back

2.2 - Emerging trends in disaster impact, hazards and vulnerability patterns

More than 90 per cent of natural disaster related deaths are to be found in developing countries. Disaster impact statistics show the global trend – there are now more disasters but fewer people die in proportion, even though more population is affected and economic losses are increasing, as discussed in the next section.

Closely linked and influenced by changing perception, hazards and vulnerability is constantly shaped by dynamic and complex socio-economic and ecological processes. They are compounded by stresses felt within individual societies.

The current aspects of physical exposure of human beings and economic assets have been partly shaped by historical patterns of settlements. Beneficial climatic and soil conditions that have spurred economic activities are in many cases also associated to hazard-prone landscapes. Both volcanic slopes and flood plains areas have historically attracted human activities. Where settlement patterns have contributed to configure risk scenarios, new forces, such as **population growth** and increased **rural/urban migration**, act as dynamic pressures contributing to changing patterns in increasing people's exposure to hazards.

The processes through which people and goods become more exposed to hazards are also socio-economic conditioned. In particular, **poverty levels** and the impact **of development processes**, especially those associated with an increasingly **globalised society**, are reflecting, to some degree, current trends in socio-economic vulnerability to disasters. The pace of modern life has also introduced new forms of vulnerabilities related to **technological** developments. In addition to discouraging poverty levels, the emergence of virulent **biological** threats has revealed even greater vulnerability.

Systemic ecological and localized **environmental degradation** is becoming highly influential as well, lowering the natural resilience to disaster impact, delaying recovery time and generally weakening the resource base on which all human activity is ultimately dependent.

At the **ecosystem level**, phenomena like El Niño/La Niña, **climate change** and the potential for rising sea levels, are affecting the patterns and intensity of **hydrometeorological hazards.** Environmental degradation influences the effects of natural hazards, by exacerbating their impacts and limiting the natural absorptive capacity and resilience of the areas affected.

Biological hazards in the forms of plant or animal contagion, extensive infestations, human disease epidemics and pandemics, continue to factor into the disasters-development scenario in new and unpredictable ways. They exert considerable socio-economic impacts on food security and human mortality, health and economic productivity, among other things.

Disaster triggered by technological hazards often resulting from major accidents associated with industrialisation and forms of technological innovation, have significant socio-economic and environmental impact. Although technological hazards have been part of society for hundreds of years, the trends are showing an increasing impact. Technological advancements, specifically in the energy, transport and industrial sectors, are developing innovations with associated risks that are not always understood or heeded. The adverse effects of some technological disasters, both on society and on the environment, can considerably outlast the impacts associated with natural disasters.

back

Trends in disaster impact

While no country in the world is entirely safe, lack of capacity to limit the impact of hazards remains a major burden for developing countries, where more than 90 per cent of natural disaster related deaths are to be found.

Twenty-four of the 49 least developed countries (LDCs) still face high levels of disaster risk. At least six of them have been hit by between two and eight major disasters per year in the last 15 years, with long-term consequences for human development *(UNDP, 2001)*. These figures do not include the consequences of the many smaller and unrecorded disasters that cause significant loss at the local community level.

The re-insurance giant Munich Re, a member of the ISDR Inter-agency Task Force, in its annual publication *Topics* for 2000, looked at the trend of economic losses and insurance costs over a 50 year period linked to what it calls "great natural catastrophes".

There were 20 of these, costing the world US$ 38 billion (at 1998 values) between 1950 and 1959. However, between 1990 and 1999, there were 82 such major disasters and the economic losses had risen to a total of US$ 535 billion. That is, disasters had multiplied fourfold but economic losses were 14 times higher. And in each decade between, both the number of great disasters and the economic loss involved had risen steadily. However, losses in 2000 and 2001 were down.

These are absolute figures of economic loss, most of them to be found in developed and industrialized countries. But seen as losses by percentage of GDP, it is developing countries that lose most in relative terms, as shown in the graphic based on figures provided by MunichRe. For example, the economic losses of the United States from the 1997-98 El Niño event were estimated to US$ 1.96 billion or 0.03 per cent of GDP. The economic losses in Ecuador were US$ 2.9 billion, but this represented 14.6 per cent of GDP (*ECLAC 2000).*

The International Federation of Red Cross and Red Crescent Societies, another ISDR Task Force member, confirms the worsening trend of human suffering and economic loss during the last decade. The total number of people each year affected by natural disaster – that is, who at least for a time either lost their homes, their crops, their animals, their livelihoods, or their health, because of the disaster – almost doubled between 1990 and 1999, by an average of 188 million people per year *(CRED 2002).* This is six times more than the average of 31 million people affected annually by conflict *(OCHA, 2002).*

Comparing the last three decades, the trend shows an increase in the number of natural hazard events and of affected populations. Even though the number of disasters has more than tripled since the 1970s, the reported death toll has decreased to less than half (see grahpic page 12). This is among other factors due to improved early warning systems and increased preparedness. This statistic varies enormously depending on region and figures used. One needs to bear in mind that large disasters are rare events that defeat any statistical analysis in

The ecological footprint

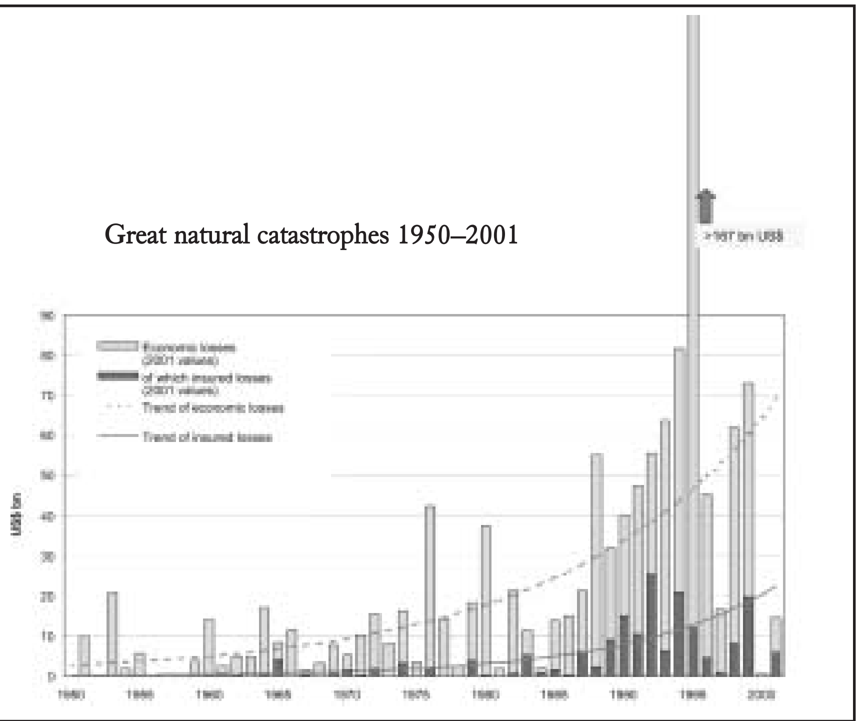
Demographic pressure means more forest loss and more land degradation. This means more flooding, drought, or both. Every human requires an area of land and shallow sea for food, water, shelter, transport, energy, commerce and waste. This is called an ecological footprint. In rich nations such as the US, this ecological footprint is almost 10 hectares per person. But even in the poorest places in the US this footprint is at least one hectare.

Every day, another 200,000 newborns will require up to 200,000 hectares of what might have been a benign and necessary wilderness. More people also means more fossil fuel consumption, which means more carbon dioxide emission, which means climate change. And such a world, climate scientists have warned repeatedly, is a world with a greater frequency of extreme events.

The combination of climate change and population growth will exact a price. The latest UN calculation is that three decades from now, around 70 per cent of the world's land will be affected in some way by human activity and half the people in the world will be short of water. Many of the other half will be at risk from increased flooding. By that time, there could be eight billion people on the planet.

Adapted from the environmentalist E O Wilson, Scientific American, February 2002

back



Source: Munich Re, 2001

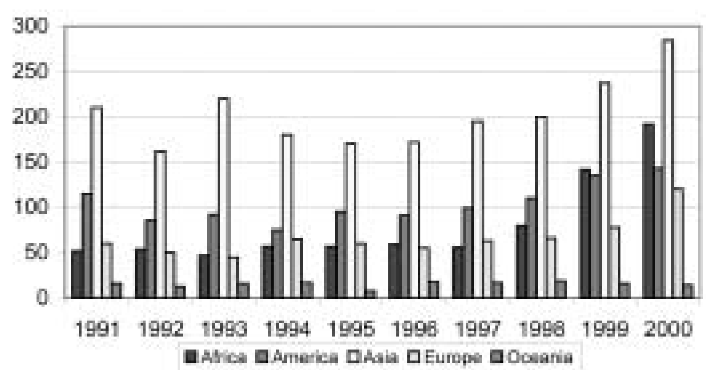
the short term. Perhaps more significant in the life of many are those daily disasters, generally underreported and not reflected at all in global figures on losses, but accumulating to probably large tolls of both economic and health losses.

There is a considerable geographic variation in the occurrence and impact of natural hazards. Asia is disproportionately affected with approximately 43 per cent of all natural disasters in the last decade. During the same period, Asia accounted for almost 70 per cent of all lives lost due to natural hazards. During the two El Niño years of 1991-92 and 1997-98, floods in China alone affected over 200 million people in each year. Nevertheless, in relative terms and counted per capita, Africa is the most heavily affected country, in particular when drought, epidemics and famine are included.

The single most terrible year in human loss during the last decade was 1991, when a cyclone devastated Bangladesh killing 139,000 people, bringing the global total of deaths for that year to 200,000. Cyclones are cyclical events and they continue to hit the Bangladesh coasts but no such catastrophe has happened again. This is at least in part because the machinery of warning and preparedness – watchful officials, an aware public and a stronger sense of community responsibility – came into play.

The worst global economic loss during last decade occurred in 1995, due to the Great Hanshin-Awaji earthquake in Kobe, Japan. A highly developed, prepared and economically strong nation faced serious set backs economically by loosing important facilities of its primary port. Even seven years after that disaster, the amount of shipping trade in Kobe has dropped by 15 per cent. But now Kobe is rebuilt and modernised.

Total Number of Reported Disasters, (1991-2000)



Source: Munich Re, 2001

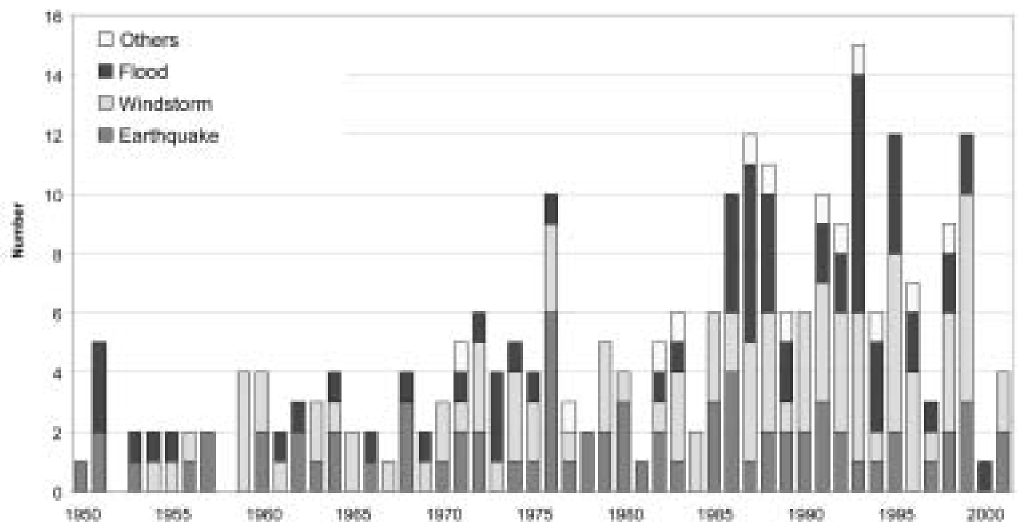
back

Trends in hazards

Until recently, the intensity and frequency of natural hazards, as events, whether geological or hydrometeorological in nature, only varied on very long time-scales due to natural variation in global temperatures and variation in the intensity of seismic activity.

Today, in particular hydrometeorological hazards are increasing due to human activities. The findings of the Intergovernmental Panel on Climate Change (IPCC) provide a new outlook about the changing patterns related to hazards themselves. Certainly, the scale of volcanic or seismic activity is not altered by human-induced sources, but it appears that our changing climate is affecting both the frequency and intensity of hydrometeorological hazards and related mass movements. Although it is very difficult to show scientific evidence of these changes, projections for the future invite concern.

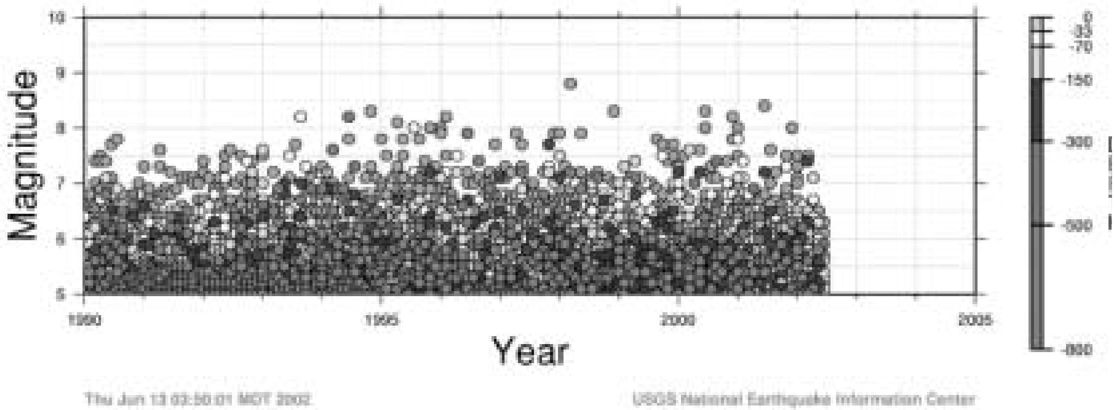
Great natural catastrophes 1950–2001



Source: MunichRe, 2001

The figure below shows that there is currently no major change in the frequency and intensity of reported earthquakes. Nevertheless, the economic losses caused by earthquakes are increasing.

Earthquakes Located by the NEIC, Magnitude 5 and greater



back

Volcanic Hazards

About 50 to 60 volcanoes erupt every year worldwide. Large eruptions endanger lives, human settlements and livelihoods of the almost 500 million people estimated to live near active volcanoes in 2000. That number will increase in the future as today more than 60 large cities are located near potentially active volcanoes, threatened by volcanic eruption.

Volcanoes with high activity are located predominantly in developing countries, particularly in Latin America, the Caribbean, parts of Asia and in the southwest Pacific. In these countries, despite the improvements in many national civil defense agencies' capacities to manage volcanic emergencies, eruptions are becoming increasingly risky because of rising population density and intense interweaving of infrastructure in the areas surrounding volcanoes.

As the physical characteristics and chemical properties of a specific volcano become better known, it can be more easily monitored. However, the prediction of an impending eruption can still remain a major challenge for volcanologists. Therefore, predicting future volcanic eruptions and related hazards must also be matched with a series of other forms of mitigation, including the following:

- Volcanic risk analysis.
- Early warning and short-term forecast of eruptions.
- Timely and effectively organized evacuation of people from hazardous areas.
- Development and application of land-use and contingency plans to minimize future volcanic disasters.
- Sustained information and educational programs for the population.

Major volcanic eruptions do not occur spontaneously and are preceded by a variety of physical, geological and chemical changes, which accompany the rise of magma toward the surface. The monitoring and measurement of these changes with well established scientific techniques provide the best opportunity to develop a warning system. Recent volcanic disasters show that the cost of monitoring volcanic activity and pre-disaster planning is very small when compared to the potential losses.

For early warning to be effective, sustained public education and information is necessary. This includes understanding results of volcanological studies and analysis, the possible dangers and the local plans to address them prior to the occurrence of emergency conditions. It can be done through the use of brochures, lectures, or courses although the best prepared communities also conduct regular disaster warning and prevention exercises.

In 1990, the *International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI)* launched a program to support the IDNDR and to promote the reduction of risks related to volcanoes. The initiative selected 16 volcanoes for monitoring and research with the aim of directing attention to a small number of active volcanoes, and to encourage the establishment of a range of research and public-awareness activities aimed at enhancing an understanding of the volcanoes and the hazards they pose.

That commitment demonstrated a concentrated effort within the scientific community to publicize the realistic aspects of disaster reduction by working in close association with communities at risk from volcanic hazards. Such collaborative scientific activities continue to show benefits as quite a lot of work continues with those same volcanoes. As a result of improvements in monitoring made during the IDNDR, better data has been developed, especially as those volcanoes continue to be restless. Ongoing work that would not have occurred were it not for this earlier concentrated attention includes, ongoing German-Indonesian cooperation at Merapi Volcano, on the Indonesian island of Java.

back

Nyiragongo Volcano, Goma, Democratic Republic of Congo, January 2002

"Goma is overshadowed by two large and active volcanoes- Nyiragongo and Nyamalagira. Part of the former is a large "hanging" crater of lava- said to be the largest active lava lake in the world. Any weaknesses in the sides could result in catastrophic consequences."

Nyiragongo is considered by the scientific community as one of the most notable and dangerous volcanoes in Africa. Nyiragongo and neighbouring Nyamuragira are responsible for nearly two-fifths of Africa's historical eruptions. However, according to a UN/DHA mission report, despite the 500,000 people living close to Nyiragongo, no serious studies has been engaged and no initiatives has been established to reduce volcanic risks.

Nyiragongo showed activity in 1977, 1982, 1994 and February 2001. Extremely fluid, fast moving lava flows drained the summit lava lake in 1977 probably killing about 50-100 people, although other estimates run as high as 2,000 fatalities. Following a crater eruption of Nyamuragira in January 2000, the one local volcanologist signaled the possibility of a later eruption of Nyiragongo, as there are subterranean geological connections between the two.

In May 2001, the small Goma observatory requested assistance for seismographs, thermometers and funds to conduct field surveys. At the beginning of 2001 and again in October 2001, Nyiragongo showed signs of activity, and an earthquake was felt in Goma while black smoke was sighted above the volcano. The same phenomena were repeated on 4 January 2002, in addition to several other signs suggesting an imminent eruption – signs noted prior to previous eruptions.

The local volcanologist sent additional messages to the international community on 8 January 2002, raising the alarm of an imminent eruption and requesting assistance. Nyiragongo began erupting on 17 January and continued until 23 January. One lava flow headed for the town of Goma, where it literally split the town in half. Another lava flow headed toward Gisenyi in Rwanda.

According to an expert report, "the eruption forced the rapid exodus of 300,000 to 400,000 persons, most into neighboring Rwanda, with dramatic humanitarian consequences… Forty-seven victims were reported as directly due to the eruption, to whom one must add about 60 people killed during the explosion of the petrol gas station in Goma center on January 21." At least 16,000 homes were destroyed, leaving 100,000 people homeless, and 24,000 children were left without schools. Goma and Gisenyi cities also suffered from strong seismic activity that accompanied and followed the eruption.

Adapted from: Final report of the French-British scientific team, 2002

Climate related hazards

Societies are increasingly dependant on medium to long term variations in the climate, such as El Niño/La Niña (see box "El Niño outlooks"), which affect precipitation and temperatures over time-scales of two to three years. These regional climatic shifts, the specific character of which is still very much unknown, develop their own variation in hazard trends, in particular hydro-climatic hazards associated with climate variability. The prevalence of droughts and floods as leading hazards shows that many countries are particularly vulnerable in dealing with current natural variability and extremes, let alone climate change.

The projected changes in climate will adversely affect many regions, in particular tropical and sub-tropical regions of the planet. When dealing with the complex issue of climate change there are some observations that can now be accepted as fact. It is now established that temperatures are increasing globally, although these increases are not evenly distributed around the planet. As the atmosphere becomes warmer throughout the world it can absorb more water vapour, leading to a general increase in humidity. As a result there is the probability that tropical storms and cyclones will be accompanied by extreme precipitation increases.

back

El Niño outlooks

Climatic factors that affect the occurrence of natural disasters are the irregularly recurrent variables, such as the El Niño and La Niña phenomena. Atmosphere-ocean circulation models project that as the earth's climate warms over the next 100 years, it is likely that a more El Niño-like condition may persist, leading to an increase in the incidence of floods and droughts in many parts of the world. Both the 1981-82 and 1997-98 events, the strongest ever recorded, had disastrous impacts on Pacific rim countries, and the effects were felt worldwide.

According to insurers SwissRe, the total economic impact of the 1997-98 event, amounted to US$ 98 billion. This highlights the need for better monitoring of the phenomena, better forecasts of the related extreme events, and more importantly, stronger institutions to deal with such information and increase local community's preparedness and resilience.

The WMO, in collaboration with the International Research Institute for Climate Prediction (IRI) of Columbia University in the U.S.A., has undertaken to coordinate the preparation of "El Niño outlooks", whenever the threat of an event manifests itself, as a contribution to the UN Interagency Task Force on Disaster Reduction. These outlooks draw on contributions from the Australian Bureau of Meteorology, China Meteorological Administration, European Centre for Medium Range Weather Forecasts, IRI, Japan Meteorological Agency, National Institute of Water and Atmospheric Research in New Zealand, Met Office United Kingdom, and the Climate Variability and Predictability (CLIVAR) Project of the World Climate Research Programme.

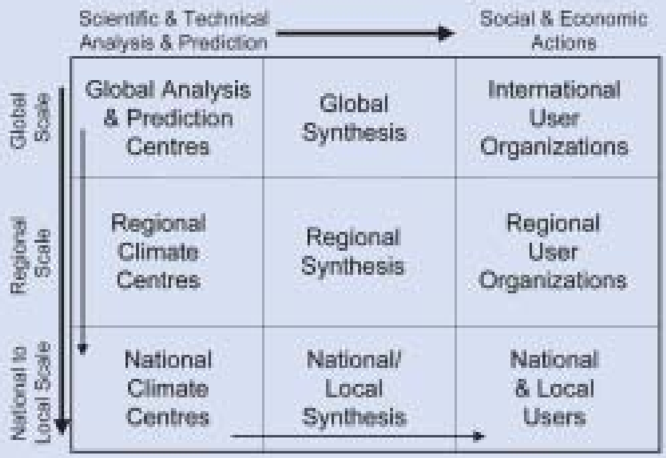
Unfortunately, these factors have a compound effect on the occurrence and impact of disasters. On the one hand, they affect the intensity and frequency of extreme hydrometeorological events, and on the other hand, they increase the vulnerability of societies. As we know, change in precipitation patterns, soil moisture and vegetation cover, are linked to the occurrence of floods, droughts, but also landslides and debris flow events. Climate change is also resulting in slight sea level rise and may cause more devastating storms and hurricanes in coastal areas. The only natural hazards that are not directly influenced by climate change are, possibly, volcanic eruptions and earthquakes.

The Inter-Agency Task Force on Disaster Reduction (IATF/DR) of the ISDR has a working group dealing with climate and disasters (WG1) and another with wildland fires (WG4). In the area of drought preparedness and mitigation, there are a number of coordinated and collaborative initiatives that are foreseen to be undertaken within the framework of the ISDR Task Force involving all its working groups.

back

ISDR working group 1: Climate and disasters (WG1)

WG1 of the Inter-agency Task Force on Disaster Reduction is led by the WMO and consists of members representing UN agencies, regional and scientific organizations and the private sector. It is examining how climate information of a scientific nature can best be conveyed to different user groups. Such information can be applicable to various space and time scales, and it is important that linkages between global, regional and national centres are working effectively in order to ensure that users, who may be obtaining information from various sources, are receiving a consistent message on a particular development and that they will know what to do with the information.



The group defined a matrix on information transfer for a more coordinated and systematic approach between those involved in the interpretation of scientific assessments and the wide range of user communities. Under the auspices of the group, El Niño outlooks are now being prepared. (see box)

In view of the direct impact of meteorological and hydro-meteorological hazards on the increase in frequency and intensity of disasters, WG1 together with the working group on risk, vulnerability and impact assessment (WG3) expressed the need to improve disaster impact databases and link them to climate databases.

The group has prepared a background paper and proposal on the need for concerted drought information and policies, for all the groups of the ISDR Task Force to engage in. The information on drought in this review draws from that paper

Drought distinction

Absence of a precise and universally accepted definition of drought adds to the confusion as to whether it exists, and if it does the degree of its severity. Thus, drought is often forgotten once it ends, and everybody seems to be caught unawares again by the next one. Most of the drought definitions have therefore been application (impact) specific. Other drought definitions have been regional specific. The discussions of drought here are focused on three types of drought – meteorological, agricultural, and hydrological. Meteorological drought is principally defined by the deficiency of precipitation from expected or normal levels over an extended period of time. Hydrological drought is best defined by deficiencies in surface and subsurface water supplies, leading to a lack of water for meeting normal and specific water demands. Agricultural drought may be characterized by deficiency in the water availability for specific agricultural operations such as deficiency of in soil moisture, which is one of the most critical factors in defining crop production potential.

During the coming decade and century, it is expected that drought vulnerability will increase, mainly due to development pressures, population increases, and environmental degradation that could itself lead to climate change. Several efforts have therefore been made at international, regional and national levels to address drought challenges. The international and regional efforts include the programmes and activities of the organizations such as WMO, FAO, WFP, IFAD, ADPC, ACMAD and the Drought Monitoring Centres in Africa, US/NOAA, IRI of Columbia University and USGS, that have established programmes to deal with drought monitoring,

back

prediction, early warning and disaster preparedness. They are also covered by the work of the UN sustainable development conventions, the UNFCCC, UNCCD and CBD.

Drought, unlike sudden-onset disasters, has some unique characteristics that may require different approaches to effectively address how to reduce their impacts:

- Drought does not directly destroy food in storage, shelter or infrastructure.
- Its effects are cumulative.
- It is often very difficult to detect its onset until some major impacts such as lack of water or food become discernible.
- Impacts can be spread over a larger geographical area than the damages that result from most of the other natural disasters, and hence quantification of impacts and provision of disaster relief is far more difficult.

"Amartya Sen, the Nobel prize winning economist of Cambridge University, famously pointed out that 'in the terrible history of famines in the world, no substantial famine has ever occurred in an independent and democratic country with a relatively free press'. The Human Rights Watch took this to heart, and asserts that 'the best way to prevent famine today is to secure the right to free expression – so that misguided government policies can be brought to public attention and corrected before food shortages become acute'"
Source: The Economist, 18 August 2001

Further, there are several social and economic parameters that affect the severity of drought including food prices, wars, various intervention methods, human activity, vegetation, water supplies and demands, making it extremely difficult to quantify its severity and also provide universal definition and indicators of drought. Drought risk is a product of a region's exposure to the natural hazards and its vulnerability to extended periods of water shortage. To reduce serious consequences, affected nations must improve understandings of hazards and the factors that influence vulnerability, and establish comprehensive and integrated early warning systems.

Case: Zimbabwe

Drought is the most common hazard in Zimbabwe, a country whose economy is dependent on agriculture. The incidence of drought is often linked to the occurrence of El Niño episodes and has worsened since the 1980s. Floods frequently occurring in the southern and northern provinces of the country compound drought conditions in other parts of the country. In 1996, there were localized floods resulting from abnormally heavy downpours. However, in 2000, flooding associated with Cyclone Eline caused considerable infrastructure and environmental damage in the country. The livelihoods of more than 250,000 people were affected in rural areas, with 100 fatalities and more than US$ 7.5 million in losses recorded.

Drought has been a recurrent feature in most parts of Southern Africa, with five major periods of drought since 1980: 1982-83, 1987-88, 1991-92, 1994-95 and 1997-98. Three of these events were regional in scale, with the 1991-92 drought considered the "worst in living memory", placing more than 20 million people at serious risk.

Case: Central Asia

The persistent multi year drought in Central and Southwest Asia is an example of climatic variability that has affected up to 60 million people in parts of Iran, Afghanistan, Tajikistan, Uzbekistan and Turkmenistan, since November 2001. Chronic political instability in many parts of the region and the recent military action in Afghanistan have further complicated the situation. A recent study by the International Research Institute for Climate Prediction (IRI) concludes that Central and Southwest Asia represent the largest region of persistent drought over the last three years in the world. In Iran alone, 37 million people are affected. Water reserves in the country were down by 45 per cent in 2001, 800,000 heads of livestock were lost in 2000, and 2.6 million hectares of irrigated land and 4 million hectares of rain-fed agriculture were affected. Damage to agriculture and livestock has been estimated by the UN at US$ 2.5 billion in 2001 and US$ 1.7 billions in 2000. Afghanistan and Pakistan are affected on a similar scale.

back

Reducing drought impacts

The need to improve drought preparedness through the development of policies and plans has become well accepted: *South Africa* (early 1990's), *Sub-Saharan Africa* (UNDP/UNSO, 2000), *West Asian and North Africa countries, Mediterranean region* (CIHEAM, 2001), *Morocco*. Some of these were developed with UNCCD, (total number of Ratification of the Convention in January 2002: 178 countries). In *Australia, the 1992 National Drought Policy* is widely recognised as a successful policy and often replicated. It has three main objectives:

- Encourage primary producers and others sections of rural Australia to adopt self-reliant approaches to managing for climatic variability.
- Maintain and protect Australia's agriculture and environment resource base during periods of extreme climate stress.
- Ensure early recovery of agriculture and rural industries, consistent with long term sustainable goals.

Climate change, sea level rise and coastal systems

Coastal zones are characterized by much diversity of ecosystems and a variety of socio-economic activities. An estimated 46 million people per year, living in coastal areas, are at risk of flooding from storm surges, and sea-level rise. Climate change will exacerbate these trends with significant impact upon the ecosystems and populations. A growing number of people will, continue to be located in coastal areas. Many traditional communities and subsistence level populations also rely on the resource wealth of coastal areas and continue to be drawn to these higher risk coastal regions. For example, indigenous coastal and island communities in the Torres Strait of Australia and in New Zealand's Pacific Island Territories are especially vulnerable. Although adaptation options do exist, such measures are not easily implemented on low-lying land. Also, climate change and sea-level rise issues are not as yet well incorporated into current models and frameworks for coastal zone management.

There is a direct link between tropical sea temperature in the oceans and the frequency of tropical cyclones, hurricanes or typhoons. More heat in the atmosphere means more evaporation which means more rainfall and more flooding in some places, more frequent drought in others, more violent windstorms or heavier snows elsewhere.

Photo: PAHO

back

Table : Examples of impacts resulting from projected changes in extreme climate events Report of Working Group 2 of the Intergovernmental Panel on Climate Change, 2001)

Projected changes during the 21st century in extreme climate phenomenaand their likelihood[a]	Representative examples of projected impacts[b]all high confidence of ocurrence in some areas[c]
Simple extremes	
Higher maximum temperatures: more hot days and heat wavesd over nearly all land areas (very likely[a]).	• Increased incidence of death and serious illness in older age groups and urban poor. • Increased heat stress in livestock and wildlife. • Shift in tourist destinations. • Increased electric cooling demand and reduced energy supply reliability.
Higher (increasing) minimum temperatures: fewer cold days, frost days, and cold wavesd over nearly all land areas (very likely[a]).	• Decreased cold-related human morbidity and mortality. • Decreased risk of damage to a number of crops and increased risk to others. • Extended range and activity of some pest and disease vectors. • Reduced heating energy demand.
More intense precipitation events (very likely[a] over many areas).	• Increased flood, landslide, avalanche, mudslide and debris flow. damage. • Increased soil erosion. • Increased flood runoff could increase recharge of some floodplain aquifers. • Increased pressure on government and private flood insurance systems and disaster relief.
Complex extremes	
Increased summer drying over most mid-latitude continental interiors and associated risk of drought (likely[a]).	• Decreased crop yields. • Increased damage to building foundations caused by ground shrinkage. • Decrease water resource quantity and quality. • Increased risk of forest fire.
Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities (likely[a] over some areas[e]).	• Increased risks to human life, risk of infestious disease and epidemics. • Increased coastal erosion and damage to coastal buildings and infrastructure. • Increased damage to coastal ecosystems such as coral reefs and mangroves.
Intensified droughts and floods associated with El Niño events in many different regions (likely[a]).	• Decreased agricultural and rangeland productivity in drought and flood-prone regions. • Decreased hydro-power potential in drought-prone regions.
Increased Asian monsoon precipitation variability (likely[a]).	• Increased flood and drought magnitude and damages in temperte and tropical Asia.
Increased intensity of mid-latitude storms (little agreement between current models [b]).	• Increased risks to human life and health. • Increased property and infrastructure losses.

a Likelihood refers to judgmental estimates of confidence used by TAR EGI: very likely (90-99% chance); likely (66-90% chance). Unless otherwise stated, information on climate phenomena is taken from the Summary for Policymakers, TAR WGI.

b These impacts can be lessened by appropriate response measures.

c High confidence refers to probabilities between 67 and 95% as described in Footnote 6.

d Information from TAR EGI, Technical Summary, Section F.5.

e Information from TAR EGI, Technical Summary, Section F.5.

back

Wildland fire as an environmental hazard

Throughout the world and in many different types of vegetation, fire is part of agriculture and pastoral livelihoods. Natural wildfires are established elements in traditional land-use systems and have beneficial effects in natural ecosystem processes and in bio-geo-chemical cycles. However, the excessive use or incidence of fire due to rapid demographic and land-use changes leads to the destruction of property and reduction of natural productivity by reducing the carrying capacities, biodiversity and vegetation cover of the landscape. Climate variability such as the periodic occurrence of extreme droughts or the protracted effects associated with the El Niño/La Niña phenomenon add to the severity of fire impacts. Projected demographic and climate change scenarios suggest that these situations will become more critical during coming decades.

ISDR working group 4: wildland fires (WG4)

The overall objective of WG4 of the Inter-agency Task Force on Disaster Reduction is to propose means and to facilitate the creation of mechanisms that can share information and undertake tasks to reduce the negative impacts of fire on the environment and humanity. It brings together both technical members of the fire community and authorities concerned with policy and national practices in fire management to realise their common interests of fire risk management and disaster reduction at a global scale.

WG4 is chaired and coordinated by the Global Fire Monitoring Centre (GFMC) at the Max Planck Institute for Chemistry, in Freiburg, Germany. WG4 attends to the existing programmes being implemented by its members to ensure complementary work plans. Its priorities are to:

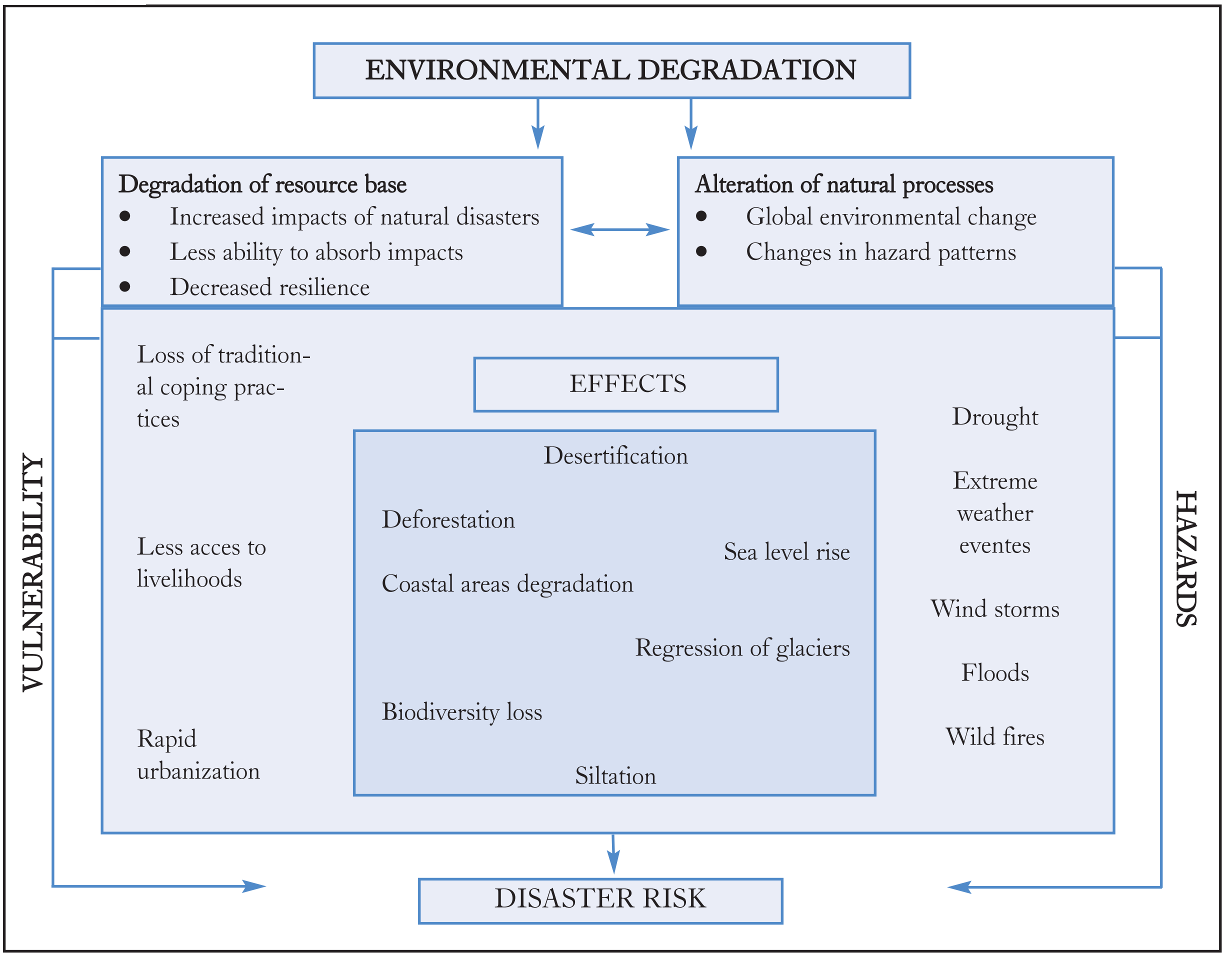
- Establish, and determine operational procedures for a global network of regional and national focal points for the early warning of wildland fire, fire monitoring and impact assessment, with the intention to enhance existing global fire monitoring capabilities and facilitate the functioning of a global fire management working programme or network.
- Propose internationally agreed criteria, common procedures, and guidelines for the collection of fire data and related damage assessments in order to generate knowledge required by the various user communities at global, regional, national and local levels.
- Strengthen the existing regional, national and local capabilities in fire management and policy development through the dissemination of information and increased networking opportunities to meet the information needs of such international initiatives as the Convention on Biological Diversity, the Convention to Combat Desertification, the UN Framework Convention on Climate Change, the United Nations Forum on Forests, the FAO Global Forest Resources Assessment and the ongoing international criteria and indicators processes of the Collaborative Partnership on Forests, as well as the overall scope of work of the UN agencies and programmes concerned.
- Transfer knowledge to local communities to advance their participation and utilization of appropriate tools that contribute to wildfire prevention, fire disaster preparedness and fire disaster mitigation.

Environmental degradation

As human activity continues to alter the biosphere, changes result in the environment in specific places and at ecosystem levels. Environmental degradation compounds the actual impact of disasters, limits an area's ability to absorb the impact, and lowers the overall general natural resilience to hazard impact and disaster recovery. In addition, environmental degradation that occurs and is significant enough to alter the natural patterns in an ecosystem, also affects the regular temporal and spatial occurrence of natural phenomenon. Climate change is currently the most obvious example.

The figure illustrates the inter-linking nature of environmental degradation, natural disasters and vulnerability. It should be noted that environmental degradation is described in terms of diminished resources. Toxification and other imbalanced forms of altering the natural environment also add to environmental degradation.

back



The interconnectedness between environmental degradation and progressive impact of natural disasters can be illustrated by the case of the Yangtze River Basin, in China, where concerns related to environmental vulnerability have been incorporated in watershed management (also see chapter 1 and 5.1).

The catastrophic floods in the Yangtze River Basin, China, in 1998, brought to national attention the fact that land use changes and environmental degradation in watersheds had greatly exacerbated flooding from extremely high levels of rainfall in the Yangtze Basin, and rapid snowmelt from Tibet and the Himalayas. Prior to this event, the pressure for rapid development tended to overshadow environmental concerns. Since environmental degradation has now been firmly accepted as one of the root causes of increased impact from natural disasters, it is essential to articulate and establish both the conceptual and operational links between environmental management and disaster risk reduction. In 1999, concluding that flooding was exacerbated by environmental degradation, the government formulated a new policy framework to promote ecological watershed management. As a result, a massive plan to redirect land-use management in river basins, targeted at the Yangtze River Basin and the Yellow River Basin was initiated.

Viet Nam offers another example of the complex links between deforestation and floods/landslides. Viet Nam's forest cover dropped from 43 per cent to 28 per cent in 50 years. This is due to a combination of many years of war, with the use of deforestation as a tool of war, legal and illegal trade in timber as Viet Nam's economy became more open to international investment and trade, and, it is also quite likely, climate change. Reduced forest cover will make the people of Viet Nam more vulnerable to floods and landslides.

The chart below, shows how primary and secondary effects of environmental degradation result in increased impacts of natural disasters – in this case in relation to watershed management and floods.

back

Primary Causal Agent

- Deforestation (commercial and subsistence)
- Increased agricultural practices
- Inappropriate agricultural practices
- Increased settlements and infrastructure development

Secondary Effects

- Decreased vegetative cover
- Decreased soil and land stability
- Increased soil erosion
- Decreased soil productivity
- Increased run off and siltation, blocking

Tertiary Effects

- Flooding
- Flash floods
- Mud and land slides

Land degradation and flash floods

According to UNEP data, two thirds of Africa is dry land over 70 per cent of which is classified as degraded. About 90 per cent of pasture land and 85 per cent of crop lands in the countries closest to the Sahara have been affected and there is some evidence that the desert is advancing towards the south and east. Deforestation is an important catalyst of land exhaustion and soil erosion. In Africa, more than 90 per cent of all wood is used for cooking and other energy needs and the demand for fuel wood has grown considerably since the oil price rise in 1974. Since kerosene is expensive to buy, there is an urban shadow of stripped land around most settlements. In effect, economic and social pressures – made worse by drought – have caused the breakdown of the traditional system of land use which was adapted to this fragile environment.

Flood risk, especially flash floods, is also exacerbated by increasing land degradation. In Southern Africa, escalating land degradation is strongly associated with overgrazing, which accounts for more than half the soil degradation in the region.

Technological hazards

Technological hazards are related to quickly occurring, high-impact events such as hazardous spills and nuclear accidents, and are therefore more linked with exposure, than long-term environmental degradation. In the case of hazardous materials – chemical and

Declining agricultural yields in the SADC region are also attributed to water erosion. In Zambia, soil erosion by water is the most serious form of physical soil degradation, with approximately 100,000 hectares at various stages degradation. Similarly, it is estimated that approximately 30 per cent of croplands in communal farming areas of Zimbabwe have been abandoned due to depleted soil fertility. In South Africa, as much as 6.1 million hectares of cultivated soil are affected by water erosion, with up to 300 million tons of soil lost annually due to physical degradation processes (FAO/AGL, 2001). Land degradation processes have been particularly prominent in Zambia as a result of deforestation, dense human population, overgrazing, poor crop cover and poor soil management techniques. This is reflected in marked deforestation, reaching 2644 km2 annually from 1990-1995. While land degradation increases the severity of flood and drought impacts in the region, it is an unsurprising outcome, both of widespread rural poverty as well as macro-economic forces.

back

toxic waste leakage – exposure is the critical factor. That was the case in Bhopal, India, in 1984, where material leaked to form a deadly cloud that killed and injured a huge number of people – most of whom came from poor families allowed to settle around the chemical plant. The fatal consequences of this chemical release were directly related to modernization efforts introduced as a complex and poorly managed industrial production system into a society unable to cope with it.

A very important aspect of exposure to technological hazards is the fact that they are not exclusively confined to urban-industrial societies. Virtually every modern product and process is disseminated to most countries and social settings. Of 25 nations with operating nuclear power stations, at least 14 are in developing countries. Great oil spills and releases of nuclear radiation are associated with the dominant energy and transportation technologies. Chernobyl, Exxon Valdez, Minimata and Bophal, are some well known examples of technological disasters.

Biohazards and vulnerability

HIV/AIDS can be considered a biological hazard. However, due to its enormous real and potential impact on the human community, it also constitutes a major vulnerability factor to the impact of other natural hazards. In particular, HIV/AIDS exacerbates vulnerability to drought conditions. Household size and income diversification, which count as key strategies to cope with droughts, are severely affected by HIV/AIDS, both by reducing the labour force and diverting vital economic resources towards medication and treatments. Moreover, infected people living in cities, usually return to their home villages to die, reinforcing the already higher vulnerability in rural environments in most African countries.

> The situation is very critical for Southern Africa, facing catastrophic consequences of HIV/AIDS infection. With many countries recording adult HIV infection rates of 25-30 per cent, the 1990s have seen the deaths of thousands of skilled young people occupying middle-management positions in the private and public sectors. Precious opportunities to develop sustainable local and technical capacities in disaster reduction have been undermined by continuing HIV-related deaths. With its far-reaching effects that span all professions, social sectors and communities in Southern Africa, HIV/AIDS will continue to constitute a major aspect of both household and national vulnerability for the foreseeable future.

Trends in physical vulnerability

Ninety per cent of the global population growth is taking place in least developed countries (LDCs). In these countries, exposure to hazards is already high through dense concentrations of population in largely unsafe human settlements. Vulnerability levels are also exacerbated by socio-economic and environmental conditions. In 1980, sub-Saharan Africa had a population of 385 million. This figure is expected to at least double by 2005. Population growth is outstripping food production that represents 40 per cent of GDP in some instances. But even this figure is precarious given less reliable rainfall patterns.

The long term trends of demographic growth for LDCs are creating environmental, as well as political, refugees. As many as 10 million people have emigrated during recent years but there may eventually be even greater redistributions of the African population in response to the deteriorating food situation. Some of this redistribution will likely concentrate even greater numbers in hazardous areas.

Due to the urban concentration of population, the greatest potential for disaster exists in the hundred most populous cities. Over three-quarters of these are exposed to at least one natural hazard. No less than seventy of these cities can expect, on average, to experience a strong earthquake at least once every fifty years. The greatest concern is for the fifty fastest growing cities, all of which are located in developing countries. Cities were often founded on accessible locations with inherent risks such as coastlines, to facilitate transport or floodplains because of their fertility and ample space for growth. Urbanization and increasing competition for land, results in the creation of unregulated construction which spills over into high risk areas, such as along hill sides, into low lying areas, next to industries, or on flood plains.

back

15 largest cities in world in 2000 and forecasts for 2010 (population in millions)	2000		2010	
	26.4	Tokyo	26.4	Tokyo
	18.1	Mexico City	23.6	Bombay
	18.1	Bombay	20.2	Lagos
	17.8	Sao Paulo	19.7	Sao Paulo
	16.6	New York	18.7	Mexico City
	13.4	Lagos	18.4	Dhaka
	13.1	Los Angeles	17.2	New York
	12.9	Calcutta	16.6	Karachi
	12.9	Shanghai	15.6	Calcutta
	12.6	Buenos Aires	15.3	Jakarta
	12.3	Dhaka	15.1	Delhi
	11.8	Karachi	13.9	Los Angeles
	11.7	Delhi	13.79	Metro Manila
	11.0	Jakarta	13.7	Buenos Aires
	11.0	Osaka	13.7	Shanghai

Urban population as a percentage of total population annual growth rate as a percentage

	1970	1995	2015	1970-1995	1995-2015
Least developed	12.7	22.9	34.9	5.1	4.6
All developing	24.7	37.4	49.3	3.8	2.9
Industrialized	67.1	73.7	78.7	1.1	0.6
HDI: Human Development Indicator (UNDP)					
Low HDI	18.2	27.4	38.6	4.1	3.7
Medium HDI	23.0	37.7	52.7	3.9	2.8
High HDI	52.8	70.9	78.5	3.3	1.7

Extract from The State of the World's Cities, UN-HABITAT, 2001.

Cities now hold disproportionate amounts of material wealth in terms of both residential and commercial buildings and infrastructure. This infrastructure is critical to the functioning of the city. The impact of disasters on cities can devastate national economies and industrial markets at an international level. This is especially important true for nation states, or emerging economies, where one or perhaps two primary urban areas will account for the vast majority of economic and social activity.

The dynamic growth of coastal areas evident in the Andean sub-region is also seen elsewhere. Nearly 3 billion people live in coastal zones, and 13 of the 15 largest cities are also located on the sea.

In some of the Andean countries, the current trend is a dynamic growth of the coastal areas, where an urban axis, articulated along the Pan-American highway, integrates the main port cities including Lima, Guayaquil, Puerto Cabello and La Guaira. Rapid urbanization in these areas contributes to increased levels of risk. Thirty-five per cent of the Peruvian population now lies between Lima and Callao.

The triangle formed by Quito, Guayaquil and Cuencas contains more than 70 per cent of the Ecuadorian population in only 15 per cent of the national territory. The triangle formed by La Paz, Cochabamba and Santa Cruz accounts for 80 per cent of the total GDP, and about 70 per cent of the Bolivian population.

back

In South Africa, it is expected that around 50 per cent of the population will live within 50 km of the coast in the near future. While this affords economic and other opportunities, it also exposes millions of people to extreme weather events triggered by the Indian, Atlantic and Southern Oceans. Moreover, coastal development for tourism is being actively promoted in many countries, which are prone to tropical cyclones and tsunamis.

Not only is the exposure of people exacerbated by the occupation of hazard-prone areas, the concentration of industrial infrastructure and critical facilities are also affected. Communication networks and educational and health infrastructure are becoming more vulnerable to the potential impact of natural hazards.

Behind the rapid urbanization process, rural displacement accounts for the rapid growth of informal, illegal settlements in the most dangerous places near cities like Mexico City, Rio de Janeiro and Manila, amongst others. Disaster risk concerns go hand in hand with other equally pressing urban issues, such as decaying infrastructure, poor housing and homelessness, hazardous industries, inadequate services, unaffordable and poor transport links, and unemployment.

Trade corridors are formed as a result of trade agreements. In Latin America we find the Central American highway, the Quito-Guayaquil corridor, the Pan-American Highway in the Andean region, the Buenos Aires-Mendoza-Santiago-Valparaiso corridor, and Brazilian coastal corridors with maritime connections to Asian and European destinations. The development of trade corridors has political, economic, social and environmental implications. Their resilience to the impact of natural hazards is particularly relevant to enhance the sustainable development of cities and regions.

An example of high vulnerability to natural hazards, in the context of trade corridors, is provided by the recurrent impacts experienced along the Pan-American Highway. For instance, during Hurricane Mitch, in 1998, the Central American intra-regional market was interrupted for more than fifteen days due to the damages in many parts of the Central American Highway. In 1997-98, in Peru and Ecuador, the impact from the El Niño event disrupted the circulation of the Pan-American Highway in hundreds of sections.

Trends in socio-economic vulnerability

The relation of disaster risk and development offers a good starting point to identify macro trends in socio-economic vulnerability. To some degree, socio-economic and environmental vulnerability is shaped by development processes and *vice versa*. Understanding how patterns of social change and development set the scene for future disasters become crucial to improving disaster risk assessment and analysis, and therefore essential for disaster risk reduction as a whole.

Development and vulnerability

The analysis of disaster impact shows that an estimated 97 per cent of natural disaster related deaths each year occur in developing countries (*World Bank*, 2001) Although smaller in absolute figures, the percentage of economic loss in relation to the GNP in developing countries far exceeds those in developed countries. This fact becomes even more relevant for SIDS. Between 1985 and 1999, the world's wealthiest countries sustained 57.3 per cent of the measured economic losses to disasters, representing 2.5 per cent of their combined GDP. During the same years, the world's poorest countries endured 24.4 per cent of the economic toll of disasters, representing 13.4 per cent of their combined GDP.

Some of the vulnerability factors or processes are closely associated with certain types of development models and initiatives. The links between disaster and development are explored in detail in the *World Vulnerability Report*, currently being developed by UNDP.

Increasing or permanent levels of poverty remain as a relevant issue for the analysis of vulnerability trends.

In Southern Africa, poverty levels remain high, especially among the rural poor, with 63.7 per cent, 36 per cent and 37 per cent of Zambians, Zimbabweans and Mozambicans respectively, living on less than US$ 1 per day. Their GDP falls far short of per capita GDP in developing countries. Moreover, GDPs for Zambia and Mozambique are around half of those for sub-Saharan Africa. In addition, high levels of foreign debt have discouraged investment and growth, with Zambia shouldering external debts that constitute 181 per cent of its GNP. Under these conditions, it is unrealistic to expect significant investments at household or national level to mitigate the impact of natural or other threats.

Globalisation as a dynamic force

Globalisation has a number of distinctive characteristics that have had a profound influence on the structure of international socio-economic relations. The impact of globalisation on patterns of vulnerability is critical to identify new trends in disaster risk. The economic dimensions of globalisation include the dominance of a global market, as one of its main features. The combined impacts of economic adjustment measures to encourage greater efficiencies and global competitiveness have been reflected in significant job losses and unemployment. In South Africa alone, between 1996-2000 more than 500,000 formal sector jobs were lost. Between 1997-2000 more than 140,000 miners became unemployed and 50,000 primarily female workers lost their jobs in textile industries. This is an increasingly relevant area which will require further analysis and focus.

Traditional knowledge at risk

The pace of technological change and the cultural implications of globalisation pose a real threat to the wealth of local knowledge, and related skills and resources, preserved among indigenous people and in many rural communities.

In the past, people from Pacific islands used various techniques to cope with the impact of natural hazards, such as special forms of food preservation, harvesting wild foods, planting disaster-resistant crops, using hazard-resistant forms of traditional house design and construction, and relying on established social networks for extended community support. Many of these traditions have become neglected as more people gravitate towards modern lifestyles, often becoming increasingly disassociated from a sensitive consideration of natural conditions in the process. It has also been observed that crops which formerly provided food security in many countries at times of disaster are now rarely planted.

Economic vulnerability is increasing as local livelihoods are transformed from relying on traditional forms of production to using more intensive or modern methods of agriculture and land use systems.

Traditional versus "modern" ways to cope. Is it necessary to choose?

The traditional pattern of agricultural land use in the Sahel was well adapted to uncertain rainfall conditions. Generally speaking, the northern zone, with a mean annual rainfall of 100-350 mm was used for livestock, while the southern Sahel, with a rainfall of 350-800mm, was used for rain fed crops. This system permitted a degree of flexible inter-dependence. Herders followed the rains by seasonal migration, while the cultivators grew a variety of drought-resistant subsistence crops, including sorghum and millet, to reduce the risk of failure. Fallow periods were used to rest the land for perhaps as much as five years in order to maintain the fertility of the soil. In the absence of a cash economy, a barter system operated between herders and sedentary farmers.

During recent decades this system has collapsed for a variety of reasons. Population growth has exerted pressure on the land, resulting in soil erosion. In turn, the range-lands have been over-grazed with rapid degradation of the resource base. The need of national governments for export earnings and foreign exchange has produced a trend towards cash crops, which have competed for land with basic grains and reduced the fallowing system. Subsistence crops have been discouraged to the extent that produce prices have consistently declined in real value for over twenty years. At the same time, the build-up of food reserves has been seriously neglected under pressure from international banks wanting loan re-payments. In addition, a lack of government investment to improve the productivity of rain-fed agriculture and a failure to organize credit facilities for poor farmers have also tended to undermine the stability of the rural base.

National governments have progressively campaigned against a nomadic lifestyle. In many instances, foreign aid has been earmarked for sedentary agriculture rather than herders. Increasingly, strict game preservation laws have been introduced which restrict the possibility of hunting for meat during drought. Traditional forms of employment, such as in caravan trading, have declined as a result of the enforcement of international boundaries and customs duties, together with competition from lorries.

Source: K. Smith, 1997