq, for example, cereal production declined by 20 per cent compared to the previous year and by 40 per cent compared to the average production for the previous five years (FAO 1999). A report by a FAO/WFP mission to Syria stated that a large proportion of the nomadic herders were facing 'financial ruin', with 4 700 households seriously vulnerable to food shortages and in urgent need of food assistance. Cereal production was also seriously affected. Barley harvest was estimated to be only 380 000 tonnes — less than half the 1998 total and down 72 per cent from the previous five-year average. Local needs had to be satisfied through imports. Reduction in wheat production was less severe (28 per cent below average) because 40 per cent of Syria's wheat fields are irrigated. Jordan was also adversely affected by the drought, which reduced the country's wheat and barley production in 1999 by 88 per cent (WFP 2001).

Drought results in economic, social and environmental problems. Economic hardships during drought intensify and can lead to social conflict between land users, especially in the Mashriq countries and in Yemen where an agricultural economy prevails. Drought is also a major limiting factor to the region's economic development, affecting the development of agricultural and water schemes, and ultimately food production.

Forage and fodder become scarce in rangelands during droughts. In addition, the decline in cereal

The 1998–99 drought in the Mashriq countries had severe effects on the sheep population and their owners — many herders were forced to sell their flocks at cheap prices for want of grazing

Source: UNEP, Topham Picturepoint

A few of the 600 oil wells deliberately ignited during the second Gulf War in January 1999

Source: UNEP, Sandro Pintras, Topham Picturepoint

production and the limited availability of crop residues worsen the impact of drought on the sheep population and consequently on human well-being. Loss of sheep and the high price of supplementary feed led to a significant drop in farmers' incomes and many families were forced to sell off their animals and other assets at low prices (FAO 1999).

Land degradation, mostly in the form of desertification, is one of the region's most serious problems. Although desertification is often attributed to poor land use practices, drought deepens the effect and extends the area prone to desertification to encompass areas normally not at risk. Decreases in plant cover due to drought may also increase erosion and lead to a nearly irreversible loss of productive potential and subsequently desertification (Le Houérou 1993, Parton and others 1993).

Nations have responded to drought by improving national efforts to combat desertification and joining international ones with the same aim such as the United Nations Convention to Combat Desertification. Under the auspices of this international treaty, national action programmes have been developed and a sub-regional action programme to combat desertification and drought was adopted in 2000 (UNCCD 2001).

At the national level, actions and measures include modification of agricultural and water policies and giving priority to drought-affected areas.

Human-induced disasters

Human-induced disasters are mostly associated with the oil industry. Intensive oil extraction in the region results in frequent oil discharges into the Gulf. It is estimated that about 10 per cent of the oil discharged in the region enters the marine environment (Al-Harmi 1998). Accidental oil spills also occur, with three such accidents being among the world's 20 largest: 300 million litres from the Nowruz Platform on 26 January 1991, 144 million litres from the tanker *Sea Star* on 19 December 1972 and 118 million litres from storage tanks in Kuwait on 20 August 1981 (Oil Spill Intelligence Report).

However, the biggest oil spill took place in January-February 1991, during the 1990-91 Gulf War, when 9 500 million litres of oil were deliberately released in the desert. An estimated 1 500 million litres of oil were released into Gulf waters and more than 600 Kuwaiti oil wells were set on fire (Bennett 1995). This human-made disaster had enormous impacts on the environment and human health. The long-term environmental effects of the Gulf War may persist for decades (UNEP 1991). Besides land and marine pollution, huge quantities of pollutants such as sulphur dioxide, nitrogen oxides, carbon monoxide and particulate matter were emitted by the burning oil wells. The high particulate matter levels have been associated with an allergic response in people. Hospital studies indicate that about 18 per cent of Kuwait's civilian population suffer from some respiratory complaint, primarily asthma, compared to roughly 6 per cent in the United States (US DoD 2000).

Armed conflict

Along with natural disasters, the region has been plagued with wars. Since the beginning of the 20th century, the region has witnessed the 1948 Arab–Israeli war, the 1967 Six-Day war, the 1973 October war and the Israeli invasion of Southern Lebanon in 1982. In the 1980s and 1990s, the first and second Gulf wars caused major environmental problems. Environmental pollution was a major impact. Fires were set deliberately in forests, and water resources were polluted and/or destroyed. Artillery fire destroyed land resources. Marine resources were polluted as well as the atmosphere from oil well fires and soils were contaminated by oil spills during the second Gulf War.

Wars create refugees. In the aftermath of the 1948

Kuwait Bay: a soup for disaster

Increases in nutrient concentrations in the Gulf have often been concentrated in the Kuwait Bay and the area around the outfall of the Shatt-Al-Arab river, and they have been cited as the cause of a number of eutrophication incidents. A major red tide and an associated fish kill occurred in 1999. The main conclusion of that incident was that unless pollution levels were reduced drastically, eutrophication conditions would worsen, causing more fish kills.

The 1999 event was one of a series. In 1986, tonnes of fish as well as other marine animals, including 527 dolphins, 7 dugongs, 58 turtles and more than 10 000 cuttle fish, had been found dead along the shores of the Gulf. During 1990 and 1991, 137 sea turtles were found dead along the Omani coast. In 1993, a fish kill was observed two months after the sinking of a Russian merchant vessel carrying chemicals. Similar phenomena were reported along the coasts of Bahrain, Iran, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates between 1993 and 1998.

Kuwait Bay has experienced a series of changes over the years, including the release of both treated and untreated sewage and oils and untreated wastes from sources connected directly to the storm water network. Two commercial ports and several marinas, three power stations, a commercial fish farm in the middle of the bay, and an artificial river in Iraq into which sewage and agriculture run-off from the newly drained marshes are released, exert pressure on the bay.

Another source of nutrients is wind-blown soil carried by the predominant northwesterly winds, which has increased over the past few years due to the shrinking marshlands in Iraq. The linkage between the marshes and the Gulf through the Shatt Al-Arab and its tributaries has allowed fish to migrate. In August-September 2001, more than 3 000 tonnes of fish, predominantly mullet, died. The pathogen identified, *Streptococcus iniae*, could have originated from sewage or contaminated fish-feed. The same species was reported in Bahrain in 1999 when there was massive mortality in rabbitfish populations. The combined effects of elimination of the Iraqi marshes as a natural wastewater treatment system and the continued input of organic matter from anthropogenic activities coupled with arid conditions have created a recipe for disaster, transforming the Gulf into a soup ready to provide a perfect media for bacterial and algal blooms.

Source: Cynthia and others 2001

Arab–Israeli war, more than 750 000 Palestinians were left landless and homeless. A second wave of approximately 350 000 Palestinians and more than 150 000 Syrians became refugees at the end of the Six-Day War. Towns and villages in Palestine and Golan Heights were depopulated and destroyed. Today, there are about 3.8 million refugees in 59 camps registered with the United Nations Relief and Works Agency (UNRWA 2002). Palestinian refugees are scattered in a number of countries, including Jordan, Lebanon and Syria. Most live in poor conditions, putting additional stress on already limited natural resources.

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Disasters: the Polar Regions

Natural disasters

Impacts of natural hazards, combined with extreme polar climatic conditions (low temperatures, short summers, extensive snow and ice cover in winter), and vulnerable ecosystems and infrastructure can easily result in disasters in the Arctic. For example, during the five-year period 1996–2001, there were two catastrophic floods in the Lena River that exceeded all previous records. In the winter of 2001, temperatures hit a record low, some rivers froze solid, and therefore took longer to thaw, and blocks of ice clogged the natural flow. In addition, in that year, the snowfall was particularly severe. The water levels in the central part of the Lena exceeded the normal average by 9 metres or more. Economic losses and environmental devastation were severe (Kriner 2001a, b). Because climate change is likely to increase precipitation in the catchment areas of Arctic rivers (IPCC 2001a), there may be a corresponding increase in the frequency and magnitude of floods.

The temperature increase observed over the Arctic land masses in recent years results in permafrost thawing in many areas. In the developed areas of the Arctic, efforts will be needed to reduce the impacts of thawing on buildings and transport infrastructure (IPCC 2001b). The permafrost zone covers 58 per cent of the Russian Federation. The zone border may move 300–400 km northwards by 2100 (Interagency Commission 1998).

Another natural disaster affecting the Arctic ecosystem is pest invasion, which can devastate a forested area and affect the related economic activities. Pest outbreaks are a major problem in the forest-tundra zone. The spruce bark beetle (*Dendroctonus rufipennis*) has caused serious destruction and forest death in the spruce forests of Alaska. In Scandinavia, autumn moths (*Epirrita autumnata*) cause massive defoliation of birch forests at about 10-year intervals. These forests do not recover for up to centuries because of the slow recovery rate of vegetation in the Arctic (CAFF 2001).

Human-caused disasters

With the exception of Finland, all the countries bordering the Arctic area have oil terminals, or major transportation routes of oil or hazardous materials in their Arctic areas. Other human activities include the exploitation of petroleum and mineral resources by all countries except Finland and Sweden. Iceland has a hazardous materials waste site, and the Russian Federation has several nuclear sites and radioactive waste sites in its Arctic area. An environmental risk survey of human activities in the Arctic, carried out under the auspices of the Arctic Council, concluded that the greatest threat from a release of a pollutant requiring emergency response is the transportation and storage of oil. Nuclear sites, although assessed as less of a threat overall, could affect much larger areas (EPPR 1997).

Pipeline ruptures and leakages, such as in the Usinsk area of Russia in 1994 when 116 million litres of crude oil were spilled (Oil Spill Intelligence Report 2002), and the *Exxon Valdez* tanker accident in Alaska in 1989 with almost 50 million litres of crude oil spilled (NOAA 2001), are examples of catastrophic environmental impacts in the region. Many smaller accidents, such as uncontrolled oil gushers and the accidental discharge of contaminated mud during drilling, also result in local environmental pollution (AMAP 1997).

Both past and current activities involving radioactive materials in the Arctic create a high potential risk of accidents, although there has been no large-scale radioactive pollution yet. For example, accidents such as the sinking of the Soviet nuclear submarine *Komsomolets* in 1989 and the Russian nuclear submarine *Kursk* in 2000, and the crash of a US aircraft with nuclear weapons aboard near Thule in Greenland in 1968, did not result in the release of radioactive substances to the environment.

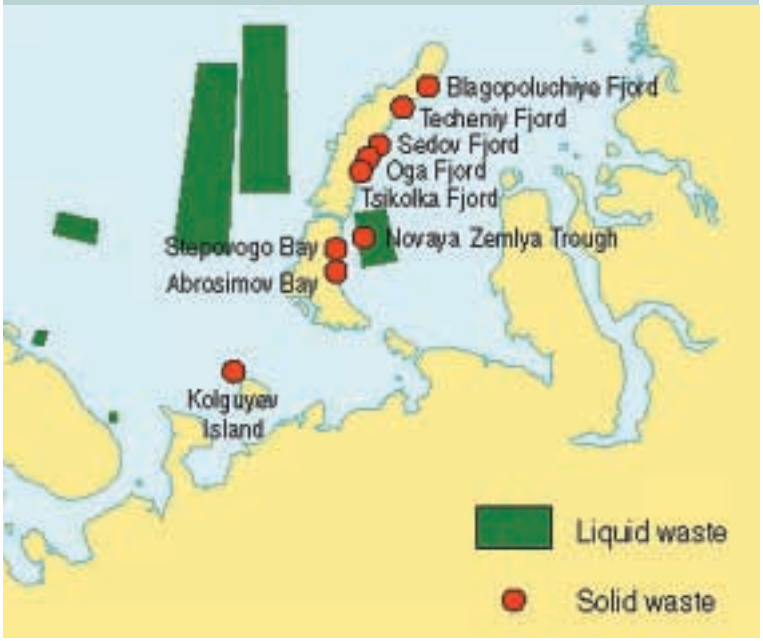
The Soviet Union dumped high, intermediate and low level radioactive waste in the Kara and Barents Seas between 1959 and 1991 (see map opposite), including six nuclear submarine reactors and a shielding assembly from an icebreaker reactor containing spent fuel (AMAP 1997). Since then, the research and data collected have indicated that no significant amounts of radioactive materials have migrated from the dumping, and only very local samples show elevated radionuclide levels. The major risks may be over the long term as the containers corrode.

Radioactive contamination from European reprocessing plants in the 1970s and atmospheric weapons testing in the 1960s have contributed to current low-level Arctic contamination (AMAP 1997,

OTA 1995). There is limited data on how much or where radioactive materials have been dumped in the Arctic, and any of these sites may be 'a disaster waiting to happen' (AMAP 1997).

Governments, businesses and international organizations are all taking action to increase disaster preparedness in the region. Intergovernmental cooperation is carried out on both a bilateral and a multilateral basis, especially via the Arctic Council. Two of the Arctic Council's programmes — Emergency Prevention, Preparedness and Response (EPPR), and Protection of the Arctic Marine Environment (PAME) — have produced important information and guidelines on environmental risks in the Arctic. For example, EPPR developed the Arctic Offshore Oil and Gas Guidelines aimed at regulatory agencies in 1997. A guideline on the transfer of petroleum products from ship to shore and ship to ship has been produced by PAME (Arctic Council 2001). The IUCN and the Oil and Gas Producers Association have prepared guidelines for environmental protection in the Arctic and sub-Arctic (IUCN and E&P Forum 1993).

Nuclear waste dumping sites: Arctic



Map shows dumping sites for solid and liquid radioactive wastes in Arctic areas of the Russian Federation

Source: AMAP 1997

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OUR CHANGING ENVIRONMENT: the Aral Sea, Central Asia

The destruction of the Aral Sea ecosystem has been sudden and severe. Beginning in the 1960s, agricultural demands deprived this large Central Asian salt lake of enough water to sustain itself, and it has shrunk rapidly. Uzbekistan, Kazakhstan, and other Central Asian states used this water to grow cotton and other export crops, in the face of widespread environmental consequences, including fisheries loss, water and soil contamination, and dangerous levels of polluted airborne sediments.

The Aral Sea is one of the greatest environmental catastrophes ever recorded. Humans have made use of the waters of the Aral basin for thousands of years, borrowing from its two major rivers: the Amu Darya, which flows into the Aral Sea from the south; and the Syr Darya, which reaches the sea at its north end. The Kara Kum Canal opened in 1956, diverting large amounts of water from the Amu Darya into the desert of Turkmenistan, and millions of hectares of land came under irrigation after 1960. While the sea had been receiving about 50 km^3 of water per year in 1965, by the early 1980s this had fallen to zero. As the Aral shrank, its salinity increased, and by the early 1980s commercially useful fish had been eliminated, shutting down an industry that had employed 60 000.

The declining sea level lowered the water table in the region, destroying many oases near its shores. Over-irrigation caused salt build-up in many agricultural areas. By the beginning of the 1990s, the surface area of the Aral had shrunk by nearly half, and its volume was down by 75 per cent. Winds picked up sediments laced with salts and pesticides, with devastating health consequences for surrounding regions (see also box on page 280).

Photo above shows an abandoned fishing boat in what was once the Aral Sea. Satellite images below show how the sea shrank between 1973 and 1999

Landsat data: USGS/EROS Data Center
Compilation: UNEP GRID Sioux Falls
Photo: UNEP, Topham Picturepoint

Conclusions

The preceding sections of this chapter show that there has been immense change in both human and environmental conditions over the past 30 years. In an unprecedented period of population increase, the environment has been heavily drawn upon to meet a multiplicity of human needs. In many areas, the state of the environment is much more fragile and degraded than it was in 1972. The result is that the world can now be categorized by four major divides:

- **The Environmental Divide** — characterized by a stable or improved environment in some regions, for example Europe and North America, and a degraded environment in the other regions, mostly the developing countries;
- **The Policy Divide** — characterized by two distinct dimensions involving policy development and implementation with some regions having strength in both and others still struggling in both areas;
- **The Vulnerability Gap** — which is widening within society, between countries and across regions with the disadvantaged more at risk to environmental change and disasters; and
- **The Lifestyle Divide** — partly a result of growing poverty and of affluence. One side of the lifestyle divide is characterized by excesses of consumption by the minority one-fifth of the world population, which is responsible for close to 90 per cent of total personal consumption; the other side by extreme poverty where 1.2 billion live on less than US$1 per day.

The four gaps are a serious threat to sustainable development. The following paragraphs highlight some of the environmental challenges facing humanity today and some of the successes that have been achieved in the past three decades.

Environmental achievements

The policies articulated in documents such as the Stockholm *Declaration and Programme of Action*, the *World Conservation Strategy, Our Common Future,* the *Rio Declaration* and *Agenda 21*, have driven the environmental agenda in the period 1972-2002. Binding legal regimes — some from before 1972 — now form the body of international environmental law, providing the appropriate muscle necessary to encourage compliance. Along with the policies and legal framework, the past three decades have also seen a proliferation of environmental institutions across public and private sectors, and civil society in general. Ministries or departments of environment are now common in all regions. Sustainable development and environmental standards have become part of the *lingua franca* of major corporations, with many now making annual environmental reporting part of the corporate agenda. Civil society has come of age, recording many successes at different levels — from community to the international level. Some of the successes that have been achieved since 1972 include the following:

- Addressing stratospheric ozone depletion is a notable victory for global environmental governance. However, it needs continuing vigilance.
- Concern over levels of common air pollutants has resulted in encouraging reductions in many countries, achieved through specific policy measures, including emissions and air quality standards, as well as technology-based regulations and different market-based instruments.
- More holistic approaches to land management, such as integrated plant nutrition systems and integrated pest management, have been introduced with positive results for the health of agricultural ecosystems in some regions.
- Freshwater policies have begun to move away from a riparian rights focus and towards exploring efficiency improvements and river basin management. Integrated water resources management is now widely accepted as a strategic policy initiative.
- A new theoretical understanding of the benefits of ecosystem services has emerged but, in practice, information and policy instruments to protect these have been lacking or sporadic.
- There has been a recent evolution from 'end-of-

pipe' approaches to goals for sustainability and a modest shift to a more integrated approach to environmental policies and management, focusing on the sustainability of ecosystems and watersheds, for example, rather than on sustaining yields.

- It is now recognized that poverty reduction, economic development and environmental stability should be mutual goals. This breaks with the old thinking prevalent in the 1970s and 1980s which regarded environmental protection and economic development as conflicting aims.
- Prosperity and an informed and active civil society have been key drivers of policies to address various environmental problems that became apparent early in the 30-year period in developed nations. Ambient air quality and point-source water pollution have been addressed satisfactorily in many areas; recycling has become more common; wastewater treatment has improved; pulp-and-paper industry effluents have declined and hazardous waste threats have been reduced. Protected areas have been increasingly set aside for conservation and recreation.
- Successes in the developing world have been mixed: there has been a growing democratization and participation process positively underpinning environment-development in some regions, with a growing civil society awareness of the debate.
- A natural 'cluster' of biodiversity policies is emerging, of which the CBD is the core regime, but which also includes a host of other treaties and initiatives such as CITES, CMS and the Ramsar Convention.
- Technological change has helped to relieve some environmental pressures: lower material intensity in production; a shift from materials and energy supply to the provision of services; a modest boost in renewable technology; and a significant clean-up in some regions in previously 'dirty' industries.
- In recent years, risk reduction has been placed higher on political agendas, and response mechanisms and early warning systems have been strengthened.

An overall observation is that many of the policies mentioned in this chapter have either no clearly defined and specific performance criteria or the criteria are not readily related to environmental performance. This is true of, for example, economic policies related to taxation, trade and investment. Although some of them have significant links to environmental issues (in some cases, they are key drivers of environmental change), their built-in evaluation criteria are usually limited to economic performance. This has made their evaluation particularly challenging from an environmental and sustainable development perspective.

Environmental challenges

Despite these achievements, a growing world population — to more than 6 000 million people (and still climbing) — is exacerbating the demand on resources and services, and increasing the generation of wastes to meet many of these demands. Overall, policy measures have not been adequate to counteract the pressures imposed by increasing poverty and uncontrolled consumption. Preceding Chapter 2 sections show indisputable evidence of continuing and widespread environmental degradation.

- Recent human impacts on the atmosphere have been enormous, with anthropogenic emissions a prime cause of environmental problems. Emissions of almost all greenhouse gases continue to rise.
- Ground-level ozone, smog and fine particulates have emerged as significant health risks, triggering or exacerbating respiratory and cardiac problems, especially in vulnerable people such as children, the elderly and asthmatics, in developed and developing nations alike.
- Overexploitation of many of the surface water resources and great aquifers upon which irrigated agriculture and domestic supplies depend has resulted in more and more countries facing water stress or scarcity. About 1 200 million people still lack access to clean drinking water and some 2 400 million to sanitation services. The consequences include the deaths of 3–5 million people annually from water-related diseases.
- The Earth's biological diversity is under increasing threat. The extinction rate of species is believed to be accelerating. Habitat destruction and/or modification are the main causes of biodiversity loss but invasive species are the second most important pressure.
- There has been a sharp global trend towards

increasingly intense exploitation and depletion of wild fish stocks. Numerous fisheries have collapsed and others are threatened with overexploitation.

- Land degradation continues to worsen, particularly in developing countries where the poor are forced onto marginal lands with fragile ecosystems and in areas where land is increasingly exploited to meet food and agricultural needs without adequate economic and political support to adopt appropriate agricultural practices.
- Many remaining forest ecosystems have been degraded and fragmented. Since 1972, extensive forest monocultures have been established in the developing world but these do not replace the ecological complexity of natural forests.
- Crop and livestock production has contributed to the large increase in reactive nitrogen in the global biosphere, contributing to the acidification and eutrophication of ecosystems.
- With almost half of the world's population living in less-developed countries, urban areas and mega-cities, infrastructure and municipal services are inadequate to accommodate millions of the urban poor. Urban air pollution and deteriorating water quality are having major health, economic and social impacts.
- An increase in the frequency and intensity of natural disasters over the past 30 years has put more people at greater risk, with the greatest burden falling on the poorest communities.

Regional challenges

At the regional level, the major environmental issues include climate change, land and soil degradation, forest degradation and deforestation, freshwater stress and scarcity as well as quality/pollution, degradation and pollution of coastal and marine areas, loss of habitats and species, growth of unplanned settlements and mounting solid waste, and increasing droughts and floods. Many of the regions face similar environmental challenges, though the magnitude and extent of the problems varies.

Africa

In Africa, the key environmental issues include land degradation, deforestation, habitat degradation, water stress and scarcity, coastal area erosion and degradation, floods and droughts, and armed conflict. These and other problems have contributed to environmental change that exacerbated under-development, poverty and food insecurity in the region. They have also limited the effectiveness of various response measures such as the Lagos Plan of Action and other environmental policies, which have been adopted by the region over the past 30 years. Tackling the region's environmental problems is now not just an option but is critical to achieving sustainable development, without which poverty will continue to worsen, contributing to even more overexploitation of the environment.

Asia and the Pacific

The world's largest region in terms of land area and also human population has an eclectic portfolio of environmental challenges, reflecting the diversity of its sub-regions. Some of the key environmental issues facing the region include land and forest degradation, habitat loss, water scarcity and pollution, greenhouse gas emissions and climate change, waste management, and natural disasters such as floods, droughts and earthquakes. What emerges from the assessment in previous sections is that some parts of the region are under severe stress, placing livelihood options for millions of people at risk. Other parts of the region, for example Japan, New Zealand and Australia, are sufficiently developed to cope with inevitable environmental changes caused by both human activities and natural phenomena.

Europe

In Europe, many of the key environmental issues are similar to those common in Africa, and Asia and the Pacific. These include forest degradation, water quantity and quality, coastal erosion and greenhouse gas emissions. Other, more specific issues analysed include soil degradation, sealing and contamination, and genetically modified organisms. Europe is generally one of the regions that is better placed to deal with its environmental challenges because of its economic development — and there are well established legal and institutional frameworks at both national and regional levels. Despite its advantages, however, the region cannot tackle global environmental issues alone and should continue to play a key role, particularly in the area of climate change.

Latin America and the Caribbean

The region faces many of the same environmental problems as Africa, and Asia and the Pacific. Additional issues include land tenure, overexploitation of fisheries and disasters, including hurricanes, earthquakes and spills of hazardous substances. Such problems will continue to exert heavy tolls on human life and the environment, setting back any efforts towards sustainable development. The risk is that millions of people in the region will continue to be marginalized, undermining efforts to improve socio-economic conditions and effectively manage the environment for current and future generations. Without more effective policy responses, the current trend of worsening environmental conditions is likely to continue, contributing to increased human vulnerability to environmental change.

North America

North America, the engine of globalization, has key environmental issues that include pesticide use, management of old growth forests, bio-invasion and quality of the Great Lakes. Despite its well developed institutional and legal framework, and successful enforcement of environmental laws, the region will continue to face a number of challenges, including the effective management of the commons. Its leadership role in international environmental management is important and this should be guided by the now widely accepted principle of common but differentiated responsibilities. The participation of governments, NGOs and civil society at national, regional and international levels is critical to progress in meeting *Agenda 21* and Millennium Declaration goals and others set by subsequent fora such as the World Summit on Sustainable Development. Many regions will continue to look to North America for assistance in terms of capacity building and development aid.

West Asia

Policy conflicts, for example those related to water management, and food production and security, have been shown to undermine efforts to achieve sustainable development. Greater synergy is critical and strategic policy development and implementation should include different stakeholders to avoid overlaps and competition which undermine effectiveness. The region has identified integrated water resources management as one of the key policy initiatives needed to improve management of its limited water resources. Countries in the region will also continue to grapple with the problems of drought and desertification, both of which place heavy limitations on environment and development.

Polar Regions

Some of the diagnosed environmental impacts on the polar regions are also clear symptoms of the excesses of human activity across the globe. The ozone-depleting substances used by humankind have manifested themselves in these regions with the discovery of the ozone hole some two decades ago. Greenhouse gas emissions are another example of how 'local' environmental problems may end up being global. The polar regions will continue to suffer the impacts of problems generated elsewhere. However, continued cooperation across various fronts at both t the regional and global levels should help address some of the existing problems and pinpoint emerging ones.