Vulnerability of people and the environment – challenges and opportunities

Background Studies

Netherlands Environmental Assessment Agency

UNEP

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Background Report on Chapter 7 of the Fourth Global Environment Outlook (GEO-4)

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Preface

This report concludes the efforts of the Chapter 7 working group that wrote the chapter on "Vulnerability of People and the Environment – Challenges and Opportunities" (UNEP 2007), during the period from 2004 to 2007. It provides an extensive account of the work carried out by the working group in preparing this chapter.

The editors would like to thank especially the following members of the working group for providing substantial input into this background report: Sylvia Karlsson, Matthias Lüdeke, Jennifer Mohamed-Katerere and Frank Thomalla. We would also like to thank Munyaradzi Chenje, Thierry De Oliviera and Neeyati Patel (UNEP/DEWA) for reviewing earlier drafts of this report. Neeyati Patel also provided all necessary assistance in getting the report into print. Annemieke Righart and Mirjam Hartman provided valuable assistance in language editing.

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Summary

Recent scientific reports have shown that we are living in an era in which human activities are having a negative influence on the earth system on an unprecedented scale. The provision of ecosystem services, such as food production, clean air and water or a stable climate, is under severe and growing pressure. The rate of global environmental change that we are currently witnessing has not been observed before in human history and has an increasing impact on human well-being. As a result, people and communities face growing vulnerability. However, environmental change is only one of many factors influencing the vulnerability of people. Others include globalization, equity and governance, which therefore also need to be taken into account in vulnerability analyses.

The Brundtland Commission stressed the interdependence of environment and development and defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development is thus about the quality of life and about the possibilities of maintaining this quality here and now, as well as elsewhere and in the future. By showing the vulnerabilities of specific people, groups or places that are exposed to environmental and non-environmental threats, an indication of "unsustainable" development patterns can be derived.

Vulnerability analysis is widely used in the work of many international and national organizations concerned with poverty reduction, sustainable development and humanitarian aid. It is used to develop policy recommendations on how to reduce vulnerability and to adapt to change. In the United Nations Environment Programme (UNEP) *Fourth Global Environment Outlook - Environment for Development* (GEO-4), vulnerability analysis has become an important way to address challenges and opportunities for enhancing human well-being and the environment, without losing sight of the needs of future generations. As the Brundtland report stated "A more careful and sensitive consideration of their [*vulnerable groups'*] interests is a touchstone of sustainable development policy" (WCED 1987, p.116).

This report presents the conceptual connotations of the term "vulnerability" and reviews past efforts of assessing and studying vulnerability. It furthermore provides a synthesis of the key insights from the literature on vulnerability analyses, and then presents the contexts that shape vulnerability, including equity, export and import vulnerability, conflict and cooperation and natural disasters. In general terms, vulnerability refers to the potential of a system to be harmed by an external stress (i.e. threat). Several approaches to assessing vulnerability have been developed, differing in how they define vulnerability, the scale of their analyses, or their thematic focus. The relations between vulnerability and human well-being are further elaborated. Different connotations of the term human well-being are reviewed and approaches to assessing this elucidated.

Vulnerability analysis is usually place-based and very context specific. In order to make such an analysis relevant within the scope of a global assessment such as GEO, a specific approach was developed for GEO-4. This involves the identification of so-called *archetypical patterns of vulnerability*. These patterns of vulnerability do not describe one specific situation, but rather focus on the most important common properties of a multitude of cases that are in that sense "archetypical". Recurring patterns of vulnerability can be found in numerous different places around the world, for example, in industrialized and developing regions, and urban and rural areas. The question is whether and how local specifics can be adequately represented and understood at this scale as a prerequisite for successful policy that is influential at the local level. The report concludes with a set of possible policy options for addressing issues of vulnerability in relation to human well-being and sustainable development.

This report provides the background to GEO-4 Chapter 7 "Vulnerability of people and the Environment: Challenges and Opportunities" published by UNEP in October 2007. It includes a more detailed explanation and elaboration of the analyses in GEO-4 and also some additional analyses.

1 Introduction

Recent scientific reports (Steffen and others 2004, MA 2005, IPCC 2007, UNEP 2007) have shown that we are living in an era in which human activities are having a negative influence on the earth system on an unprecedented scale. The provision of ecosystem services, such as food production, clean air and water or a stable climate, is under severe and growing pressure. The rate of global environmental change that we are currently witnessing has not been observed before in human history and has an increasing impact on human well-being. As a result, people and communities face growing vulnerability. However, environmental change is only one of many factors influencing the vulnerability of people. Others include globalization, equity and governance, which therefore also need to be taken into account in vulnerability analyses.

The World Commission on Environment and Development (WCED), also known as the Brundtland Commission stressed the interdependence of environment and development in its seminal report *"Our Common Journey"* and defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Sustainable development is thus about the quality of life and about the possibilities of maintaining this quality here and now, as well as elsewhere and in the future. Sustainable development requires the integrated analysis of the economic, social and environmental domains. However, this often proves difficult to realize, both in research and in national and international policy-making. By showing the vulnerabilities of individual people, groups of people or places that are exposed to environmental and non-environmental threats, an indication of "unsustainable" development patterns can be derived. This analysis can serve as a basis for the identification of challenges to and opportunities for enhancing human well-being and the environment, without losing sight of the needs of future generations. As the Brundtland report stated "A more careful and sensitive consideration of their [*vulnerable groups*] interests is a touchstone of sustainable development policy" (WCED 1987, p.116).

The concept of vulnerability is important in many different fields of research. In general terms, vulnerability refers to the potential of a system to be harmed by an external stress (for instance a threat). Several approaches to assessing vulnerability have been developed, differing in how they define vulnerability, the scale of analyses, or their thematic focus. Although vulnerability analysis has been a feature of UNEP's work for some time, the Global Environment Outlook 3 (GEO-3) (UNEP 2002a) was the first GEO report that analysed vulnerability in a systematic manner. In that report, vulnerability was defined as "the interface between exposure to physical threats to human well-being and the capacity of people and communities to cope with those threats". An overview of different definitions and approaches to vulnerability is provided in UNEP (2003) and Thywissen (2006). Vulnerability analysis is usually place-based and very context specific. In order to make such an analysis relevant within the scope of a global assessment such as GEO, a specific approach was developed for GEO-4. This involves the identification of so-called *archetypical patterns of vulnerability*. An "archetype of vulnerability" is defined as "a specific, representative pattern of the interactions between environmental change and human well-being". It does not describe one specific situation, but rather focuses on the most important common properties of a multitude of cases that are in that sense "archetypical". Recurring patterns of vulnerability can be found in numerous different places around the world, for example, in industrialized and developing regions, and urban and rural areas. The question is whether and how local specifics can be adequately represented and understood, at this scale, as a prerequisite for successful policy that is influential at the local level. To address these issues, a number of archetypes of vulnerability were identified and analysed in GEO-4. See Table 1.1 for a full overview of these archetypes.

The United Nations Environment Programme (UNEP) applied the Drivers-Pressures-State-Impacts-Response (DPSIR) framework (see Figure 2.1) in the conduct of its global integrated environmental assessment – where the Drivers are the socio-economic and socio-cultural forces driving human activities, which increase or mitigate pressures on the environment; Pressures are the stressors that human activities place on the environment; State is the condition of the environment; Impacts are the effects of the environmental change; and Responses are the responses by society to the changing environmental situation.

The underlying theme of GEO-4 was *Environment for Development*. GEO-4 used 1987 as its temporal baseline for the assessment – the year in which the WCED published *Our Common Future*. GEO-4 showed how crucial the environment is to human well-being. It also highlighted the importance of the environment for other policy domains by addressing what is known in the Bali Strategic Plan of Action (UNEP's capacity building strategy) as cross-cutting issues. One way it did this was by strengthening vulnerability analyses within the overall

GEO approach. The intergovernmental consultations that were part of the design phase of GEO-4 also confirmed the importance of using a vulnerability approach and identified a set of questions to be addressed in the vulnerability chapter of GEO-4 (see Box 1.1).

This background report provides the background to Chapter 7 "Vulnerability of people and the Environment: Challenges and Opportunities" of GEO-4 published in October 2007. This report has the following objectives:

1. to document the process of the evolution and preparation of the chapter;
2. to provide a more detailed explanation and elaboration of the analyses done;
3. to report on the analyses carried out during the preparation of the chapter, but not included in the final version of the chapter;
4. to identify areas for further research on vulnerability in general, and within the GEO/UNEP framework in particular.

This report is organised as follows: the vulnerability approach is described in Chapter 2. It presents the conceptual connotations of the term "vulnerability" and past efforts at assessing and studying vulnerability are reviewed. The chapter provides a synthesis of the key insights from the literature on vulnerability analyses, and then presents the contexts that shape vulnerability. Chapter 3 links the concepts of vulnerability and human well-being. Different connotations of the term are reviewed and approaches to assessing well-being elucidated. Chapter 4 elaborates the archetype approach to analyse patterns of vulnerability. Chapter 5 describes the policy analysis that is based on this approach. A set of possible policy options is presented for addressing issues of vulnerability in relation to human well-being and sustainable development. An important message of this chapter is that interventions need to be very specific to local contexts and that addressing well-being and vulnerability concerns are needed. Annex 1 briefly describes the process of preparing and writing chapter 7 of GEO-4.

Overall, this background report follows the structure of Chapter 7, as published in GEO-4 (UNEP 2007). Throughout, however, it elaborates on material, concepts and methodologies used in far more detail than was possible within the final report of GEO-4. In several places, the background report is more extensive in elaborating specific issues, notably with respect to the context in which vulnerability unfolds and the aspects of vulnerability. The clear difference between the GEO-4 chapter and this background report is in the number of archetypical patterns included. As part of the preparation process of GEO-4, 11 patterns of vulnerability were elaborated in some detail. Due to space restrictions only 7 could be included in GEO-4 at a meaningful level of detail. These are already in GEO-4 itself and are not included in this report. The remaining 4 are not in GEO-4, but are presented in Chapter 4 of this report. Table 1.1 presents an overview of the archetypical patterns of vulnerability that are included in GEO-4.

The authors hope that this report and our reflections on the work done in the period 2004-2007 will enhance future work on vulnerability and human well-being within UNEP and more specifically the GEO framework. A good opportunity for applying this approach lies in the regional GEOs that are published regularly. The report also points to some relevant directions for further research and action.

Box 1.1 Statement by the Global Intergovernmental and Multistakeholder Consultation on the Fourth Global Environment Outlook, held in Nairobi on 19 and 20 February 2005

1. From reference points such as the Brundtland Commission and Agenda 21 and other relevant international documents, where did we want to be in 2007? How far have we got? How did we get here? What can we learn from success stories?

2. Where do we stand on the environmental contribution to the implementation of the internationally agreed development goals, including those contained in the Millennium Declaration, and in particular Millennium Development Goals number 1 (poverty alleviation), 3 (gender equality) and 7 (ensuring environmental sustainability)?

3. Does environmental governance adequately take into account the links between environment and cross-cutting challenges, among others, as they relate to those listed in the Bali Strategic Plan for Technology Support and Capacity-building such as poverty alleviation and improvements to health, institutions and governance, better access to and use of science and technology, more equitable trade, and equal opportunities for the sustainable use of environmental resources?

4. How vulnerable are human and/or social systems to natural and human-induced disasters?

5. What policies are in place to address the mitigation, coping, and adaptation capacity needs of groups vulnerable to environmental change?

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Overview of archetypical patterns of vulnerability analysed in GEO-4

Table 1.1

Archetype	Description	Regional priorities from GEO-4	Key issues related to Human Well Being	Key policy messages
Contaminated sites	Sites polluted by harmful and toxic substances at concentrations above background levels, and which pose or are likely to pose an immediate or long-term hazard to human health or the environment, or which exceed levels specified in policies and/or regulations.	Asia Pacific – waste management; Polar – persistent toxics; Polar – industry and related development activities.	Health hazards - main impacts on the marginalized, in terms of people (forced into contaminated sites), and nations (hazardous waste imports).	Better laws and better enforcement against special interests. Increased participation of the most vulnerable in decision-making.
Drylands	Contemporary production and consumption patterns (from global to local levels) disturb the fragile equilibrium of human-environment interactions, which have developed in drylands, between the sensitivity to a variable water supply and, at the same time, a resilience to aridity, creating new levels of vulnerability.	Africa – land degradation; West Asia – land degradation and desertification.	Worsening supply in drinking water, loss of productive land, conflict due to environmental migration.	Improve security of tenure (for example by cooperatives). Provide more equal access to global markets.
Securing Energy	Vulnerabilities as a consequence of efforts to secure energy for development, particularly in countries that depend on energy imports.	Europe – energy and climate change; LAC – energy supply and consumption patterns; North America – energy and climate change.	Affects material well-being, which is marginalized/ mostly endangered by rising energy prices.	Secure energy for the most vulnerable, let them participate in energy decisions, foster decentralized and sustainable technology, and invest in the diversification of the energy systems.
Global commons	Vulnerability resulting from misuse of the global commons, which include the atmosphere, the deep oceans and the seabed, beyond national jurisdiction,	LAC – degraded coasts and polluted seas; LAC – shrinking forests; Polar – climate change; West Asia – degraded coasts.	Decline or collapse of fisheries with some gender-specific poverty consequences, health consequences of air pollution, and social deterioration.	Integrated regulations for fisheries and marine mammal conservation and oil exploration etc. Use of the promising policies on Heavy Metals and Persistent Organic Pollutants.
Small Island Developing States (SIDS)	The vulnerability of (SIDS) to climate change impacts in the context of external shocks, isolation and limited resources.	LAC – degraded coasts and polluted seas; Asia Pacific – alleviating pressures on precious and valuable ecosystems.	Livelihoods of users of climate-dependent natural resources are most endangered, resulting in migration and conflict.	Adapt to climate change by improving early warning, making the economy more climate independent, and shifting from "controlling of" to "working with" nature paradigm
Technology-centred approaches to water problems	Vulnerability induced by poorly planned or managed large-scale projects that commonly involve massive reshaping of the natural environment. Important examples are some irrigation and drainage schemes, the canalization and diversion of rivers, large desalinization plants, and dams.	Asia Pacific – balancing water resources and demands; North America – freshwater quantity and quality; West Asia – water scarcity and quality.	Forced resettlement, uneven distribution of benefits from dam building, and health hazards from waterborne disease vectors	The World Commission of Dams' path of stakeholder participation should be followed further; dam alternatives, such as small-scale solutions and green engineering, should play an important role.
Urbanization of the Coastal Fringe	Illustrates the challenges for sustainable development that arise from rapid and poorly-planned urbanization in often ecologically sensitive coastal areas, in the context of increasing vulnerabilities to coastal hazards and climate-change impacts.	Europe – urban sprawl; LAC – growing cities; LAC – degraded coasts; West Asia – degradation of coastal and marine environments; West Asia – management of the urban environment.	Lives and material assets endangered by floods and landslides; health endangered by poor sanitary conditions due to rapid and unplanned coastal urbanization; strong distributional aspects.	Implementation of the Hyogo Framework of action; bring forward green engineering solutions which integrate coastal protection and livelihood opportunities.

Overview of archetypes, the link to regional priorities, human well-being and possible policy options analysed in the vulnerability chapter in GEO-4.

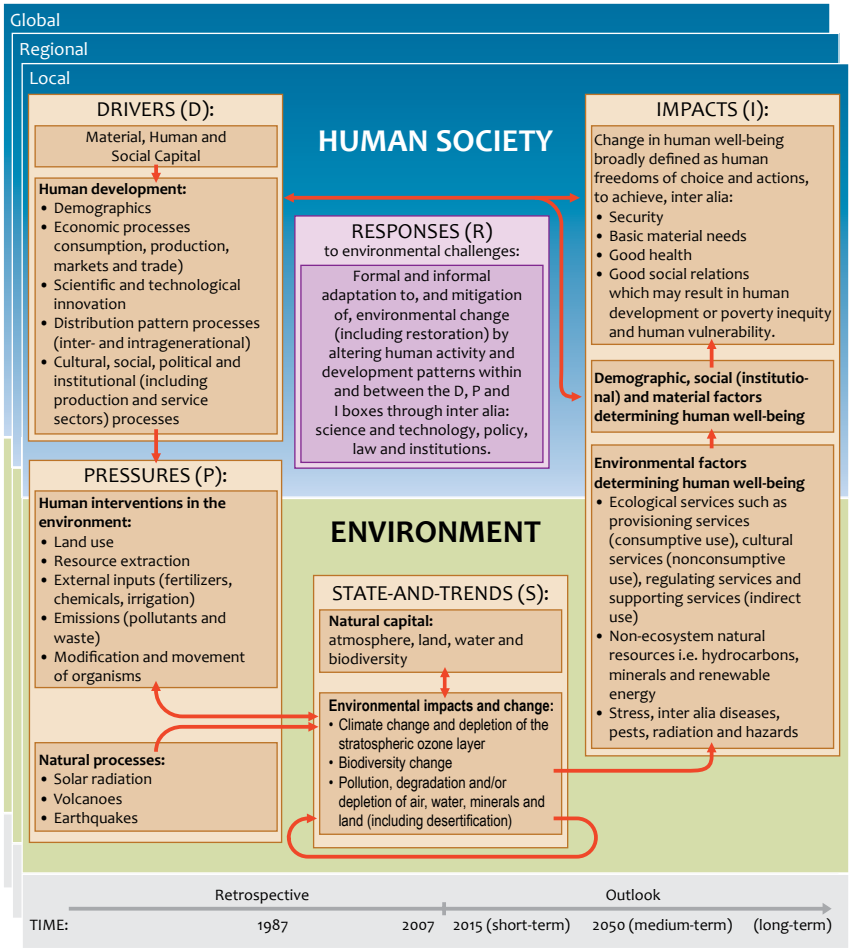
2 Vulnerability of people

2.1 Introduction

Scholars and policymakers have been increasingly applying an integrated approach in their analyses of environmental problems, recognizing that these cannot be looked at in isolation. Understanding environmental trends requires the analysis of underlying pressures as well as looking at how society responds to them. A framework conventionally employed for the integrated analysis of environmental problems, including UNEP's Global Environment Outlook (GEO) is the Drivers-Pressures-State-Impacts-Response (DPSIR) framework. This framework seeks to connect causes (drivers and pressures) to environmental outcomes (state and impacts) and to activities that shape the environment (policies, responses and decisions). In GEO-4, this framework was further modified in an attempt to reflect better the role of environmental goods and services in determining human well-being (see Figure 2.1).

An opportunity to deconstruct the impacts of environmental change on human systems even further is provided by the vulnerability approach. Human vulnerability represents the interface between hazards, environmental and socio-eco-

GEO-4 conceptual framework **Figure 2.1**



The GEO-4 conceptual framework (UNEP, 2007).

nomic changes, human well-being and the capacity of people and communities to cope with hazards and change. It is increasingly recognized that many of the social and economic problems in the world cannot be seen as separate from environmental problems (and vice versa), and that the human-environment system should be studied in an integrated manner.

GEO-3 made a start towards analysing vulnerability, noting that vulnerability is shaped by a mix of social, ecological and economic forces: "Human vulnerability to environmental conditions has social, economic and ecological dimensions" (UNEP 2002a, p. 303). GEO-3 recognized that vulnerability has both spatial and temporal dimensions. The extent of vulnerability varies spatially. For instance, developing countries are more vulnerable to the impacts of climate change than developed countries (IPCC 2001). Likewise, some areas such as high altitudes, flood plains, river banks, small islands, and coastal areas may be more exposed to environmental hazards than others. The temporal dimension of vulnerability is illustrated by the fact that in many countries coping capacity that was strong in the past has not kept pace with environmental change. GEO-3 identified some of the causes of why this can occur: when traditional options are reduced or eliminated, when new hazards emerge for which no coping mechanism exists, when resources are lacking or technology and skills are not or no longer available.

At the same time, vulnerability varies across groups: men and women, poor and rich, rural and urban, different livelihood activities, and so on. Refugees, migrants, displaced groups, the very young and very old, women and children are often among the most vulnerable groups, subject to multiple stressors (UNEP 2002a). GEO-3 identified three critical areas as closely related to vulnerability: human health, food security and economic losses. The report also noted that "no standard framework exists for identifying all these factors" (UNEP 2002a; p. 303). However, an important message from GEO-3 was the need for "a significant policy response and action on several fronts" (UNEP 2002a; p. 309). Two types of policy response were identified: reducing the hazards through prevention and preparedness initiatives, and improving the coping capacity of vulnerable groups to enable them to deal with hazards. A case was also made for assessing and measuring vulnerability and developing systems of early warning.

In addition to GEO-3, the issue of human vulnerability to environmental change also featured in many of the Regional GEOs (see www.unep.org/geo). The amount of attention given to this topic varies for each report, but a comparison of the most recent reports with earlier publications shows that human vulnerability is receiving increased attention. In the reports of Small Island Developing States (SIDS), human vulnerability to environmental change is an important topic, especially given the growing threat of natural disasters attributed to climate change (UNEP 2005a/b/c). The issue of human vulnerability was also taken up in the first African Environment Outlook (UNEP 2002b), which specifically looked at human vulnerability to environmental change. Main themes addressed were poverty and the direct dependence of people in Africa on their natural resource base. The detailed case studies that provided the basis for these analyses can be found in UNEP (2004). Another regional report elaborating on the issue of human vulnerability was North America's Environment Outlook (UNEP 2002c). Here, health and human settlement were dominant themes.

Building on the lessons learned during GEO-3 and insights gained from the broader vulnerability literature, it was clear from the outset (Wonink, Kok and Hilderink 2005) that the vulnerability analysis in GEO-4 had to take into account:

- multiple stressors on the human-environment system;
- different vulnerable groups in both developing and developed countries;
- the time dimension (cumulative effects, dynamic vulnerability);
- cross-scale effects (for example multi-level governance);
- available case studies;
- interests of stakeholders (including private sector);
- points of intervention.

This chapter aims: to elaborate the vulnerability approach and some of the lessons from the literature (2.2); to show the context in which vulnerability unfolds (2.3); and tohighlight aspects of vulnerability that are especially important as part of vulnerability analysis (2.4).

2.2 Vulnerability approach

Nowadays, vulnerability analysis is widely used in the work of many international organizations and research programmes concerned with poverty reduction and sustainable development, such as FAO, Humanitarian Aid Organizations, such as the Red Cross/Red Crescent, as well as UNDP, UNEP, World Bank and donor agencies. Vulnerability analysis helps to identify the places, people and ecosystems that will suffer most from environmental and/or human-induced variability and change, and identifies the underlying causes. It supports the development of policy relevant recommendations for decision makers on how to reduce vulnerability and adapt to change (Kasperson and others 2005, Birkmann 2006).

The concept of vulnerability is an important extension of traditional risk analysis, which focuses primarily on natural hazards (Burton 1978, Hewitt 1983, 1997, Blaikie and others 1994, Wisner and others 2004). Vulnerability has become a central aspect of studies on food insecurity (Watts and Bohle 1993, Bohle, Downing and Watts 1994); poverty and livelihoods (Chambers 1989, Chambers and Conway 1992, Prowse 2003); and climate change (Klein and Nicholls 1999, Downing 2000, Downing and Patwardhan 2003). Whilst earlier research tended to regard vulnerable people and communities as victims in the face of environmental and socio-economic risks, more recent work has placed increasing emphasis on the capacities of various affected groups to anticipate and cope with risks, and the capacities of institutions to build resilience and adapt to change (Bankoff 2001).

In studies on vulnerability, over the last few decades, at least two main strands of research can be distinguished. The first has concentrated on the field of natural hazards research, looking at human vulnerability related to physical threats and disaster risk reduction (for example Cutter 1995 or World Bank 2005). This work has focused on vulnerability in rela-

tion to environmental threats, such as flooding, hurricanes, droughts and earthquakes. Vulnerability to such extreme events depends both on their likelihood and the place where they occur. Global environmental change, particularly climate change, is expected to result in considerable increases in the frequencies and magnitudes of climate and weather-related extreme events. In this field the environmental threats posed by slower, long-term processes of climate change have also been examined. Most of this research has resulted in analysing the dynamics in hazardous areas and the impacts that occurred.

The second strand of research has looked at socio-economic factors contributing to human vulnerability (e.g. Adger and Kelly 1999 or Watts and Bohle 1993). This work has shown that in the face of both environmental and non-environmental threats, socio-economic factors are equally important in constructing vulnerability. Sensitivity to both kinds of threats is to a large extent determined by socio-economic factors, as is the ability to cope with those threats. This has been demonstrated in many comparable cases, where the exposure to similar threats has resulted in substantially different impacts for different communities and people. Poverty, marginalization, conflict and lack of entitlements and access to resources are some of the principle determinants of vulnerability.

In recent years, a number of studies have combined these two strands of research, in recognition of the fact that both environmental changes and risks and socio-economic factors together determine human vulnerability to environmental change. This emerging, more comprehensive approach looks at multiple stressors from different domains and in this way comes closer to the concept of sustainable development, which requires integrating the economic, environmental and social dimensions within one framework. Such integrated studies have, for example, analysed the vulnerability of communities in drylands in West Africa to climate change (Dietz and others 2004) or the vulnerability of Indian agriculture to global change (TERI 2003). An important element to be considered in human vulnerability studies, which is often masked in highly aggregated national data, is the spatial heterogeneity of people; poor people tend to live in areas that are highly exposed to environmental risks, such as pollution and natural and man-made hazards. Increasingly, a combination of biogeophysical and socio-economic (poverty or vulnerability) maps are used to determine which people are at greatest risk from sea-level rise, extreme weather events or other environmental stressors (Henninger and Snel 2002).

Although there are differences in the use of terminology, most analytic frameworks for vulnerability analysis distinguish between three components of vulnerability: exposure, sensitivity and coping capacity/resilience. Exposure refers to external stress (e.g. threat) to the system (community or individual), which can be caused by extreme events such as flooding, but also by changes in the magnitude and intensity of those hazardous events as a consequence of climate change. It could also be caused by socio-economic "events", such as economic collapse or price changes of commodities. Sensitivity determines the extent to which each system is susceptible to exposure to that external stress – for example entitlement or proximity to an environmental threat, such as a floodplain. Coping capacity/resilience determines the ability to deal with or recover from the impact of external stress and depends on factors such as the level of education, the availability of insurance, and access to other types of resources.

These three components that determine human vulnerability can vary considerably among individuals, different social groups and communities, making human vulnerability to environmental change inherently different for each community or individual (Vogel and O'Brien 2004). In addition, human vulnerability is:

i) *multidimensional*. Many communities and people tend to be affected by more than one stress at the same time. For instance, climate change and globalization cause multiple stressors on farmers through changing weather patterns and a new economic reality (O'Brien and Leichenko 2000).

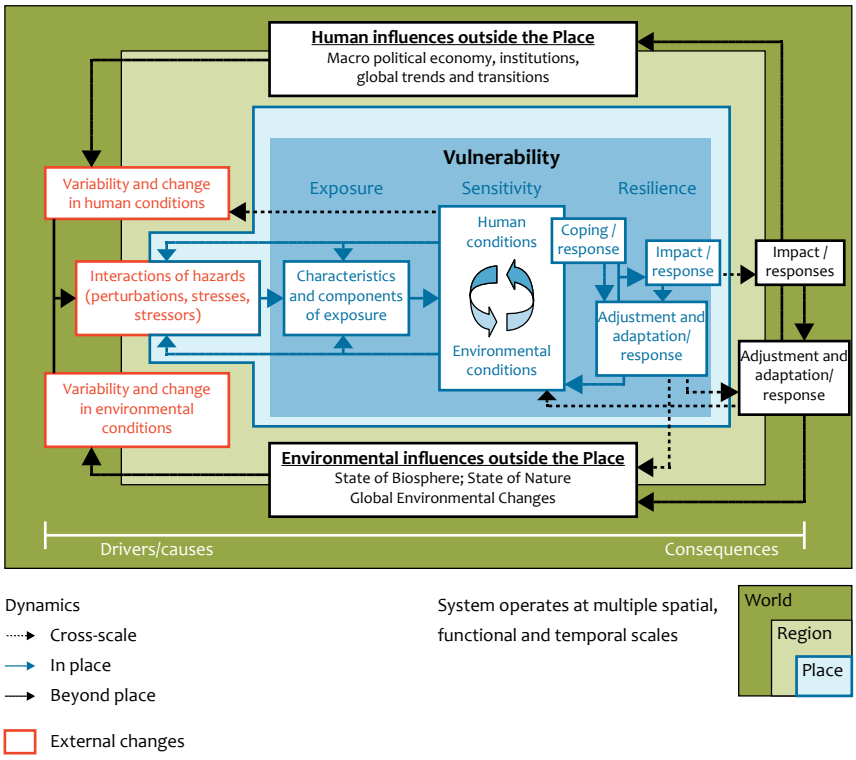
ii) *scale dependent*. Factors determining vulnerability operate over different time and spatial scales. They can be global and take place over a longer time period (e.g. climate change or trade liberalization) or occur at the local or individual level (e.g. lack of entitlement) and take place during the relatively short time scale of an extreme event, such as an earthquake.

iii) *dynamic*. Stressors on the human-environment system are constantly subject to change in response to environmental change and socio-economic developments.

Few frameworks have incorporated all of these different aspects of vulnerability. One example of an integrated framework, that aims to capture all of these aspects, is the vulnerability framework developed by Turner and others (2003). It assesses the human-environment system as a whole, describing its vulnerability as a combination of exposure, sensitivity and resilience. It also takes a multi-scale and multidimensional perspective, making it a comprehensive, though complex framework to use (see Figure 2.2).

Another approach to vulnerability comes from the perspective of resilience (see for instance the Resilience Alliance at http://www.resalliance.org/ev_en.php). The complementary concept of resilience has been used to characterize a system's ability to bounce back to a reference state after a disturbance (Pimm 1984) and the capacity of a system to maintain certain structures and functions despite disturbance (Holling 1973). If a system's resilience is exceeded, collapse can occur (see, for example, Diamond 2004) and the system can change to a different state. Although resilience is also used as a component of other vulnerability concepts, the resilience approach focuses particularly on this system characteristic. It determines the capacity to cope with the impact of a stressor, depending on, for example, institutional capacity or financial resources. This approach does not focus on the desired future outcome, given that drivers are largely unpredictable, but on creating a system that is able to cope with this unpredictability in many different situations.

There is also a growing interest in human security as a part of vulnerability analysis. Human security is viewed as an umbrella concept that embraces overall economic development, social justice, environmental protection, democratization, disarma-



Vulnerability framework developed by Turner and others (2003).

ment and respect for human rights. Research in this field links the human dimensions of environmental change with a re-conceptualization of security (UNEP/Woodrow Wilson International Center for Scholars 2004). It builds on the assumption that environmental stress, often the result of global environmental change, coupled with increasingly vulnerable societies, may contribute to insecurity and even conflict.

For the vulnerability analysis in GEO-4 (Chapter 7), a simplified version of Figure 2.2 was developed as a guide to the aspects of vulnerability to be considered in the chapter. On the left side of Figure 2.3, the stress complex is considered – the drivers and pressures also included in the overall GEO-4 assessment framework. The stressors on the human-environment system are multiple and interacting and consist of both biophysical changes (as discussed in Chapters 2 through 6 of GEO-4) and socio-economic changes (as discussed in Chapter 1 of GEO-4). The right-hand side of the box in Figure 2.3 looks at the impacts of the stressors, but highlights the fact that the impacts depend on the sensitivity of the system and, importantly, on the capacity to adapt to change. Responses (mitigation and adaptation) are embodied by the arrows between the boxes. With this approach the Impacts box in the overall GEO-4 Conceptual Framework (Figure 2.1) is further unpacked.

2.3 The context within which vulnerability unfolds

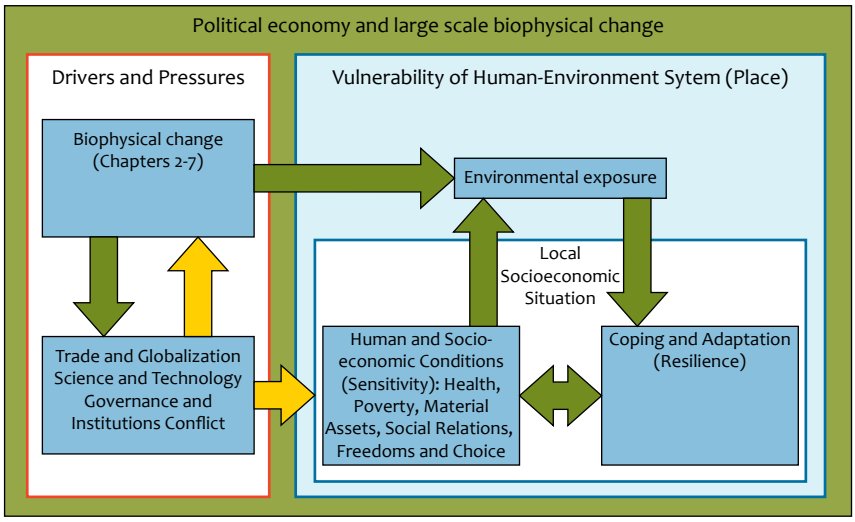
A number of factors shape the vulnerability of people and the environment, including population size and age, poverty, health, globalization, trade and aid, conflict, changing levels of governance, and science and technology. This section describes current trends in these areas.

2.3.1 Population and values

The world's population is currently growing by around 78 million people per year, for the most part in Asia and Africa (UN 2004). At the same time, developed regions such as Europe are facing a growth close to zero, relying mainly on immigration for a positive population growth. In the developed regions, the ageing population has become a primary cause for concern. Providing for the needs of the ageing population and the increasing incidence of age-related illnesses creates important challenges for various areas of public policy, such as health, social security and housing. In many developing countries, an ageing population is a trend that takes place simultaneously with the disintegration of the joint family system that has traditionally provided support to the elderly. This makes the challenge even more complex.

In addition to population size and age structure, the place where people live is an important aspect of vulnerability. The proportion of the population living in urban areas is expected to increase dramatically in the coming decades. In 2007 half of the world population was living in urban areas. This process of rapid urbanization can result in a worsening of living conditions. However, urbanization, provided it is well planned, can also improve opportunities for development (IOM 2005). The effect of crowding increases chances of easily transmittable diseases such as TB, while urban poverty is very often both cause and effect of urbanization – see for instance

Framework for vulnerability analysis in GEO-4 **Figure 2.3**



Framework for the analysis of vulnerability (based on the framework developed by Turner and others 2003; Figure 2.2). Green arrows show connections between the human and environment system. Yellow arrows are the focus of this chapter.

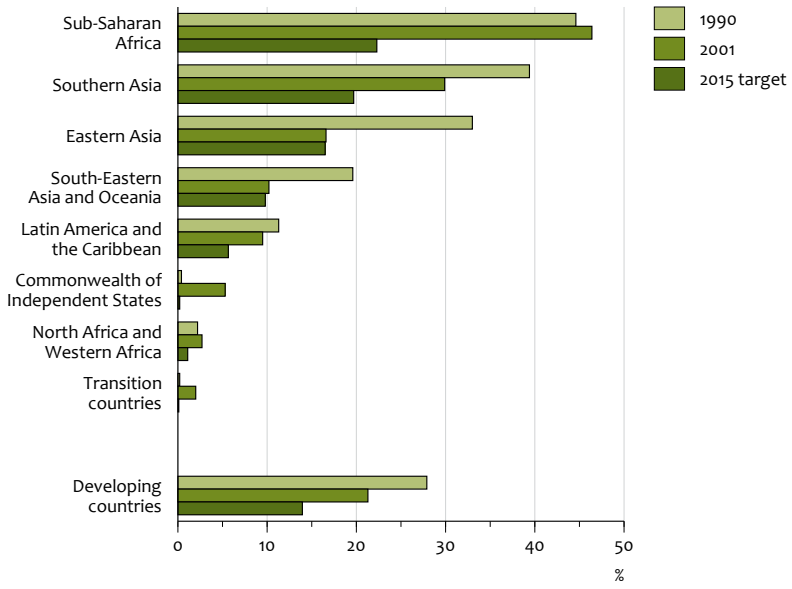
Gray (2001). In addition, the pressure on local environmental goods and services increases with a growing concentration of people in one particular place. At the same time, the process of urban development also creates important implications for the countryside, which provides the much needed land resources for urban expansion, and serves as a receptacle for urban waste. As a result, new challenges inevitably arise for the management of emerging peri-urban settlements.

The large-scale structural changes in economic and political contexts as well as population and migration patterns both influence and are influenced by changes in the values and priorities of people at large. Public opinion certainly influences which measures governments are willing to take to address short and long-term environmental issues, but these values also show the deeper backdrop for vulnerability. There is limited global data available on such changing values but one example is the World Value Survey (Inglehart 1999). This survey is not universal (it includes 61 countries, only two of which are in Africa) but it covers a substantial part of the world's population. It has been carried out four times so far: in 1981-82, 1990-91, 1995-98 and in 2000. In the most industrialized countries, where most people do not face basic survival issues, the first three surveys identified a pattern of systematic changes towards so called post-materialist values. These values place more emphasis on the need to belong, self-expression and having a participating role in society (Inglehart 1999). A study of values in eight developed and developing countries carried out at the end of the 1990s showed that significant segments of their populations were concerned about the state of the environment. When asked about trade-offs, the respondents consistently prioritized environmental concerns over economic interests (Ester and others 2003). An indication of changing priorities is which issues influence people's voting behaviour in elections and it was shown that in most western countries, the salience of new ecological and cultural issues, over economic issues, has increased significantly since 1945. The obvious problem is that these political priorities are often not matched by behavioural changes. Civic engagement is yet another indicator of people's values. In the 1990s, the number of international non-governmental organizations grew by nearly 20 per cent to reach 37 000 in the year 2000, and 1 170 of these focused on environmental issues (UNDP 2002). The fastest growth in membership of these international NGOs occurred in low and middle-income countries (Anheiner and others 2001).

2.3.2 Poverty

Poverty reduces the ability of individuals to respond and adapt to environmental change. Although the multidimensional nature of poverty is widely recognized, income and consumption remain the most common measures. Even though some progress has been made in improving health, education, water, sanitation and economic development, poverty remains a major problem for improving human well-being and achieving sustainable environmental management. Globally, policymakers have reconfirmed their commitment to reducing poverty in the Millennium Development Goals. While 1 billion people still subsist on less than US$1 per day, there have been improvements in some regions (Figure 2.4). In Asia, the number of people living on less than US$1 per day dropped by nearly a quarter of a billion between 1990 and 2001, due to sustained growth in China and acceleration of the economy in India. China's accomplishments alone accounted for most of the global progress in reducing poverty in the last 20 years (Dollar 2004, Chen and Ravallion 2004). However, the statistics show that the very poor are getting even poorer. The average income of the extremely poor in sub-Saharan Africa declined between 1990 and 2001 (UN 2005). Reversing this trend will require economic growth that actually reaches the poor, which is a challenge especially because of the HIV/AIDS epidemic and armed conflicts in the region. Dramatic increases in the proportion of people living on less than US$1 per day are found in the transition

People living on less than US$1 a day **Figure 2.4**



Proportion of people living on less than US$1 per day (UN 2005).

countries of south-eastern Europe and the CIS countries (see Figure 2.4). Figure 2.4 also shows the difference between the present situation and the Millennium Development Goal to halve the proportion of people living on less than US$1 per day, between 1990 and 2015.

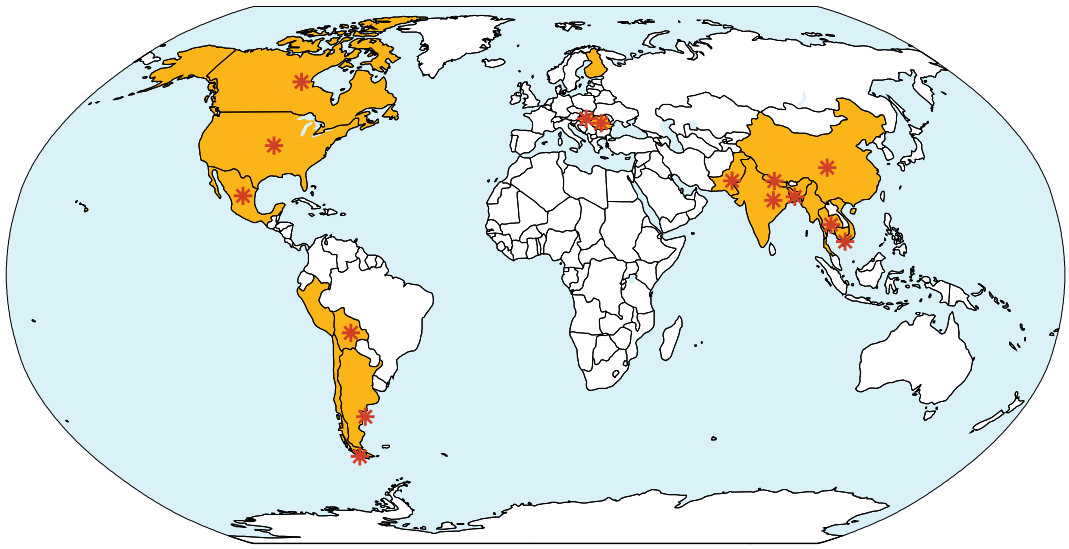
Even in regions and countries with economic growth, many poor people are left behind. In Latin America, for example, the last decade saw an increase in the number of people living in poverty, as well as an increase in GDP per capita (WRI 2005). In China, economic growth has led to a widening income gap between urban and rural areas over the last two decades. In the developed world, poverty persists in spite of the general affluence of the population. In the United States, the number of poor has risen steadily since 2000, reaching almost 36 million people in 2003, which is 1.3 million more than in 2002 (WRI 2005). Historically marginalized groups, such as Native Americans, African Americans and Hispanics, continue to suffer significantly higher rates of poverty. In 2003, for example, 24.4 per cent of African Americans were living below the poverty line compared to the national rate of 12.5 per cent (WRI 2005).

At country level, global initiatives have changed course slightly, by giving greater credence to the role of government and civil society in addressing poverty reduction, as well as acknowledging that poverty alleviation needs to go beyond economic growth. The World Bank's Poverty Reduction Strategies (PRSP), initiated in 1999, aim at poverty reduction through a participatory, long-term and result-oriented strategy that seeks to bring together both government and civil society in finding solutions. More than 50 countries are in various stages of preparation and implementation of Poverty Reduction Strategies (Bojo and Reddy 2003). The mainstreaming of environmental issues remains weak, although there has been improvement in this area since 1999 (Bojo and Reddy 2003).

The fact that the very poor are getting poorer and that poverty remains a problem in many world regions provides a very important context for the analysis of broad patterns of vulnerability, in particular since poverty strongly influences the capacity to adapt to multiple stressors. Poverty is inextricably connected with the environment and natural resource base; poverty can drive people to short-term survival strategies to the detriment of natural resources. At the same time, resource degradation affects the poor more than the rich, and can drive them to further poverty. For instance, as water tables fall, the costs of extraction increase, making water further out of reach of the poor (Narain 1998). In the absence of organized sources of drinking water supply, the poor may spend a large proportion of their income on buying water, and be left with smaller disposable incomes for other needs of sustenance.

2.3.3 Health

In the last five decades, there has been a general improvement in health worldwide, as a result of social, economic, environmental, and technological advances, as well as the increased availability of health care services and the effectiveness of public health programmes. However, these health gains have not been achieved to the same degree in all countries of the world, nor have all groups within a population benefited equally from them; in some cases, the past 20 years have seen marked deteriorations. The least favourable health situations are those in which the persistence of communicable diseases is associated with deficient living conditions, including poverty and progressive environmental degradation. While the death toll of several infectious diseases has decreased drastically, the toll due to chronic diseases has



Arsenic contamination (Gordon and others 2004).

increased. But some new infectious pandemics appear possible, and at least one – HIV/AIDS – is already with us.

A very important global context for vulnerability is the risk faced by children. As Gordon and others (2004) point out, over ten million children under five years of age die every year – 98 per cent of them in developing countries. Widespread malnutrition hampers children's growth and makes them vulnerable to other risks: perinatal diseases, pneumonia, diarrhoea, and malaria. In industrialized countries, in contrast, junk food and a sedentary lifestyle are leading to an unprecedented epidemic of obesity in children. Among the risks that children face, as documented by Gordon and others (2004), are fluoride and arsenic in drinking water, and the ingestion of lead. In certain areas of the world, children's drinking water contain dangerous levels of arsenic (see Figure 2.5). Lead is still found as an additive to gasoline, an ingredient of paint and pottery glaze, and in old water pipes. Children are at the greatest risk because lead is more readily absorbed by their growing bodies and their tissues are more sensitive to damage. The threshold above which irreparable damage occurs is still exceeded around the world, particularly for children in cities in the developing world. In industrialized countries, where progress has been made in phasing out lead in gasoline and banning its use in consumer goods, lead-based paint continues to be a problem (Gordon and others 2004).

AIDS has become a leading cause of premature deaths in sub-Saharan Africa and the fourth largest killer worldwide (UN 2005). At the end of 2004, an estimated 39 million people were living with HIV. The epidemic has reversed decades of development progress in the worst affected countries. In sub-Saharan Africa, 7 out of 100 adults carry HIV. HIV is spreading fastest in the European countries of CIS and in parts of Asia (UN 2005). In countries where the epidemic is still at an early stage, programmes targeted at the most vulnerable are effective. However, in many countries inadequate resources and a lack of political leadership inhibit progress, especially where HIV has spread among marginalized and stigmatized groups. Globally, just under half of the people with HIV are female, but this share is growing. Also, as the epidemic spreads, the number of children who have lost both parents to AIDS is growing. In 2003, over 4 million children in sub-Saharan Africa had lost both parents and 8 million had lost one parent. This points to an unprecedented social problem with large implications for vulnerability to multiple stressors (see, for instance, Ziervogel and others 2006).

Malaria is endemic in many of the world's poorest regions, affecting an estimated 350 to 500 million people per year. Ninety per cent of the 1 million malaria deaths each year occur in sub-Saharan Africa (UN 2005). The disease disturbs mental and physical development, and has debilitating effects on adults, often removing them from the work force for days or even weeks at a time. In poor regions, therefore, malaria reduces the already low adaptive capacity, while at the same time being one of the many stressors that humans have to deal with. As demonstrated in the Millennium Ecosystem Assessment, there are strong interrelationships between ecosystem services, aspects of human well-being and human health. Over 1 billion people still lack access to safe water supplies, while 2.6 billion people lack adequate sanitation (MA 2005). As a result, water-related infectious diseases claim up to 3.2 million lives each year, approximately 6 per cent of all deaths globally. The burden of disease from inadequate water, sanitation and hygiene totals 1.8 million deaths and the loss of more than 75 million healthy life years.

While aggregate food production is currently sufficient to meet the needs of the total world population, about 800

million people are underfed with protein and/or energy, while a similar number are overfed (MA 2005). In addition, at least 1 billion people experience chronic micronutrient deficiency. In contrast, in some countries health problems related to lifestyles, urbanization, and an ageing population have increased (PAHO 2002). Cardio-vascular disease (CVD) now ranks as the world's number one cause of death, causing one third of all deaths globally (Mackay and Mensah 2004). However, heart disease is no longer just a problem of overworked, overweight men in the developed world. Women and children are also at risk and already 75 per cent of all CVD deaths occur in developing countries (Mackay and Mensah 2004). In many OECD countries, the growing number of overweight and obese children and adults is rapidly becoming a major public health concern (OECD 2005) and is clearly related to consumption levels, as well as to the nature of consumption in these countries. More than 50 per cent of adults are now defined as being overweight or obese in ten OECD countries: the United States, Mexico, the United Kingdom, Australia, the Slovak Republic, Greece, New Zealand, Hungary, Luxembourg and the Czech Republic (OECD 2005). Obesity is a risk factor for a number of health problems and is linked to significant additional health care costs.

Both indoor and outdoor pollution continue to have health impacts, in particular heart and lung disease. About 3 per cent of the global burden of disease is attributed to indoor air pollution from the burning of biofuels. Fuel wood scarcity has a number of health effects, not only because of the long distances that have to be covered to search for and carry firewood, but also because a lack of fuel reduces the possibilities to boil and thus sterilize water, cook food, or heat a home. Indoor air pollution has strong equity implications, since women and children are the most vulnerable.

The Arctic Monitoring and Assessment Programme (ACIA 2004) established that the highest Arctic exposures to several persistent organic pollutants and mercury are faced by Inuit populations in Greenland and Canada. These exposures are linked mainly to consumption of marine species as part of traditional diets. Subtle health effects are occurring in certain areas of the Arctic due to exposure to contaminants in traditional food, raising particular concern for foetal and neonatal development.

There are various ways of measuring population health, depending on what the results are intended for (Murray and others 2002). Health measurements range roughly from more static measures for monitoring the health status of a population to comparing different (sub)populations, to provide more insights into underlying dynamics and causes of death. The most commonly used measure of mortality levels is life expectancy. The life expectancy reflects the mean number of years an age cohort (persons born in the same year) may expect to live if current levels of mortality prevail. The life expectancy can be calculated for all ages. The combination of the age at which death occurs, and the life expectancy a person has at the age of their death, result in the number of years of life lost (YLL). The summation of YLL over all annual deaths in a population results in the total number of life years lost due to premature deaths.

Murray and Lopez (1994) developed a methodology in which morbidity is also taken into account. Their methodology is similar to the YLL. They quantified the number of years of life lived with a disease (YLD) by taking into account incidence, prevalence and duration of a disease, combined with the severity of the disease. The sum of the YLL and YLD results in disability-adjusted life years (DALY) and expresses a measure of the burden of disease.

As Figure 2.6 shows, the two regions sub-Saharan Africa (SSA) and East Asia and the Pacific were at similar levels of life expectancy in 1960, but the latter region has now almost caught up with the rich countries, while the former has in recent years shown declines despite some initial gains. The decline in life expectancy in SSA is likely the result of the "lost decade" of development, the AIDS pandemic, and continuing civil war (Mills and Shillcutt 2004).

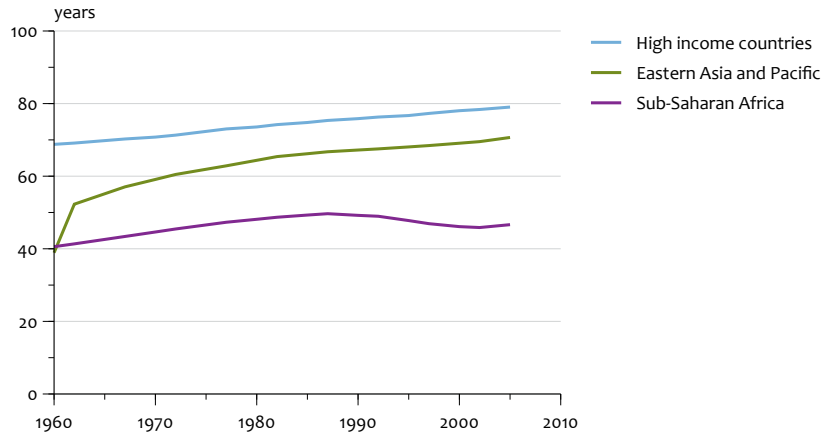
While considerable improvements have been made in some areas of public health, many others still warrant attention. In sub-Saharan Africa, for example, malaria accounted for an estimated loss of 36 million Disability Adjusted Life Years (DALYs) in 1999, out of a population of 616 million. If each DALY is valued very conservatively as equal to per capita income, the total cost of malaria would be valued at 5.8 per cent (=F 36 / 616) of the gross national product of the region.

2.3.4 The economic context: globalization, trade and aid

The economic sphere is characterized by growing globalization, or interdependence, the outcomes of which are contested. On the concept of globalization, Cerney, Menz and Soederberg (2005: 9) note that "there are almost as many definitions as there are scholars and actors writing and thinking about globalization".

Globalization has been defined as "the closer integration of the countries and peoples of the world which has been brought about by the enormous reduction of costs of transportation and communication, and the breaking down of artificial barriers to the flows of goods, services, capital, knowledge and (to a lesser extent) people across borders (Stiglitz 2002: 9)". Bertucci and Alberti (2003: 17) define globalization as "the increasing flows between countries of goods, services, capital, ideas, information and people that produce cross-border integration of economic, social and cultural activities". They note that it creates both opportunities and costs for the actors involved, and for this reason it should not be demonized or sanctified, nor should it be made a scapegoat for the major problems affecting the world today.

Jacques (2003), noting the many ways in which the term can be interpreted, sees globalization as a system, a process, an ideology and an alibi. As a system, it represents the total control of the world by supranational economic interests. As a process, it represents a series of actions carried out in order to achieve a particular result. As an ideology, it represents a coherent set of beliefs, views and ideas determining the nature of truth in a given society. Its role is to justify the established political and economic system and make people accept it as the only one that is legitimate, respectable and possible. As an alibi, globalization is presented as a natural,



Trends in life expectancy in different world repliers (WHO 2005)

inevitable and irresistible phenomenon, that lets the major economic and political decision makers off the hook.

While it is common to see globalization as a predominantly economic phenomenon represented in the integration of world markets, it should actually be seen as a multi-faceted phenomenon with political, economic, technological and cultural dimensions (Giddens 2002). Giddens refers to a process of "reverse colonization", implying that the non-Western countries have come to exercise an influence over developments in the West – the emergence of a globally-oriented high tech sector in India or the selling of Brazilian television programmes in Portugal. Cerney, Menz and Soederberg (2005: p.2) see globalization as "essentially a political process of convergence".

Some suggest that increasing democracy and interdependence bodes well for cooperation, peace, and for solving common problems (Bhagwati 2004, Birdsall and Lawrence 1999, Russett and Oneal 2000). Others see growing economic interdependence as exploitative and, therefore, see a murkier future for global cooperation and justice (Mittelman 2000). They point to the fact that the gap between the haves and the have-nots is increasing and that instead of multilateral solutions, states are giving increasing precedence to nationalistic, short-term, profit-driven priorities. Moreover, states are supposedly hampered from taxing a "footloose" tax base (because money, people and business are no longer strongly connected to a country), undermining their ability to provide public goods that strengthen communities (Rodrik 1997). The economic growth rates of the poor countries have increased in recent years after the "lost decade" of the 1980s, but they do not match those of the rich countries, nor compare well against the dynamic economies of East Asia.

The era of globalization is characterized by the rise of global corporations that are influential economic actors. As such, giant corporations cannot be ignored in a global governance context traditionally dominated by states. For example, important outcomes, such as health, environmental protection or decisions about the quantity and quality of consumption, have more to do with corporate decisions and market outcomes than government-level, political factors that are conducive to legislation. Moreover, corporations are in possession of a large proportion of technology and knowledge that individual states and communities do not have access to, and have become important drivers of agricultural policy. While states still "rule the world," recently global corporations have publicly begun to seek the global political stage, particularly at gatherings, such as the World Economic Summit, and multilateral negotiations, such as the Multilateral Agreement on Investment (De Grauwe and Camerman 2003, Graham 2000, Wolf 2004).

International trade has developed within the context of the World Trade Organization. However, as the Millennium Goals Report points out, if developing countries are to take advantage of the potential of international trade to enhance economic growth, the main barriers to their exports must be removed: tariffs imposed by developed countries on imports and subsidies that developed countries provide to domestic agricultural producers. Developed countries' tariffs remain high on goods that are strategically important for developing economies (UN 2005). It is estimated that free trade in farm products alone would benefit developing countries by US$20 billion per year.

The UN Millennium Declaration embodies an agreement that developing countries will work to maintain sound economies, to ensure their own development and to address human and social needs. At the same time, developed countries agreed to support poorer countries through aid, trade and debt relief. With the growing interest in markets, the aid agenda has changed. Poor countries have been beset by debt, particularly after borrowing heavily through the 1970s from private banks eager to recycle the so-called petrodollars (Spero and Hart 2003). Inward looking industrialization and large project mentalities drove many of the economic policies, in some cases resulting in waste of resources since the expected development never took place. Aid policies of the multilateral lending agencies also reflected this big-project bias. This thinking has changed with the end of the Cold War and the collapse of the Soviet Union. With the move to the market, the donor agencies and banks concentrate on raising human

capital and alleviating poverty, with economic development left up to liberalizing markets rather than states. While for many, this may seem a kinder, more gentle approach to economic development, others are more skeptical as to whether the retreat of the government is going to accelerate development at all (Sen 1999, Wade 2003).

As the 2005 Millennium Development Goals Report (UN 2005) points out, most of the recent increases in aid have been used to cancel debts and to meet humanitarian and reconstruction needs after emergencies. Even though Africa has only 5 per cent of the developing world's income, it carries about two thirds of the Global South's debt burden – over US$300 billion. Despite extreme poverty, the continent transfers almost US$15 billion a year to rich nations in external debt repayments. This effectively means that the average African country spends three times more on repaying debt than it does on providing basic services to its people. By the end of 2004, Africa spent about 70 per cent of its export earnings on external debt servicing (Africa Recovery 2004). Debt repayments continue to be a major impediment to growth (Katerere and Mohamed-Katerere 2005). Debt relief often goes to countries that have ceased debt repayments and does not necessarily provide new finance for social services or poverty reduction. Nevertheless, in many countries it has had positive impacts. For example, in Tanzania, debt relief led to a 50% increase in primary school enrolment, while in Ghana, it created the opportunity to rehabilitate the road network. Emergency and disaster relief usually does not address long-term development needs. The share of total official aid going to basic human needs has doubled since the mid-1990s, but the share going to agriculture and physical infrastructure has diminished – two sectors that need support if countries are to feed their own people, build their economies (UN 2005) and increase their adaptive capacity in the face of multiple stressors. A debt relief programme for the most heavily indebted countries has reduced future debt payments for 27 nations by US$54 billion (UN 2005). However, external debt is still an obstacle to development.

The end of the Cold War has also led to changes in development aid. Developing countries are now moving to market solutions and pragmatic arrangements for increasing trade and foreign direct investment (FDI) for generating employment and alleviating poverty (Dollar and Kraay 2000, UNCTAD 2005, Ward and Gleditsch 2003, World Bank 1996). Africa is, however, still a marginal recipient of FDI, receiving only about 2 per cent of the global tota1 (ADB 2004). Countries in sub-Saharan Africa share less than 1 per cent, half of which goes to South Africa (Oxfam 2003). Although FDI increased in the 1990s (FAO 2004a), it has now taken a dramatic downward swing. In 2002, FDI inflows declined from US$19 billion in 2001 to US$10.9 billion, a staggering 41 per cent reduction, which affected 23 countries (ADB 2004). Most FDI goes into oil and gas projects in Angola, Algeria, Sudan, Nigeria and Gabon and into gold mining in Tanzania and South Africa. Africa's share of FDI to developing countries is only around 4 per cent compared to 45 to 50 per cent for Asia and 30 per cent for Latin America (ADB 2004). A large percentage of FDI earnings are externalized.

Overall, the global context with regard to globalization, trade, aid and poverty, suggests that major progress has yet to be achieved in reducing poverty and, thus, increasing adaptive capacity in the face of multiple stressors. The trade and development agendas have not been reconciled and the gap between the rich and the very poor is still growing, leading to large differences in adaptive capacity.

2.3.5 Conflict

Since the end of the Cold War, the incidence of civil and interstate conflicts has decreased dramatically (see Figure 2.7), while the growth of democracy has been unprecedented (see Figure 2.8). Almost all regions of the world have seen a decrease in civil war risk except sub-Saharan Africa. The current security scene is dominated by the War on Terror, at least since the 9/11 attacks on the United States. While terrorism is high on the global security agenda, there is no marked overall incidence of terrorism globally, and no indication that international terrorism is on the rise (De Soysa 2005).

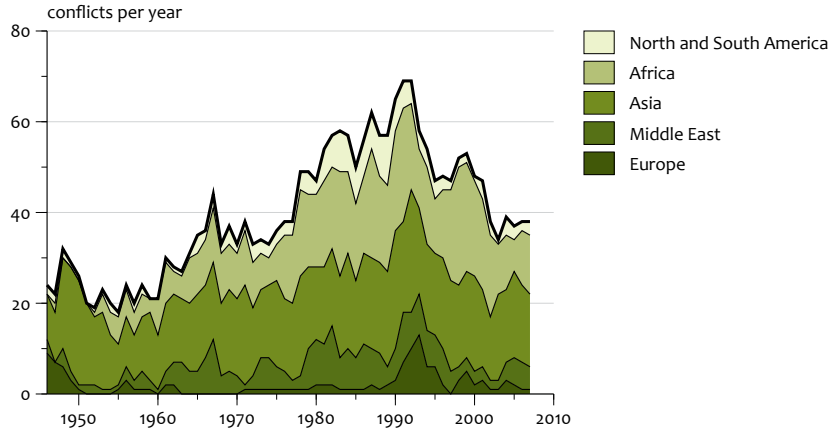
Conflicts are inextricably interwoven with the natural resource base. On the one hand, resource scarcity can trigger conflicts. On the other hand, conflicts over natural resources can be expressions or results of other social tensions. Natural resource use is contested and reflects struggles over scarce social and material resources.

Efforts to eradicate poverty and hunger are frequently set back by both conflict and natural disasters. Out of 13 million deaths in large-scale conflicts from 1994 to 2003, over 12 million occurred in sub-Saharan Africa, Western and Southern Asia. These regions are also home to three-quarters of the world's 37 million refugees and displaced persons and the areas where the number of hungry people is growing. In two of these regions – sub-Saharan Africa and Western Asia – poverty is also on the rise. Over the same period of time, 669,000 people died as a consequence of natural disasters.

2.3.6 Changing levels of governance

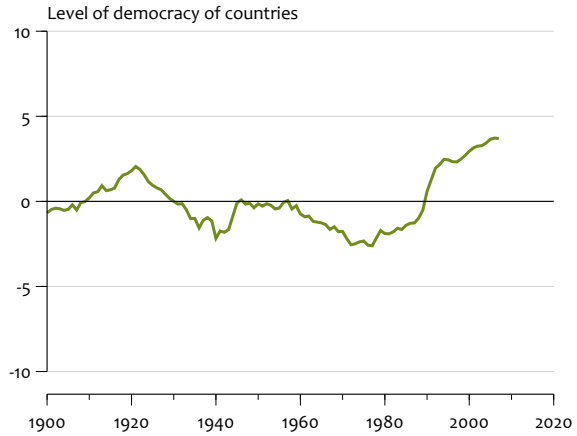
The changing political context includes changes in the approach to multilateralism on the part of countries and regions. The early years after the end of the Cold War, coinciding with the 1992 Earth Summit, witnessed a renewed optimism in multilateralism and global governance. There were a number of other Summits in the 1990s, which covered, for example, children (1990), human rights (1994), population (1994), Small Island Developing States (SIDS) (1994), social development (1995), and human settlements (1996). The Millennium Summit in 2000 also reflected the same kind of aspiration for global cooperation, formulating detailed, bold but necessary goals for the first 15 years of the new millennium. Global governance in the form of normative declarations and ambitious action plans from all of these summits have illustrated an emerging unity in how governments and the international community understand the increasingly complex and globalized problems and how these should be addressed. Global governance was strengthened also through new bodies with considerable authority; in the area of trade, through the establishment of the World Trade Organization in 1994; and in the area of crimes against humanity through the establishment of the International Criminal Court in 2002. Other reforms of the UN system itself have been slower in

Number of armed conflicts **Figure 2.7**



Armed conflicts 1946 – 2004 by region (Uppsala-PRIO armed conflicts dataset).

Global democracy **Figure 2.8**



Global Democracy 1900-2006 (Polity 4 database).

coming, even if some steps were made at the 60th anniversary of the United Nations in 2005.

In parallel, regional cooperation has made significant progress around the world even if its forms and intensity have varied considerably. Regional political cooperation reached new peaks in the European Union, but other regions have also created agreements on trade and other types of cooperation, such as the North American Free Trade Association (NAFTA), the Association of Southeast Asian Nations (ASEAN) and the African Union. Regional actors have even become involved in peace keeping which had previously been considered an exclusive task for global organizations. Regions have also become more visible in global deliberations, for example, through the emphasis on regional preparation meetings for international summits including the World Summit on Sustainable Development. In governance, the national level remains central, despite continuing discussions on the erosion of sovereignty. However, the capacity of national governments to exercise effective governance varies considerably.

Many of the least developed countries are still struggling to create the basic elements of governance and services. Within some countries, the last few decades have also seen a trend towards both political and fiscal decentralization of governance to sub-national levels; these include OECD countries (Stegarescu 2004), as well as developing countries in Africa and Latin America, which inherited very centralized governance structures from the colonial period (Stein 1999, Brosio 2000). This may not necessarily mean that local authorities have been empowered, as decentralization without devolution can be a way to strengthen the presence of the central authority (Stohr 2001). Local governments have also engaged much more widely in international cooperation in various arenas and at the global level their role was strengthened through the establishment of the United Nations Advisory Committee of Local Authorities (UNACLA) in 2000.

Chang (2006) argues that the rising influence of multilateral organizations, such as the IMF and the World Bank, as well as the growing number of international conventions and

regimes, has led to the shrinkage of policy space to dangerous levels for most developing countries – to the point that their ability to achieve economic development itself is being threatened. The current phase of shrinkage in policy space started in the 1980s, when, in the aftermath of the debt crisis in 1982, the World Bank and the IMF massively expanded their programme loans in the form of structural adjustment programmes and broadened the scope and enhanced the strength of the conditionalities attached to their loans. Chang takes an extreme view, asserting that, these days, there is virtually no area in which the World Bank and the IMF do not have very strong influence – democracy, judicial reform, health, education, and so on. At the same time, aid policies of the developed countries also have contributed to the shrinking of the policy space. This policy space is further reduced through the actions of developed countries in the WTO. Chang concludes on a pessimistic note that "urgent action is needed; if nothing is done, the policy space available for developing countries will shrink to virtually nothing, over the next several years, which could spell the end of development". This view, however, has been challenged by skeptics, such as Shalini Randeria, who argue that the state selectively implements what it wants to, and, in doing so, exercises discretion to suit its convenience. The government has room to manoeuvre or to manipulate policy reforms, giving rise to the notion of the "cunning state" (Randeria 2003).

Environmental governance has evolved extensively over the past 20 years, both in real terms and in the norms and criteria after which its process and outcome is evaluated and judged – sometimes leading and in other cases following the development of governance in other areas. There are four trends which seem most prominent.

Firstly, the scope has broadened of the issues that are considered relevant. The marriage of environment and development in the 1987 report of the World Commission on Environment and Development "gave birth" to the integrated and unifying concept of sustainable development (World Commission on Environment and Development 1987). At the 2002 World Summit on Sustainable Development, this unification had reached the point where poverty reduction was integrated in all parts of the implementation plan, particularly through the adoption and expansion of the Millennium Development Goals. Furthermore, the issues of trade, economic development, good governance, transfer of technology, science and education policies, and the globalization processes that link them together are all seen as intrinsically relevant from the perspective of the sustainable development governance process. Hardly any issue has been left out. The integration of the global environment and development agendas is an important step, but it has been a continuing struggle to operationalize this normative goal into policy and practice. Action has been fragmented, overall (United Nations Economic and Social Council 2001). Nevertheless, despite the challenges to make this marriage work, a divorce has been unthinkable.

Secondly, over time, there have been shifts in which levels of government are active and which are called upon to get engaged. The post-UNCED period saw a strong increase in sub-national, including local, government action, for example through local Agenda 21 processes – one of the few success stories in the ten-year review of the Agenda 21 implementation (United Nations Economic and Social Council 2001). Another example is the Cities for Climate Protection, a campaign by ICLEI (Local Governments for Sustainability), with 650 local governments integrating climate mitigation in their decision-making processes. The global intergovernmental action was also significant post-UNCED, with a number of Multilateral Environmental Agreements (MEAs) being negotiated, ratified and entered into force. There was weaker performance on national and regional levels. For example, in the year 2000, less than half of the UN member countries had developed some kind of national strategy for sustainable development called for in Agenda 21 and many did not live up to financial commitments nationally or internationally to implement Agenda 21 (United Nations Economic and Social Council 2001). The Johannesburg Plan of Implementation stated that the role of national policies and development strategies "cannot be overemphasized" and it also strengthened the role of the regional level, for instance, through giving the regional UN Economic Commissions new tasks and establishing a regional preparation process for the Commission on Sustainable Development (CSD) (United Nations 2002).

Thirdly, the types of actor — often called stakeholder groups — that are both bringing about change and are seen as essential to bring about change, have expanded. While decades ago, environmental — often Northern-based — NGOs tended to be the prime movers and pushers to get environmental issues on the agenda and governments were the first major actors, the actor landscape has since changed considerably. The nine major groups identified in Agenda 21 — local authorities, women, farmers, youth, indigenous peoples, trade unions, the scientific and technological community, businesses —have an increasing presence and role in deliberations related to the UNCED and WSSD follow-up processes, from global to local levels. At local level, many of these groups are also playing an important role in reducing vulnerability and improving well-being, whether linked to national or global action plans or based on local needs and priorities. In the private sector there have been many initiatives for the environment. Individual businesses have taken action. Businesses or whole industrial sectors have chosen to develop voluntary codes through self-regulation or to follow codes developed by non-governmental organizations or governmental or intergovernmental regulators (Prakash 2000). While many of these actions have been taken by companies that produce goods and thus directly use natural resources and produce pollution, there are also new sub-groups within the private sector that are taking action. Examples include insurance companies, investment (pension) funds, and groups of shareholders (Kasemir and others 2005). There are also other groups, beyond the nine major groups, which are increasingly acting for sustainable development. Educators have contributed enormously to providing knowledge and inspiring more "sustainable" values, in both formal and informal educational settings, efforts which are now being pulled together and strengthened in the framework of the United Nations Decade on Education for Sustainable Development (UNESCO 2005). Groups of faith have also engaged directly in both deliberations on environment and development and direct implementation project.

Fourthly, the ways in which stakeholder groups interact, have changed. They now do so, both with each other and with governments; for example, through dialogues, networks and partnerships. On the one hand, this development reflects the need for a drastic improvement of the effectiveness of governance, which necessitates a broader coalition of actors and pooling of resources. On the other hand, it relates to the fact that governance has increasingly become evaluated by criteria of legitimacy. There should be "good" governance, not just effective governance. Good governance is measured by such criteria as transparency, accountability and legitimacy. It is not only governments that are expected to provide their governance process and outcomes by those standards; governments' collective efforts in global governance as well as corporations, NGOs and the scientific community are judged by them, too. At times, environmental governance and institutions have taken the lead in breaking new grounds to increase their legitimacy, and created learning opportunities for new modes of governance in a broad set of areas. A number of ways to interact with major groups at local, national and global level were institutionalized in the action plans of UNCED and WSSD. Chapter 37 of Agenda 21 urged countries to involve all possible interest groups in building national consensus on implementation of the plan of action (37.5), while Chapter 28 recommended local authorities to engage in dialogue with its citizens, local organizations and private enterprise for the formulation of a local Agenda 21 (28.3) (UNCED 1993). Since 1998, multi-stakeholder dialogues have been incorporated in CSD meetings; later they have become part of the WSSD process. Global public policy networks have emerged on a wide range of issues. These are usually initiatives limited in time, involving many different actors to cooperate with a minimum of formal organization. Multi-stakeholder cooperation in the formulation and implementation of projects has increased (Hemmati 2002). The WSSD Partnerships were just the latest step in supporting this approach of collaboration among IGOs, governments, business and NGOs. The emphasis on voluntary partnerships at the start of the new millennium is perhaps a realisation of the fact that neither the government, the market, nor local institutions, are capable of improved service delivery on their own, but that there is a need for partnerships between various actors, that capitalize on each other's strengths. The World Commission on Dams is another example of the rising significance of multiple stakeholder forums in processes of international governance. In many developing and developed countries, the thrust on public–private partnerships at the national level is another pointer to the need for collaboration among various actors. In India, for instance, public–private partnerships are seen as a mechanism for channelling resources within critical infrastructural sectors, for instance, in the case of roads and highways.

2.3.7 Science and technology

Twentieth-century technologies were central to many improvements in human well-being, including increased life expectancy in Asia, Africa and Latin America and reductions in malnutrition in South Asia (UNDP, 2001). Science and technology have clearly played an important part in the new industrialization in East Asia. However, this growth would not have been possible without institutional flexibility, export orientation, and collaboration between public and private sectors (UNMP, 2005). The pace of development related to science and technology and the levels at which different regions achieve progress, vary widely. While some countries are having marked success in reducing under-five mortality, increasing water access and alleviating poverty, others are lagging far behind (UNDP, 2001).

Technological advances in agriculture, energy, medicine, communications, and manufacturing have been central to many development achievements. Technological change and the ability to acquire, adapt and develop technologies are associated with long-term economic growth rates. In the 1980s, oral rehydration therapies and vaccines suitable for use in developing countries were critical in reducing child mortality. Beginning in 1960, new farming technologies and practices (relating to water use, fertilizer, plant breeding, improved seeds and labour productivity) were part of a transformation in agriculture that increased food production and decreased food prices, addressing malnutrition and chronic famine in many regions. As the development of computing and communication technologies, biotechnology and nanotechnologies shows, contemporary technological growth rates have a faster pace than those of earlier decades. Biotechnology promises huge advances in agriculture and medicine, genetics offers new horizons for pharmaceutical development, and nanotechnology promises to transform multiple domains from medicine to energy and politics (UNDP 2001).

During the 20th century, telephone, radio, television, and the fax machine enhanced communication, allowing people to be better informed and to participate in decision-making, and influencing both peoples' perceptions and priorities. In the 1980s, the fax was a particularly important tool for popular communication at global to local levels (UNDP, 2001).

When Our Common Future was published, the Internet had not yet reached the general public. That did not happen until 1990. In 2003, it had 665 million users worldwide, although the significant regional differences, as well as differences within individual countries illustrate the so-called digital divide (ITU 2004). Global figures for increase in access to other media are also impressive, even if regional disparities prevail. In 1985, 35 per cent of the world's population had access to radio, and 15 per cent had access to TV; in 1997 the figures were 42 and 24 per cent, respectively (UNESCO 2002). Between 1991 and 2003, the percentage of people with access to a landline increased by over 220 per cent and in the same period the number of mobile phone subscribers increased by 8300 per cent to over 1300 million (ITU 2004) .

This globalization of information flows has dramatically changed the information and images people are exposed to on a daily basis. It contributes to the fact that there are much larger differences in value orientations among people living in the same country than between people from different countries (Welzel, Inglehart, and Klingemann 2002). The changing media scene is also likely to have an impact, negative or positive, on people's sense of vulnerability. In a very concrete sense, it gives unprecedented early warning opportunities for man-made and sudden natural disasters, such as hurricanes, tsunamis, and earthquakes; it also enables, for example, farmers to access seasonal weather forecasts. Again,

however, it is the most vulnerable that tend to lack access to these media and other resources.

In fact, the process of globalization of governance, is largely being shaped through the rapid spread of information technology, as well as its wide acceptance and use. In 2001, about 520 million people used the Internet, linked by a global network of 147 million host computers (World Watch Institute 2002). The Internet has almost doubled in size since 1999, though since 1996, it has been growing more slowly than it did initially. It is estimated that 1 in every 12 people in the world goes online to get news, send email, buy goods or be entertained.

However, there are, at the global level, asymmetries in access to this resource. The United States, where the Internet was developed, continues to dominate this electronic network. About a third of all people online, worldwide, are American. In the developing countries, however, just a small share of the people has access to the Internet: 2.6% in China, 1% in Indonesia, and less than 0.5% in India. Most of Africa is still left out of the global network, plagued by a lack of infrastructure, particularly telephone lines, and high connection costs.

Furthermore, the asymmetries extend to the disposal of the Internet's waste, as well. The wired world generates a tremendous amount of hazardous waste: a computer monitor, for instance, contains 4 to 8 pounds of lead (World Watch Institute 2002). It is estimated that some 50-80% of used computers, circuit boards, and monitors discarded in the United States are sent to China, India and Pakistan for recycling and disposal, exposing workers to toxins and poisoning groundwater supplies.

Although the Internet is making slow progress in some of the poorest parts of the world, it can be extremely useful to accelerate its dissemination. For instance, telemedicine projects in Mozambique, Uganda and Bangladesh have improved medical care in remote and poorly equipped areas. Using low-cost equipment, rural doctors can send x-rays or laboratory results to medical experts at hospitals in larger cities, and obtain advice about treatment. At 20 learning centres in India and Morocco, primary school teachers are getting long-distance training over single terminal hook-ups.

The information flow further contributes to the formation of a "world public opinion" which is emerging on many issue areas. Media access allows those who are not immediately affected to learn about disasters in distant places in painstaking detail almost instantly, as exemplified by the 2004 tsunami in the Indian Ocean and the 2005 flooding of New Orleans; this can spur concern and action, for instance, through financial donations. From the perspective of the lowest-income groups, the information flow probably influences people's "perceived" poverty and well-being as the images of wealthy (luxury) consumption lifestyles reaches them. These information channels thus also serve as a vehicle for globalizing the desire for and spread of specific types of consumption and often environmentally destructive behaviour across the world. However, ultimately the media provides an often underutilized potential to educate populations on our dependence on ecosystem services and the impact of human actions on them.

Science and technology have undoubtedly added to the risks faced by the human-environment system in a number of cases, in particular through driving environmental change (see, for instance, the stratospheric ozone depletion). The potential for science and technology to reduce vulnerability to multiple stressors remains very unevenly distributed worldwide. In developing countries, technology such as the use of mobile phones and e-kiosks can, by improving the flow of information about markets and prices to farmers, reduce transaction costs (costs of information, contracting and enforcement) and lead to gains in efficiency and productivity.

2.4 Aspects of vulnerability

Although vulnerability is context and site specific, certain common elements can be observed across various regions, scales and contexts. Overarching vulnerability issues, such as equity, the export and import of vulnerability from one place or generation to another, and the causal relationships with conflict, hazards and the environment, deserve special attention, since they represent strategic entry points for effective vulnerability reduction and policy-making.

2.4.1 Inequalities, equity and vulnerable groups

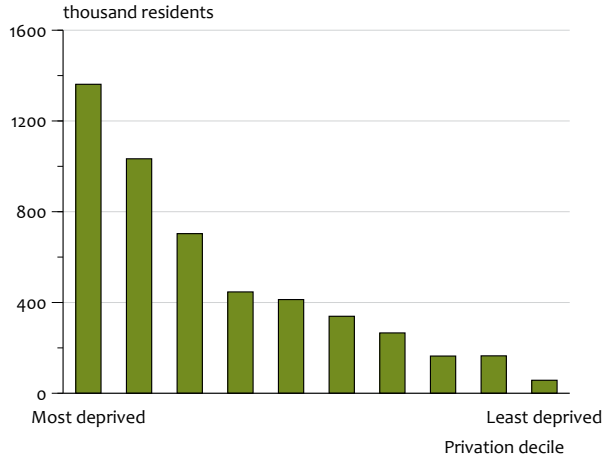
All of the patterns of vulnerability analysed for GEO-4 show that vulnerability varies across groups: men and women, poor and rich, rural and urban. Refugees, migrants, displaced people, the very young and old, and women and children are often the most vulnerable groups subject to multiple stressors. Figure 2.9, for example, illustrates the distribution of an air quality index with respect to an index of deprivation in the United Kingdom (Walter and others 2003). It clearly shows that the most deprived are also the ones who suffer from the worst air quality. Factors such as ethnicity, caste, gender, financial status or geographical location underlie problems of marginalization and disempowerment, all of which lower the capacity to respond to environmental and non-environmental changes. Choice and security also vary according to gender, age, disability, location, poverty, unemployment, group affiliation and conflict. These disparities make it essential to consider inequalities in assessments of vulnerability and impacts of multiple stressors on well-being. These inequalities also have been addressed in discussions of environmental justice (see Box 2.1).

Human well-being, or the lack of it, and vulnerability have intergenerational aspects. Poorer children start out at a disadvantage with poverty and ill-being (see Figure 3.1 for what constitutes ill-being), inherited from one generation to the next (Brock 1999, Chronic Poverty Research Centre 2005). Social, political, economic and environmental change and the responses to it, affect opportunities available for development, reduction of vulnerability and future promotion of human well-being.

2.4.2 Export of vulnerability

Many of the patterns of vulnerability demonstrate the phenomenon of "exporting vulnerability". Decreasing the

Population in wards with 10% worst air quality 2001 **Figure 2.9**



Distribution of population in wards with 10% worst air quality, in United Kingdom per privation categories (Walker and others 2003).

vulnerability of some is increasing vulnerability of others far away (Martinez-Alier 2002). While most people in industrialized countries and the new consumers in the developing countries do not feel most of the impacts on the environment that they cause through their behaviour, negative effects on the environment and well-being (especially health, security, and material assets) are felt most strongly by the poor. They are the ones who, as a result of unsustainable production patterns, have to cope with polluted land, water and air, unsafe working conditions, environmental hazards and an increased risk of disasters, changing social ties and lack of enforcement of their rights. Industrialized countries consume more resources than are available to them in their own regions; they have a large "ecological footprint" (Venetoulis and others 2004, WWF and others 2005, WWF and others 2004). Consumers in industrializing countries are catching up rapidly (Myers 2004).

Despite past efforts in industrialized countries to reduce material use, today, 25 per cent of the world population still uses 80 per cent of the resources and generates 80 per cent of the waste (UNDP 1998, von Weizsäcker and others 1997, WI 2005). Waste is still exported from industrialized to developing countries. While international trade can lead to an increase in welfare and has helped millions of people out of poverty, it also, increasingly, plays a role in sustaining these unequal patterns of consumption, as industrialized countries continue to outsource the extraction of natural resources, much of the production and manufacturing and also their haz-

Box 2.1 Environmental Justice

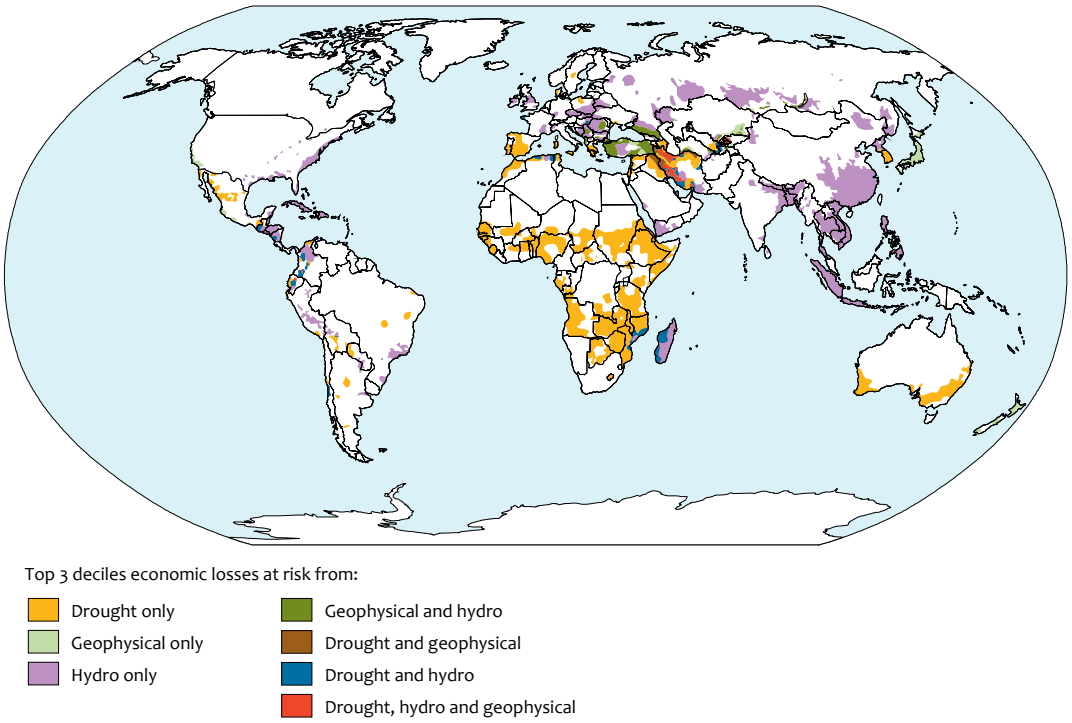
The concept of Environmental Justice was first coined in community struggles and movements against unequal treatment and discrimination in the distribution of adverse environmental effects in the United States. The Warren County, North Carolina case, in which African Americans protested against a toxic waste dump in 1982, is often labelled as a watershed event of the protest movement.

Definitions of Environmental Justice, see for example EPA (2000), discuss fair treatment for people of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies, with further elaboration on what is meant by "fair treatment". The concept of environmental justice originally focused on the distribution of environmental harms (for example toxic waste landfills) in socially disadvantaged or ethnic minority communities. Later, access to environmental benefits (for example clean water) was added, together with a focus on procedural aspects of the justice.

Environmental justice literature in the United States or the United Kingdom deals primarily with the distribution of environmental benefits and harms, at present within the borders of nation states. Distributive justice also includes international aspects and justice to future generations.

If nobody should be disproportionably exposed to adverse environmental impacts because of their ethnic origin or social situation and if everybody should have fair access to a clean and healthy environment, then environmental justice is about just distribution of the environmental benefits and indiscriminate exposure to environmental harms. Furthermore, if, as in national legal systems, all people are equal in the face of the law and have equal access to fair and unbiased treatment, then environmental justice is also about fair and equal treatment in decision-making leading to distribution of environmental benefits and harms.

Highest risk hot spots by natural hazard type **Figure 2.10**



Global distribution of highest risk hotspots by hazard type (World Bank 2005).

ardous waste to the rest of the world (Grether and de Melo 2003, Schütz and others 2004).

Approximately 1.7 billion people, worldwide, now belong to the "transnational consumer class", the group of people characterized by an income beyond US$7 000 in purchasing power parities; diets rich in meat; transport by cars; and lifestyles devoted to the accumulation of non-essential goods. Their lifestyle choices are already placing huge demands on local ecosystems around the globe, and they increasingly threaten the global environment as well. Today, nearly half of global consumers reside in developing countries, including 240 million in China and 120 million in India – markets with a high potential for expansion (WRI 2004, WI 2005).

2.4.3 Vulnerability and conflict

Many of the patterns of vulnerability demonstrate the potential for or actual realization of conflict. This is closely related to the inequalities discussed in the previous paragraphs. Conflicts surrounding the quality and distribution of and access to water resources often arise between upstream and downstream riparian groups. While the costs of dam construction are generally borne by riparian communities, the benefits are often enjoyed elsewhere (WCD 2000), giving rise to potential conflict. At the same time, however, the need for joint management of water resources gathers conflicting parties around the table and encourages cooperative negotiating (see policy section of this report). In drylands, there is conflict potential because of unequal access to scarce resources and migration (Dietz and others 2004). The overexploitation of Common Pool Resources (CPR) lowers the well-being of some groups more than others. This is shown, for example, in the case of the Arctic, which is disproportionally affected by changes to the climate system, a global CPR. The question of future energy generation and the issue of climate change are both directly linked to security and conflict concerns. Energy security and the prevention of distribution conflicts present a political challenge that is likely to continue to increase. In rapidly urbanizing coastal zones and SIDs there are conflicts over competing uses between tourism activities and environmental goods and services related to marine ecosystems. There is also conflict related to migration. For instance, national migration in the Solomon Islands escalated tensions that led to outright conflict, while international migration in Fiji gave rise to a complex conflict situation.

2.4.4 Vulnerability, well-being and natural hazards

Seasonal changes in climate-related hazards, such as floods, hurricanes, droughts, insect invasions, extreme heat or cold, and their related impacts on social systems, including food production in much of the developing world, have significant impacts on human vulnerability and well-being worldwide, and may undermine social and ecological resilience. Figure 2.10 shows the global distribution of high risk hazard hotspots. Natural hazards have an impact on food security, water supply, health, income and shelter (Brock 1999). These impacts are illustrated in several of the patterns of vulnerability. Environmental security is affected by multiple environmental, political, social and economic factors and is also closely related to issues of material access and social relations. Inefficient and poor governance, as well as inadequate or inefficient response systems exacerbate vulnerability and the risks associated with environmental change and natural disasters.

More than half of the deaths related to disasters occur in countries with a low Human Development Index (HDI) (White and others 2005). There is increased exposure to climate change hazards, for example, due to the destruction of coastal ecosystems, such as mangroves, that provide some protection from storms, tidal surges and other coastal hazards. Adaptive capacity is also being eroded through the liberalization of agricultural markets, the reduction of government-level social protection schemes, the undermining of informal safety nets, poorly built or maintained infrastructure, chronic illness or conflict (White and others 2005).

Global datasets on extreme events indicate that the number of natural hazards is increasing (EM-DAT; Munich Re NatCat Service 2004, Munich Re 2006) and that particularly hydro-meteorological disasters, such as floods, windstorms and temperature extremes, occur with increasing frequency. Between 1992 and 2001, floods were the most frequent natural disaster, killing nearly 100 000 people and affecting more than 1.2 billion people worldwide (Munich Re 2004).

3 Vulnerability and human well-being

3.1 Introduction

GEO-4 focuses on "Environment for Development" and, thus, on the need to demonstrate the connections between the environment, the goods and services that it provides, and human well-being. Chapter 7 of GEO-4 devoted considerable effort to considering the connections between human well-being and vulnerability.

A wide range of interpretations of well-being from different disciplinary perspectives were considered. Given that one of the objectives of Chapter 7 was to identify the challenges to and opportunities for reducing vulnerability, there was a need for the analysis to go beyond being academically interesting to being policy relevant and capable of speaking to policymakers in a way that increases the likelihood of meeting desired outcomes. As a result of discussions and the review of large amounts of material compiled in the "zero-order draft" of the chapter, there was a critical shift in our approach to well-being. While we started by considering well-being as "good quality of life", we moved to focus on well-being in terms of the "ability to achieve". Reflecting this, the opportunities we identified for reducing vulnerability and increasing the capacity to adapt, focused on reducing sensitivity to environmental change and enhancing resilience by empowering people. This does not discount the value of using quality-of-life indicators that are widely available in the (mostly) academic literature, but emphasizes the policy-relevant linkages between vulnerability and well-being.

During discussions within the GEO-4 process as a whole, as well as during the development of Chapter 7, a need for indicators of human well-being became clear. Chapter 7 contributed to these discussions by producing a table of possible indicators, classified according to the different aspects of well-being and the available approaches used for interpreting well-being. While this table, presented as an Annex to this report, was not used rigorously in the final analysis for Chapter 7, it provided a basis for further analysis of the linkages between vulnerability and human well-being.

The approach to the connections between human well-being and environment through the lens of vulnerability, as adopted in Chapter 7 of GEO-4, focuses on improving the understanding of (1) the linkages between the different aspects of well-being and how these relate to broader development and human rights goals, which can also be linked to our approach to environmental security; (2) the relationship of human well-being to environmental change – both in terms of positive quality-of-life improvements and sustainability risks; and (3) environmental opportunities for addressing vulnerability and well-being.

In each of the archetypes, we found examples of how the environmental and socio-economic pressures that were part of the pattern of vulnerability led to changes in human well-being. This occurred, for example, by affecting availability of food, water and/or shelter, by causing negative impacts on human health or by influencing the physical security of the population. But in each archetype we also found that farsighted initiatives that were able to strengthen essential capabilities and/or entitlements, helped reduce vulnerability.

In this chapter we first discuss the evolution of the concept of human well-being and the different areas of focus. This work was carried out at the beginning of the development of the GEO-4 chapter and provided the basis for the approach that was finally taken, which is described here in Section 3.3. In Section 3.4, we then discuss the connections between human well-being, the environment and vulnerability. Section 3.5 examines the links between human well-being and the patterns of vulnerability that were the focus of the GEO-4 chapter. The concluding section emphasizes the strong links that we have found between patterns of vulnerability and human well-being and shows that if vulnerability is not dealt with, it will be difficult or even impossible to reach development goals. The possible indicators for measuring well-being and tracking its changes, over time, are presented in Annex 2.

3.2 The evolution of the concept of human well-being

3.2.1 Three different areas of focus

To make sense of the wide range of interpretations of well-being, we can distinguish three broad approaches (see, for example, Gasper 2004 and Robeyns 2004): (1) Inputs, some of which can be measured in monetary terms; (2) Subjective Well-being, measured in terms of how people feel about how they live; and (3) Objective Well-being, measured in terms of the various objective aspects of living that are deemed

important. In other words, what people have, how they feel, and how they live.

The first family of approaches takes inputs and resources as the most relevant aspect for well-being. Inputs include not only financial resources, but also a broad spectrum of material means that can be used to promote well-being. People determine how to use these resources to achieve well-being. Economic theories, for example, focus on income or expenditure as measures of control over other relevant resources. However, national income/Gross Domestic Product (GDP) as a proxy for well-being has been convincingly criticized, since it excludes many relevant sources of well-being and includes various expenditures that reflect ill-being rather than well-being, such as over-consumption. Nevertheless, GDP remains a relevant measure of economic activity and of economic power, including power to acquire more resources, distribute information, influence decisions, and acquire means of coercion. However, as indicated below, these forms of economic power do not necessarily contribute to subjective perceptions of well-being.

A second family of approaches – those of Subjective Well-Being – focuses on how people experience or value the quality of their lives, in measures of satisfaction or happiness (see, for instance, Veenhoven 2004). Utilitarianism is an example of such an approach. This family of approaches presents difficulties for obtaining aggregate measures of well-being because its definition depends on criteria that can be defined differently by every person. Furthermore, some people, whose lives have very many valuable features, such as secure and significant income, declare themselves dissatisfied, while other people, who have little of material value in their lives, not through their own choice, declare themselves more satisfied, perhaps because they cannot afford to have a negative attitude in dealing with their difficult situation. A person's perception of their well-being may not only reflect their own quality of life, but also how they perceive their position relative to that of other people. Evidence on subjective well-being remains very important, as it can help identify critical areas for policy attention, but it cannot be the main basis for most public policy exercises.

It is not enough to look only at inputs or only at subjective well-being, because the relationships between inputs and subjective well-being are complex and sometimes unreliable or even non-existent, as shown in an overview of recent subjective well-being indexes for 82 countries. The highest ranking countries were in Latin America; and many of the lowest ranking were middle-income countries that have experienced relative decline recently. Economic inputs, in particular, may bring little and sometimes no sustained increase in subjective well-being beyond high middle-income levels (around US$10–12000 per annum per capita). This is the so-called "Easterlin paradox" (Easterlin 2002). The reason for this could be that a further increase in economic inputs does not contribute to satisfying some key needs for well-being, and/or can undermine inputs that are required for sustained or increased well-being – for example, various environmental services, or close personal relations.

The third family of approaches – those of Objective Well-Being – looks, therefore, not at how people feel about their lives, but directly at the content of their lives. This includes, for example, the often neglected aspects of physical security and time use. How much time people must spend to sustain themselves can depend heavily on environmental systems affecting the availability of water and fuel, the patterns of commuting, and so on. Improvements in forest cover have been shown, in some areas, to lessen the time women and girls spend collecting wood and thus increase the opportunity for girls to go to school (WRI and others 2005).

One version of this third family is the capability approach (Sen 1999), which has been adopted in the UNDP's Human Development Reports and, subsequently, in much related development work, including that of the World Bank and other United Nations agencies, such as UNEP. Focusing on the real possibilities for people to be valuable or do valuable things, this approach usefully combines a more objectively-oriented perspective (evidence on how people actually live and on their freedom to achieve well-being) with a more subjectively-oriented dimension (highlighting the role of value judgements on well-being). The objective aspects of a person's life that the approach considers, are, firstly, valuable "functionings", meaning the valued parts of a person's life; and, secondly, "capabilities", meaning the range of alternative valued lives that a person could achieve. People face choices between these alternative lives. The capability approach calls for people to have a better set of alternative paths of life to choose from. Among the basic capabilities are the ability to lead a long life in good health, be well nourished, educated, housed, adequately clothed and integrated into the community.

This third family of approaches, on objective well-being, is well-suited for use in global assessments and policy-making, because it looks directly at the content of people's lives and because it presents a notion of well-being that can be evaluated in all situations and countries. This sort of approach has been used not only for UNDP's Human Development Reports (HDRs), but also, indirectly, for the Millennium Development Goals (MDGs), as well as for the conceptual framework of the Millennium Ecosystem Assessment (MA). The MDGs are themselves not a definition of well-being but a set of interim human development targets for the period up to 2015; a list of accepted priority public responsibilities for the medium term. The HDRs understand human development to be the expansion of valued opportunities in ordinary people's lives. The MA highlights that such freedoms and choices contain, and rest on, basic material opportunities, health, environmental and personal security, and stable good social relations. Nevertheless, these four underlying components are linked to each other and reinforce each other (MA 2003, 74). Improvements in health, for example, may require expanding livelihood options through more secure access to resources, as well as achieving security from disaster. These five components of well-being in the MA have emerged from the "Voices of the Poor" study.

The range of approaches to human well-being found in different disciplines and schools of thought, and their interconnections, can be understood in terms of the three approaches

to the concept of human well-being. First, some disciplines, such as environmental studies and economics, have mostly concentrated on inputs to well-being. Livelihood approaches have helpfully extended the range of inputs that were looked at, well beyond the range that has been conventional in economics. Second, subjective well-being research looks at the feelings that individuals have and the judgements they make about the way they live. Third, health sciences, social-indicators research, psychology, and a major part of quality-of-life research, all look especially at how people live; at the components of objective well-being and ill-being. The first and second approach are relatively less reliable bases around which to build policy. The third approach is generally more reliable and suited for policy work. In it, the judgements about priority aspects to guide policy decisions are made through public processes and public agencies. The concept of well-being, adopted in this report, mainly reflects this third approach, with elements of the first. Building on the approach adopted by the MA, we have adopted a focus on five interlocking components of well-being: health, security, good social relations, and freedoms and opportunities, as well as on the basic material inputs for a good life.

In practice, measures of human well-being often include some mixture of the three approaches described above. This can be appropriate, provided the different character and role of each is understood. For example, the Human Development Index includes both measures of education and physical health, and the input indicator per capita GDP. Quality-of-life studies often include subjective well-being measures as well as various objective measures of valued aspects of well-being. Especially in more inclusive governance frameworks, self-perceptions are important and are critical for successful policy interventions.

3.2.2 The evolution of ideas on Human Well-Being in policy

Over the last 20 years, there has been a gradual shift to a policy focus on achieving human development goals from an earlier prioritization of economic consequences. Nevertheless, there remain substantial differences in how well-being considerations are taken into account, particularly between different development sectors.

Although there is broad consensus on what human well-being encompasses, some variations remain around the core areas. All concepts of well-being value life itself and health, for example. Being respected, feeling proud and achieving status are also universally accepted. A substantial degree of consensus is indicated – around some specifics, and around the question of which are relevant general categories in several other areas – both by social science research and by products of global policy processes which have had universal or near-universal approval; these include the United Nations Millennium Declaration, the UNDP concept of "human development", which is the foundation of the human development report, and the major statements on sustainable development (e.g. Brundtland Report, WSSD and the Vienna Declaration on Development), as well as the Universal Declaration of Human Rights. International human rights law and constitutions of individual countries, as well as demands for revising, extending and giving effect to them, provide insights into variations, as well as commonalities in what is valued and how human well-being is understood. Box 3.1 illustrates how human well-being has been conceptualized in a number of international processes.

3.3 Human well-being: our approach

3.3.1 Human Well-Being as a multidimensional concept

Well-being is multidimensional. There are many important aspects of being, for example: access to material goods to support livelihoods; power and independence, or lack thereof; voice; fun; physical health and mental health, and these are not reducible to a single thing. This is vividly and amply illustrated in the Voices of the Poor studies (Narayan and others 2000, Brock 1999), which present the views of 60 000 individuals from 60 countries – a compilation of new surveys and a synthesis of earlier ones. The same findings emerge in studies in high-income countries, and they are reflected in the current adoption of a multidimensional approach in nearly all studies on quality of life. The different dimensions of well-being are closely related to each other, with changes in one affecting another.

Figure 3.1 from Voices of the Poor study (Narayan and others 2000) shows how critical aspects of ill-being and well-being define the subjective experience of being.

In operationalizing this set of components in the discussions on archetypes of vulnerability and cross-cutting issues, we must take into account practicality and relevance for the cases concerned. For the various different archetypes, some well-being impacts are more relevant than others. For example, in the SIDS archetype, physical security impacts are important, while in the contaminated sites archetype health impacts play a significant role. In general, "good social relations" will receive less emphasis, because they constitute an aspect that is more difficult to conceptualize and measure. It must, however, be kept in mind as an important factor in determining resilience to stressors.

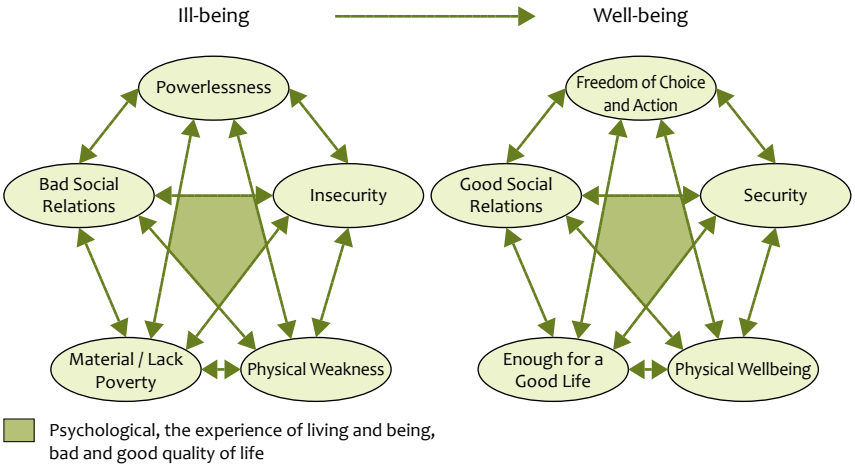
The lack of well-being, or ill-being, is closely associated with poverty. Multidimensionality is increasingly found in interpretations of poverty. Concepts of poverty have steadily widened, to take into account not only a person's private consumption, but also their use of common property resources and goods provided by society, and their assets (for these reduce vulnerability), insecurity and powerlessness, dignity, autonomy and health. These various aspects tend to be reinforcing poverty, making it difficult for individuals to move out of poverty (WRI and others 2005).

3.3.2 The normative basis for an approach to well-being

Following the Human Development Reports, we focus both on the priority areas in people's lives and on the real options that they have (thus, in Amartya Sen's terminology, on both "functioning" and "capabilities").

"Real options" refer to the things that a person could choose *and* attain. This brings attention to the critical aspect of *choices* (or their absence) in people's lives. It means that we look not only at outcomes, but also at how much freedom, and which freedoms, people have. This is shaped by relations

Development as good change, from ill-being to well-being **Figure 3.1**



Development as a good change – from ill-being to well-being (Narayan and others 2000).

Box 3.1 Human well-being in international processes

A number of international organizations and institutions have used the concept of human well-being to assess, describe and compare the quality of human life throughout the world.

Perhaps the best known measure of human well-being is found at the core of the United Nations Development Programme's Human Development Report (UNDP 2005). Since 1990, this report, published annually, has relied on the United Nation's Human Development Index (HDI), a comparative measure of well-being, based on indicators of literacy, life expectancy, school enrolment, and GDP per capita[1]. It is complemented by measures for poverty in developing (HPI-1) and developed countries (HPI-2), as well as measures for gender inequality, gender-related development index (GDI) and the gender empowerment measure (GEM). The scope of the HDR has widened considerably to cover public commitments to health and education, water and sanitation, nutrition, the structure of trade, aid and debt, energy and the environment, refugees and armaments, crime and human rights.

This widening of understanding of human well-being is also evident in recent analysis, which point to facets of well-being often overlooked in conventional studies – for example, ways in which well-being depends upon human rights and on the environment and its natural resources (Dasgupta 2001). The Arctic Human Development Report (AHDR) adopts a definition that accounts for a range of well-being factors important to Arctic residents, but not reflected in the HDI. The AHDR notes that, while many Arctic residents would not receive extremely high HDI scores, they do not think that they are experiencing an inferior quality of life, compared to other people throughout the world. Consequently, in its evaluation of human development, the report also considers the maintenance of traditional hunting and herding practices, knowledge held by Arctic peoples, lives lived close to nature, and the minimization of natural resource use (AHDR 2004).

With the growing understanding of the importance of the environment and human development and futures, there has been a more concerted effort to integrate these factors into assessments and policies. For example, the Millennium Ecosystem Assessment (MA 2005) and the United Nations Millennium Project (UNMP 2005) focus on environment-related components of human well-being, by examining ways in which changes in ecosystem services impact on human well-being. The MA defines well-being as comprised of a number of constituents, including basic material for a good life, health, good social relations, security, and freedom of choice and action. The MA further considers links between ecosystem services (for instance provisioning, regulating and cultural) and the varied components of well-being, whereby provisions refer to food, water, fibre and fuel; regulating functions regulate climate, floods, disease and water purification; and cultural services concern aesthetics, spirituality, education and recreation.

Like the MA, the United Nation's Millennium Project addresses relationships linking environment and human well-being. The report, Environment and Human Well-being: A Practical Strategy (UNMP 2005), identifies six key elements affecting human health and economic well-being: agricultural production systems, forests, freshwater resources and ecosystems, fisheries and marine ecosystems, air and water pollution, and global climate change.

1 The HDI is not an all-encompassing measure of well-being, but is an easily computable indicator that illustrates that GDP per capita alone is a misleading well-being indicator.

of power and in particular on multiple aspects of inequality, including concerning gender and poverty. Also relevant are people's skills for making choices, and their opportunities for choice-making at multiple levels, from local group to national, regional and global.

Freedoms are hard but not impossible to measure satisfactorily. Firstly, basic capabilities, in areas such as education and health, provide the basis to be free and to make valued choices; this is a large part of why the HDI highlights education and health. Secondly, for each outcome we can also consider how the choice was: whether this respected people's freedoms.

Outside of their own choices, people may be exposed to risks and harms that fundamentally affect their well-being by way of insecurity and vulnerability; for example, through war, environmental disasters or negative trends, diseases and epidemics. The concept of *human security* complements the HDR concept of human development (2003 Sen–Ogata commission report *Human Security Now*). It represents, first of all, a concern for setting priorities within the broad canvas of human development concerns, such as done in the MDGs; in other words, a focus on basic human needs, which includes concerns for physical security, but only as one concern among many others, as well as for environmental security. Secondly, it represents a concern for the stable fulfilment of basic needs (Gasper 2005b).

Choice and security are affected by many social relations. Analysis here needs to take account of gender, age, disability, location, poverty, unemployment, group affiliation and conflict. Gender inequalities, for example, are reflected in male and female differences in life expectancy and nutrition, as well as participation in social choice. These disparities make it essential to include gender inequalities in an assessment of well-being. One can measure men's and women's well-being separately, and/or adjust the aggregate figures to take into account the inequality in distribution of well-being between men and women. UNDP's Gender Development Index, for example, adjusts the HDI for a country or region on the basis of how unequally distributed the aspects of well-being between the genders are. It is also sensible to present the disaggregated figures separately, for example, for life expectancy and literacy.

Well-being, or the lack of it, also has intergenerational aspects. Poorer children start out at a disadvantage, with poverty and ill-being being inherited from one generation to the next (Brock 1999, Chronic Poverty Research Centre 2005). Social, political, economic and environmental change and the responses to it, affect the opportunities available for developing and promoting human well-being in the future.

3.4 Vulnerability, the environment and human well-being

3.4.1 Linking vulnerability and human well-being

Vulnerability can be seen as "the strength of the potential for negative outcomes or adverse consequences for well-being", and can be characterized by the probability of a sharp decline in, for example, access to various resources, such as food and drinking water, or the probability of consumption levels sinking below the minimum needs for survival. It is a result of exposure to risk factors, such as drought, conflict or extreme price fluctuations, and of underlying socio-economic and institutional conditions that reduce people's ability to cope with the negative impacts of exposure. These impacts do not only depend on exposure but also on the sensitivity to these exposures. Thus, for example, in the case of contamination of land and water by pollutants, the population is exposed to these pollutants. Women and children are particularly sensitive to certain pollutants and the consequences for well-being include serious deterioration of human health. Other consequences for well-being can include reduced access to food and drinking water, conflict and reduced personal security.

The global context in which vulnerability unfolds is contributing to increasing vulnerability (especially the increasing gaps in equity) and is undercutting the ability to meet human well-being goals. This is also illustrated at the end of this chapter, where we show how dealing with vulnerability could contribute to achieving the Millennium Development Goals. Overall, it can be concluded that without addressing global governance and issues, such as economic disadvantages and conflict, it is not possible to meet the targets for human well-being and subsequently maintaining it.

3.4.2 Environmental opportunities for improving human well-being

The link between environment and well-being is complex, non-linear and mediated by multiple factors including poverty, trade, technology, gender and other social relations, governance, and the different aspects of vulnerability. Global interconnectedness – through a shared natural environment and globalization – means that human well-being in one location may be affected by practices elsewhere.

How people actually live and the opportunities they have are closely connected to the environment (Prescott-Allen 2001, MA 2003). Poor environmental management places significant costs on society, setting limits to opportunity and well-being. As early as 1987, the Brundtland Commission warned that environmental degradation contributes to "the downward spiral of poverty" and amounts to "a waste of opportunities and of resources" (WCED 1987). Yet 20 years later, the integration of environmental and development policy and practice remains weak. Good health, for example, is directly dependent on good environment quality, and while many national constitutions now recognize a healthy environment as a fundamental human right, few countries have mainstreamed health in either environment or development planning. Despite some improvements, pollution continues to be a problem, sometimes spurred on by factors outside the control of local users (see global commons and contaminated sites archetypes). Associated risks and costs are unevenly distributed across society. Although globally the incidence of ill-health has been reduced, its costs remain monumental.

Improving human well-being – the extent to which individuals have the ability to live the kind of life they value and the opportunities they have to achieve what they would actually want to do or become – lies at the heart of development objectives. This is not just a moral imperative but also a critical

aspect of fundamental human rights (UN 1966, UN 1986, UN 2003) and is essential for reducing vulnerability and achieving sustainable use of the environment. Identifying the "environmental opportunities" for achieving the targets for human well-being, can provide a powerful incentive for sustainable environmental management.

Since the 1987 Brundtland Commission emphasized the environment–development link, numerous policies, including the 1992 Rio Declaration (Principle 1) and the conventions on biological diversity and on climate change, have drawn attention to the opportunities the environment holds for development. Increased convergence between these international approaches and those at national level is evident from the highest-level recognition of environmental rights as human rights (Ncube and others 1996, Mollo and others 2005). Importantly, environmental-rights approaches have moved from a focus on environmental quality to incorporating basic needs, development, and intergenerational and governance concerns (UN 2003, Gleick 1999, Mollo and others 2005). However, progress to meeting development objectives has been chequered.

3.5 Linking aspects of well-being to the patterns of vulnerability

The Millennium Ecosystem Assessment (MA) identified five components of well-being: basic material for a good life, health, good social relations, security, and freedom of choice and action. We used this same categorization and were able to show, as illustrated below, that they are directly linked to vulnerability outcomes.

3.5.1 Material assets – access, distribution, equity, poverty

The MA identifies the following materials as essential for a good life: secure and adequate livelihoods, income and assets, enough food and water at all times, shelter, furniture, clothing, access to energy to keep warm and cool, and access to goods (MA 2003, MA 2005). Having secure and adequate livelihoods, however, requires access to a wider range of goods and services than identified in the MA. For example, many people identify infrastructure and services to support their livelihoods as essential material assets (Brock 1999). Additionally, access to education takes on particular importance in poor communities, where it is often highly valued as a potential route to a better situation (The Center for Global Development 2002). The MDGs also draw attention to the need for improved access to such materials; MDG 1 emphasizes the need to eradicate extreme poverty and hunger through increased income, while MDG 2 focuses on universal primary education.

The relationship between the environment, material assets and human well-being varies from setting to setting. In developing countries, as well as for poor or marginalized people in developed countries, productive assets, such as land, are particularly valued – in rural areas as the basis for food security, and in urban areas for safe shelter free from environmental hazards and risks. Changes in supporting, provisioning and regulating services have direct and often strong impacts on well-being. The wealthy may be more able to cushion themselves from these negative impacts.

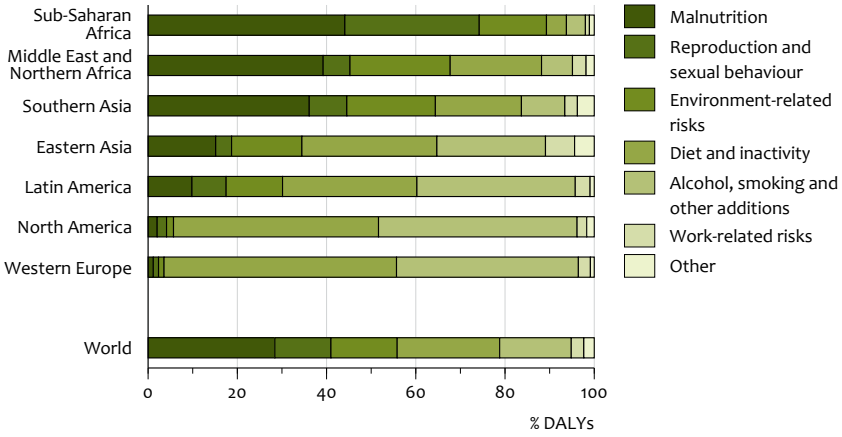
The study *Voices of the Poor* found that respondents in rural areas placed a strong emphasis on food security as well as on employment, money and assets as critical material needs to support well-being (Brock 1999). Emphasis was placed on both productive and non-productive assets as the basis for this well-being; the asset most frequently cited as lacking was land, specifically secure access to good quality land for agriculture and livestock rearing. Other productive assets essential to sustainable livelihoods and food security, such as oxen, ploughs, forests and water are also highly valued. Access to land and other productive assets are affected by a range of different factors, including caste and political context. Additionally, rural people emphasized the vulnerability of particular groups within the community: the old, the disabled, female-headed households and those living alone, as they may be isolated from social networks. In urban settings, much more emphasis is placed on land in the context of the immediate living environment: crowded and unsanitary housing, lack of access to water, dirty and dangerous streets, and violence both within and outside the household (Brock 1999). The importance of this is seen in the archetype on contaminated sites.

Secure entitlements are necessary requirements for ensuring real access. Where people live close to and depend directly on environmental goods and services, such entitlement to natural assets may be essential to ensure sustainable livelihoods. Both physical and social threats to common property resources may affect vulnerability, as illustrated, for example, in the SIDS archetype. Poor access to material assets is part of a cycle of impoverishment and vulnerability, as one element of a sequence of becoming poor and staying poor (WRI and others 2005).

3.5.2 Health

Health is a central aspect of human well-being. It includes being strong, feeling well and having a healthy physical environment (MA 2003), as well as having sufficient supporting services, such as access to energy to keep cool or warm (MA 2005), and to adequate goods, such as water and clean air (MA 2005), to remain well. Sufficient rest is crucial to being healthy. The importance attached by the global community to improved health as essential for human well-being is emphasized in three MDGs, which focus on reducing child mortality, improving maternal health, and combating HIV/Aids, malaria and other major diseases, respectively.

Health indicators include life expectancy at birth, mortality rates, child mortality and survival, occurrence of malaria and tuberculosis, etc. Using such measures, we have seen a general improvement in health worldwide in the last five decades, as a result of social, economic, environmental, and technological advances, as well as the increased availability of health-care services and effectiveness of public health programmes. However, these health gains have not been achieved to the same degree in all the countries of the world, nor have all groups within a population benefited equally from them; in some cases, there have even been marked deteriorations in the past 20 years. The least favour-



Environmental risk factors for different regions (WHO 2002).

able health situations are those in which the persistence of communicable diseases is associated with deficient living conditions, including poverty and progressive environmental degradation. In some countries, health problems related to lifestyle, urbanization, and population ageing have increased (PAHO 2002). While the death toll of several infectious diseases has decreased drastically, the death toll of chronic diseases has increased. But some new infectious pandemics remain a possibility, and at least one – HIV/AIDS – is already with us. Many diseases, including Severe Acute Respiratory Syndrome (SARS) and avian flu, are closely related to the environment and its poor management; the environmental disease burden and associated mortality burden is carried disproportionately by the poor, women and children (WRI and others 2005). Diseases associated with poor management of chemicals is evident in both developed and developing countries with, for example, elevated levels of arsenic in water sources in wealthy countries, such as the United States and Canada, countries with economies in transition, such as Poland, and developing countries, such as India and China (Gordon and others 2005). Lead and other poisons remain threats within all regions.

Health is closely interlinked with patterns of poverty and consumption. Poor people, in general, have considerably lower levels of health; while people suffering from diseases are less productive and have fewer possibilities to escape from poverty. In addition, health inequalities are influenced by the degree of equity in the distribution of income. Gains in life expectancy, survival, the reduction in infant and child mortality, as well as gains in per-capita health expenditure, for example, have been systematically greater in those countries with more equitable income distribution and associated access to treatment. Thus, healthier societies are not necessarily those that are wealthier, but those most equitable in the distribution of income, regardless of its level (PAHO 2002). Costa Rica, for example, has higher average life expectancy than the United States. In many developed countries, high levels of consumption are associated with diseases partially associated with opulence, including obesity, heart disease and diabetes.

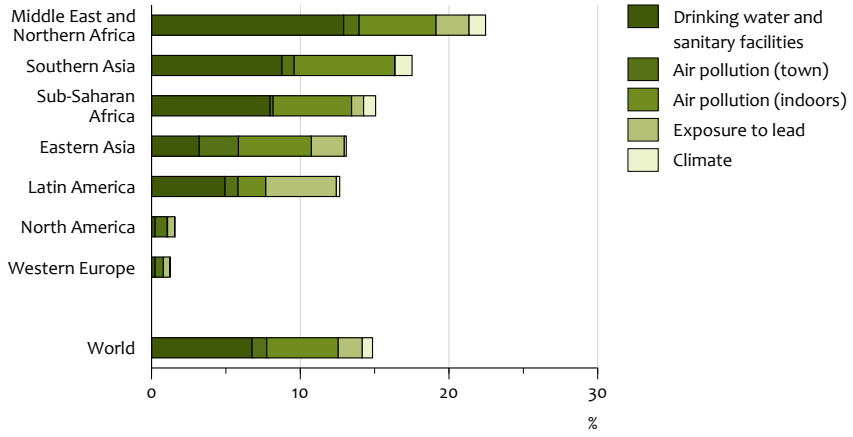
Disability-Adjusted Life Years (DALY) is a measure of disease burden (see chapter 2), which takes both mortality and morbidity levels into account. Figure 3.2 shows the most important health risk factors that contribute to the loss of DALYs. In developing countries, undernourishment ranks high, while in developed countries diet-related risk factors and physical inactivity dominate.

Figure 3.3 shows how the environmental risk factors relating to health vary for different regions. Since the 1980s, the dynamics of the environment and health have changed as a result of globalization and the increased integration of the world's economies and politics, and the mixing of cultures. Globalization may have an impact on health. Increasing global interconnectedness contributes to the spreading of infectious diseases (such as SARS and avian flu) through the movement of people and global markets. However, it can also provide increased access to medical technology and research. The role and impact of HIV/AIDS, not only on health outcomes but also on society as a whole, is of particular concern as a result of its demographic and economic effects. Urbanization, too, is becoming more and more relevant in relation to poverty and health issues.

Changes to provisioning and regulating services may have a direct impact on health. In some developing countries, the loss of biodiversity may result in the loss of traditional medicines and other plants on which poor people rely.

Human health has begun to feel the effects of even larger-scale global changes, including environmental and socio-economic changes, simultaneously and often interactively. International assessments show that changes in the climate system, the ozone layer, biodiversity, land use and degradation, have impaired human health (McMichael and others 2003) and are expected continue to do so, in the medium and long term (IPCC 2007).

Environmental causes of health loss 2000 **Figure 3.3**



Environmental risk factors for different regions (WHO 2002).

3.5.3 Good social relations

The MA describes good social relations as including social cohesion, mutual respect, good gender and family relations, and the ability to help others and provide for children (MA 2003, 74). Other studies, such as the Voices of the Poor, demonstrate that a broader set of social relations is also important. Society creates the immediate social and institutional setting for the exercise of choice and the opportunities people have for responding effectively to environmental change – social relations are, thus, a key aspect of well-being and poverty. In particular, ethnicity, caste, gender, financial status and geographical location underlie problems of marginalization and disempowerment. The MDGs specifically draw attention to the need to promote gender equality and empower women.

Although poor or good social relations and their relationship to environmental change are difficult to measure, some bad social relations are easily quantifiable – such as domestic violence, alcohol abuse and crime – and some trends and relationships with the environment are evident (see, for example, the SIDS archetype).

Where livelihoods are closely related to environmental goods and services, changes in provisioning and regulating services can effect social relations. This is primarily as a result of their direct impact on material well-being, health and human security (MA 2005). There is evidence that declining ecosystem services exacerbate existing tensions and contribute to an increased likelihood of conflict, for example, where there is decreasing food, water, and energy security. Additionally, where cultural identities are closely associated with resources, such as in the Arctic and many SIDS, social conflict and breakdown may be directly linked to habitat destruction or decreasing availability of environmental services. For many people, spiritual life and religious observance are intimately interwoven with other aspects of well-being: the importance to poor people of the church, mosque, temple and sacred place was repeatedly shown from comparisons with other institutions, in which religious and spiritual institutions frequently ranked high, if not highest, in the list of key supports in people's lives (Narayan and others 2000). Violent conflict, domestic violence, crime and alcohol abuse are relevant indicators of social breakdown. In SIDS, where livelihoods and cultures revolve around the ocean and its resources, environmental change may directly impact on social organization and cohesion. The loss of biodiversity may also be associated with the loss of indigenous knowledge which, in some cases, forms the very basis of the cultural system. The loss of cultural identity may be associated with the loss of important safety nets and contribute to an increasing sense of powerlessness.

Investing in good social relations and building social capital through better governance, improving cooperation, and empowering women, not only supports conservation efforts, but also builds opportunities for peace, development and improving well-being, and provides an essential safety net for those who endure environmental and other shocks. Experience in developed countries suggests that well-financed government, the insurance industry, transport and communication infrastructure, democratic participation and personal affluence, help hedge the impact of disaster (Barnett 2003). Improving capacity and access to technology, as envisaged under JPOI and the Bali Strategic Plan for Technology Support and Capacity Building (BSP), can improve coping capacity, as agricultural and other early warning systems, in Africa and elsewhere, have demonstrated. However, progress towards developing the global partnership to support this, remains slow. Additionally, more far-sighted and equitable approaches to the movement of resources, goods and people is critical for addressing the new levels of stress that the most vulnerable communities will face as a result of environmental change (See the drylands, SIDS, global commons archetypes).

3.5.4 Personal and environmental security

The personal and environmental security component includes secure access to natural and other resources, safety of person and possessions, and living in a predictable and secure environment with security from natural and human-made disasters (MA 2003, 74). Personal safety also includes being free

from threats of bodily harm and from violence, crime and war (Brock 1999). In many developing countries, poor people see security as peace of mind or confidence in survival. Survival is seen not just in terms of livelihood, but also in terms of sheer physical survival in the face of crime, violence, corruption, lack of protection by the police and absence of recourse to justice, wars between ethnic groups, tribes and clans, frequency of natural disasters, and uncertainties of season and climate (Narayan and others 2000). These aspects of insecurity are closely linked to problems associated with decreasing social cohesion.

Insecurity, although an objective aspect of well-being, is closely linked to subjective feelings. How people feel, impacts on their ability to participate socially and make valued choices (Brock 1999).

Insecurity is affected by a multiplicity of environmental, political, social and economic factors and is also closely related to issues of material access and social relations. Inefficient and poor governance and managerial systems, as well as inadequate or inefficient response systems, might exacerbate vulnerability and the risks associated with environmental change and natural disasters. As with other aspects of well-being, personal and environmental security is not equally shared across society.

Seasonal changes in climatic conditions, such as floods, droughts, increased likelihood of insect invasions, extreme heat or cold and their related impacts on social systems including food production in much of the developing world, all have significant impacts on human vulnerability and well-being, and may undermine resilience. Resource-poor farmers are among the hardest hit, as they lack the ability to cope with these changes. In these circumstances, they experience loss of income, with a run-on effect on their overall well-being. Similarly, poor people – particularly those who live in impoverished and slum conditions – face high levels of exposure to seasonal climatic changes and their associated health and safety risks, such as flooding and water-borne diseases, for instance dengue and malaria.

Living in remote areas, poorly served by roads and with inadequate facilities, may exacerbate personal insecurity and compound local peoples' sense of being abandoned and ostracized. At the same time, isolation undercuts trade and marketing opportunities as well as access to technology, which in turn limits the ability to use natural resources in an efficient and productive manner.

Some groups may face added challenges related to security. This is the case for women, for instance, in situations of poverty, conflict and highly divided societies, where they often become targets of violent crimes, including rape. In many developing countries, particularly in Africa and Asia and the Pacific, rules, norms and attitudes surrounding widowhood and the inheritance of assets, affect the livelihood security of women and the choices and opportunities available to them (Braidotti and others 1994, Mies and Shiva 1993). This vulnerability is also evident in relation to environmental hazards; for example, during the 2005 Indian Ocean tsunami there was a higher incidence of female adult deaths compared with male adult deaths, as women could not swim as well as men, suggesting a gendered division of opportunity. They may also be more vulnerable to risks associated with chemical pollution from contaminated sites.

3.5.5 Freedom and choice

Freedom and choice, as an aspect of well-being, includes having control over what happens in your life and being able to achieve what you value (MA 2003, 74). Relationships of power are often crucial in the extent of agency and how it is exercised. It is influenced by a range of social relations, including those related to gender, caste, race, and poverty. Making choices at group level, as well as participating in higher-level decision-making, are both affected.

Democratic freedoms are crucial in shaping the ability to participate in the life of the community (Deneulin 2003). However, in addition to freedoms such as the right to participate in elections and access to justice, various studies show the importance of those freedoms which enhance the day-to-day capacity of individuals, including in relation to environmental management. Increasingly, social rights are recognized as equally important for supporting the exercise of choice (Cornwall and Gaventa 2000, Turner 1999). These rights may be products of social struggles (Stammers 1999) and thus a good indication of what people themselves value. Such rights include the right to health and education, to be treated with dignity, to access to information, to be consulted, and to prior informed consent where one's livelihood or assets are affected. Increasingly, development agencies and the global community, for example, in the 1993 Vienna Declaration, have recognized the indivisibility of human rights and their close connection to human well-being (UNDP 2000).

Dignity is often seen as a fundamental aspect of well-being (including Clark 2002, Universal Declaration on Human Rights). The lack of dignity affects agency and the opportunities for making choices. Its relevance in the human well-being-environmental nexus is evident in the archetypes dealing with conflict, rapid urbanization and breakdown of infrastructure, and in unequal exposure to environmental hazards. This is important to all people – in both developed and developing countries.

Fear, insecurity, dependency, depression, anxiety, shame, hopelessness, isolation and powerlessness are all feelings named by the less well-off as being associated with poverty. These feelings are not quantifiable phenomena, but poor people place a strong emphasis on how such experiential elements of a bad life affect their agency and well-being (Brock, 1999). In addition, free time, relaxation and recreation, rest and sleep, are important to people's ability of exercising choice.

3.6 Reducing vulnerability and improving well-being

The analysis of all components of human well-being in relation to patterns of vulnerability to environmental and socio-economic pressures, has demonstrated the need for strategies – both multi-level and cross-sectoral – to improve adaptive capacity to changes and to improve and maintain

Examples from the archetypes showing how vulnerability could affect the achievement **Table 3.1**

MDGs and selected targets	Vulnerability affects potential to achieve the MDGs	Adopting strategies to reduce vulnerability that contribute to reaching the MDGs
Goal 1 *Eradicate extreme poverty and hunger* *Targets:* *Halve the proportion of people living on less than US$1 a day* *Halve the number of people who suffer from hunger*	Contaminated sites reduce health and, thus, the ability to work; this undercuts opportunities to eradicate extreme poverty and hunger. In drylands land degradation, insufficient investments and conflict contribute to low agricultural productivity, threatening food security and nutrition.	Improving environmental management and restoring threatened environments will help protect natural capital and increase opportunities for livelihoods and food security. Improving governance systems – through wider inclusion, transparency and accountability – can increase livelihood opportunities as policies and investments become more responsive to the needs of poor people.
Goal 2 *Achieve universal primary education* *Target:* *Ensure that all boys and girls complete a full course of primary school*	Children are particularly at risk when they play, reside or attend school near contaminated sites. Lead and mercury contamination presents specific risks for child development. The time-consuming and gendered activity of fetching water and fuel wood reduces school attendance, particularly for girls.	Sustainable resource management can decrease the environmental health risks children face and, thus, increase school attendance. Improved and secure access to energy supports learning at home and at school. It is essential for access to IT-based information, and opportunities to engage in scientific and other experimentation.
Goal 3 *Promote gender equality and empower women* *Target:* *Eliminate gender disparity in primary and secondary education*	Women with poor access to education are at greater risk of ill-health than men. For example, in many SIDS women have a disproportional share of the HIV-burden. Women play a pivotal role as resource managers but they are marginalized in decision-making, often have insecure tenure rights and lack access to credit.	Redressing inequities – in access to health care and education – is critical in improving coping capacity. Strategies that link health and housing, nutrition, education, information and means, increase opportunities for women, including in decision-making.
Goal 4 *Reduce child mortality* *Target:* *Reduce the under-five child mortality by two-thirds*	Contaminated sites affect mortality of all, but children are particularly vulnerable to pollution-related diseases. Annually, 26 000 children die from air pollution-related diseases.	Interlinked environment-development-health strategies, improved environmental management and ensuring access to environmentally derived services can contribute to reducing child mortality and reducing vulnerability.
Goal 5 *Improve maternal health* *Target:* *Reduce the maternal mortality ratio by three-quarters*	The accumulation of POPs in food sources impacts on maternal health. Dams may increase the risk of malaria which, in turn, threatens maternal health. Malaria increases maternal anaemia, threatening healthy foetal development.	Improved environmental management can improve maternal well-being by improving nutrition, reducing risks from pollutants and by providing essential services. Integrated environment-health strategies can contribute to achieving this goal and reducing vulnerability.
Goal 6 *Combat HIV/AIDS, malaria and other diseases* *Targets:* *Halt and begin to reverse the spread of HIV/Aids* *Halt and begin to reverse the incidence of malaria and other major diseases*	Contaminated sites are a huge risk for individuals already exposed to HIV/AIDS, potentially further compromising their health. Climate change is likely to increase the disease burden of poor people, including the incidence of malaria.	Integrated environment-health planning and management is critical. Acknowledging of, and acting on, the shared responsibility – by developed and developing countries – for the adverse impacts of climate change on the most vulnerable is essential.
Goal 7 *Ensure environmental sustainability* *Targets:* *Integrate the principles of sustainable development into planning and programmes* *Reduce the proportion of people without access to safe drinking water by half* *Achieve significant improvement in the lives of at least 100 million slum dwellers*	Water contamination caused by dumps, industry and agriculture, water-borne diseases, and growing water scarcity, threaten well-being at all levels. The lack of access to energy limits opportunities for investment in technologies, including those in the field of water provisioning and treatment.	Improving governance systems, including strengthening institutions, laws and policies, and adopting interlinked strategies are critical to contributing to environmental sustainability and reducing vulnerability. Securing energy is critical to improving the living conditions of the growing number of slum dwellers, among others.
Goal 8 *Develop a global partnership for development* *Targets:* *An open trading and financial system* *Cancellation of official bilateral debt and more generous ODA* *In cooperation with the private sector, ensure developing counties have access to the benefits of new technologies* *Address the special needs of land-locked countries and SIDS*	Unfair trade regimes reduce earnings from agricultural products in developing countries. Low income countries rely on agriculture for close to 25 per cent of GDP. Poor access to energy undermines the investments and technologies that can be used in productive land and natural resource management. Sea-level rise is threatening the security and socio-economic development of SIDS and low-lying coastal areas. More than 60 per cent of the global population live within 100 km of the coastline. And 21 of the world's 33 megacities are located in coastal zones in developing countries.	Transparent and fair global processes, especially in trade, are essential for increasing opportunities in developing countries and can help increase local investments in environmental capital. Massive investments – and technology-sharing –in clean energy and transport systems can reduce poverty, increase security, and stabilize greenhouse gas emissions. It has been estimated that about US$16 trillion will be required for global infrastructure investment in the energy sector within less than 25 years. Building partnerships for addressing climate change and honouring technology-transfer promises is essential for increasing adaptive and coping capacity in low-lying areas.

Examples from the archetypes showing how vulnerability could affect the achievement of the MDGs, and the opportunities for reducing vulnerability and achieving the MDGs

human well-being. These strategies are discussed in more detail in Chapter 5 of this background report. Among these strategies, the need for increased attention to issues of equity and the fair distribution of environmental (and other) benefits in policy, decision-making and management is particularly important. Most importantly, in identifying these strategies we have prioritized the relationship between well-being and the "ability to achieve", and this resulted in a focus on opportunities for reducing vulnerability, increasing adaptive capacity, and enhancing resilience by empowering people. This includes reducing sensitivity to hazards and environmental change by strengthening people's basic capabilities by providing more opportunities for making valued choices. Furthermore, investing in human and social capital (and, thus, improving well-being) reduces vulnerability.

These strong links between human well-being and vulnerability are also shown in an analysis of the connections between the patterns of vulnerability and the Millennium Development Goals (MDGs). As we began this analysis and created a large matrix, it became clear that, on the one hand, if vulnerability to the various pressures addressed in Chapter 7 is not dealt with, then achievement of the MDGs will be difficult or even impossible. On the other hand, achievement of the MDGs – in many cases – would contribute to reducing vulnerability. To illustrate these two cases: (i) the MDG target to halve the number of people who suffer from hunger by 2015, is difficult, if not impossible to achieve, if the underlying causes of vulnerability of humans and the environment in the drylands are not dealt with; (ii) the MDG to achieve universal primary education would support the reduction of vulnerability in many of the archetypes studied in Chapter 7 of GEO-4, since education could support the diversification of livelihood activities. This reciprocal relationship between human well-being and vulnerability indicates a need for more effective incorporation of environmental and vulnerability issues in development planning. It demands that synergies between different sectoral policies are found and that development approaches cut across spatial, sectoral, and temporal boundaries. The large amount of material gathered to support the discussion on the relationship between MDGs and patterns of vulnerability is summarized in Table 3.1.

Towards patterns of vulnerability

4

4.1 Introduction

This chapter elaborates the approach followed in GEO-4 of analysing and highlighting the vulnerability of people and the environment to multiple stressors resulting from environmental and socio-economic changes. Recurring patterns of vulnerability can be found in numerous different places around the world, for example, in industrialized and developing regions, and urban and rural areas.

With the recognition of the relevance of multiple stressors and close inter-linkages between local, regional and global scales, adequate vulnerability analyses become increasingly complex, especially in a global assessment, such as GEO-4. On the one hand, detailed local vulnerability case studies face the question of the extent to which the outcomes of such studies are relevant to similar cases elsewhere? As important policy decisions with a wider impact are not taken at local level, this is a challenge. On the other hand, global vulnerability assessments, even when dealing with a fine spatial resolution, are necessarily based on aggregated data and rather crude assumptions of the underlying mechanisms. The question is whether and how local specifics can be adequately represented and understood at this scale – a prerequisite for policy to have an influence at the local level successfully. To address these issues, a number of typical patterns of vulnerability, so-called "archetypes of vulnerability", were developed and analysed in GEO-4. An archetype of vulnerability is defined as "a specific, representative pattern of the interactions between environmental change and human well-being". It does not describe one specific situation, but rather focuses on the most important common properties of a multitude of cases that are in that sense "archetypical". The approach is founded in and inspired by the "syndrome approach", which looks at non-sustainable patterns of interaction between people and the environment, and unveils the dynamics behind them (Petschel-Held and others 1999, Haupt and Müller-Boker 2005, Lüdeke and others 2004, Manuel-Navarrete and others 2006). The archetype approach, however, is broader, as it includes opportunities offered by the environment to reduce vulnerability and improve human well-being (Wonink and others 2005).

The archetypes of vulnerability have been identified as part of the GEO-4 process, ensuring regional relevance and global balance of the patterns. The seven archetypes presented in GEO-4 are not meant to provide an exhaustive overview of all possible patterns of vulnerability. They provide, however, a good basis for identifying challenges and exploring opportunities for reducing vulnerability while protecting the environment. During the selection process, other patterns were also considered but, for practical reasons, not included in GEO-4; these are included in Section 4.4 of this background report. The archetypes that were described in GEO-4, are not included in this background report.

The aims of this chapter are: to elaborate the methodological foundations of the archetype approach (4.2); to show the process of identifying and selecting the archetypes (4.3); to present in more detail the archetypes not included in the final version of Chapter 7 (4.4); and to present a quantitative methodology developed for the analysis of the drylands archetype (4.5).

4.2 Origins and foundation of the archetype approach

The concept of archetypes of vulnerability is a further development of the ideas of the syndrome approach, which was introduced in the 1990s, to obtain a global overview of the non-sustainable dynamics and mechanisms of Global Change (Schellnhuber and others 1997, WBGU 1995).

4.2.1 Syndromes

Syndromes focus on the better understanding of *non-sustainability,* while particularly taking into account the close interactions existing between global environmental change (such as climate change, desertification, water scarcity) and rapid developments in the socio-economic sphere (WCED 1987). This required the development of a new methodology that explicitly started at the human-environment interface, requiring a truly *inter*disciplinary endeavour in terms of the organization of science.

The syndrome approach deals with the following problems:

a. a multitude of non-sustainable cases of human–environment interaction needs to be considered to cope with the high degree of interconnectedness of Global Change (GC);

b. the approach should not rely on the paradigm of only one of the contributing sciences;
c. different kinds of knowledge collected in different disciplines have to be combined, in particular, more qualitatively oriented knowledge from sociology and political science with more quantitative knowledge from the natural sciences.

With respect to (a), the approach was based on the hypothesis that it is possible to identify a limited number of *typical* dynamic cause–effect diagrams (syndromes). These should be general enough, so that each relevant case of problematic (that is, non-sustainable) human–environment interaction observed can be subsumed under one syndrome. The aim was to have an understanding of GC on an intermediate level of complexity: the multitude of empirical problematic cases (from Canadian cod overfishing to deforestation in Kalimantan to groundwater pollution with nitrite in Europe) was reduced to *several* typical cause–effect patterns, without striving for a disciplinary first principle explanation (profit optimization, pure thermodynamic approaches, etc.), thereby considering requirement (b). With respect to requirement (c), two complementary methods were developed to identify and verify these typical cause–effect patterns:

1. a systematic procedure for the inductive syndrome identification in multidisciplinary expert groups (WBGU 1995);
2. indicator based identification of the spatial distribution of the hypothesized syndromes, opening falsification possibilities (Lüdeke and others 2004).

With respect to method (1), an expert group was presented with a segmentation of the global human–environment system into about ten different natural spheres (atmosphere, pedosphere, etc.) and human spheres (economy, social organization, etc). Each expert was then asked to define a small number of states and trends for their sphere that were most relevant to the interaction with the other spheres and the sphere-endogenous dynamics. On the basis of these, about 100 (10 spheres x 10 states/trends) states and trends influence diagrams were suggested inductively by the expert group, which describe typical and relevant interaction patterns in the realm of problematic Global Environmental Change. These diagrams were then discussed qualitatively by the group, on the basis of the members' knowledge about cases and mechanisms related to Global Change, resulting in the definition of additional influence diagrams or the modification of existing ones.

This methodology can be described as an iterative, interdisciplinary and qualitative system analysis. In the next step (2), this functional understanding was combined with quantitative indicators. One of the aims was to indicate the combination of actual trends and states, specific to one syndrome, to measure the intensity of the specific syndrome mechanism in a specific region and at a specific time. Another objective was to indicate if a specific region is naturally and socio-economically/culturally inclined to one specific syndrome mechanism – a property called "disposition towards a syndrome". As the syndromes were defined as qualitative influence diagrams, the choice of indicators and their combination was not given by strict formal rules but relied also on qualitative arguments. In many cases, fuzzy-logic formulations appeared to be most appropriate to reflect this (Cassel-Gintz and others 1997, Kropp and others 2001). These resulted in global maps which show, for instance, the truth value of the statement "the intensity of syndrome X is high" between 0 (statement is wrong) and 1 (statement is true). Such maps also serve validation purposes, as they allow independent experts to check the postulated spatial distribution of a specific functional pattern (syndrome) against their case-study knowledge.

The sub-concept within the syndrome approach closest to the vulnerability concept is the disposition of a region towards a specific syndrome. The disposition is determined by structural peculiarities of the region that persist over medium and long-term time scales. Described in terms of interacting symptoms, the disposition towards a syndrome is determined by the ensemble of conditions for the existence of the interactions in the syndrome-specific mechanism. These conditions can be either natural (climate, geography, soil properties, etc.) or socio-economic (political system, traditions, culture, etc.). So, for instance, the following questions would need to be addressed: why do we have rapid economic growth connected with a disregard for environmental standards (Asian Tiger Syndrome) in Southeast Asia, but not in Africa? What is the reason for the environmental degradation due to the overuse of marginal land in the Sahel? What are the socio-economic and natural prerequisites for the development and destruction of nature for recreational purposes?

These different conditions have to be assessed on the basis of both quantitative and qualitative information available, which is then systematically interpreted with regard to the specific mechanism behind the interaction considered. Combining these geographically explicit contributions in an evaluation tree yields the geographically-explicit overall disposition measure. This measure is not only relevant for the analysis of currently ongoing Global Change, but is even more important when considering the future. Regions that are prone to one or even more of the syndromes (in other words regions with high disposition), but that have not yet been affected (that is, with presently low syndrome-intensity values), have to be considered as particularly at risk. Therefore, strategies for the management and governance of these regions (local, regional, and global) have to place particular emphasis on either the prevention of exposition factors that can trigger the syndrome or on measures aimed at reducing the disposition itself. For regions that presently have high syndrome intensity, disposition is necessarily high and policy measures need to aim at mitigating and adapting to the syndrome mechanism already occurring.

4.2.2 Comparing the concepts of syndromes and vulnerability

GEO-4 defines vulnerability as follows: "vulnerability is the combination of exposure and sensitivity to risk and the (in) ability to cope or adapt". The comparison of this concept with the syndrome disposition defined above yields some differences in emphasis. Firstly, the specific kind of exposure – a necessary part of vulnerability – is not explicitly included in the core of the syndrome definition. Within the syndrome concept, the problematic syndrome mechanism and its dynamics is observed and described first. Then, as a second step, potential external drivers, which could initiate or further enforce the problematic syndrome mechanism, are

identified. In the case of the Sahel Syndrome, for example, the basic endogenous mechanism is the downward spiral of impoverishment, overuse of resources, declining yield and further impoverishment. Then, given this mechanism, triggering or enforcing factors such as inequitable land distribution, climate change and market changes (and many others) are considered.

In operationalizing this vulnerability definition, the usual way of analysis is to ask *who* (for instance poor people) are vulnerable to *what* (for instance climate change) with respect to *which aspect* of human well-being (for instance their food security). This implies that it is reasonable to investigate one vulnerable group exposed to one driver, at least as a first analytical step.

"Conventional" vulnerability research has taken some steps towards the syndrome "philosophy". One example is the concept of "double exposure" (O'Brien and others 2004), where climate change and market effects are introduced as simultaneous drivers; it was found that the initial analytical separation of vulnerabilities towards different exposures is not adequate, as they interact instead of simply adding up in their effects. Another major difference is that syndrome disposition asks for the risk or danger that a specific problematic process would start (a dynamic view considering endogenous feedbacks, see the above Sahel Syndrome example), while conventional vulnerability analysis tends to emphasize an impact on a specific property. Again, this is corrected in newer developments in vulnerability research by defining "baseline vulnerabilities", describing the result of endogenous processes, which modify sensitivity or adaptability without exogenous exposure. With respect to the question "who is vulnerable", specific vulnerable groups are identified and investigated separately – again, the question can be posed here whether this analytical separation is adequate if there are close interactions between different groups.

To summarize, vulnerability research tends to revisit interactions with respect to multiple exposures, various sensitivities and vulnerable groups. This can be interpreted as a step towards a leading paradigm of the syndrome approach. However, the syndrome approach, which deals with the overall non-sustainability problem, focuses strictly on the civilization–environment interface and values environmental degradation and human living conditions in a symmetrical manner. Vulnerability research usually takes a somewhat more anthropocentric view, by asking primarily for impacts on human well-being – a focus which fits well with the task of the vulnerability chapter of the GEO-4 report. On that basis, the vulnerability chapter in GEO-4 introduced the new concept of archetypes of vulnerability (ATs), which aims at the combination of the two concepts discussed above.

4.2.3 Archetypes of vulnerability

The archetypes of vulnerability are defined in GEO-4 as "specific representative patterns of the interactions between environmental change and human well-being". Within the diversity of human-environment systems throughout the world, some situations share certain vulnerability-creating conditions. These are broad patterns of vulnerability that can be found in numerous different places around the world, for example, in industrialized and developing regions, and urban and rural areas. The archetypes represent real cases, simplified in order to show the basic processes that produce vulnerability within a context of multiple stressors. This may allow policymakers to recognize their specific situations within a broader context, providing regional perspectives and important connections between regions, as well as the global context and insights into possible solutions. Although analysed individually, many different patterns of vulnerability emerge. They are also not mutually exclusive – in some ecosystems, countries, sub-regions, regions and globally, a mosaic of the selected patterns of vulnerability may exist (as well as other ones). This makes the development of policy responses a complex challenge.

By analysing the vulnerability of human-environment systems to multiple stressors (drivers and pressures), challenges and opportunities within and beyond the environmental policy domain are identified. The analysis also shows how vulnerabilities are affected by actions elsewhere and indicates

Box 4.1 Basic analytic framework for archetype analysis (after Turner and others 2003)

The template used for the archetype analysis and descriptions follows the main components from the Turner and others (2003) framework for vulnerability analysis that was presented in Chapter 3:

- *What are the main pressures – environmental and socio-economic?*
  - *defining the pattern*
  - *showing global relevance*
- *What are key vulnerable communities, social and economic groups involved, including gender dimensions?*
- *What are the major (sub-)dimensions of human well-being affected?*
- *How do the six cross-cutting issues shape the vulnerability in question?*
  - *poverty*
  - *trade and globalization*
  - *science and technology*
  - *human health*
  - *institutions and governance*
  - *conflict and cooperation*
- *Challenges: how do changes of the human-environment system affect*
  - *human well-being*
  - *environmental consequences?*
- *Opportunities: policy responses*
- *Boxes with real world stories*
  - *general*
  - *"success stories"*
  - *indicators, measures, maps, graphs*

worldwide inter-dependencies. It, thus, reflects the different components of the Turner and others (2003) framework of vulnerability presented in Chapter 2 (Figure 2.2). Box 4.1 presents the basic analytical framework that was derived from this as a basis for archetype analysis. Overarching issues in relation to vulnerability are equity, the export of vulnerability from one place or generation to another, the potential for conflict or peace-building co-operation and the impacts of natural hazards (see Chapter 2). The components of well-being analysed in the archetypes, are material assets, health, security, social relations, and freedom and choice (see Chapter 3).

4.3 The identification of archetypes

There is no unique or objective way to identify a set of archetypes. Different approaches to identify archetypes could be used, including:

- Expert-based, building on individual knowledge
  - for example, patterns of land-use change (Lambin and others 2001)
  - necessary: broad coverage of regions and knowledge
- User-driven, through science policy workshops
  - for example, syndromes in Latin America (Gallopin, ECLAC) and identification of archetypes through the GEO-process
  - necessary: broad coverage of interests
- Data analysis
  - using methods of cluster analysis, for example, drylands archetype in GEO-4
  - results depend on indicator use
- Meta-analysis of case studies
  - problems: heavy workload due to large number of case studies which might not cover a sufficient range of vulnerabilities
  - positive: representative case studies appear automatically

The process followed in GEO-4 combines elements of the first three approaches, through the role of the collective expertise of the chapter working group, as well as the GEO process. The regional and global consultation process for GEO-4 offered an opportunity to identify and select a relevant set of archetypes for GEO-4. A number of criteria were formulated at the start. The archetypes included in GEO-4 together had to represent some of the most important vulnerabilities, and also including the most vulnerable population groups throughout the world, such as indigenous people, and the urban or rural poor, or economic sectors heavily dependent on environmental services. Also, the archetypes would have to reflect vulnerabilities across the full range of geographic and economic contexts that require attention in the GEO context: developing countries, industrialized countries and countries in transition. Finally, the set of archetypes should allow detailed and elaborate analysis of the way in which issues, such as poverty, human health, institutions and governance, science and technology, trade and globalization, and conflict and cooperation influence or interact with human-environment systems. The fact that these issues play out differently in different contexts was one of the major motivations for choosing the archetype approach.

The identification and selection process of the archetypes started from global and regional priorities, set by the seven UNEP/GEO regions for GEO-4, in its consultation process with government representatives and other stakeholders. Throughout the entire production process, the most important outcomes of the state and trend chapters of GEO-4 and, even more importantly, the regional chapter were taken into account. Table 4.1 provides an overview of the identification and selection process during the preparation of the chapter (see also Annex 1).

During the first chapter working group meeting in Scheveningen, the Netherlands, an initial set of possible archetypes for further consideration in GEO-4 was developed (first column Table 4.1), based on the GEO-consultation process, previous work on the syndromes and the outcomes of the scientific scoping meeting in Costa Rica (Wonink, Kok and Hilderink 2005). A number of criteria were used for the selection process: country type, dependence on environment, income groups, relevance for the cross-cutting issues, and exposures. This was done to avoid overlap between the archetypes and to see to which topics, regions and groups they related.

The first production meeting, in which all GEO-chapter authors met, was used to consult with all regions on the relevance of the initial set of archetypes and to develop and consolidate these further. In the storyline that resulted from the first production meeting in June 2005 (Nairobi, Kenya), a first set of 12 archetypes was proposed (second column Table 4.1). These were subsequently elaborated before and during the second chapter expert group meeting in October 2005 (Hua Hin, Thailand). At this stage, it had become clear that actual inclusion in the report would depend on further discussions of regional priorities and that it would not be possible to include all 12 archetypes in the final version of the chapter.

Following the outcomes of the second chapter working group meeting, a slightly modified set of archetypes was further elaborated and included in the zero-order draft of the vulnerability chapter for further discussion and selection at the second production meeting (June 2006, Nairobi, Kenya) (third column Table 4.1). For practical reasons – the total number of pages available for this chapter in GEO-4 – it was decided to select seven archetypes (fourth column Table 4.1). Based on an analysis of the state and trend and regional chapters, it became clear that especially the global commons, the contaminated sites, drylands, the technological fixes of water problems, the urbanization of the coastal fringe and the energy archetypes addressed issues that featured prominently throughout the GEO-4 report. This was used as first selection criteria. For the export of vulnerability, the global markets and local opportunities and post-conflict archetypes, it was recognized that they covered aspects of vulnerability relevant in many of the other archetypes. It was, therefore, decided to strengthen the coverage of these issues in the other archetypes and not to include them as separate archetypes. This left one final choice to be made between the SIDS and the resource paradox archetype. Here UNEP's preference for the SIDS was decisive. The resource paradox, however, is addressed as part of the energy archetype and in the section on conflict in GEO-4.

Overview of the archetypes that were identified and selected during the preparation of the chapter **Table 4.1**

Scheveningen meeting	First Nairobi meeting – storyline chapter	After Hua Hin – zero-order draft	Second Nairobi meeting – first-order draft
First identification of possible archetypes based on GEO consultation process, including global and regional priorities and expert judgement (n=17)	*Consolidation of initial list and ensuring regional relevance, some lumping, two new ones (n=12)*	*First analysis, some reformulation, some lumping, added new one (n=11)*	*Selection for GEO-4 based on coverage in state and trend and regional analysis, possibilities to cover specific issues in another way in chapter and preference of UNEP (n=7)*
• Drylands in developing regions, could also include "dry forests" • Drylands in industrialized countries (Southwestern United States, Spain, Greece)	• Drylands in developing countries	• Desertification in drylands	• Drylands
• Depreciation of infrastructure and institutions (Russia, Ukraine, ...)	• Infrastructure depreciation • Rapid economic growth	• Contaminated sites - legacies of the past	• Contaminated sites
• Urban lifestyles and export/ import of vulnerability (New York, London, Berlin,...)	• Export of vulnerability and consumption patterns	• A growing consumer class and the export of vulnerability	
• Institutional failures in resource rich areas	• Institutions and resource rich areas	• Resource paradox and vulnerability	
• Migration to major coastal areas • Mega cities and lack of infrastructure (Lagos, Sao Paolo, Moscow) • Rapid economic development (Asian Tigers)	• Heavily urbanized coastal areas • Unequal exposure to environmental hazards (human settlements)	• Urbanization of the coastal fringe: balancing environmental risks and economic opportunities	• Urbanization of the coastal fringe
• Conflict-induced vulnerability (Middle East, Great Lakes Regions in Africa, Central and Eastern Europe)	• (Post) Conflict induced vulnerability	• (Post) Conflict vulnerability	
• Common pool resources (open access resources) fisheries; Arctic	• Common pool/property resources	• Common pool resources	• Global commons
• Export of natural resources bypassing local needs and local development; • Cash-cropping for export in international markets • Loss of access, e.g. to forest because of concessions to international concerns	• Agriculture and globalization	• Global markets, local opportunities	
	• Water stress in industrialized countries	• Technological fixes of water problems	• Technology-centred approaches to water problems
	• Inertia and lock-in looking at energy systems	• Vulnerability of energy production and consumption systems in industrialized countries: the next energy crises?	• Securing energy
		• Small Island Developing States (SIDS)	• Small Island Developing States (SIDS)
• Overintensive agriculture in the north			
• Extreme environmental events (floods and heatwaves in Europe, floods in the United States)			
• Invasive species			
• Marginalisation of indigenous populations of e.g. highlands			

Revisiting the process reflected in Table 4.1, it is clear that four of the archetypes that were included in GEO-4 were identified in the beginning of the process. The other three, which were added during the second and third step in the process and were also included in GEO-4 (energy, water, SIDS), reflect the need to strengthen the link with the regional priorities and to ensure a regional balance. The identification of archetypes for industrialized countries, in particular, required special attention from the chapter working group.

This process resulted in the final set of archetypes included in GEO-4 (fourth column, Table 4.1), already summarized in Table 1.1. That table shows how these archetypes relate to the regional priorities, which dimensions of human well-being they address, and which policy responses were proposed by the expert working group to reduce vulnerability. The expert and country peer review process did not question this set of archetypes. No other archetypes were suggested, nor was this set of archetypes contested as unbalanced or biased.

4.4 The archetypes that were not included in GEO-4

Table 1.1 provides an overview of the archetypes that are included in the report. Full descriptions and analyses of these archetypes can be found there (UNEP 2007). This section presents the archetypes that were analysed, but not included in GEO-4:

- a growing consumer class and the export of vulnerability;
- global markets, local opportunities; land-use change and livelihood insecurity;
- post-conflict vulnerabilities and human well-being;
- the resource paradox and vulnerability.

These archetypes have not been analysed in as much detail as the ones included in GEO-4, nor have they undergone full peer and government review. Nevertheless, they present an interesting and relevant set of patterns of vulnerability, deserving further attention.

4.4.1 A growing consumer class and the export of vulnerability

In the archetype of growing consumer class and export of vulnerability, we analysed the consequences of increasing global consumption, the harmful effects of this behaviour on natural systems, and the challenges faced by the poorest people that directly depend on these systems to meet their basic needs. As global figures show (see Box 4.2), consumers in industrialized countries have a large ecological footprint (as illustrated for example by the total ecological footprint, Venetoulis and others 2004, WWF and others 2005, WWF and others 2004). Moreover, consumers in newly-industrialized countries are now catching up rapidly (Myers 2004). However, the poor are not part of the consumer class, but tend to be the most vulnerable to the negative environmental effects of consumerism. Examples include the relocation of resource extraction, the move of production sites to other countries, and the export of hazardous waste to places with low environmental standards for recycling or land fills.

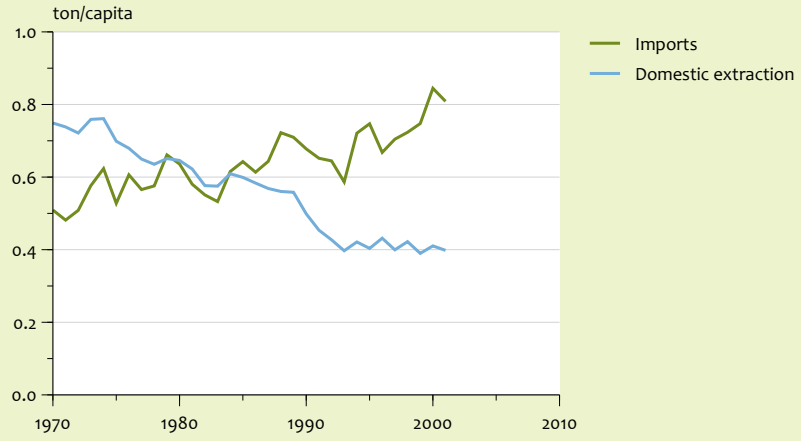
Global relevance

The current level of resource use that is predominant in developed countries cannot be sustained at the global level. Despite past efforts in industrialized countries to reduce material use, today 25 per cent of the world population still uses 80 per cent of the resources and generates 80 per cent of the waste (UNDP 1998, von Weizsäcker and others 1997, WI 2005). While international trade can lead to increases in welfare, it also plays an (increasing) role in sustaining such unequal patterns of consumption, as industrialized countries

Box 4.2 The footprint of consumption

Approximately 1.7 billion people worldwide now belong to the "transnational consumer class", the group of people characterized by an income of over US$7 000 in purchasing power parities, diets rich in meat, transport by car, and lifestyles devoted to the accumulation of non-essential goods. The affluent consumers' lifestyle includes spending large proportions of their expanding disposable incomes on automobiles, meat, and electricity-demanding appliances. Such lifestyle choices are already placing huge demands on local ecosystems, and they increasingly threaten the global environment as well. Per-capita consumption worldwide has increased by 3 per cent per year during the past quarter century (Hawken and others 1999). A recent study reveals that a large proportion of the environmental load of Dutch private consumption takes place abroad. For greenhouse gases, this amounts to 49 per cent; 56 per cent for pesticide use; 61 per cent for summer smog; 64 per cent for eutrophication; 74 per cent for acidification; and 84 per cent for land use. The consumption domains of food, car use and indoor heating had the highest environmental loads (Nijdam and others 2005). Figure 4.1 shows the balance for extraction, import, consumption and export of metal ores in Europe.

Use of industrial minerals and ore in EU-15 **Figure 4.1**



Metal ores: domestic extraction, imports, exports, and domestic consumption, EU-15 1970-2001 (Eurostat/IFF 2004).

continue to outsource natural resource extraction, production and manufacturing, and hazardous waste dumping and recycling to the rest of the world (Grether and de Melo 2003, Schütz and others 2004).

The trade patterns between industrialized, newly industrialized and developing countries reveal that the high resource consumption of industrialized countries depends increasingly on imports: products are imported from newly industrialized countries, and raw material and energy are imported from developing countries. In return, industrialized countries export some products to newly industrialized countries and the waste to both groups of countries. Newly industrialized countries (such as India, China and Brasil) have gained much wealth in restructuring their economy towards manufacturing and export, and they increasingly import raw material from developing countries. Developing countries rely on the extraction and export of primary commodities, which are the most resource intensive per unit of economic output and require large amounts of resources to be extracted for relatively little added value (Raffer and Singer 2005). The consequences for the local environmental are severe. The gap between countries "which have made it", and other countries widens. Finally, export-driven economics in developing countries often results in environmental degradation that could be avoided. Although the available data on income disparities between countries is ambiguous (WI 2005), on a global level the disparities between the richest and the poorest people can be seen clearly.

Vulnerable groups and impacts on human well-being

Decreasing the vulnerability of some people is increasing vulnerability of others far away (Martinez-Alier, 2002). While most people in industrialized nations and the new consumers do not feel most of the impacts on the environment they cause through their behaviour, these negative effects on the environment, direct and indirect, are felt most strongly by the poor. They have to cope with polluted land, water and air, unsafe working conditions, environmental hazards and an increased risk of disasters, changing social ties and lack of enforcement of their rights.

Newly industrialized countries face social disparities, if the transition goes too fast for some. This creates a new gap between a consumer class and a poor working class. At the moment, the new consumer class lives off its country's social and natural capital. Issues like work safety, bio-safety, levels of acceptable risk and gender inequalities directly affect the well-being of the poorest part of the population. Environmental stressors arise at extraction sites of primary commodities and in places where waste is dumped or recycled. In developing countries, such stressors frequently result in ill-being, as they coincide with the presence of poor local populations with low coping capacities. The negative effects are exacerbated by global stressors, such as global warming. Disasters, resulting either directly from the production process (for instance, the accidental spilling of 100 tonnes of benzene from a petrochemical site into the Songhua River, in Northeast China, in November 2005), or from the exacerbated impacts of natural hazards through environmental degradation (for example the loss of protective mangrove forests in tsunami-affected coastal areas) are mostly felt by the poor. The health of local communities is particularly affected by pollution. Livelihood insecurity is high in countries where the local population relies on one particular resource or export product. The local population also faces limitations in the freedom of choice when access to resources (such as common pool resources or privately owned land) is restricted, or when people are forced to relocate because of new extraction sites.

Responses

Eco-efficient production, services and dematerialization should allow material prosperity while being environmentally friendly (see also Box 4.3). There are many eco-technologies on the market to enjoy material well-being, while using less

Box 4.3 Greening the production and consumption chain

Education and information for local communities

In artisanal gold mining, miners use mercury to extract gold, which pollutes nearby aquifers. For every gram of gold recovered, 2 to 5 grams of mercury is released into the environment. The lack of appropriate technologies and health and safety procedures has led to severe environmental degradation and pollution. To respond rapidly to potential health dangers, trainers from local small-scale mining associations and provincial and municipal environment offices have been trained in cleaner production methods that reduce the use of mercury through recycling (http://www.unido.org/doc/4199).

Technology transfer on a regional level

As the aquaculture industry is still in its learning phase, the exchange of industry-adopted best management practices (www.enaca.org) can reduce the pressure on the environment tremendously. Even small changes in practice can lead to a significant reduction in diseases (www.aims.gov.au).

Shifting consumer preferences to environmentally and socially sound production

Consumption patterns shift according to changing tastes and preferences. In recent years, the demand for environmentally friendly produced goods has been rising steadily, and this has led to a need for certification. Such certificates help to ensure transparency throughout the production process.

Policy mainstreaming

In 2001, to raise awareness and sensitize policymakers to issues of sustainable consumption, UNEP issued the strategic report "Consumption Opportunities", which addresses issues of sustainable consumption, including overconsumption and misconsumption.

raw materials and energy and causing less pollution. A change in attitude is needed to change consumer behaviour. Currently, the goal of decoupling material use from economic growth is difficult to realize in Europe (EEA 2004).

While the change in consumer behaviour remains the main challenge, many opportunities are used at smaller scales and within shorter time frames. The long-term goal for developing countries will be to reduce their dependency on primary commodity exports. This can be achieved by increasing efforts to diversify the economy – a strategy that has been of vital importance for development in industrialized countries. Similarly, encouraging the domestic processing of natural resources ("vertical diversification") is expected to increase the added value of exports. This would require increased investments and aid for infrastructural development to enable economies in the South to reduce extraction rates of natural resources and, thus, decrease pressures on the domestic environment. Simultaneously, "horizontal diversification" should be encouraged to build up other, less resource-intensive sectors. Active investment in education and training to foster the acquisition of skills in the labour force is one central measure to shift comparative advantages away from unprocessed to processed primary production and, later on, from primary production to manufacturing, which on average is more skill intensive than activities in the primary sectors (Wood 1999).

4.4.2 Global markets, local opportunities; land-use change and livelihood insecurity

In this archetype, we investigated the cash crop sector and the consequences for local communities as they often bear the brunt of agricultural expansion. This can result in a pattern of vulnerability, where cash crop-driven agricultural land-use change undermines the livelihood of natural ecosystem-dependent communities, that do not have sufficient alternatives to overcome the loss of their livelihood base, and that hardly share in the benefits from the resource exploitation. The impact on local communities is not always negative; cash cropping has also helped local development. Therefore, the pattern of vulnerability described above should not be regarded as intrinsic or an inevitable consequence of the cash crop sector, but neither should it be ignored from the perspective of sustainability.

Global relevance

Food production has grown substantially in the last 50 years. This has helped secure food supply for many, even in the face of a rapidly growing world population. Between 1960 and 2000, the world population doubled (from 3 to 6 billion) and food production increased around two-and-a-half times (MEA 2005). The increase in food production was primarily achieved through the intensification of agricultural production. In developing countries, the area under cultivation also grew rapidly (see Figure 4.2a). This expansion still continues, often at the expense of natural ecosystems. A substantial part of this expansion is for agricultural export (see Figure 4.2b). Trade in agricultural and aqua-cultural products has grown even faster than the increase in production itself, growing fourfold between 1961 and 1999 (Millstone and Lang 2003). Agri-businesses have become powerful multinationals with a high degree of vertical integration between production and consumption. A small number of businesses increasingly control agricultural trade, at the international level (FAO 2004b).

Cash crops generate substantial revenues for many developing countries. Often it is one of the primary export sectors, bringing in significant foreign revenues. For as many as 43 developing countries, a single agricultural commodity accounted for more than 20 per cent of their total revenues from foreign trade (FAO 2004). Products, such as soya bean, palm oil (see Box 4.4), shrimps (see Box 4.5) or wood, generate many jobs and large amounts of export revenues, but they are also associated with the loss of large areas of natural resources such as forests and mangroves. Short-term exploitation is often favoured over long-term management of natural resources and there is little concern about the long-

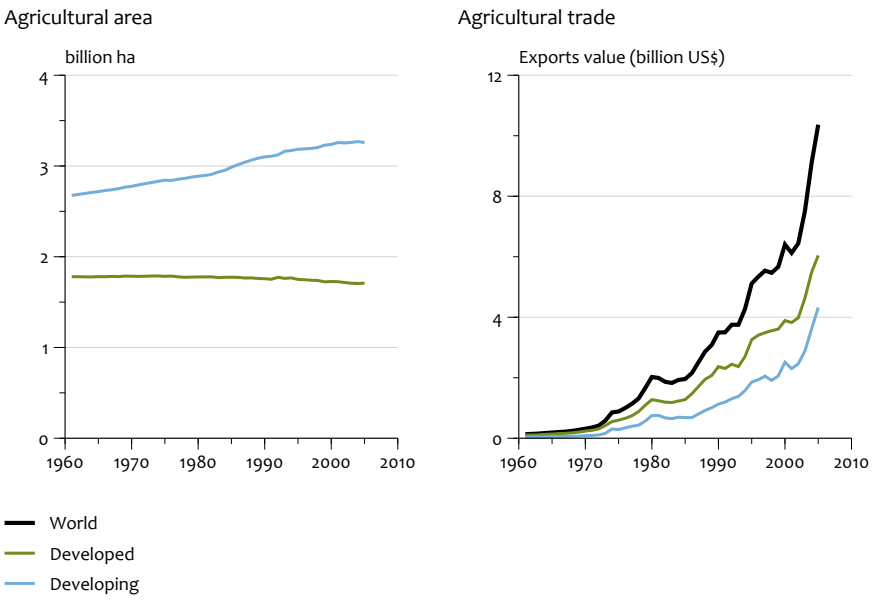
Box 4.4 Oil palm in Indonesia

Palm oil production has increased rapidly over the last 40 years. Currently, it is the world's second most produced vegetable oil after soya oil, and the primary vegetable oil traded on the world market (Basiron, Balu and others 2004). It is also increasingly in demand as a biofuel. In Indonesia, the second largest producer after Malaysia, palm oil contributed with 31 per cent to the agricultural export in 1997 and its production employed around 2 million people (Susila 2004). In 2000, 46 per cent of the oil palm production area was held by private enterprises, the rest by small-holders and government-run plantations (Barber 2002).

Much of the growth in palm oil production has come at the expense of tropical forest. Expansion of oil palm plantations is currently among the most important forces driving deforestation in Indonesia (Barber 2002). Even if development of oil palm plantations does not take place in natural forest areas, increasing demand for land will inevitably lead to further deforestation. For Kalimantan (Curran, Trigg and others 2004) it was found that the establishment of oil palm plantations outside lowland protected areas did increase pressure on these protected areas.

Natural forests are important for securing the livelihood of forest-dependent people, including many indigenous forest-dwelling peoples with long-standing customary traditions of forest resource management (Barber 2002). The lack of land rights of local and indigenous people and lack of government protection have given them little security against ongoing deforestation. Forest conversions have provided little direct benefits for forest-dependent communities and threaten their traditional livelihood. This has led to social tension and conflict over resources and land rights. In Indonesia, these conflicts grew violent in the 1990s, when indigenous people protested against the development of new oil palm plantations.

Agricultural area and trade **Figure 4.2**



Growth in agricultural area (a) and agricultural exports (b) in developed and developing countries (FAO-stat).

term economic impact of such activities (Dewi, Belcher and others 2005). Consequently, the establishment of new areas for cash crop production often cause problems with original users of the natural ecosystems.

Vulnerable groups and impacts on human well-being

The most vulnerable group is the indigenous population which depends directly on ecosystem functions for a living. But other communities also retain a significant share of their livelihood base from natural ecosystems. Without the traditional way of sustaining their livelihood, alternatives have to be sought. Tropical forests, for example, provide a host of ecosystem goods and services, such as food, firewood or the cleaning of water. Conversion of those ecosystems for agricultural, aqua-cultural or forestry use can have enormous consequences for the supply of these services. The impact on the well-being of a local community depends on how much they gain or lose from the conversion.

Basic material needs are under threat where the loss of access to communal grounds deprives local communities of the basic resources that are part of their livelihood. Human health suffers when basic material needs are not met, for instance, through malnutrition. Health is also affected by air and water pollution and unsafe production methods. The expansion of cash crop production has led to many conflicts over land rights and the use of communal grounds. This threatens good social relations and increases insecurity, particularly when conflicts grow violent. Finally, this form of resource exploitation, with little stakeholder participation, also infringes on the freedom and entitlements of people.

Responses

It is likely that the growth of cash crops in the agricultural sector will continue in the coming decades. The archetype focused on the consequences of this trend for ecosystem-dependent communities. However, cash crop expansion does not have to result in marginalization of local communities. It is the particular combination of factors that results in this outcome. Avoiding this will bring great benefits, not only for local communities but also for national governments and the private sector. Avoidance does not have to hamper the growth of the export sector. On the contrary, it can create a broader basis of support for these developments, ensuring a more solid foundation for long-term economic development.

There are many opportunities to make the cash crop sector more sustainable. Policy and action focused on reducing the impact on livelihoods can provide many opportunities for improving human well-being, for example, by reducing the negative consequences of land-use change or through the development of an alternative livelihood base. Which approach is taken, clearly depends on the local situation, but the recognition of local community rights in the exploitation and sharing of natural resources will be required. Opportunities include the internalization of negative effects on humans and the environment (for example, through fair trade, certification and labelling), and support of R & D for the development of more environmental and socially friendly alternatives.

4.4.3 Post-conflict vulnerabilities and human well-being

The environment is a common casualty of conflict, just as environment can be a cause for conflict (Westing 1991, Austin and Bruch 2000). Conflict and post-conflict conditions undercut the capacity to adapt to or mitigate global change (Barnett 2006). This archetype focuses on the last category, the post-conflict period and its threat to human well-being. The breakdown of infrastructure, social order and the rule of law in many post-conflict settings increase the vulnerability of human-environment systems. Environmental cooperation to facilitate the distribution of environmental goods and services, in this period, addresses the direct vulnerabilities, but is

also a means to improve the chances of avoiding relapse to conflict, a situation that would exacerbate the existing vulnerabilities and threats to human well-being.

Global relevance

Poverty reduces the capacity of populations in post-conflict settings to adapt to environmental vulnerabilities from conflict and post-conflict settings. At the same time, poor populations dependent on natural resources may gain increased access to those resources once conflict has ended (safer to farm, gather fuel wood, hunt etc.). Environmental cooperation may reduce poverty by supporting sustainable development that brings long-term benefits for human well-being. In some cases, informal and/or illegal trade in valuable natural resources was part of fuelling or prolonging the conflict (Collier and others 2003, De Soysa 2005, Ross 2001). These trade networks are often interrupted in the immediate post-conflict period. Newly accessible former conflict zones also have increased natural resource exploitation (logging, bush meat, hunting for export of traditional and medicinal items) (McNeely 2000, McNeely 2003, Shambaugh and others 2001).

Mortality caused by disease and starvation is much higher than by bullets or bombs during wartime: battle fatalities made up only 11 per cent of deaths in Angola's 27-year civil war, and 6 per cent in the Democratic Republic of the Congo, between 1998 and 2001 (Lascina and Gleditsch 2005). These same human health threats often persist in immediate post-conflict settings, impeding reconstruction efforts. Environmental damage due to the conflict itself deepens these vulnerabilities by directly impacting human health or limiting efforts to restart economic and agricultural activity that would improve health. Mental health problems, due to traumas experienced during the conflict, represent a major issue for the conflict-impacted population, at the individual level and at the community level, since it increases vulnerability and affects the human capacity to cope with or respond to environmental stress.

Institutions and governance around environmental issues in post-conflict settings are often weak. Often already weak in peacetime, the capacity for formal environmental management has been non-existent in some conflict and post-conflict settings. In others, governmental and non-governmental officials have continued working to preserve precious biodiversity, at great peril to themselves, just as some wildlife officials have done to protect gorillas in Rwanda, Uganda and the Democratic Republic of the Congo. Natural resource regimes have changed as part of a negotiated peace agreement, where the potential for lucrative resource control is used as an incentive to end the conflict. Countries in conflict and post-conflict periods find it more difficult to participate actively in regional and international environmental cooperation or negotiations.

Vulnerable groups and impacts on human well-being

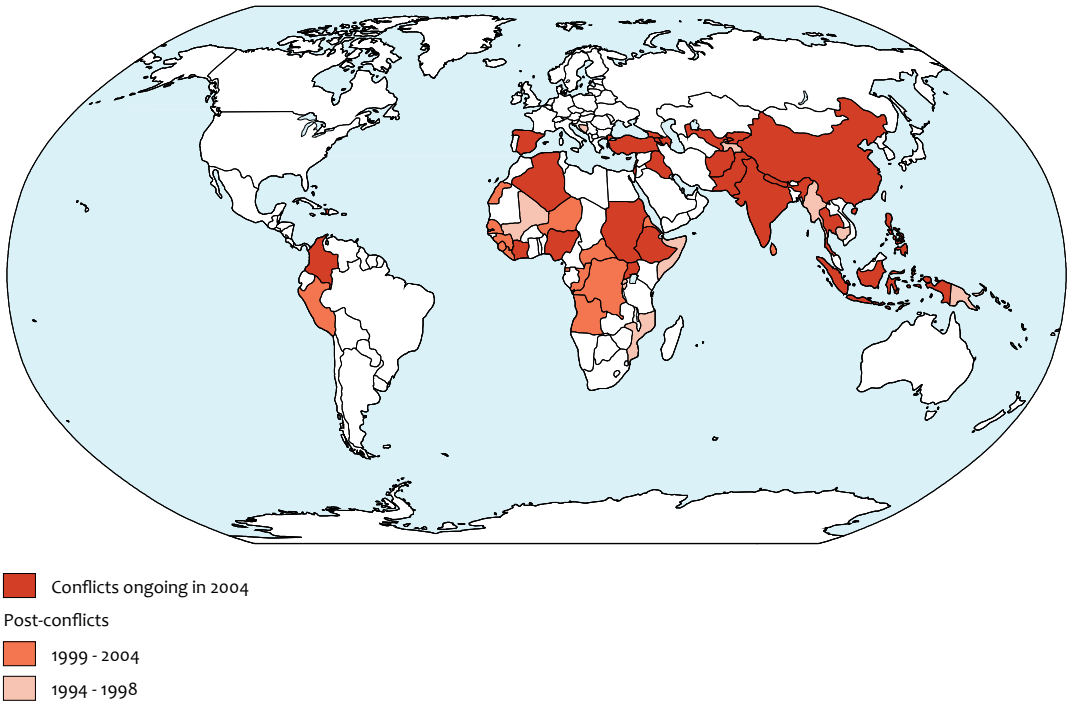
Many vulnerable groups are affected in post-conflict settings: refugees, internally displaced persons, women and children. Their vulnerability often consists of threats to key aspects of human well-being. Populations in post-conflict settings often have limited access to resources because of unsettled ownership rights, depleted or degraded resources or unsafe areas (such as mined agricultural fields). They also suffer both direct and indirect health threats. Direct health effects stem from degraded or poisoned water sources. Indirect health effects stem from malnutrition or lack of purchasing power when

Box 4.5 Shrimp farming

Commercial shrimp farming began in the late 1960s and early 1970s, in line with growing global demand for cheap shrimp, which could no longer be entirely supplied by wild catch. As a result of technological advances, intensive forms of shrimp farming developed and farming expanded into many parts of the tropical and sub-tropical regions of the world, where farms can generally produce two to three crops per year. Today, there are commercial shrimp farms in over 50 countries. About 75 per cent of the world production of farmed shrimp comes from Asia, particularly China and Thailand. It is estimated that between 5 and 10 per cent of the global mangrove forests have been converted for shrimp aquaculture. This has led to increased coastal erosion and reduced protection against floods. Destruction of mangroves also affects local fisheries, as mangroves are critical spawning and nursery grounds for many commercially important fish species. Furthermore, prolonged use of a pond leads to an incremental build up of toxic sludge. Flushing the pond never completely removes this sludge and eventually the pond is abandoned and a new area cleared to build another pond.

Comparison between countries shows that the impact on the environment and human well-being varies, depending on the intensity of production. This offers the opportunity to learn from different areas the positive and negative effects of different forms of production. For example in Thailand, farm produced shrimp are now most commonly raised in intensive, industrialized cultures, whereas in Vietnam, a late starter in the business, the production methods still vary between hatcheries, extensive, semi-intensive and intensive. In 2002, Vietnam still had a variety of locally diverse production modes. Until the mid-1990s, expansion was more important than intensification. The more extensive ponds covered a much larger area, requiring a larger workforce and possibly – if stocked with more than one species – a workforce that had more than one source of income, lowering the risk of failure. Extensive systems also allowed the farmers to work in other fields, such as rice paddies. The intensively used, industrialized ponds are single-use and also single-profit enterprises. The smaller the ponds, the more likely local former rice farmers can afford the investment to convert their production to shrimps, and contribute to local wealth. This still remains a high-risk business, and many are forced to give up after one crop failure. Nevertheless, the high and quick return on investments makes the intensification of the industry attractive.

Selected conflict and 'post-conflict' zones 1994 - 2004 Figure 4.3



Selected conflict and "post-conflict" zones 1994-2004 (Small Arms Survey, 2004).

natural resource-intensive livelihoods are undercut or unavailable. People in post-conflict settings often suffer separation and destruction of family units and extended support networks. These break-downs in good social relations undercut social safety nets and lower coping capacity and resilience. Finally, they face persistent personal security challenges, impeding access to livelihood activities.

Responses

Casting the environment as the victim or instigator, misses a critical opportunity to utilize the environment as a builder of confidence, cooperation and peace. "Environmental peacemaking" pathways range all along a conflict continuum that begins with conflict prevention, runs through times of conflict, and ends with post-conflict reconstruction (Conca and Dabelko 2002, Conca and others 2005).

Environmental assessments in post-conflict settings bring objective and practical knowledge to the struggle of rebuilding after conflict, as the UN Environment Programme's Post-Conflict Branch (formerly the Post-Conflict Assessment Unit (PCAU)) has done in Bosnia, Serbia, Albania, Afghanistan, Iraq (see Box 4.6), Liberia, and the Occupied Palestinian Territories, among other areas. Systematic steps to map, assess, and address environmental conditions in post-conflict settings have direct and measurable impacts on improving human well-being and reducing people's vulnerabilities. Environmental assessments have presented opportunities for collaboration among parties still in conflict; thus, these assessments not only bring a benefit to the environment and subsequently to human well-being, but also prevent resumption of conflict. Post-conflict rebuilding of environmental institutions paves the way to sustainable development. Environmental post-conflict rehabilitation offers short-term and long-term benefits for human well-being. In the short term, water quality measurements help local populations determine which wells are poisoned and which are safe to use. Assessments of depleted uranium or landmines left on the battlefields tell farmers whether their fields and groundwater are safe, as PCAU assessments have done in Bosnia and Kosovo (UNEP 1999, UNEP 2001). Longer-term benefits from sustainable forestry management structures, such as those being established in post-conflict Liberia, will help preserve the natural resource base for the populations which are highly dependent on forest products for their livelihoods (UNEP 2004). The availability of or access to science and technology are fundamental to reducing the vulnerability of human populations in post-conflict situations. Rebuilding infrastructures and environmental clean-ups of contaminated sites are among the basic steps to a new prosperity of the affected population.

4.4.4 The resource paradox and vulnerability

Abundance of resource can, as increasingly documented, result in what is called the "natural resource curse". The danger of resource wealth is also known as "Dutch disease". It was already stated several decades ago that "to refer to a vast, valuable energy resource (which was the case with natural gas in the Netherlands) as the source of a 'disease' sounds rather ungrateful" (Van Wijnbergen 1984). There is a remarkable consistency in the findings of studies in several social fields that abundant natural wealth can be a curse rather than a blessing (Auty 2001, Bulte, Damania and Deacon 2005, Collier and others 2003, De Soysa 2005, Ross 2001). This archetype is about the problems related to lower economic, social, and political performance within resource-rich countries, which result in tremendous waste of natural assets

without the commensurate human development and creation of well-being. In fact, natural resource abundance may underlie the generating of vulnerability and ill-being, even resulting in violent conflict (Collier and others 2003, De Soysa 2002a and b).

Global relevance

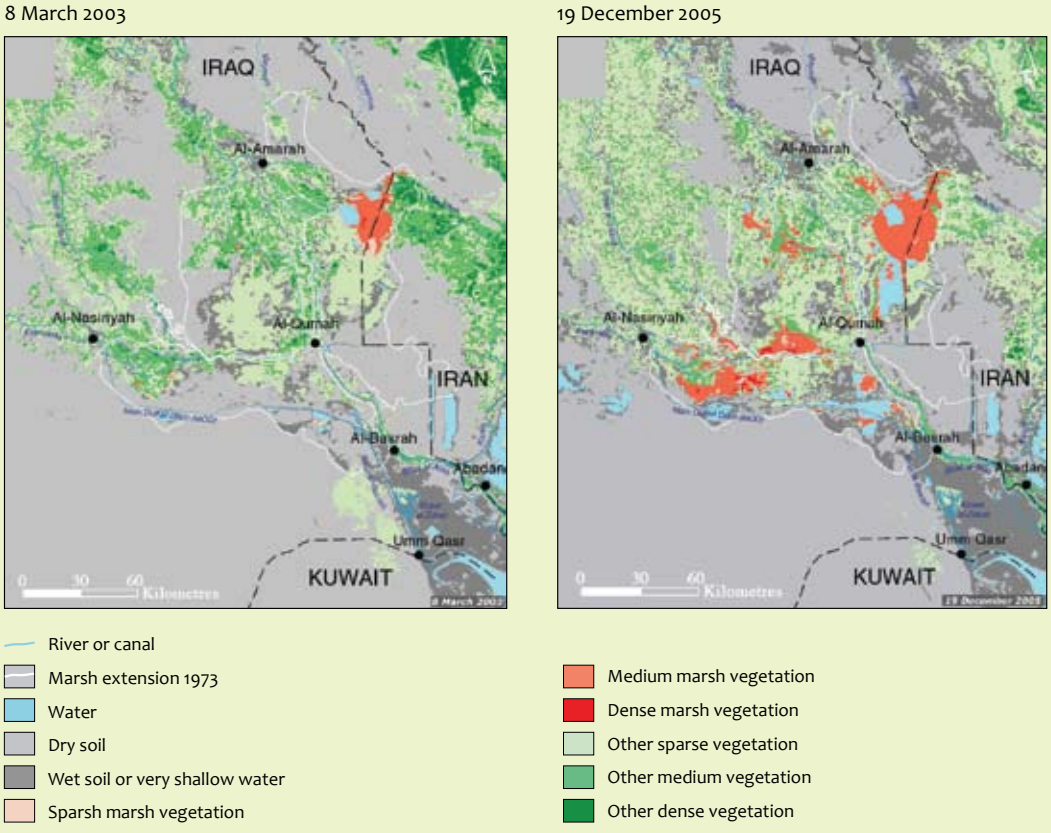
The empirical evidence of lower economic growth among resource-rich countries relative to resource poor counterparts is numerous (Auty 2001, Lal and Mynt 1996, Leite and Weidmann 1999, Sachs and Warner 2001, Sala-I-Martin 1997) and includes both industrialized and developing countries. The "resource paradox" is apparently correctable through policy, but political scientists are pessimistic about whether better policy will be forthcoming in resource-rich countries, largely due to the fact that this situation tends to occur in authoritarian regimes (Ross 2001). Political survival dictates profligacy and waste, rather than public goods provision, and runs down

Box 4.6 The Mesopotamian marshlands

In the wake of the 1990-91 Gulf War, the then Iraqi President Saddam Hussein systematically drained the Mesopotamian Marshlands of southern Iraq as a retribution for Marsh Arab participation in the thwarted uprising that followed the war. Since 2003, the Mesopotamian Marshlands have been restored and this unique ecosystem is again receiving large quantities of water (see Figure 4.4).

This re-flooding is lowering a range of human vulnerabilities for those parts of the Marsh Arab population whose culture, economy, and health depend on this fragile ecosystem. The Mesopotamian Marshlands are transboundary, as they are shared between Iraq and Iran. The process of restoration has been utilized by external facilitators, such as the UNEP Post-Conflict Branch, to facilitate dialogue and cooperation between Iraqi and Iranian scientists and officials. According to facilitator Pekka Haavisto (2005), this dialogue is a first in nearly three decades. The main beneficiaries of the marshland restoration project are the communities that participate in the pilot implementation of water, waste water, and marshland management. The promotion of sustainable marshland-management practices provides benefits of environmental protection and water management, with positive effects on human health and sustainable livelihood for the Iraqi population. In addition, the Iraqi Ministry of Environment will receive institutional and capacity support to start addressing the marshland issues in a more integrated manner. Technical experts from line ministries and local universities will also receive technical training.

Restoration of the Mesopotamian marshes in Iraq **Figure 4.4**



The restoration of the Mesopotamian Marshlands.

human and social capital (Bulte, Damania and Deacon 2005, Smith 2004, Woolcock, Pritchett and Isham 2001). The empirical evidence supporting the view that the resource paradox works largely through government and political variables, particularly corruption, is quite robust, with severe consequences for human well-being and welfare (Dietz, Neumayer and De Soysa 2004, Leite and Weidmann 1999, Papyrakis and Gerlagh 2004, Torvik 2002). See also Box 4.7.

Vulnerable groups and impacts on human well-being

The resource paradox is a macro phenomenon, since it depends much on national policies. However, the abundance of oil in places, such as Angola, has rarely benefited the local population. Local, disempowered people suffer the consequences of the breakdown of national politics, the violence of paramilitary groups that develop around extortion, such as in Colombia or Nigeria, and the environmental harm caused by irresponsible resource extraction, exemplified by places, such as the Ogoniland (Nigeria). As many argue, local populations are ignored by national policies because resource wealth offers states income independent of human production. Since people are not valuable to rulers as taxpayers, government policies rarely provide local public goods in an equitable manner, nor do they build institutions that provide public goods, particularly justice. Thus, both local and national society is bound to suffer the consequences of increasing poverty, lower levels of public goods, lower quality of government, higher risk of violence, and the overall low quality of well-being.

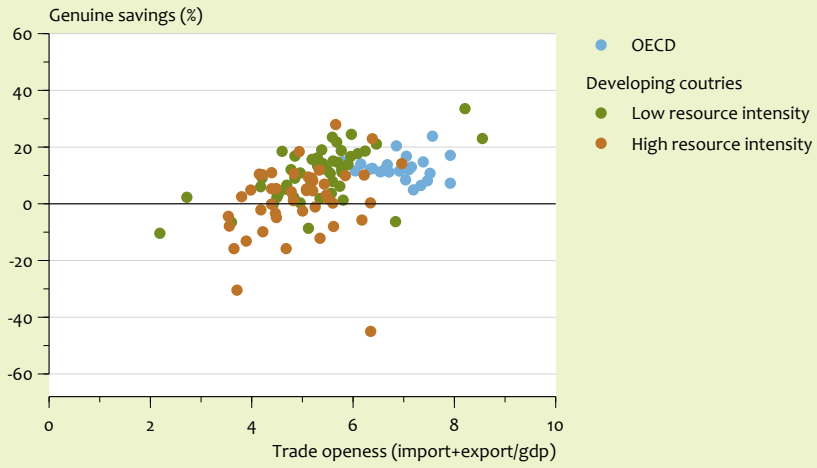
Responses

The Chad pipeline project is an example of how to respond to this paradox: allowing the World Bank to manage the project funds while expending certain portions of revenue on health and education, the project thus minimizes the politicization of oil rents and curbs corruption. The Kimberly Process certification scheme that excludes "conflict diamonds" from the market is another measure that has helped curb the use of violence in controlling resource wealth, for example, in Sierra Leone and Angola. Good institutions and governance matter most crucially. For instance, the international community may impose conditions on governments that trade in commodities, such as oil, to increase transparency – conditions that multinational corporations already adhere to in terms of "publish what you pay" schemes. Such governance mechanisms may control corruption. Resource wealth could also be earmarked for schemes that improve environmental conditions, since oil in particular is a major source of global CO_2 pollution. There could be global schemes that earmark particular taxes on oil-extracting nations and corporations to help develop cleaner technologies and social investments. In general, governance mechanisms that promote greater public supervision over the deployment of resource rents, including democratization within resource-rich regions, are desirable.

Box 4.7 The resource paradox

The extent of the waste of natural resources can be observed by looking at the relative performance of resource-rich countries with the resource scarce ones in terms of the accumulation of genuine savings over time. These savings increase well-being as it measures the quality of growth or the accumulation of wealth with minimum environmental degradation and maximum investment in human capital. As Figure 4.5 demonstrates, resource-rich countries seem to be the worst performers on genuine savings, a conclusion also confirmed by the Millennium Ecosystem Assessment (MEA 2005).

Trade openess and genuine savings by resource intensity of countries 2000 **Figure 4.5**



Period mean values of logged trade openness (horizontal axis) and genuine savings rates (vertical axis).

4.5 Using quantitative methods to define and analyse the archetypes: the dryland archetype as an example

Similarly to the use of quantitative data in the syndrome diagnosis, indicator-based analysis of the archetypes can contribute to their further determination and generate global maps of their distribution. In particular in the case of geographically characterized archetypes, such analysis is useful for further classification of the characteristics and severity of vulnerability. This section illustrates this for the dryland archetype, where a cluster-analysis is used to identify qualitatively different dryland situations, which could be ranked according to their degree of vulnerability. This analysis was carried out for GEO-4 and included in the final draft of Chapter 7. This section provides a background to that analysis.

Typical dryland characteristics that reflect human well-being, water scarcity, degradation and quality of natural resources as well as infrastructure are described by using five indicators. These are: infant mortality, water scarcity, soil degradation, agro-potential and road density. They are listed in Table 4.2 with their temporal reference, spatial resolution, indicator range and source.

Particularly noteworthy is the indication of human well-being at sub-national level. As poverty headcount indices are not available globally and are not comparable across different countries, the suggestion of the Center for International Earth Science Information Network (CIESIN) is followed to use infant mortality as an integrating indicator for human well-being, since this is comparable and available at relatively good sub-national resolution. The 2.5x2.5` dataset, as compiled by CIESIN (2005), is used and resampled to the 0.5°x0.5° resolution to be used in the cluster analysis.

An important indicator for water scarcity is the relation between water withdrawal and availability. The main question is whether the scarce water resource is overused. To assess this globally at a sub-national resolution, the model results of WaterGAP 2 (Alcamo and others 2003) are used, which give this ratio in a 0.5°x0.5° geographical resolution. To transform these results into an appropriate water criticality measure, this ratio is combined with the actual water availability/caput values after Kulshreshtha (1993).

A further important issue is the overuse of soil by farming or grazing, which often occurs in drylands. Here, the results of the Global Assessment of Human Induced Soil Degradation (GLASOD) assessment, with respect to severity of anthropogenic soil degradation, are available as an indicator (Oldeman and others 1990). The original map is defined on the polygons of the FAO soil map of the world, but a gridded version is also available, again in a 0.5°x0.5° resolution.

The fourth indicator, the agro-potential from the Global Agroecological Zonation (GAEZ 2000), was also included. Originally, it is provided at 5x5` resolution. This resolution was adjusted in two ways. Firstly, it was resampled to the 0.5x0.5° resolution of the other indicators. Secondly, it was adjusted to the originally less resolved soil quality indicator GLASOD, which is based on the FAO soil map polygons by using the 2° running mean values. This procedure smoothes the original agro-potential and allows the integration of the two indicators at a more equal spatial scale.

In addition to these two data sets indicating the degree of typical dryland overuse of resources, a fifth indicator for market integration and infrastructure was chosen. Here, the road density from the ArcWorld ESRI (2002) coverage is used. Again, it is provided in a 0.5°x0.5° resolution and was subsequently adjusted to the originally less resolved soil quality indicator based on the 2° running mean values to enhance comparability among them.

After normalizing these indicators to the interval 0-1 according to their minimum and maximum values, a cluster analysis was performed, covering the 20 574 global dryland 0.5x0.5° grid elements. For this, the five indicators were weighted according to their importance to dryland characteristics. The infant mortality used to indicate human well-being is clearly separate from the remaining four indicators for natural and economic development. For reasons of equal balance between the indicators, the infant mortality was weighted four times. This also underlines the development perspective in terms of human development, which is a major focus of the Global Environmental Outlook.

Furthermore, we assumed infant mortality to be, to a certain degree, not dependent on the poverty conditions and, hence, resulting from two main causes: (a) a natural mortality component which is independent of poverty conditions and below which a country never will get; and (b) a mortality component driven by poverty conditions, for example, conditions of and access to the overall health-care system. To reflect this adequately for further analysis of dryland vulnerability, we lowered the indicator for regions with a maximum of 100 deaths per 10 000 live births, modelled on the typical values for developed industrial countries, to allow a clear distinction between the natural and the poverty-driven component of infant mortality.

For the cluster analysis, a sequence of common hierarchical and exchange cluster algorithms was used, that is, hclust and kmeans (subroutines from the widely used open-source statistics package R; see, for example, Maindonald and Braun, 2003). Cluster numbers from 1 to 20 were tried and for up to 8 clusters a strong improvement of the quality of reproduction, that is, the sum of the squared distances of the data points to their cluster centre, was observed. Further increase of the cluster number improved the reproduction much less. Based on the results from the cluster analysis, Table 4.3 shows the cluster centroids for the 8 clusters identified. To compare between the individual clusters, the cluster centroids were translated into qualitative measures by dividing the total range of the values [0,1] into three equal subintervals ([0,1/3[: -, [1/3,2/3[: 0 , [2/3,1]: +). Table 4.4 gives the qualitative measures for all cluster centroids.

Within the drylands, the indicators cluster significantly in 8 typical constellations. Their spatial distribution is depicted by the different colours in Figure 4.6. It can be seen from this map that the clusters in the dryland areas in the Western United States, Australia and Southern Europe (clusters 7 and 8) are clearly different from other dryland areas. Here, the

Indicators used for cluster analysis of drylands

Table 4.2

Indicator	Temporal reference	Spatial resolution	Range and unit	Source
Infant Mortality	2000	2.5x2.5`	40-2031 deaths per 10 000 live births	CIESIN (2005)
Water Scarcity	1995 (water withdrawal) 1961-1990 (water availability)	0.5x0.5° based on major river basins	1-4	Alcamo and others (2003) Kulshreshtha (1993)
Soil Degradation-GLASOD	1990	0.5x0.5° based on polygons of FAO world soil map	0-4	Oldeman and others (1990)
Agro-Potential	2000	5x5`	1-9	GAEZ (2000)
Road Density	2002	0.5x0.5°	0-0.62 km/km²	ArcWorld ESRI (2002)

Cluster centroids for the eight clusters

Table 4.3

Cluster	Infant Mortality	Water Scarcity	Soil Degradation	Agro-Potential	Road Density
1	0.75	0.95	0.18	0.83	0.17
2	0.70	0.35	0.46	0.49	0.36
3	0.47	0.99	0.74	0.70	0.37
4	0.42	0.99	0.08	0.83	0.25
5	0.42	0.32	0.67	0.66	0.39
6	0.43	0.31	0.04	0.81	0.30
7	0.01	0.97	0.36	0.81	0.31
8	0.01	0.26	0.39	0.66	0.35

Qualitative cluster centroids

Table 4.4

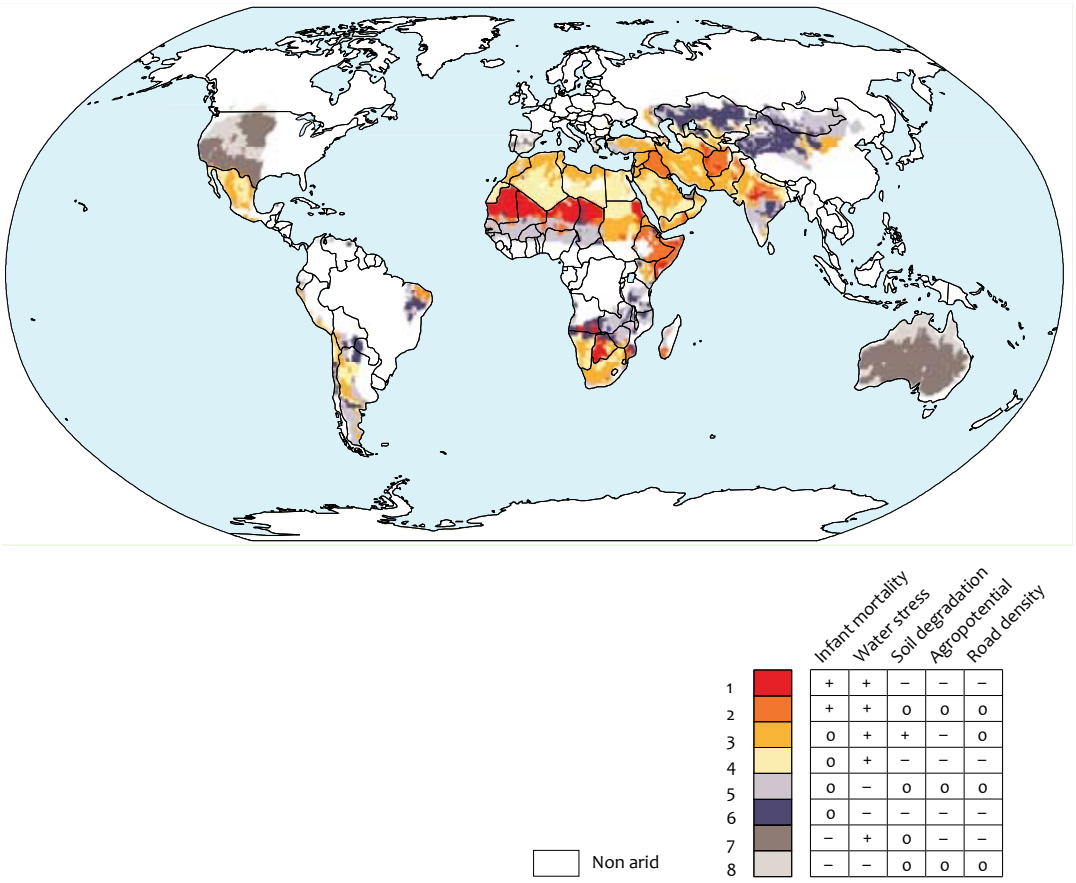
Cluster	Infant Mortality	Water Scarcity	Soil Degradation	Agro-Potential	Road Density
1	+	+	-	-	-
2	+	O	O	O	O
3	O	+	+	-	O
4	O	+	-	-	-
5	O	-	O	O	O
6	O	-	-	-	-
7	-	+	O	-	-
8	-	-	O	O	O

red areas (cluster 1) represent the downward spiral discussed before, with high infant mortality, high water stress, low agro-potential and infrastructure. The insufficient soil quality and the scarce water resource have an extremely negative impact on human well-being. A similarly problematic situation is described by cluster 2 (dark orange). High rates of infant mortality cluster with potential overuse of the water resource, as expressed in the medium water scarcity. The degradation of the poor soils is smaller, showing less or better adapted agricultural activity. These two clusters occur mainly in Africa and Asia.

The subsequent four clusters show a somewhat lower rate of infant mortality. Clusters 3 and 4 are very close to clusters 1 and 2, with respect to the natural and socio-economic conditions: high water stress, low agro-potential and low to medium road density. They differ with respect to high and low soil degradation, but this does not generate significant differences in human well-being between the two. Cluster 3 and 4 occur mainly in Northern Africa, West Asia and Latin America, but can be found also in other parts of the arid world. Two further clusters (5 and 6) show a lower water stress: water demand is more adapted to the relatively sparse water supply in dryland regions. These clusters occur typically at the borders of semi-humid areas, indicating that improved supply plays an important role. But even this natural situation does not significantly improve human well-being.

Clusters number 7 and 8 are the least vulnerable areas depicting the highest human well-being. Yet, it becomes evident that, for example, the intensive input of highly developed irrigation technologies or the mechanisation of mono-cultural production cycles provoke depletion of natural resources. Cluster 7, especially, shows high water stress in combination with soil degradation at medium level. Large areas of Australia and the South-western United States are challenged to overcome the ongoing degradation of natural resources to avoid becoming uninhabitable badlands.

In summary, all dryland clusters 1-6 are vulnerable, since the average human well-being is poor and at risk, but clusters 1 and 2 are clearly the most problematic. The large areas described by the clusters 3 and 4 which exhibit a better level of human well-being compared to clusters 1 and 2 under similar levels of exploitation of the water and soil resources shows that the worst expressions of the dryland archetype



Global distribution of 8 typical constellations ("clusters") of socio-economic and natural conditions in drylands (coloured regions), illustrating the different forms of the dryland archetype. The table shows the qualitative values of the five indicators which are typical for the respective cluster: "+" ➞ high value; "-" ➞ low value; "o" ➞ intermediate value. The different constellations are described above. Humid regions are depicted white.

are not a necessary fate. However, more adapted water use alone, as depicted in clusters 5 and 6, does not guarantee improved human well-being. In contrast, the clusters 7 and 8 are the least vulnerable regions – though highlighting that human well-being is not the single guarantor for sustainability. Instead, they call, above all for a sensible and efficient use of resources, in the face of available knowledge and technological options.

Based on the typical indicator combinations within the individual clusters, specific policy recommendations can be derived. An entry point for improved human well-being in clusters 1-4 includes, for example, to ensure the access water resources by enhancing the efficient use of available water resources and equity among water users. In clusters 5 and 6, human well-being may be advanced by considering an improved agro-potential and reduced soil degradation. Given the severe natural conditions, this may in the long term also involve the search for alternative income activities outside the agricultural sector.

4.6 Conclusions

The archetype analysis in a broader vulnerability context

The patterns of vulnerability elaborated for GEO-4 show how environmental and non-environmental changes affect human well-being. By looking at the diversity of human-environment systems throughout the world, it became evident that some situations share certain vulnerability-creating conditions. In GEO-4, 11 archetypes were analysed; this highlights vulnerabilities across the full range of geographic and economic contexts in developing countries, industrialized countries and countries in transition. This allows placing particular situations within a broader context – providing regional perspectives while showing important connections between regions and the global context, as well as possible opportunities to deal with these situations. Furthermore, the analysis of the archetypes underlines findings of other vulnerability research:

- Vulnerability arises from multiple stressors, which are also dynamic over time. The recognition of this in the policy arena is imperative for successful use of vulnerability research findings. If vulnerability assessment is reduced to a static indicator, the richness and complexity of the

Relations between syndromes and archetypes of vulnerability **Table 4.5**

Vulnerability Archetype, GEO_4	Relation	Syndrome, WBGU/PIK
(Post)-conflict induced vulnerability	=	Scorched earth syndrome
Technological fixes of water problems	=	Aral Sea syndrome
Urbanization of the coastal fringe	⊂	Favela ∪ Urban sprawl
Desertification in drylands	⊂	Sahel syndrome
Common pool resources	⊃	Overexploitation syndrome
Contaminated sites – legacies of the past	=	Waste dumping ∪ Contaminated land
Global markets, local opportunities	⊂	Dust bowl syndrome

"=" almost identical, "⊂": sub-set of, "∪": union

processes that create and maintain vulnerability over time are lost.

- Research on the underlying causal structures of human vulnerability to environmental change (Kasperson and Kasperson 2001, Turner and others 2003, Pelling 2003, Kasperson and others 2005) increasingly recognizes that vulnerability arises through complex interactions of multiple socio-political, ecological and geo-physical processes. These processes operate at different spatial and temporal scales and result in highly differentiated impacts between regions (Kasperson and others 1995, Hewitt 1997, Kasperson and others 2001), social groups (Flynn and others 1994, Fordham 1999) and individuals.
- Environmental risks affect a wide range of natural, economic, political and social activities and processes. Therefore, vulnerability reduction needs to be integrated as a strategic goal into overall development planning across many sectors, including education, health, economic development, and governance. Reducing vulnerability in one place often results in increasing vulnerabilities far away or moving it into the future, which needs to be taken into account.
- Environmental change has the potential to spur conflict. However, managed environmental change (conservation, cooperation, etc.) can also make tangible its contributions to conflict prevention, de-escalation, and post-conflict reconstruction (Conca and Dabelko 2002, Haavisto 2005a).
- Human vulnerability and livelihood security are closely linked to biodiversity and ecosystem resilience (Holling 2001, Folke and others 2002, Millennium Ecosystem Assessment 2005). Sustainable environmental and resource management is, therefore, an important component in reducing poverty and vulnerability. Extreme events like the 2004 Indian Ocean tsunami show that environmental degradation and poorly planned development activities increase communities' vulnerability to shocks (UNDP 2004).
- Vulnerability is determined to a large extent by a lack of options resulting from the unequal distribution of power and resources among actors; these include the most vulnerable population groups throughout the world, such as indigenous people, and the urban or rural poor, or economic sectors heavily dependent on environmental services. Resilience increases with diversification of livelihood strategies and with access to these strategies, social support networks and other resources.

Reflection on differences between the "historical" syndrome list and the set of archetypes as identified during the GEO-4 Process

This section discusses the relation of the archetypes defined in GEO-4 and the "historical" syndrome list. Table 4.5 shows that there is a similarity between the former syndromes and 7 of the 11 archetypes.

Following the earlier discussion on commonalities and differences between the syndrome and the archetype approach in Section 4.2, this correspondence shows that in many cases the endogenous non-sustainable dynamics (which is the realm of the syndrome concept) dominate the generation of vulnerability on which the archetypes focus. The remaining four archetypes have no direct counterparts in the syndrome list. These are:

- Vulnerability of energy production and consumption systems in industrialized countries: the next energy crises?
- Small Island Developing States
- Exporting vulnerability
- Resource paradox

The identification of an energy archetype suggests that, while syndromes are mainly based on patterns that have been observed in the past, archetypes of vulnerability can pick up emerging issues. Several recent events have made clear that we are increasingly confronted with a typical pattern of vulnerability in the case of energy. The choice of the SIDS archetype, however, reflects the importance of the vulnerable groups in the archetypes: in this case small developing islands were the basis of the pattern and a typical and striking mechanism was secondary. The recognition of SIDS is also directly related to their growing presence in the political arena and the fact that they have been organized around their commonalities. For probably the same reason (emphasis on vulnerable groups), in the case of "exporting vulnerability" a stronger equity-oriented perspective is taken than in the original syndrome definition. Finally, the resource paradox is not clearly explained by the difference between the syndrome and vulnerability view and its selection was probably a result of the composition of the expert group, research trends around resource paradox and also the growing political priority. For example, conflicts related to diamonds, oil and timber have been the focus of greater political attention and have increasing international dimensions. Another important consideration is the GEO process, which increased "interaction" between policymakers and the chapter working group in defining policy-relevant issues.

Some of the lessons learned regarding the use of the archetype approach

- The approach has been useful for multi-scale analysis that includes environmental and non-environmental exposures in a coherent framework by combining global analysis and local examples.
- The GEO process has offered opportunities for a more participatory and policy-relevant way of identifying and selecting archetypes for further analysis. This has strengthened the legitimacy and relevance of the set of archetypes analysed and provides a basis for further work.
- Trade-offs between multiple goals would need further attention in research and policy-making. Policies for vulnerability reduction can help to define acceptable balances of risk and benefit, based on improved assessment of the patterns of exposure, sensitivity, and resilience.
- The archetype approach to vulnerability analysis can, in principle, be used for developing, industrialized and transition countries. However, although vulnerability research tends to focus on developing countries, the analysis for GEO-4 shows the wider relevance of vulnerability research beyond developing countries.
- The aim of the analysis of the archetypes was to provide a basis for strategic directions for policy-making (see Chapter 5) and not to provide detailed policy advice on each of the specific situations analysed in each archetype. The archetypes, therefore, are used in a heuristic manner for policy analysis in GEO-4. More direct policy advice based on archetype analysis would be a next step.

Recommendations for further research

- In vulnerability research, indicators of human well-being could be included more systematically than perhaps has been done so far.
- In an ideal world, more of the archetype analysis would have been carried out within the region itself, with involvement of local stakeholders. The regional, national and local GEO-processes might offer opportunities for such participation in the future. UNEP's regional offices and collaborating centres could explore this further.
- The example of the analysis of the drylands archetype indicates that there is a potential to develop a methodology for formalizing research approaches that offer better qualitative descriptions, as well as quantifying representative patterns of vulnerability of human-environment systems to multiple stressors. This would support the accurate communication within and between different academic communities, policymakers and practitioners, and eliminate misunderstandings that result from the use of ambiguous terminology. Such a methodology would facilitate the systematic assessment of vulnerability across different sectors and geographical scales, improve the clarity of communication on vulnerability, and provide a basis for computational modelling.
- Quantification of archetypes could be explored further, for example, by making the analysis more dynamic and including future developments in the analysis. This would allow exploration of how vulnerabilities may evolve over time under different scenarios.
- It would be useful to develop methods to make more systematic assessments of possible policy response to reduce vulnerability, while making use of the opportunities the environment offers.

5 Policy responses to vulnerability

5.1 Introduction

At the early development stages of Chapter 7 of GEO-4, a number of cross-cutting issues were identified, on the basis of the GEO regional consultations and through discussions with experts from the GEO regions. The importance of these issues was confirmed by the Multi-stakeholder Consultation in February 2005. The chapter expert group concluded that each of these issues cut across the elements of vulnerability – exposure, sensitivity and coping capacity – and that they were also policy areas of interest to the potential user community.

Thus, at the beginning of the writing process the plan was to use six cross-cutting issues as entry-points for analysis of responses to vulnerability. We planned to analyse how initiatives across these six cross-cutting issues have impacted and shaped vulnerability and human well-being in the archetypes and to scale up these lessons. In doing so, we planned to look at interactions across levels – the influence of the international governance and political context on decision-making at national and lower levels. We would examine the influence of the policy/response context at higher levels on local efforts on mitigation and adaptation to environmental change; this would lead to the identification, and development, of an international policy framework that could facilitate adaptation, reduce vulnerability and enhance well-being.

The six cross-cutting issues identified were:

- poverty
- human health
- science and technology
- trade
- conflict and cooperation
- institutions and governance.

As the drafting of the chapter proceeded, however, it became clear that, since the chapter focuses on the opportunities for policymakers and other societal actors for reducing vulnerability and increasing well-being without causing further environmental damage, the final section of Chapter 7 should focus on these opportunities at a strategic level and be based on the analysis of the archetypes. The six cross-cutting issues were strongly reflected in the opportunities for reducing vulnerability identified in the archetypes, which confirmed the significance of the initial list.

The cross-cutting issues played an important role in the analytical process of Chapter 7; in earlier drafts there was more thorough consideration of the importance of each of them for reducing vulnerability and improving human well-being. This analysis also provided valuable insights into inter-linkages and the close relationship between the different cross-cutting issues and into the multiple and complex policy processes of recent decades.

Thus, although the cross-cutting issues no longer provided the structure of the final section of the chapter, they were central to the process of writing it. They guided the writing process and helped us maintain our focus on the overall development priorities. This influenced our thinking and how we prioritized the opportunities both within the individual archetypes and in our final set of opportunities.

Additionally, the cross-cutting issues provided an essential link to the priorities of policymakers and other societal actors – having these issues permanently present helped us shape responses and opportunities that capture the imagination of decision makers and reviewers. It is worth noting that, although the opportunities identified are very locally grounded, they have gone largely unchallenged through the various review stages. In part, the cross-cutting issues help us link these local and national approaches to governance and enabling frameworks at higher levels. Because GEO is designed to be a policy-relevant assessment (at the global level) it is important to make the links between local and global action.

The following sections provide more detailed analyses of the opportunities described in Chapter 7 of GEO-4. Section 6.2 discusses issues of governance and institutions, which are central to most opportunities for reducing vulnerability and increasing well-being. Section 6.3 expands on the other opportunities that were synthesized from the analysis of the archetypes.

5.2 Developing effective policy approaches

Governance is increasingly used to describe the efforts societies make to "manage their common affairs", including exercising control over natural resources and responding to

environmental problems. Governance is also about mediating relationships and defining roles in the management of common affairs. A range of actors are or can be involved in governance, from local and national governments and intergovernmental organizations to civil society groups and corporations. Institutions are those regularized patterns of interaction by which society organizes itself. The term as we use it here includes the rules, practices and conventions that structure human interaction, both formal (explicit, written, often having the sanction of the government) and informal (unwritten, implied, tacit, mutually agreed and accepted).

Improving human well-being is often considered to be at the heart of societies' aspirations and an explicit goal of governance; in reality, however, there are many barriers to achieving this goal. Existing institutions and governance have contributed to the current patterns of vulnerability of human-environment systems and lack of well-being around the world. Examples from the archetypes include poorly defined water and land rights and international institutions that prevent farmers' access to global markets in drylands, and the concentration of power and governance focusing on private gain rather than public goods in resource rich countries. Sometimes appropriate institutions to protect the environment do exist but are not enforced due to lack of will or capacity, for instance in post-conflict situations.

These negative impacts of governance reflect the existence of a range of conflicting goals and trade-offs — both intentional and unintentional — in governance and a multitude of institutions with widely diverging incentives for behavioural change. Incongruence of interests of the range of actors often contributes to policy failure. The major challenge for governance is to address situations in which the pursuit of well-being for individuals or certain sub-groups infringes on the well-being and vulnerability of other people alive today or future generations. Governments are the primary actors that make decisions on these trade-offs, but all actors can cooperate in the search for possibilities to turn trade-offs into mutual benefits. Since decisions on trade-offs often involve value judgements, not all trade-offs have solutions that are mutually beneficial. Conflicts can arise and priorities have to be set that do not affect all actors equally.

Certain contributors to well-being described in Chapter 3 of this report, such as education, culture and better social relations, can be pursued indefinitely without major concern for negative impacts on others and in many cases they should have positive impact on others' well-being. However, other activities in pursuit of well-being, such as unrestrained consumption of natural resources and other ecosystem services, quickly affect the ability of other people to achieve well-being and reduce vulnerability. It is in this context that governance becomes central to the mediation of societal concerns.

There is one common criteria for an effective governance system: it should address the issue it aims to solve (Young and Demko 1996). There are numerous factors that have the potential to influence the effectiveness of governance, including accountability, transparency, well-defined roles and rights etc. Integration is one such factor and one which emerges as a key challenge for the higher levels of complexity in governance described above. Integration implies the strengthening of linkages among different dimensions of governance and the merging of these into a more connected whole. The challenges come in the integration of four principle domains: sectors, levels, actors and time.

5.2.1 Integrating governance across levels

The importance of governance at all levels – global, regional, national and local — as well as the need for a governance framework for sustainable development that is integrated across this vertical scale, is increasingly stressed: in global policy (United Nations 2002) and in research (Folke and others 2002, Keohane and Ostrom 1995, Ostrom and others, Héritier 2002, Karlsson 2004).

It is more difficult to establish what would constitute such a framework of multilevel or multilayered governance and how to design the institutions (Hooghe and Marks 2003), as the understanding of how to achieve effective vertical linkages is still rudimentary (Stern and others 2002). For example, the Johannesburg Plan of Implementation (JPOI) is full of references to the need for governance and institutions linkages at various levels but the text is relatively quiet on how linkages should be established between the different levels (Karlsson 2005). Nevertheless, a general direction for what vertically integrated governance needs to achieve is emerging. It would involve a nested hierarchy of mutually supportive policies and institutions initiated at all governance levels (Karlsson 2000). The MEAs needs to be supported by effective institutions at national and local levels. Local Agenda 21 processes need supportive measures from higher governance levels. In identifying at what levels governance is needed, it can be helpful to consider various normative and functional criteria for allocating responsibility between them. These can include both *culpability* (contributing to causing the problem) and the *capacity* to address it; however, there is also the need to consider which decision makers have, or could develop, the necessary *concern* for those who are vulnerable (Karlsson 2007).

Vertical integration can take place in not only in the institutional domain but also in the domains of knowledge and values, which need to underpin and support institutional design and compliance. In assessment processes such as the Arctic Climate Impact Assessment and the Millennium Ecosystem Assessment and in the environmental advisory processes in the UN System, for example, in the UNCCD (United Nations 2005) and the efforts of a global earth observation systems, such as IGOS (IGOS 2004), measures have been taken to ensure that indigenous and local knowledge is included in developing understanding. One example of improved integration in the value domain is the continuing work to develop consensus around the basic principles for interaction between humans and the environment through the Earth Charter process (Earth Charter Initiative 2000). This process has made a deliberate effort to include indigenous perspectives, in taking a decisively grass-roots orientation after governments had failed to develop such basic principles at the Rio Earth Summit. An iterative process of drafting open to input and deliberation across a multitude of stakeholder groups over almost eight years produced a document which was again taken to intergovernmental fora with a hope for ultimate adoption; there it received support from a number of

governments, even if there was far from consensus. Another example is the labelling schemes developed for fair trade and organic products. These formal but voluntary institutions allow the concern of consumers in one part of the world for both the environment and their own health, as well as the health and well-being of the producers of the products, to influence their consumption choices; this is illustrated in the archetype on the growing consumer class and the export of vulnerability (Chapter 4 in this report). In similar ways, environmentally concerned tourists can stimulate stricter regulations for environmental preservation in heavily urbanized coastal areas. Likewise, as exemplified in the resource paradox archetype, diamond buyers can be assured of avoiding diamonds that finance bloodshed through a certification scheme. Finally, in the institutional domain there are, for example, special organizational forms which facilitate cross-level interaction, such as co-management of natural resources, where power is shared between government and local resource users (Berkes 2002).

5.2.2 Integrating governance across sectors

The importance of integrating the three pillars of sustainable development — economic, social and environmental — is underscored in many global policy processes. It would be valuable to have coherent elements of governance in different sectors, in order both to capture the opportunities for synergy that reside among the different dimensions of sustainable development, and to address proactively potential trade-offs between them (Karlsson and Kok, forthcoming). Much progress has been made in this regard, for example, in the declarations and action plans adopted by global conferences of the 1990s and in the WSSD. Much remains, however, to operationalize this in the practice of governance. One approach to integration has been to "mainstream" environment into other policy domains. Such mainstreaming has been tried at various governance levels, including in the United Nations System itself, with varying degrees of success (Sohn, Nakhooda, and Baumert 2005, UNEP 2005). Similar efforts have been referred to as environmental policy integration justified for normative reasons – the environment needs to be higher on the agenda – and for rational reasons – it makes sense to pay attention to environmental concerns in direct relation to the driving forces in other sectors (Persson 2004).

But mainstreaming implies a one-way direction – integrating prioritized policy issues of one sector into another. Integration in the proper sense of the word, rather, implies a two-way (or multiple) direction – integration between policy sectors where one direction is deemed more feasible than the other. For example, it can be easier to take the policy field that is most closely related to daily operations, and is usually ranked highest on individuals' and societies' list of priorities, as the one into which mainstreaming of other issues should be made. An example of this is the mainstreaming of climate change and energy aspects into the development agenda, at least at national and operational levels (Karlsson and Kok forthcoming). There have been attempts to integrate all three dimensions of sustainable development in very practical contexts, such as in the development of indicators (Hák 2007). Another example is the effort to move from Environmental Impact Assessments to Integrated Sustainability Assessments (ISA). ISA is used in the development stage of various research efforts. The intention with ISA is to emphasize stakeholder engagement in the process, formulating visions, objectives, and strategies, and nurturing a reframing and learning process among participants in the process (Weaver and Rotmans 2006).

One important tool to support these and other forms of integration is institutionalization. Often the reason why integration poses such a challenge is that existing institutions conserve old sectoral patterns of how things are done. It is the nature of institutions to be enduring and difficult to change. However, if such institutions can be changed, or indeed if new ones can be established in empty institutional spaces – as is the case in emerging issues – integration in the long term, is possible (Karlsson and Kok forthcoming). There have been attempts to institutionalize integration in organisational terms, in the way councils, task forces and even ministries are set up.

5.2.3 Integrating governance across time

The discussions above have shown the significant challenges of integration in governance across levels and sectors. But the major challenge is to integrate the time dimension, particularly the future, into governance. There seems to be a widespread, even structural failure in governance to institutionalize more long-term thinking and concern for future generations. The clear policy message from the contaminated site archetype is the need for clear and enforced long-term responsibility for pollution, otherwise those who are responsible for the contamination will evade all the cost for clean-up and environmental and health damages. Mitigation and adaptation to climate change, too, will pose enormous challenges, as discussed in the SIDS archetype. Currently, both political and economic structures and institutions invariably steer decision-making towards a preference for short-term benefits over long-term costs; this happens even when the long term is as near as a few years to a decade from now, let alone decades to a century away, as in the case of climate change (see, for example, Meadows and others (2004)).

It will be a considerable challenge to find ways to overcome this reluctance to consider long-term impacts; additionally, there is the fundamental challenge of compounded uncertainty in being able to assess impacts over extended time horizons. Possible strategies to address these challenges include: developing clear and unifying visions for the long-term future, which can serve as inspiration and motivation for both individual and collective actors; changing the accounting measures and indicators in use and in this way make the impact of current decisions on the future more visible; adopting long-term planning horizons with concrete goals and timetables on how to reach them; making decisions on implementation, following the adoption of long-term goals detached from the ever shifting pressures of day-to-day decision-making; finding ways to give a "voice" to future generations in decision-making, for example, through the concept of trusteeship; and relying more on the rule of law rather than on ad hoc policies. One recent bold example of breaking with the conventions of favouring the future in decision-making, is the calculation of the costs of climate change by Sir Nicholas Stern, who – against the convention of economic theory and

practice – used a zero per cent discount rate for the future (Stern 2007).

5.3 Specific opportunities for reducing vulnerability

5.3.1 Building institutions for equity

There is very little equity or justice in who is vulnerable to environmental change. The archetypes of vulnerability show that those who are already marginalized in society are also the most vulnerable, and this includes particularly women and children (see, for example, contaminated sites and SIDS archetypes). The poor and marginalized are almost always hit hardest by the degrading environment (Stephens 1996). Existing institutions have often contributed to this pattern of inequity in vulnerability and helped to cement it. For this reason, it would be important to look closer at institutional design and identify how modified and new institutions can be specifically targeted towards creating more equity. This would not only be one of the most efficient ways of reducing extreme vulnerability but also benefit social development in general.

Improved governance and tenure regimes may not improve opportunities for the poorest people if their participation is not specifically strengthened. Women, children, the elderly, ethnic minorities, and people of the lowest caste are often among the poorest of the poor (Chronic Poverty Research Centre 2005) and the most marginalized. Policy responses need to focus specifically on these groups.

There are many purely normative arguments for strengthening legitimacy in and of governance and these are usually linked to aspects of democracy and justice, which in turn are intimately linked to human well-being, particularly to the components of good social relations and freedom and choice. The concept of legitimacy and related components of "good governance" have been the subject of extensive political debate and academic analysis (Bodansky 1999, Scharpf 2001, Frickel and Davidson 2004, Howse and Nicolaidis 2003). Legitimacy is about the authority to govern either in normative terms (for example, according to normative theorists and philosophers) or in subjective terms (in the eyes of those who are governed). In the latter case, subjective legitimacy concerns the degree to which governance is recognized and accepted, which is often closely linked to the process through which decisions are made (input legitimacy) and the impact they have (output legitimacy). These two dimensions of legitimacy are also composed of many elements. The focus here is on two of the central elements: in the case of input legitimacy, the role of participation in the process of governance; in the case of output legitimacy, the degree of equity in its outcome.

Increasing the participation of a set of stakeholder groups beyond governments in the actual process of governance has been considered a key aspect of increasing legitimacy and procedural justice. At the global level, the argument for this is linked to the particular character of governance, centred on some 180 sovereign states, that govern through a range of different intergovernmental organizations but without many elements generally considered part of the national democratic process, such as an elected parliament. The increased participation of non-governmental actors in the process of global governance, particularly organizations from civil society, is considered by some a possible way to strengthen the legitimacy of global governance (Reinicke & Witte 2000, Scholte 2002). Others, however, are concerned that civil society organizations themselves have challenges to establish their legitimacy as a result of their often limited representative base, excluding voices from the marginalized, or from non-western cultures, etc. (Scholte 2002). But, also at the national level are many actors who feel their views are not reaching the decision makers through the established channels, such as political parties. Experiments with various types of multi-stakeholder dialogue processes have been carried out in a number of countries, although the role of these countries has been mostly advisory, rather than decisive. At the local level, participation becomes closely linked to the empowerment of citizens to be part of a democratic process for issues that concern their vulnerability and well-being. Pluralistic decision-making processes can improve opportunities for better information sharing and distribution of financial and other resources (Edmonds and Wollenberg 2003, Leach and others 2002). Additionally, these processes can address the tension between values and cultural and heritage rights of people, which are often closely linked to resource management and exploitation, and state institutions (Paré and others 2002). Poor governance, social exclusion and powerlessness mean that many poor people have inadequate opportunities to participate in the decision-making related to a country's resources and environment which impact on their well-being (Cornwall and Gaventa 2001).

Participation can take place in various stages of the governance process; agenda-setting, deliberation, decision-making, implementation, monitoring and evaluation. Increased participation can sometimes be an isolated experiment, but in more and more cases it is made permanent by modifying those institutions that set the rules for the governance process. The Rio Conference (UNCED) provided the basic institutional change for this development of increasing participation in environment-related decision-making through Principle 10 of the Rio Declaration, now commonly called the "access principle". This has been echoed, for example, in the Aarhus Convention in Europe.

In the earlier phases of governance, where agendas are formed and deliberations on compromises made, the participation of stakeholder groups may allow a stronger voice to be raised from those groups that are most vulnerable in society and whose understanding, concerns and priorities seldom reach decision makers. Having the opportunity to express one's concerns is a part of the freedom component of well-being. More opportunities for face-to-face interactions contribute to improving social relations through cooperation and trust building. For example, in governance of local common pool resources, research has shown how some mutual experience and communication can lead to a cooperative outcome rather than a mutually destructive one (McCay and Jentoft 1998). In these respects, participation should be positive. However, this depends on the quality of participation. The examples of innovative efforts to increase participation in formal governance processes have had considerable limitations. One such limitation is that it is still primarily representatives of Northern — and sometimes Southern —

elites who participate in global governance arenas. A lack of capacity and resources poses obstacles for other groups to access these arenas or, when they have access, to use it effectively. At national and local levels, the same pattern of biased representation by certain groups with more access to resources often occurs.

At all levels, there is also an issue of which groups, if any, are invited to the table. While the nine major groups cover a broad spectrum of stakeholders, there are still those that feel excluded at the global level, such as educators, who consider themselves to be significant players in sustainable development. Efforts to add more major groups to the list, however, for example in the WSSD negotiations, have not been successful. Another limitation is the extent to which the new voices are listened to by governments, which has been a recurring complaint, for example, in the multi-stakeholder dialogues at the global level (IISD 2002, Hiblin, Dodds and Middleton 2002, Consensus Building Institute 2002). Having a voice without being listened to can lead to greater estrangement and even conflict. In other cases, the absence of a listener was caused by the distance between stakeholders, who are linked together through the processes of globalization, as illustrated in the growing consumer class archetype. A third and related limitation is the degree to which participation has an impact on the actual outcome of the process at hand. This is very difficult to assess (Consensus Building Institute 2002). Many NGOs ignore some of the official participation opportunities, such as in the Commission on Sustainable Development, either because they consider this to be of limited value and taking valuable time away from direct lobbying, or because they consider the body itself to be without importance, and there is a widening split between NGOs that engage with other stakeholders and those that do not (Hemmati 2002).

The second aspect of legitimacy is the degree of fairness in the outcome of governance, referred to by some as output legitimacy (Van Kersbergen and Waarden 2004). While there are some aspects of environmental degradation that affect people indiscriminately, the extensive literature on environmental justice has shown that the poor and marginalized are hit hardest by the degrading environment as a result of higher exposure, resource dependence and vulnerability (Young 1994, Dobson 1998, Shrader-Frechette 2002, World Commission on Dams 2000) as well as by environmental and other policies that do not take full account of diverse needs and rights (Griffiths and Robin 1997, Agyeman and others 2003).

Many governance efforts have obviously failed to address these inequities, with many institutions tending to preserve the status quo. This is partly because of the complexity of the institutional basis of inequity and the absence of holistic approaches to deal with this complexity. In addition, many inequities are deeply engrained in cultural and normative systems, which adds to the challenge. Furthermore, environmental governance confronts perhaps the largest challenge of equity in all areas, as it also involves providing equity for future generations. There are two major, possible approaches by governance for improving output legitimacy in relation to vulnerability and environment. Firstly, it can aim to address certain components of vulnerability among the most vulnerable groups. This can include strengthening their specific resilience and adaptation through, for example, changing laws and regulations to reduce their exposure to environmental hazards, establishing early warning systems for these groups, etc. Secondly, governance can aim to address the root causes of inequity. This can include a focus on poverty reduction strategies, education, health, employment, etc. Such measures at the national level can be supported by appropriate use of the revenues from natural resources. The resource paradox archetype shows the wider negative consequences for society, when wealth in the form of natural resources is concentrated in the hands of a few and not used for the welfare of the population as a whole. Many of the measures to devolve the management of natural resources to local communities and user groups aim to decrease inequity, but cannot guarantee it.

The legal foundation for equity and justice in relation to the environment is relatively weak at global level and, often, also at national levels. However, it is stronger in more indirect terms through the human rights regime, even if the explicit right to, for instance, a clean environment or water, has not yet been codified into international law. The Principle 10 of the Rio Declaration, a non-legally binding document that was adopted by all countries present at the 1992 Earth Summit, includes the right to access to justice in environmental decision-making, in addition to the right to access to information and participation. However, research on the implementation of this principle shows that access to justice was the component least addressed by countries (Petkova and others 2002). The increasing application of the rights-based approach to development puts further attention on the discussion of adding the "right" to a healthy environment, but the institutional basis is weak.

5.3.2 Strengthening local rights

Across the world, weak or absent rights – to environmental resources and to contribute to decisions that shape development and livelihood outcomes – diminishes efforts to adapt to and cope with adverse environmental change. Furthermore, weak access to justice, including to legal recourse to redress harm suffered, perpetuates existing patterns of vulnerability. The archetypes of vulnerability provide many illustrations of this: without strong rights to land, dryland farmers find themselves unable to access credit to invest in land productivity or recover from droughts; without opportunities to shape development choices, populations in SIDS and in the Arctic face a decline in fisheries and other environmental goods and services; and without full rights to justice and due process, the people most exposed to the life-threatening impacts of contaminated sites are unable to reverse this situation or claim compensation. Wide-ranging institutional change that helps the most vulnerable people secure their well-being, can help break existing patterns of vulnerability by broadening the range of available economic opportunities, by ensuring that they have a voice in development decisions, and by providing avenues for recourse when things go wrong.

Securing access to resource assets and maintaining it

Rights to environmental resources provide a foundation for well-being and, consequently, enhance adaptive and coping capacity. For most developing nations, for indigenous peoples in developed countries and even for certain groups in devel-

oped countries, such as farmers and fishermen, livelihoods and human well-being depend on access to natural resources. For the world's poorest, most of whom live in rural areas and are directly dependent on the use of natural resources to secure a livelihood, the lack of access to these resources entrenches economic and social dimensions of poverty which, in turn, reduces choice and agency (Narayan 2000, Brock 1999). Resource access is shaped, to a large extent, by institutions, in particular for property rights, the legal framework, and social and power relationships, as well as the state of environmental resource. Interventions at any of these levels can help secure these resources for current and future use, and improve opportunities for those most directly dependent on resources.

There is evidence that more and more governments are recognizing the importance of developing more secure rights to resources (White and Martin 2002). However, efforts towards this remain piecemeal and many struggle to achieve the desired outcomes. Building understanding about environmental goods and services and their potential for reducing vulnerability (through their multiple contributions to human well-being) can be an important step in motivating governments to take actions that secure access. The value of environmental resources in local livelihoods is often undervalued, with resources treated as subsistence goods or as a safety net for agricultural production, rather than as essential productive assets. In many places, local tenure rights have been weakened as states have sought to improve national earnings or benefits. International development institutions and development agencies have encouraged the public control of environmental assets, such as forests. At times, new institutional arrangements that strengthen regional and global cooperation have had the unintended consequence of diminishing rural livelihoods. For example, transboundary natural resource management often shifts

Box 5.1 Institutional reform for poverty alleviation in drylands

Drylands are not divided equally between poor and rich countries – some 72% of the global dryland areas is found in developing countries. Consequently, the majority of dryland people live in developing countries (87% to 93%, depending on how the former Soviet Union countries are categorized) (Safriel and others 2005). The Millennium Ecosystem Assessment found that the human well-being of dryland people is among the lowest in the world, with high infant mortality rates and poor economic conditions (Scholes and others 2005).

Addressing the issues of environmental change and poverty eradication in drylands is central to the achievement of the MDGs. Enabling policies and institutions that reinforce and strengthen the capacity of local communities to cope with change, can improve resilience. A range of interventions, including access to soft credit and capital and increased access to transport and market infrastructure, can support livelihood diversification and improve income, making populations less vulnerable to environmental change. At the same time, perverse policy and governance interventions, such as forced sedentarization of nomadic pastoral communities, that have traditionally used their migration to cope with ecological change, need to be addressed. Similarly, policies that favour agricultural expansion over pastoral livelihoods through, for example, privatizing water trade, make pastoral communities more vulnerable and can engender conflict.

Building institutions and providing knowledge to promote alternative livelihood strategies offer new opportunities for dryland communities. For example, some drylands have sparsely inhabited pristine areas that can be promoted for tourism-related activities, which benefits poor people, as has been the case in southern Africa (Hulme and Murphree 2001). Broader economic policies and institutions that promote the development of new and well-planned urban centres in drylands, can also help relieve the pressure on dryland ecosystems and promote coping and adaptation. Fragmented and overly centralized land and water-management policies do not support the participation of local and community-based institutions in land-use and water-use decisions.

Lack of access to technology, credit and capital for sustainable land use and generation of alternative livelihoods at the local level diminishes coping capacity.

Faulty land tenure policies and inadequate water rights create a disincentive for sustainable use of resources and reduce the ability of communities and households to manage their resources and adapt to changes (Dobie 2001, WRI 2005). Women are often discriminated against under land-ownership regulations, despite their important role in generating livelihoods.

Opportunities for dryland products to access international markets, are mediated through a range of protectionist tariffs and agricultural subsidies in the major markets of Europe, the United States, and Japan. These measures have reduced the competitiveness of developing countries' cotton produce, even though these countries are among the lowest-cost producers (Goreux and Macrae 2003). Some regional trade agreements, such as the North American Free Trade Agreement, may in part lower such barriers for dryland areas of Mexico. In developing countries, where national and regional markets are small, removing legislative and policy barriers and creating more equitable access to global markets is essential for improving opportunities (WRI 2005). Niche products, such as non-timber forest products, can offer alternative livelihoods for farmers, particularly where there is sufficient technical and marketing support (Sunderland and Ndoye 2004, Kusters and Belcher 2004, Landell-Mills and Porras 2000, Katerere and Mohamed-Katerere 2005, FAO 2005a). Seed production and horticulture may be other important niche markets. Several global initiatives, including the WSSD, the Bali Strategy, and FAO and UNCCD programmes, seek to develop capacity (production and marketing) and improve access to information, micro-credit and technology.

responsibility from local users to states (Mohamed-Katerere 2001) and redistributes rights from the local to the national or even regional level (WCD 2000). One consequence of this is shrinking human well-being, as small farmers find themselves displaced and dispossessed of their pasture and cultural heritage by dam developments supporting hydroelectricity generation for populations elsewhere (see Taking technological approaches). The proliferation of protected areas that exclude people, has extinguished local rights to land, forests, wildlife, and water, in developing and developed countries (Hulme and Murphree 2001). Conflicting legal and normative systems – some stemming from colonization and large-scale settlement (as in Canada and Australia) – have resulted in contested claims to environmental resources, often engendering persistent conflicts around conservation areas (Borrini-Feyerabend 1996, Hulme and Murphree 2001), water (Bruns and Meizin-Dick 2000, Spiertz 2000, Wolf 2000, Mohamed-Katerere and Van der Zaag 2003) and forests (Edmunds and Wollenberg 2003, Katerere and Mohamed-Katerere 2005). These conflicts have negative consequences for the environment and livelihoods, reducing the resilience of both people and ecosystems.

Strengthening – and restoring – local tenure through more secure property rights can help increase the assets available to local people to build more secure livelihoods and diversify their options. The lack of viable and alternative livelihood opportunities has been identified in several archetypes as an impediment to adaptation and a critical factor in weak coping capacity. Furthermore, it effectively reduces the capacity of poor people to use natural resources in an efficient, productive and sustainable manner (Pearce 2005, World Resource Institute and others 2005). Research shows that improved wealth at the household level, comprising physical assets (skills, knowledge and good health, "human capital"), environmental assets ("natural capital") and a functioning social environment – trust, freedom, fairness and voice ("social capital") (Pearce 2005) – is essential for escaping poverty and improving well-being. Improvements in any one of these assets stimulate others to improve as well. Improved earning opportunities enhances people's ability to obtain health care and education, among others things. More secure access to resources in communally held areas, Small Island Developing States, and drylands, through improved tenure, including enhancing access to productive assets, can increase real opportunities and improve human well-being (Chambers 1995). However, for improved tenure rights to be effective, they need to be complemented by other institutional changes, such as more effective local resource management and governance, better market access, increased access to financial resources and market information. Existing local institutions, such as common pool resource institutions, can be mobilized as platforms for building social capital.

Inequity and power also affect the opportunities of specific groups of poor people and it is essential that tenure development takes account of this. Inequality of assets appears to explain limited economic growth and the lack of mobility far more than income inequality (Pearce 2005, WRI and others 2005). Countries with more equitable land distribution achieve growth rates two to three times greater than those in which distribution is less equitable (Deininger 2003). Gendered policies on the management of shared resources and the right to secure tenure, affect the quality of life of women (Bojo and Reddy 2003). Women play key roles in managing natural resources and are particularly affected by environmental degradation, so strengthening their resource rights is vital (e.g. Brown and Lapuyade 2001). In addition, weak tenure rights make it especially difficult for poor farmers – the majority of whom are women – to obtain credit to address declining environmental conditions (decreasing water availability or decreasing soil quality) or to recover from the often devastating impacts of droughts and floods. Where floods, tsunamis and other disasters displace populations, women whose resource rights are based on their relationships to men, as wives or daughters, may be unable to reclaim title to land on which their livelihoods are based, if the title-holding relative has died in the disaster.

Maintaining resource assets provides an opportunity for reducing exposure and sensitivity to stressors. Improving tenure regimes can be a highly effective means of enhancing natural resource management (Hulme and Murphree 2001, WRI 2005). Secure tenure regimes may lead to better conservation practices by encouraging long-term perspectives that favour investment and good management over shorter-term benefits (Katerere and Mohamed-Katerere 2005, Edmonds and Wollenberg 2003). Because security of tenure increases the range of future options associated with a resource, it may increase the value placed on a resource and support choices that do not curtail the options of future generations.

The form tenure takes is crucial for livelihood security and coping capacity – it not only determines the uses that assets can be put to, but also how they are managed. It is important to ensure that tenure is not only secure but also fair and just, taking into consideration contested rights and deep-rooted inequities.

Strengthening local governance, empowering people

The archetypes of vulnerability demonstrate the need for governance and management approaches that help local people build their asset basis – this demands empowering local users as decision makers and as citizens. In addition, there is a need for stronger synergies between local aspirations and the strategies and policy responses adopted at the regional and global level (see, for example, Arctic regions and SIDS). Achieving this will require policy and institutional changes that cut across different sectors, and different levels, including those which lie outside of the control of environmental institutions. Additionally, recognition is needed of the multiple scales of human well-being and the implications of initiatives at one spatial, or temporal, level or another. Policy approaches that integrate poverty-environment issues into mainstream development planning and resource-allocation processes are necessary (Hazelwood 2002). While new institutional arrangements need to be grounded in local realities, they should not be treated in isolation from other institutions at a country, sub-global and global level.

Secure property rights – at individual or community level – can provide the foundation for inclusion in governance and widen the opportunities for a broad range of people by encouraging both entrepreneurship and good stewardship.

However, the registration of individual property rights can marginalize poor people through accumulation, as found, for example, in Kenya (Mackenzie 1989). Without transparent and accountable systems, local institutions, like all institutions, can be abused and are subject to elite capture, for example, with earnings from wildlife management or timber harvesting going only to elites, rather than to all stakeholders. Where information about decision-making is widely and freely available, the opportunities for abuse can be minimized.

Recognizing existing local institutions before and instead of creating new institutions may have positive outcomes for both people and the environment, especially where these have a high degree of local legitimacy and are able to establish management regimes that have local support. Often, traditional or other longstanding governance and management systems have tried-and-tested measures to ensure fair, or at least legitimate, outcomes. In some contexts, existing common-pool resource institutions can provide bases for building social capital – an important way of enhancing coping capacity. In many countries, common-pool resource institutions are being eroded, either due to nationalization or privatization. Where this is occurring, new institutions that support alternative sources of livelihoods are essential.

Changing values – around gender, traditional institutions, democracy and accountability – make the context in which environmental resources are managed extremely complex and present challenges for institutional development (Mohamed-Katerere and Van der Zaag 2003, Spiertz 1996, Paré and others 2002). In some places, the authority within established institutions is breaking down (Bromley 1998), demonstrating the need for institutional forms that can be responsive to change. One approach is to focus on processes in which local users become active "makers and shapers" of the rights, management and use of regimes on which their livelihoods are based (Cornwall and Gaventa 2001). There is a need for systems which give voice to local users and communities in defining their rights (Mohamed-Katerere and Van der Zaag 2003, Sengupta, 1996 and Spiertz 1996).

Many different approaches to governance have been adopted, in an attempt to empower local users in decision-making and to ensure that greater benefits accrue to local people. These approaches include participation in public management processes, joint management, common property regimes and decentralization. However, the extent to which local users have become more influential varies significantly between approaches, and from place to place. Many efforts at institutional reform have decentralized management responsibility to users, while the government has retained control and ultimate authority over use and benefits (Jeffrey and Sunder 2000, Narain 2003, Lele 2000). For example, an important question in debates on irrigation-management transfer is whether the formation of user groups for water leads to the creation of mutual-accountability relationships between the government and the users, or whether user groups remain essential parts of the bureaucracy (Narain 2000, Mollinga 2001). Despite a growing trend towards decentralization and devolution since the 1980s, and a broad policy commitment to give users greater authority, the institutional reform which is required to ensure real, substantial transfer of rights, is often lacking.

Efforts at devolution that improve communities' access to natural resources, through policies that transfer control over resources rather than simply effecting decentralization, can provide a turning point. In many places, these have demonstrated benefits for environmental quality (Sarin and others 2003, Hulme and Murphree 2001) and, thus, have enhanced the basis for improved well-being. Devolution needs to be complemented by capacity building and empowerment initiatives, improved tenure, and better trade and value-adding options.

5.3.3 Promoting trade

Two of the archetypes described in Chapter 4 of this report – and not included in the final version of Chapter 7 in GEO-4 – deal specifically with the issue of trade. The archetype on the export of vulnerability looks at the consequences of increasing global consumption and its harmful effects on natural systems, making it harder for the poorest on the planet to meet their basic needs. The archetype points out that, while international trade can lead to increased welfare and has helped millions of people out of poverty, it also plays an (increasing) role in sustaining unequal patterns of consumption; industrialized countries continue to outsource the extraction of natural resources, including much of the production and manufacturing and their hazardous waste, to the rest of the world. The archetype on global markets takes a closer look at the cash crop sector and the consequences for local communities, as they often bear the brunt of agricultural expansion. This can result in a pattern of vulnerability where cash-crop driven agricultural land-use change undermines the livelihood of natural ecosystem-dependent communities, that do not have sufficient alternatives to overcome the loss of livelihood base and have little sharing of the benefits from the resource exploitation. In some cases, this seriously affects the well-being of local communities. In the drylands archetype, it is noted that global trade regimes, particularly protectionist tariffs and agricultural subsidies in developed countries' markets, affect income of drylands producers in developing countries. These tariffs and subsidies have, for example, reduced the competitiveness of developing countries' cotton produce, even though developing countries are among the lowest-cost producers.

The archetypes of vulnerability provide three examples in which trade contributes to an increase in vulnerability of local populations. However, trade is seen by many as the most direct way for the rich to reduce poverty, thereby substantially lessening the number of people who most frequently experience vulnerability (Anderson 2004, Hertel and Winters 2006). It is, therefore, necessary to take a differentiated look at the cross-cutting issue of trade, to identify the opportunities that it offers for reducing vulnerability.

Several opportunities exist for improving the income levels of poor people through better access to markets and harnessing trends in world trade and globalization. Improving international cooperation and building equitable partnerships can be an important strategy for responding to challenges of poverty reduction. Reforming international policies on trade,

investment, global public goods, and aid, to support developing countries' efforts of addressing poverty-environment concerns better, is an important area for global policy (DfID and others 2002, WRI and others 2005).

Trade policy is both domestic and international. Ever since David Ricardo expounded the idea of comparative advantage and the benefits of specialization, trade has been regarded as "an engine of growth", which increases income and reduces poverty. By openness to trade, we mean "freer trade" under multilateral rules. The trade regime, particularly when it comes to agriculture and textiles, is characterized largely by "preferential trade agreement (PTA)", bilateral agreements and quotas, which rich countries negotiate bilaterally with the poor. However, such PTAs do more harm than good (see the archetype on exporting vulnerability in Chapter 4). Countries are better off exploiting their comparative advantage by trading abundant resources for scarce ones that may be abundant somewhere else, rather than striving for self-sufficiency, or acquiring special access to rich markets for particular products under PTAs (Hertel and Winters 2006, Krugman 2003).

Poor countries, whose abundant factor is labour, are expected to gain from access to richer, larger markets abroad. Since small countries have smaller internal markets, lower barriers allow countries the opportunity to exploit economies of scale, benefiting labour, which is generally disadvantaged relative to domestic capitalists. In other words, the poor can garner employment and better wages. The liberalization of trade under the Doha round in the WTO was expected to reduce poverty, particularly if developing countries were to adjust their policies accordingly (Anderson, Martin, and Van der Mensbrugghe 2005).

Trade forces diversification and facilitates learning by doing, which drives higher productivity and industrialization (Leamer and others 1999). If poor countries, particularly primary commodity exporters, are vulnerable to exposure to rich markets through price shocks and other market failures, then diversification is a good option for reducing vulnerability (UNCTAD 2004). Empirical analyses, however, show that exposure to shock arguments are exaggerated (Calderon, Loayza and Schmidt-Hebbel 2005). Higher levels of income, sophisticated markets, and increased power of non-governmental actors may enhance the prospects for democracy and liberty, perhaps via better institutions of governance necessitated by trade (Anderson 2004, Henisz and Williamson 1999, Wei 2000). Since sophisticated markets, particularly those which are dependent on trade, contain large amounts of arm's-length transactions of many sorts, better institutions are required for its smooth functioning (Greif 1992, Hall and Jones 1999). Trade, thereby, may not only improve the level of income, but promote better international governance and societal welfare, both directly and indirectly (Birdsall and Lawrence 1999), not to mention international and civil peace, which reinforces and is reinforced, in turn, by prosperity (Barbieri and Reuveny 2005, De Soysa 2002 and b, Russett and Oneal 2000, Schneider, Barbieri and Gleditsch 2003, Weede 2004).

The proposition that trade reduces poverty is built on strong theoretical foundations and robust and consistent empirical realities (Bhagwati 2003, Cline 2004). Several recent studies have found that trade openness increases economic growth (Frankel and Romer 1999, Levine and Renelt 1992, Sachs and Warner 1995). Not only actual trade dependence, which is in turn dependent on such factors as population size and geography, but trade policy openness also boosts economic growth (Cline 2004). Economic growth supposedly benefits the poor (Dollar and Kraay 2000). However, data suggests that it is not benefiting the very poor (see Chapter 3) and that subsidies and tariffs still prevent economic benefits of trade. Trade also increases productivity of workers. Productivity increases allows people greater insulation from economic shocks. Growth is not everything, but it allows the finances necessary for providing other public goods that society values above income, such as education and health, which also contributes to reducing poverty in the long-run. The spin-offs from trade are many, but one important aspect is that it provides governments with the necessary incentives to provide public goods, such as education and health, because such public goods raise productivity.

Critics of trade argue that trade dependence leads to a "race to the bottom". Governments eager to attract investment and to compete in the global market place will allow standards to drop, so that competition will lead to "social dumping". Governments reliant on taxes to provide the public goods will increasingly find themselves faced with a "footloose" tax base, which erodes the basis of government finances. Apparently, internationalization of the economy lets in "fiscal termites" (Tanzi 2000). However, the empirical reality is that trade openness is also commensurate with higher government spending. Paradoxically, as countries become more dependent on trade, the size of government increases, a result first discovered for the OECD countries, and later found to apply to the rest of the world, as well (Cameron 1978, Rodrik 1997).

Large objections are raised against free trade, one of them concerns its effects on the environment (Daly 1993, Ekins, Folke, and Costanza 1994) which, in turn, would increase the pressure on vulnerable communities and ecosystems. One of the objections is the contention that countries open to competition lower environmental standards, and the poor countries become "havens" for polluting industries forced out of richer markets (see the archetype on exporting vulnerability). Some highly popularized, anecdotal and journalistic arguments suggest that globalization leads to "global pillage" (Brecher and Costello 1994, Zammit 2003). The latter argue that increased competition that drives down prices will result in unsustainable levels of consumption and waste, and that trade will increase atmospheric pollution as poorer countries also begin to industrialize. More generally, critics of globalization argue that trade agreements bind countries to standardized laws and regulations, which will reduce the ability of governments and societies to make autonomous decisions by addressing local problems with local solutions. Moreover, they argue that the systemic interdependence takes away agency from LDC governments. Greater integration of developing countries in market relations diminishes their capacity to act independently, because they become locked in dependent relations with the rich countries. Countries more dependent on trade and investment are expected not

to be able to follow sustainable paths of development, as it would be against the interests of international capital (Grimes and Kentor 2003, Roberts and Grimes 1997, York, Rosa and Dietz 2003). A further argument concerns the environmental effects of trade itself, with, for example, transport as the fastest growing source of carbon dioxide emissions (IPCC 2007). A recent report from the European Environment Agency shows that road transport remains the single most important source of nitrogen oxides (NOx), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs), and the second most important source of fine particulate emissions (PM10 and PM2.5) in the EU-27.

The counter argument is that trade is good for sustainability, since it drives efficient allocation of resources across the world. If a country specializes in those activities it has an advantage in, countries with an abundance of one resource can trade with those that have an abundance of another. Such an exchange will allow maximum output for a given input — in other words, movement towards sustainability through minimization of waste (Brack 1995). Openness to trade is also associated with getting prices right and ending distortions, which enhances sustainability. Governments are likely to subsidize economic activity for political reasons, thereby increasing waste – a highly costly policy, that becomes increasingly untenable as a country becomes more exposed to global markets (Birdsall and Wheeler 2001, Yu 1994). The German Government, for instance, spends billions of Euros subsidizing inefficient coal miners. Not only is such a policy socially wasteful, but it also harms the environment by keeping coal prices artificially low. Price supports are known to lead to a waste of resources. Price support for fishermen, for example, by countries such as Norway, leads to overfishing and wasteful harvesting of a valuable resource. The Center for Global Development estimates yearly fishing subsidies at US$36.42 per person, in Norway alone, which amounts to a total of US$182.1 million.

Trade openness seems to be good for economic sustainability (or weak sustainability) when tested against the World Bank's genuine savings measure (De Soysa and Neumayer 2005). Countries more open to trade and FDI and allowing more economic freedoms, tend to be higher genuine savers, a measure of well-being also preferred by the Millennium Ecosystem Assessment (MEA 2005) and others, that tie genuine savings to the quality of growth and higher human well-being (Dasgupta 2001).

One of the strongest recommendations for trade is that the growth of commercial ties breeds a culture of peace (Hirschman 1977). Peace researchers find that trade reduces conflict between and within countries (De Soysa 2002 a and b, Russett and Oneal 2000). Controlling for relevant factors, countries that trade more with each other tend to be involved in fewer militarized disputes. Several also find that trade determines the level of civil conflict (Barbieri and Reuveny 2005, De Soysa 2002, Krause and Suzuki 2005). If trade drives increased integration of countries, then international cooperation on many dimensions is likely to be achieved through higher levels of cooperation between countries.

Global agreements that bind countries to the same rules, that are easy to monitor, seem the best option, since the incentive for countries to freeride on others, in terms of trade, is massive, and the incentives within countries for producers and politicians to rent-seek are also large. Institutions bind power by rules and collective monitoring, which increases cooperation and trust (Keohane and Nye 2000, Nye and Donahue 2000). Moreover, the rules that are set within these institutions for decreasing vulnerabilities and protecting the environment, in particular, are more likely to be agreed on in a consensual manner and to be monitored more effectively. National governments that ignore the internationally sanctioned rules of the game, such as a ban on trade in endangered species, can be more effectively sanctioned in multilateral settings, as this raises the costs of anti-social behaviour. Countries will find it costly to participate in risky trading activities which global consumers and trade rules deem as harmful to society and the environment, because agreed-on WTO protocols are binding. In contrast, bilateral trade agreements and PTAs are hard to monitor and control (Baghwati 2005). PTAs and bilateral treaties may contain trade agreements allowing governments to trade in hazardous materials, which endanger local and global communities, but leave little recourse for people to act.

Removing restrictions which hamper and harm the productive and efficient use of assets, is crucial. For example, abolishing restrictions on the cutting and transport of trees from private land, increases farm-gate values for trees, encourages tree planting and protection and, thus, enhances livelihood security by allowing trees to become valuable assets for small and poor farmers (Chambers 1995). Increasing earnings from natural products requires increasing opportunities for commercialization of natural resource products. Increased market opportunities through better market access and consumer- orientated product development are important areas for policy reform (Landell-Mills and Porras 2002). Reaching agreement around farm subsidies and import tariffs is seen as particularly important for development. Infrastructural development is important for creating better access to markets and trade opportunities (UN Millennium Project 2005), access to social services and addressing rural isolation.

5.3.4 Improving health

Health is an issue common to all of the archetypes and ill-health severely reduces the capacity to adapt to both environmental and socio-economic changes. The archetypes show a number of examples of health impacts resulting from environmental and socio-economic change: in the contaminated sites archetype, women and children in particular are exposed to pollutants that have serious health effects; the health of the people living in small island developing states is over-proportionately threatened by natural and human-induced risks; urbanization has a number of health-related implications (see Box 5.2); health is at a higher risk in post-conflict situations; the Arctic is exposed to persistent organic pollutants that have significant health effects; intensive shrimp aquaculture leads to water pollution and health risks and dryland agricultural systems are prone to risks of hunger, malnutrition and water scarcity. Extreme events are also responsible for high morbidity and mortality in vulnerable areas, due to a lack of early warning systems, poor medical care and population

displacement. Morbidity and mortality are admittedly higher in communities with limited resources and compromised economic indices, and with less developed housing, water supplies, food storage, and communication links. In affected areas, desertification and drought have direct impacts on health. There are several pathways by which drought affects health. Famine often occurs when a pre-existing situation of malnutrition worsens. The health consequences of drought include diseases resulting from lack of water. Studies have shown that in times of shortage, water is used for cooking rather than hygiene; this practice particularly increases the risk of disease. Malnutrition also increases susceptibility to infection. Technology-centred solutions to water problems can lead to the spread of water-borne disease. Thus the archetypes provide numerous examples of increased exposure to factors that lead to ill-health.

Investing in health improves coping capacity

Every culture teaches that "health is wealth" (CMH, 2001). Health is the basis for job productivity, the capacity to learn in school, and the capability to grow intellectually, physically, and emotionally. In economic terms, health and education are the two cornerstones of human capital, which is the basis of the economic productivity of individuals and communities (Dreze and Sen 1989; Sen 1999). They also create opportunities for individuals to participate in society and make life choices consistent with their goals. Good population health is a critical input into poverty reduction and economic growth; health status seems to offer an explanation for an important part of the difference in economic growth rates, even after controlling for standard macroeconomic variables.

The channels of influence that lead from disease to economic development are related to the individual's direct loss of well-being (CMH 2001). Quantitative accounts of the loss of well-being are usually by a three-part calculation: (1) the reduction in market income caused by disease; (2) the reduction in longevity caused by disease; and (3) the reduction in psychological well-being caused by disease, often labelled "pain and suffering", even when there is no reduction in market income or longevity. The least favourable health situations are those in which the persistence of communicable diseases is associated with deficient living conditions, including poverty and progressive environmental degradation.

In general, environmental standards and regulations pertaining to air, water, food, vehicle emissions and labour, are more closely adhered to in developed countries; this is more difficult in the developing world, where such standards and regulations often do not exist and even if they do, mechanisms for upholding them are lacking. Given the tendency for environmental issues to be dichotomized in terms of economic growth and progress, it is critical for health and environment planning to work in coordination with macroeconomic policy.

Opportunities for improving health and adaptive capacity

In recent years, several international policies and regulations have made provisions for more emphasis on the consideration of health. These include:

- The Strategic Environmental Assessment Protocol that supplements the UNECE Convention on Environmental Impact Assessment places a special emphasis on consideration of human health;
- Article 152 of the Amsterdam Treaty of the European Union calls for the EU to examine the possible impact of major policies on health;
- WHO (2005) recommends a health impact assessment.

Several of the Millennium Development Goals relate to health, particularly the targets to reduce hunger and halt and reverse the spread of HIV/AIDS, malaria and other major diseases. Other targets agreed upon in the Millennium Declaration include a significant improvement in the lives of slum dwellers; halving the proportion of people unable to reach or afford safe drinking water; reducing maternal and under-five child mortality; and making drugs more widely available and affordable (see also Chapter 3 of this report).

The emphasis on environmental factors has been a strong part of the public health tradition, beginning with the Sanitarian Movements and can be traced through ideas of health promotion and current work on inequalities in health. Increasingly, this tradition has emphasized the social and economic environment as having the greatest influence on health (Glouberman, 2001).

The complex interactions between environment and human health are very difficult to unravel, in particular because of a general lack of data from developing countries and fragmented, discipline-oriented data in developed countries. In addition, except for infectious diseases and acute poisonings, environmental causes are often masked in health statistics, particularly in developing countries and concerning poor women. There is, however, agreement that environment-

Box 5.2 Health issues in urban areas

Overcrowding, poor housing, malnutrition, inadequate basic services, and other problems associated with poverty and inequity exacerbate the exposure of poor urban residents to health hazards, such as vector- and water-borne diseases and heat stress. The lack of mass transport systems leads to considerable air pollution, which leads to respiratory diseases and allergies. Traffic accidents occur frequently and road deaths are common. Climate variability and climate change are expected to have significant impacts on the health of urban populations in tropical regions, as the threshold of vector-borne diseases, such as malaria, dengue and yellow fever, may expand, and the spread of diseases in already affected areas may be accelerated (Patz and Balbus 1996, Tayanc and others 1997). The spread of water-borne diseases in urban areas is also expected to increase as a result of climate-change effects on the supply, distribution, and quality of water. Increasing temperatures during the summer are expected to lead to increasing heat stress morbidity and mortality among the poor and the elderly.

related ill-health is broadly underestimated (WHO 1996, WHO 1997, WHO 1998). This suggests that improved monitoring and data storage and access are necessary steps in mainstreaming environmental aspects into health policy.

Furthermore, environmental health research methodologies tend to focus on pathogens and pollutants, while neglecting social determinants linked to poverty. As a result, it is difficult to show scientifically acceptable causal connections in the areas of environment, poverty and health (Sims and Butter 2005). Any meaningful strategy to address environment and health issues must therefore take gender-sensitive poverty alleviation in both rural and urban settings as a central component (Sims and Butter 2000).

A better understanding of the dynamic linkages between ecosystems and public health is leading to new and diverse opportunities for earlier interventions in processes that could become direct threats to public health (Aron and others 2001).There are no simple answers to complex problems affecting ecosystem change and public health. However, other experiences in integrated assessment demonstrate that the establishment of an open and participatory process is essential (Pielke and others 1999, Shrader-Frechette 1991). Methods for demonstrating the linkages between ecosystem change and public health must build upon the experience in the field of environmental health, which has a long tradition of using indicators as "an expression of the link between environment and health, targeted at an issue of specific policy or management concern and presented in a form which facilitates interpretation for effective decision-making" (Corvalán and others 1996). Indicators need to be evaluated in terms of scientific credibility and utility in the decision-making process for particular programmes, following guidelines developed for more traditional environmental health indicators (Aron and others 2001). Indicators for integrated assessment of ecosystem change and public health are necessary to support the management of integrated programmes.

In general, there is a huge opportunity for improving health and, thus, adaptive capacity through more integrated approaches used in policy-making, education and research.

Currently, there are multiple health-related policies being developed by various ministries and government departments. Worldwide, ministries of Environment, Natural Resources, Agriculture, Mines and Energy, Construction, Labour, and Planning are all involved in health and environmental issues, in different ways. This pattern is mirrored in universities and research institutions, that similarly fragment environmental health issues among different faculties and departments, hindering the acquisition of an integrated and synergistic understanding of the problem.

Last but not least, an important opportunity for improving health and reducing vulnerability is the provision of health warning systems, as illustrated in the Box 5.3. While the box refers to warning systems for heatwaves, provision of warnings in case of contamination and natural hazards would reduce health risks that are central to many of the archetypes of vulnerability.

5.3.5 Learning to cope: building and bridging knowledge

The access to relevant knowledge is essential for enabling vulnerable communities to cope with change, as illustrated, for example, in the global commons archetype. In some cases, science and local knowledge can prove instrumental in identifying and characterizing changes in a resource, such as global climate, and the implications of these changes. In other cases, as with strip mining or deforestation, science and technology are the tools with which a resource is degraded.

Vulnerable communities can have a substantial base of local and highly relevant knowledge to cope with change. In some cases, this knowledge fits into the formalized form of science; in other cases, it falls into categories of indigenous knowledge systems. These different types of packaged knowledge are often complementary and can be integrated (see below). However, the source and nature of the pressures on the local environment are increasingly of a kind previously not encountered by vulnerable groups; it often takes various types of scientific knowledge to identify and understand the threats of, for example, climate change or economic globalization, and how to deal with them.

Box 5.3 Heat health warning systems

Although heat-waves are rare events, they are associated with significant mortality impacts. A range of measures are available that potentially reduce the impact of extreme temperature episodes on mortality and morbidity, including health promotion, building design, urban planning, and heatwave early warning systems.

In 1995, partly in response to the city's 1993 and 1994 heatwaves, the Philadelphia Hot Weather-Health Watch/Warning System (PWWS) was developed to alert the city's population when weather conditions pose risks to health (Kalkstein and others 1996, Sheridan and Kalkstein 1998). This system is the basis for many other heat health watch warning systems being instituted in cities, worldwide (Kalkstein 2003, Sheridan and Kalkstein 1998). Once a heat-related warning is issued, the Philadelphia Department of Health implements emergency precautions and mitigation procedures to reduce mortality risk (Kalkstein and others 1996). The number of lives saved and the economic benefits of this system were estimated using data from 1995-1998 (Ebi and others 2004).

As with many environmental health problems, the technology (air conditioning, natural ventilation, drinking fluids) is widely and readily available. However, many barriers to their effective use remain. Heat health warning systems are an important strategy for reducing heat-related deaths, providing care and an active detection of vulnerable individuals (Kovats and Koppe, 2005).

The development of scientific knowledge – which is relevant on both macro scale (as discussed in the next section), and, for the most vulnerable, micro scale – is, therefore, an important issue. In the latter case, the way this knowledge is produced and those who have access to it, is also highly relevant. There are challenges in both these aspects, which can be turned into opportunities.

Vulnerable groups often lack access to scientific education, institutions and knowledge, and to the technological and other benefits that science provides. Not only is this a severe constraint for the ability of these communities to cope with change themselves, but it also increases the risk that their particular challenges remain invisible (or at least underrepresented) in the eye of science and on governance agendas that rely on scientific information. The largest groups of vulnerable communities reside in developing countries, which are significantly underrepresented in the production of scientific knowledge, including environmental science. This means that there is a significant knowledge divide between industrialized and developing countries in their ability to base adaptation on scientific knowledge produced within a locally relevant eco-climatic context (Karlsson 2007). Furthermore, because western science is rooted in developed countries, scientists often focus their attention on developed country challenges, and frame problems in ways that align with western perspectives (Agarwal, Narain and Sharma 1999).

Involving vulnerable people and their local expertise in environmental knowledge-producing processes is one way of giving these people a voice in policy-related processes, bring marginalized people in contact with scientific knowledge and viewpoints, and vice versa, and enhance coping capacity. Those who participate in a knowledge-producing process can affect its underlying assumptions and values, its perceived legitimacy, and the uptake of its findings (Farrell and Jäger 2005).

The engagement of vulnerable groups in the development of knowledge relevant for adaptation and resilience, is in itself not a sufficient measure for ensuring their broad, empowering, access to knowledge. This requires access to education in a much broader sense, encompassing formal and informal education, general and vocational education, as well as more directed environmental education. Universal primary education (MDG 2) would give everyone the skills of reading, writing and numeracy, as well as social competence and critical thinking; these form the foundation for any further vocational training or higher education. Such education and training, in its turn, provides people with the basic capabilities and skills needed to pursue a livelihood, live a healthier life, and acquire material goods. A good basic education also increases the ability of vulnerable groups both to understand information from public awareness and early warning campaigns about specific sources of vulnerability and to develop coping and adaptation strategies to address environmental change. For example, it was the poorest and lowest educated groups that did not heed the evacuation warnings for hurricane Katrina in 2004 (Cutter and others 2006). The targeting of general education for the most vulnerable groups is, thus, an opportunity to improve coping capacities most cost effectively, and is also important for equity reasons. A related example supporting this strategy is the more rapid development gains from the education of girls. This is one of the key means to break the cycle of intergenerational transfer of poverty and is strongly associated with healthier children and families (UN Millennium Project 2005). More targeted. environmental education provides people with the ability to learn about, for example, the functioning of ecosystems and the human impacts on them, as well as the options for action. Such learning, however, requires policies that foster multidisciplinarity, as promoted through the United Nations Decade of Education for Sustainable Development (see Box 5.4). Integrating such learning with direct participation in the generation of knowledge, can achieve multiple benefits through programmes in which school children, non-governmental organizations, amateur volunteers, and other societal groups participate in data collection activities, the application of simple research methodologies, data analysis and the dissemination of research results.

Box 5. 4 United Nations Decade Of Education For Sustainable Development (2005-2014)

The World Summit on Sustainable Development recommended to the United Nations General Assembly that "it considers adopting a Decade of Education for Sustainable Development starting in 2005" (par. 117d, Plan of Implementation). In December 2002, resolution 57/254 on the United Nations Decade of Education for Sustainable Development, beginning 1 January 2005, was adopted by consensus. The Plan of Implementation establishes the linkages between the Millennium Development Goals on universal primary education for both boys and girls, but especially girls, and the Dakar Framework for Action on Education for All. The creation of a gender-sensitive education system at all levels and of all types – formal, non-formal and informal – is emphasized as a crucial component of education for sustainable development.

Education for sustainable development is based on the following major thrusts:

1. *Reorienting existing educational programmes*. Rethinking and revising education from nursery school through university to include more principles, knowledge, skills, perspectives and values in all dimensions of sustainability
2. *Training*. The development of specialized training programmes to ensure that all sectors of the workforce have the knowledge and skills necessary to perform the work in a sustainable manner.

There is no universal model of education for sustainable development. Each country has to define its own priorities and actions, depending on its culture and the local environmental, social and economic conditions. Education for sustainable development is equally relevant and critical to both developed and developing countries.

In addition to building knowledge and raising the level of education and access to knowledge, as discussed above, connecting the various bodies of knowledge is very important for reducing vulnerability and improving human well-being. Within science itself, experts who specialize in particular knowledge areas tend to work within their respective domains. Yet, there is much to be gained by developing interdisciplinary knowledge and practising interdisciplinary approaches. Poverty mapping, described in Box 5.5, is one such form of knowledge production. It brings together data from various natural science and social science disciplines, and can be used to increase understanding of the root cause of vulnerability, as well as provide the basis for discussions about improving adaptive capacity.

Furthermore, in the application of scientific knowledge in society, improved monitoring and assessment of the environmental, social and health-related aspects of pollution could help people to deal with contaminated sites and with potentially contaminated foods. Early warning systems, indicators (for example, the Environmental Vulnerability Index, see Gowrie 2003) and other mechanisms for communicating and disseminating information on environmental change, could benefit people in coastal areas, the Arctic and other regions where environmental change is pronounced. These systems should be integrated into mainstream development. More effective disaster risk reduction can be achieved by establishing and strengthening early warning systems, improving awareness and preparedness, and supporting community-based risk management programmes (Yokohama Strategy and Plan of Action for a Safer World, 2005). With respect to the contaminated sites archetype, there is a need for better monitoring and environmental, social, and health assessment. These activities could take the form of data gathering on long-term effects of pollution, but their value would rise significantly if they linked such efforts to new assessment methods, which make a point of not only integrating health, social, environmental and economic impacts but also involving stakeholders and, thus, making knowledge more legitimate and accessible (see above).

There are a number of options for bringing different forms of science into local contexts through scientific projects that focus on issues of sustainable development, institutions that make science education available to the poor, the communication of scientific information that is relevant and accessible to local people, and monitoring projects through which local people can observe environmental and social changes. Such monitoring processes could build local scientific capacity and provide information valuable in promoting environmental awareness and informed decision-making. In New Caledonia, contemporary science is being used to enhance and validate traditional knowledge about the region's biodiversity and about agricultural and irrigation practices (Dahl 1989). Environmental impact assessment (EIA) is an activity through which local people can bring together scientific and local forms of knowledge for a better understanding of their environment and ecological processes. EIA tools also help to install a greater sense of responsibility in local people for environmental resources and an enhanced understanding of how to manage these resources. Another, similar initiative, the South Pacific Biodiversity Conservation Programme, has successfully encouraged the establishment of local protected areas for biodiversity conservation owned and managed by the local communities, and incorporating their own local monitoring (Dahl 2002).

5.3.6 Investing in science and technology for adaptation

We already discussed the importance of access to scientific relevant knowledge for vulnerable groups and communities, for their ability to cope with micro-scale change. But there is also a significant opportunity in the strengthening of both science and technology to increase resilience and ability to adapt to macro-scale change.

The archetypes of vulnerability highlight numerous ways in which both scientific knowledge and its application in technology can contribute to reducing vulnerability, where a more large-scale investment is required at the macro level. In the water sector, science and technology play an important role in reducing water consumption and increasing the capacity to adapt to changes in water availability. The archetype on technological fixes of water problems indicates advantages of replacing large-scale water regulating projects (from supply and demand side) with small-scale projects that have fewer negative social and environmental consequences. Other opportunities for addressing water problems include flood control measures, promotion of less-intensive irrigation products, irrigation methods that utilize micro-scale catchment management, optimized irrigation technologies, and small-scale power generation and alternative renewable power generation (wind, photovoltaics, etc.).

Box 5.5 Poverty mapping

Poverty mapping is a tool for understanding and reducing vulnerability. Poverty maps disaggregate national data, locate impoverished communities, and identify linkages between poverty, environment, and human well-being, at temporal and spatial scales. Poverty mapping involves qualitative and quantitative data and can be used to indicate relationships between data in bio-physical, social and economic sectors. Increasingly, institutions and countries are using poverty maps to investigate and discuss social, economic, and environmental problems. Poverty maps have been highly effective in identifying areas of lagging development and in promoting asset development, which is key to poverty reduction. Analysts have also used poverty maps to identify areas in need of assistance, such as food aid and environmental health interventions. The maps have been used to understand relationships between ethnicity and poverty (Vietnam), poverty and roads (Guatemala), and poverty and cholera (South Africa). Poverty maps are currently being developed in Madagascar to identify hotspots for risk and disaster management (Henninger and Spen 2002).

The increasing urbanization of coastal areas underscores a need to develop sustainable sanitation systems and sustainable energy resources. Contaminated sites require increased support for research on causes and effects of industrial production, chemicals (especially cumulative effects), life cycle analyses, and environmental impact assessments. These sites also call for technology transfer, the use of Best Available Technologies and improved decontamination and remediation alternatives. Small Island Developing States face a number of risks and challenges for which new innovations in and applications of science and technology could be beneficial. These developments include the technology and capacity to assess impacts and adaptation options; documentation of traditional coping mechanisms; shifts in thinking from controlling nature to working with nature; and the development of alternative energy solutions such as hydropower and biogas. The energy sector requires innovation covering the full menu of options (energy diversity) that needs to be deployed (renewables, fossil, efficiency improvement), and accelerated learning. Science and technology for this sector needs to include various sustainable development concerns, including security of energy supply, climate change, health concerns and energy poverty.

Critical to local livelihoods and to broader forms of economic development, science and technology support the resources and products that comprise a material basis for a good life (see Section 3.5.1). Systematic environmental knowledge and technology, as well as indigenous and traditional knowledge, are often central to agricultural practices, livestock production, water access and use, forest and woodland management and wildlife management. It is also essential to the maintenance of safe water supplies, good air quality, energy supplies, and alternative energy developments. Furthermore, science and technology are central to transportation, housing, educational materials, and infrastructures. Information technologies can promote the educational measures targeted at vulnerable communities, through distance learning and remote access to educational materials. But, on a larger scale, the Internet, mobile telephones and other information technologies are enabling people to obtain information and participate in governance in unprecedented ways. With these new technologies, citizens are voicing their views, accessing public resources and holding authorities accountable. Democratic uses of science and technology are vividly illustrated in global civil society and its international networks of NGOs, that depend heavily on information technologies for communication, organization, and knowledge sharing (UNMP 2005). These technologies also increase the efficiency of markets (UNDP 2001).

The importance of particular technologies often depends on specific (and often local) social, economic and environmental contexts (UNMP 2005). Institutions comprise a critical feature of these contexts. Institutions and the governance decisions that put them in place, can have a significant role in shaping knowledge production and dissemination, as well as in technological development, diffusion and use. Institutions can create incentives and disincentives for particular types of technological innovation and their distribution. Tax policies, governmental budgets, subsidies and trade policies can shape the production and export of particular technologies. Informal institutions, such as those embedded in gender-specific water collecting responsibilities, beliefs about acceptable farming practices, and reliance on traditional hunting tools, can also shape the use, misuse or rejection of particular technologies.

Developing countries stand to derive many benefits from science and technology, but they also face the greatest challenges in managing science and technology risks. Many of these countries lack, for example, the specialized knowledge, regulatory institutions and enforcement mechanisms that can help to identify and manage risks associated with science and technology (UNDP 2001). There is also an ever-widening gap, worldwide, between those who benefit from science and technology and those who do not. This trend is likely to worsen, as developed countries continue to invest in technological innovation and, in some cases, even attract the human resources of developing countries (IAC 2003).

Science, technology and innovation are bedrocks of economic development. 20th century technologies were central to many improvements in human well-being, including increased life expectancy in Asia, Africa and Latin America and reduced malnutrition in South Asia (UNDP 2001). Science and technology have clearly been an important part of the new industrialization in East Asia. However, this growth would not have been possible without institutional flexibility, export orientation, and collaboration between public and private sectors (UNMP 2005).

More targeted investment in science is needed in developing countries to address this significant divide in science and technology development and access. Investors can direct money to environmental monitoring and data gathering initiatives, make long-term commitments to science education, and provide research grants to researchers in the developing world. Other support can focus on expanding the community of scientists from developed countries focused on issues from developing countries, and encouraging them to engage, learn from, and share knowledge and results with local people in their research.

New contributions to science and technology for development require new linkages between governments, universities and industry. This could include, for example, universities becoming more engaged with development and with fostering it, for example, through business incubation centres, entrepreneurial training and internships, and transferring university research to firms. Science education is also of the utmost importance at the primary and secondary levels (UNMP 2005). The transformation of knowledge to products and services is at the core of many businesses. A major challenge for many developing countries resides in linking knowledge production and business formation. The stimulation of the creation of small and medium-size businesses would be one approach to dealing with this challenge and these enterprises could then contribute to the development of new opportunities for and uses of technology. Banks and other financial institutions could also stimulate technological innovation. It has also been recommended that national governments in developing countries should increase their spending on research and development to between 1 and

1.5 per cent of GDP (IAC 2003). Government procurement could serve as a tool to stimulate technological development. Foreign direct investment is needed in developing countries in order to bolster technological capacity and promote regional markets (UNMP 2005).

Computer and information and communication technologies, biotechnology, genetics and nanotechnology are all promising technologies (UNDP 2001) that remain unavailable to vast numbers of people in the developing world. Policies and funds are needed to explore the potential sharing of such technologies, the appropriateness of technologies for particular contexts, and the infrastructures necessary to make such technologies safe and beneficial in new areas. Past experience has shown the importance of attending to the appropriateness of technology's multiple connections with broader society, its fit (or lack thereof) within particular social, cultural and economic contexts and its implications for gender. The United Nations Task Force on Science, Technology and Innovation makes a number of recommendations, which include: focus on so-called platform technologies, existing technologies with broad economic impacts (for instance biotechnology, nanotechnology, and information and communication technology); provide adequate infrastructural services as a foundation for technology; invest in science and technology education; and promote technology-based business activities (UNMP 2005).

5.3.7 Learning to care: building a culture of responsibility

More access for vulnerable groups to knowledge of risks and strategies to adapt is essential, but it is, of course, not enough; it has to be turned into individual and collective action. The extent to which this happens depends on a range of other factors, including the degree to which people are engaged in the process of developing knowledge, as previously discussed. However, as the export of vulnerability archetype illustrates, there are many situations where vulnerability is exported across communities, countries or even continents. In these cases, it is essential to engage those actors who are responsible for the actions that export vulnerability, to change their behaviour, both in terms of individual actions and collective decision-making.

This means that people everywhere need to learn more about how their production and consumption patterns export vulnerability to other areas, continents and generations, and how this affects the prospects for living together at local scales — such as in the coastal zones, where, for example, degradation of mangrove forests has grave implications for the vulnerability of large populations — and at global scales — for example, where patterns of energy and transport use in industrialized countries and areas have enormous impacts on the well-being of inhabitants of, for example, SIDS and the Arctic. However, the chain of interactive drivers is often far too complex to enable individual and collective actors to be aware of their own contributing role and, as a result, to feel more responsible to act (Karlsson 2007). Furthermore, unlike in the most vulnerable communities, these actors do not receive an immediate benefit from assuming responsibility for their actions and from changing their behaviour, since they are not the ones directly affected. Even if these actors were aware of the negative impact of their actions on populations and places distant in space and time, they need an additional motivation. Both individuals and collectivities, such as countries, need to feel actual concern for those who suffer and, thus, have a broad adherence to values of global solidarity.

This opens up the way for a strategy to reduce vulnerability, where a culture of responsibility is built more on global solidarity for present and future generations, as a way of integrating neighbourhood values with global solidarity (Mertens 2005). Such solidarity can be actively nurtured through, for example, education (Dubois and Trabelsi 2007), processes of cooperative interaction (Tasioulas 2005) or the design of institutions which strengthen cosmopolitan aspirations and commitments (Tan 2005). UNESCO's Education for All emphasizes the need to expand the view of education to include learning "to live together" and learning "to be" (UNESCO 2005). These so-called "life skills" are very important for addressing vulnerability.

Learning how one's behaviour impacts others needs to be integrated with learning how to adopt positive values, such as caring for and feeling empathy for others nearby and far away, both in space and time. Enabling "students" in such programmes to participate directly in environmental problem solving is one effective way to enhance conservation behaviour (Monroe 2003). Examples of teaching environmentally relevant life skills include the education initiatives related to the Earth Charter and various programmes on global citizenship and human rights (Earth Charter Initiative Secretariat 2005).

5.3.8 Building cooperation (and peacebuilding)

Conflict and cooperation are both cause and consequence of environmental change and vulnerability. Conflict over resources is not a new phenomenon but one that has existed since antiquity, as has cooperation. Conflict and cooperation have resulted from both the scarcity and the abundance of natural resources, as well as from institutional interventions designed to manage them.

Conflict, whether related to the environment or not, has direct and indirect negative impacts on human health and vulnerability. There are a few exceptions. Some conflicts, particularly non-violent local disputes over resource control or mega projects, such as dams, can begin to define competing resource needs, address inequalities for vulnerable populations, and increase human well-being through social change (Desloges and Gauthia 1997).

Just as conflict typically holds negative consequences for human well-being and vulnerability, cooperation typically improves human well-being and lowers vulnerability. Like conflict, exceptions also persist: cooperation among subnational elites – or even countries engaged in resource capture – can further limit access to livelihood resources and thereby increase vulnerability and undercut human well-being for at-risk populations. Environmental resource management is, in many ways, a form of conflict management, arbitrating between differing values and priorities around resources. Disputes can undermine the formal and informal institutions for resource use, resulting in environmental degradation and economic decline (Castro and Nielsen 2003).

The level of conflict over natural resources and environmental services ranges from non-violent disputes to organized violence and from local or community levels (farmer to farmer) to national and international levels. When mapping out conflict dynamics and the prospects for cooperation, it appears critical to distinguish between renewables and non-renewables. For example, non-renewables, such as mineral oil and minerals, have been salient factors in violent conflict, while there is less evidence of organized violence between states over renewables. Violent conflict over renewables, such as water, forests and fish, tends to remain civil or sub-national in nature.

As indicated in the resource paradox archetype, the neo-Malthusian discourse of scarcity, the so-called grievance-based explanations, have dominated recent investigations of environment and conflict linkages. Resource abundances, or greed-based explanations for conflict, have drawn more of the field's attention within the last six years, in part in reaction to some of the more ambitious claims on the scarcity side of the equation. The greed and grievance hypotheses are often set against one another as a dichotomous choice, where only one can be correct. Such a characterization is a false choice, given that both dynamics appear to be in play in different context-specific settings. Both hypotheses, but particularly the scarcity thesis, suffer from just a paucity of reliable data covering place, time, and resource type. This shortfall in data necessarily limits the extensive use of quantitative analytical tools for uncovering linkages. Scholars investigating the abundance hypothesis have the benefit of easier-to-determine economic valuations of natural resources that are traded in the international marketplace, as also seen in the resource paradox archetype.

The environment and conflict discourse has garnered significant attention of scholars and practitioners over the last 20 years, since it was highlighted with an entire chapter of the Brundtland Commission's *Our Common Future*. In the rush to understand and then design policy interventions to sever the links between environment and conflict, analysts and practitioners alike have neglected the prospect for building upon the interdependence engendered by many environmental resources and services to achieve confidence-building, cooperation, and, perhaps, peace (Conca and Dabelko 2002, Conca and others 2005). As highlighted in the institutions and governance section above, the primary focus of environmental cooperation has been at the international level, with special emphasis on multilateral treaties aimed at mitigating the effects of global change. Since 1987 and the Brundtland Commission report, there has been clear trend in the number and reach of international environmental agreements signed and ratified.

Yet exploring environmental pathways to confidence-building, or so-called "environmental peacemaking" ideas, seeks to take principles of environmental interdependence and long-term iterated cooperation and utilize them within a conflict prevention frame. Environmental peacemaking is a strategy for using environmental cooperation in a way so that it can transform insecurities by building trust and confidence between the parties in dispute. Confidence based on environmental cooperation may then prove a foundation for spill-over cooperation between the parties in a wider set of issues.

Environmental issues typically create interdependencies between communities, groups, and countries, as the environmental phenomena ignore political boundaries. Managing shared resources or common pollution threats require long-term and regular interactions across the political lines that separate parties at local, national, regional and global levels. These necessary long-term, interdependent interactions present the foundation for turning the environment and conflict thesis on its head and devising opportunities for environmental cooperation as pathways to peace. These environmental peacemaking pathways range all along a conflict continuum that begins with conflict prevention (preventive action), runs through times of conflict (peacemaking), and ends with post-conflict reconstruction (peace-building). At each juncture, there are often opportunities for dialogue around environmental assessment or management, which may build trust and confidence among the parties in conflict. While conflict continua are typically portrayed linearly, the

Box 5.6 Natural resource conflicts

It is a common perception that environmental vulnerabilities or environmental governance are luxury items of secondary importance in times of post-conflict reconstruction. Human vulnerabilities stemming from environmental damage done in war-time often receive little attention or funding from local officials, peacekeeping forces, or external donors.

However, there are no more immediate questions in post-conflict settings than the contamination of the local water supply or mined agricultural fields;, and generous natural resource concessions given to rebel forces in exchange for laying down their arms threaten vulnerable communities dependent on natural resources for their basic livelihoods (Haavisto 2005). The challenge for post-conflict vulnerabilities pertaining to environmental conditions centres around the firm establishment of the economic, health, and agricultural benefits derived from lowering these vulnerabilities.

Managing shared resources or common threats from pollution requires long-term and regular interactions across the political lines that separate parties along respective political levels of aggregation. These necessary long-term, interdependent interactions present the foundation for turning the environment and conflict thesis on its head and devising opportunities for environmental cooperation as pathways to peace.

The UNEP Post Conflict Branch (PCoB) assessment process experience has revealed the prospect for confidence-building and cooperation through assessment and institutional design in post-conflict settings (Haavisto 2005).

three stages of conflict are often continually cycling and, therefore, can be better pictured as one continuous circle. Peace-building in post-conflict settings, for example, is quite explicitly preventive action, given the high number of conflicts that restart after a period of peace.

Diplomacy between parties in conflict typically occurs at an official level, commonly country to country, in the formal international system. Environmental diplomacy certainly comprises this primary feature of official interactions and negotiation between countries. Yet environmental issues, given their decentralized nature, also hold opportunities and entry points for civil society, within and between states. It is these dual tracks, and the interactions among them, that gives environmental issues opportunities to play these peacemaking roles, perhaps more so than in other issues areas. Negotiations over nuclear weapons or trade policy, for example, are tightly controlled by the government track with markedly less room for civil society intervention.

In principle, environmental peacemaking strategies could be employed at all levels of political organization. Most analyses to date have focused on the bilateral or regional levels among states, such as around regional seas (VanDeveer 2002, Blum 2002), along transboundary rivers (Weinthal 2002, Swain 2002, Lopez 2005), or across transboundary conservation areas, commonly known as "peace parks" (Ali 2005, Besançon and Sandwith 2005, Swatuk 2002). Analysis of dynamics and potentials at lower levels of political organization represent a ripe area for future research and policy attention.

At least four categories of environmental peacemaking opportunities are present at different stages along a conflict continuum (Dabelko 2005). Policy interventions, involving a wide range of environmental, development, diplomatic, and security policy actors, could have roles to play in these different stages. They are: 1) environmental cooperation and natural resource management as conflict prevention; 2) environment as lifeline in times of conflict; 3) environment as essential ingredient in achieving peace; and 4) environment as post-conflict confidence builder.

Environmental issues and environmental management play different roles during these stages. Different resources (water, land and forests) appear to have different roles in peacemaking. Despite the "water wars" rhetoric, favoured by the press and some politicians, the history of water interactions between countries is a story of cooperation rather than conflict. The water archetype and the research highlighted in Figure 5.1 provides a basis for water as the most promising resource for environmental peacemaking.

The environmental component can also vary in terms of its level of political priority (low politics or high politics). In some cases, environmental issues have low levels of political sensitivity and provide an easier avenue for dialogue in otherwise contentious relationships. Joint scientific assessment of threats from radioactive contamination in the North-western Federal District of Russia provided an opportunity for Russian, Norwegian, and American exchange, as the Cold War ended and the superpowers began to develop links for confidence-building.

In other settings, it is the high political importance assigned to natural resources that give them their peacemaking potential. Shared water resources in South Asia or the Middle East are not the fundamental causes of conflict between countries. Yet achieving a negotiated settlement on water allocations is viewed as an essential step for reaching a negotiated and sustainable peace.

In all of these environmental peacemaking efforts, there are both environmental and peace goals in play. The dialogue on environmental management is designed to improve human well-being and reduce vulnerabilities as first order goals. But environmental peacemaking efforts also have preventive action, peacemaking, and peace-building goals. In this way, environmental peacemaking may be bringing additional vulnerability and human well-being benefits, by heading off negative environmental consequences of any avoided conflict.

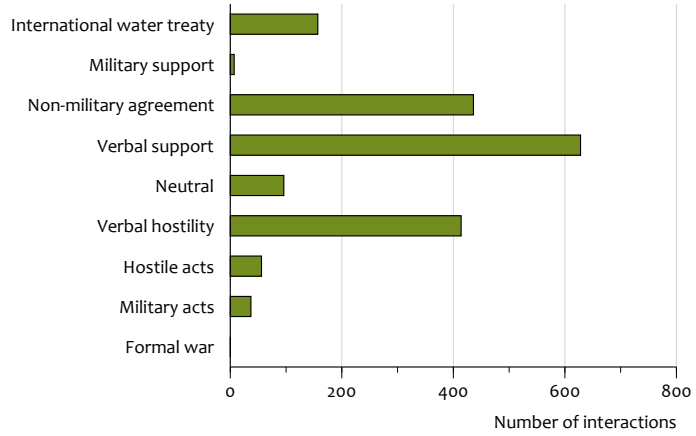
Environmental peacemaking as a term or a frame is not without its shortcomings. Peacemaking per se is perhaps the most ambitious form of exploiting environmental dynamics to build trust, confidence, and cooperation. Many environmental peacemaking efforts will fall far short of achieving actual peace and any effort must be made in conjunction with other sectoral efforts. Practitioner experience in the Nile Basin and the Caucasus indicates that, when parties are engaged in what is described here as environmental peacemaking, they may find the peacemaking label impedes rather than advances the efforts. The parties in negotiation are interested in pursuing the peacemaking opportunities presented by environmental dialogue, but find it most efficacious for the negotiations to be framed publicly, in terms of low politics environmental management or high priority development issues — not in conflict prevention.

5.3.9 Building capacity for implementation

"Implementation failure" is common. Many elaborate, agreed action plans at regional and global levels, designed to reduce vulnerability and improve resilience, such as the Mauritius Plan of Action for Small Island Developing States, lag behind in terms of implementation. Improved implementation can help reduce environmental and other risks or factors that contribute to vulnerability. For example, more effective implementation of the Convention on Biological Diversity may reduce the risks the loss of biodiversity poses to human well-being, by ensuring that biological resources continue to be available, for example, to support medical use and development; for tourism, forestry and other biodiversity-based enterprises; and as a cultural and heritage asset.

The reasons behind implementation failure are complex, and there are no simple solutions. However, the archetypes reveal several factors that weaken implementation, notably poor enforcement, insufficient monitoring and evaluation, weak technical capacity, lack of access to financial and other resources, and the lack of urgency or political will. In addition, the failure to ground policies in local or national realities is undoubtedly a factor – priorities identified at the global level may not be mirrored at the local level (Peterson 1995, Victor and others 1998). Consequently, achieving implementation

State-to-state water interactions in transboundary basins 1946 - 1999 **Figure 5.1**



Water interactions between countries in transboundary basins, 1946-1999 (Wolf et al., 2003).

may require a process in which this gap is bridged and understanding of what motivates national action is improved.

Addressing the challenges that the lack of effective implementation creates for vulnerability requires a multi-level approach. Three important opportunities can be identified: improving funding, investing in capacity, and developing effective monitoring and evaluation of existing plans and policies. International partnership is critical to success.

Implementation requires political will and commitment. This demands a supporting public, able to push the responsible agencies to action and ensure that short-term constraints do not prevent attainment of long-term benefits (Victor and others 1998). However, in many countries public engagement with government-driven policy processes is weak (Scoones and Keeley 2003), and this (as discussed above) is even more evident in international processes. Changes in the underlying culture and priority of a society come about slowly, however, and much more rapid changes can be achieved by proactive leadership and innovative design of institutions, which create a conducive setting for high degrees of implementation and enforcement.

In addition, successful implementation and enforcement require that those with authority for implementation and enforcement have access to the necessary technical and financial resources. Increased financial resources and more creative ways of dealing with available resources are essential to support the implementation of MEAs. For example, strengthening synergies between environmental commitments and national development priorities can ensure that maximum value or benefit is attained from available resources. 'Health and environment' and 'poverty and environment' can be effectively linked in development strategies and actions (Kulindwa and others 2006). One serious and persistent challenge is that official development assistance (ODA) continues to lag behind agreed targets, undercutting the ability of many developing countries to fulfil global commitments. At the 1992 Rio Conference, most countries pledged to increase ODA towards the UN target of 0.7 per cent of GNI (Parish and Looi 1999). However, in 1993, the average level of ODA was just 0.3 per cent of GNI (Brundtland 1995). The 2002 Monterrey Consensus recommitted developed countries to meeting the UN target. Since then, there has been a steady increase in aid and, by 2004, the average ODA was 0.42 per cent of GNI. However, only five countries have met the UN target and, by 2006, the average was down to 0.3 per cent again. The IMF's 15 richest member countries have agreed to allocate at least 0.51 per cent of GNI by 2010, increasing this share to 0.7 per cent by 2015 (Gupta and others 2006).

Improved access to technology is particularly important where implementation requires the development of costly infrastructure or technologies, as might be needed in early warning systems. In these circumstances, the international community has often envisaged technological transfer and financial support as the cornerstone of success. The Johannesburg Declaration, for example, makes explicit commitments to technology transfer for energy development and improved water resource management. Similarly, certain responses might require skills that are lacking in a national context – national implementation of the Convention on Biological Diversity provisions to reduce the environmental and livelihood risks of invasive alien species have, both in developing and developed countries, fallen short of agreed targets due to deficiencies in capacity (CBD 2006).

In situations similar to the contaminated sites archetype, where governance needs formal institutions, better laws — both national and international laws and regulations — and better enforcement of existing laws are crucial opportunities for reduced vulnerability. This requires a strong and well-functioning government with law-making, implementation and enforcement branches working towards the same goals. At the same time, it requires a government that is open to public engagement; empirical evidence suggests that with such engagement implementation is more likely to succeed (Victor and others 1998). In other cases, there is a need to strengthen

the ability of international organizations to monitor multilateral agreements. However, the regulatory framework that can hold the polluters accountable and give local groups access to relevant environmental information on the risks,

Box 5.7 The Mesoamerican biological corridor: a strategy for transboundary cooperation and development

Mesoamerica is one of the most politically fragmented regions in the world, but this fragmentation contrasts with the shared ecosystems and natural links that unify the region. Until recently, transboundary cooperation was not a priority in Central America, but there has been an increasing recognition of the importance of frontier areas. Most forests, including 40% of Central America's protected areas, are in frontier lands; there are 23 international basins, that provide water for the most populated cities, and are home to the majority of ethnic groups of this region (Jiménez, 200, FUNAPDEM, 2000).

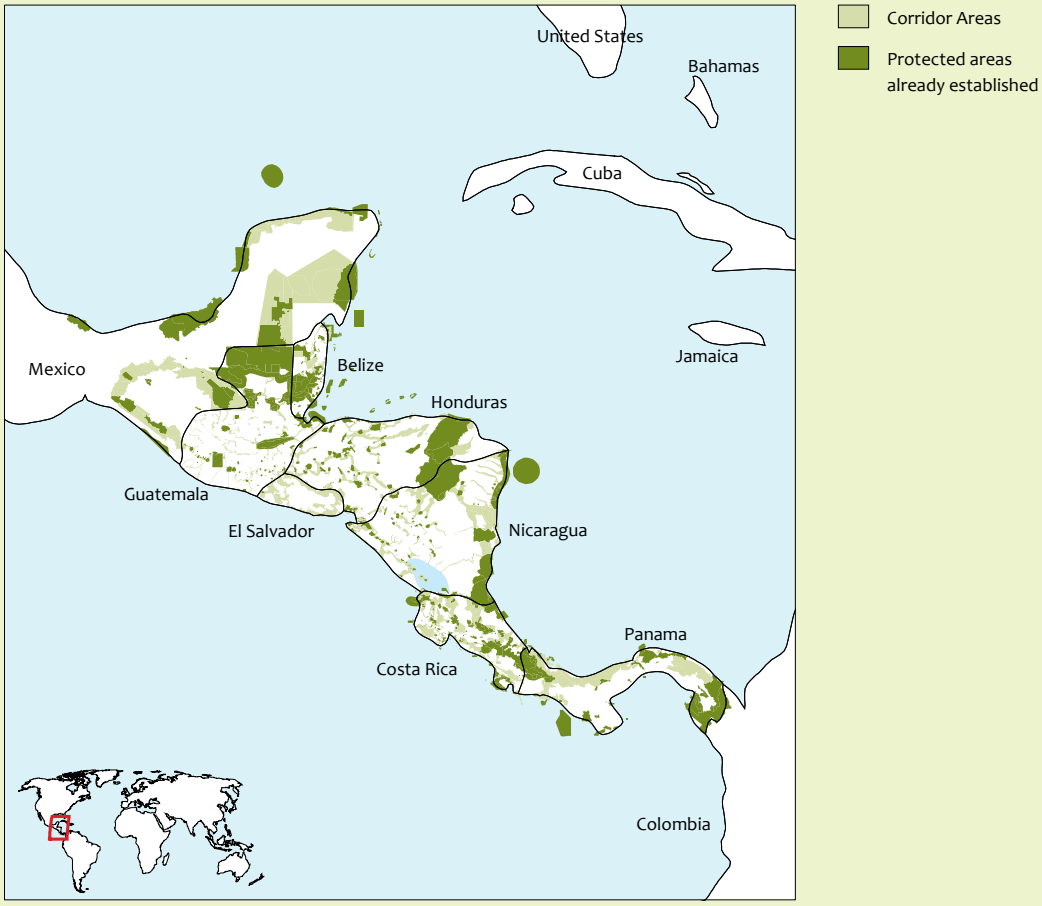
Transboundary resource management requires specific institutions to establish creative forms of cooperation. After the end of the civil conflicts, there were several isolated initiatives that created the conditions for environmental cooperation in transboundary areas (Trifinio, Honduras Gulf, La Amistad Biosphere Reserve, San Juan watershed).

Going beyond isolated efforts, the Mesoamerican Biological Corridor (MBC) is an important regional coordination instrument to reduce the pressures on ecosystems and local populations in frontier areas, and to put regional integration into practice. It was first conceived as a conservation strategy with a strong environmentalist focus. In 1997, the MBC was reframed as a land-use planning strategy including social and economic components (see Figure 5.2).

The first phase of the MBC started in 2000 and ended in 2006; achievements of this phase include: harmonization of instruments to support regional cooperation; collaboration to develop manuals for transboundary wildlife management; a platform for eight transboundary, multi-stakeholder projects; and a strategy for biological corridors.

Mesoamerican Biological Corridor 2001

Figure 5.2



Proposed elements of the Mesoamerican Biological Corridor (Source: Miller et al, 2001).

access to decision-making and judiciary processes, have to be national. Investing in capacity building at government level is crucial; however, as capacity takes time to build, this typically requires long-term investments and a strategic approach. Measures that strengthen the capacity of states are also conducive to strengthening coping capacity at local levels, as long as the higher level governance is supportive (see discussion on vertical integration) (Friedmann 1992). Better institutional and governance mechanisms, including measures to ensure access to relevant information and the courts, support people in safeguarding their interests.

5.3.10 Providing financial resources

One of the most crucial aspects of implementation and enforcement is that those actors who should be the most capable to address vulnerability — individuals, communities or governments — have access to the necessary human, technical and financial resources.

But trends in international aid might reduce the availability of financial resources at the local level. Increasingly, aid is given as budgetary support and not as project-based aid. However, a large amount of aid is conditional or tied (WRI and others 2005). Current levels of aid are inadequate to address existing global commitments. While the share of total official aid going to basic human needs – mainly as humanitarian help and disaster relief – has doubled since the mid-1990s, the share for agriculture and physical infrastructure has diminished – two sectors that need support if countries are to feed their own people and build their economies (UN 2005) and increase their adaptive capacity in the face of multiple stressors. Because improvements in human well-being are essential for reducing vulnerability and improving adaptive capacity, a key challenge for the global community will be to provide the resources committed to make globally agreed targets a reality.

Increasingly, PRSPs form the basis for international aid to developing countries. Using these strategies in an effective way, that promotes environment sustainability and poverty reduction, requires strengthening the linkage between these two aspects. This can be an important area of global cooperation (WRI and others 2005). Public credit guarantees (national) and international credits (World Bank) for large-scale water projects should depend on the consideration of the social and ecological factors involved in the construction of large dams.

It is important to create financial, technical and extension support to allow for diversification of livelihood opportunities and to provide credit and financial support for reducing vulnerability in the drylands. Access to credit for small farmers and those directly reliant on ecosystem services is extremely important. Credit schemes such as the Grameen banks in Bangladesh, can be designed to compensate those who ensure that environmental services are maintained. There is also a need for financing alternative activities to those that harm ecosystems, such as the destruction of mangroves or coral reefs. Finance schemes that target women, in particular, can have higher than usual pay-offs.

FDI, which is productive capital that employs people and finds new markets for products, is an important development driver; in turn, it can have positive spin-offs for development. However, in many regions, such as Africa and the Middle East, it is a great deal lower, than aid. Africa receives about two per cent of the global total of FDI (ADB 2004). South Asia and the Middle East remain the least globalized regions, measured as inflow of FDI, relative to economic size.

Appendix 1 The process of producing the chapter

A.1 Introduction

This annex chronologically describes the various stages in the preparation, analysis and writing of the vulnerability chapter for GEO-4. It distinguishes between a design and preparatory phase and the actual production phase. As mentioned above, the goal of this annex is to provide an overview of the evolution and development of the GEO-4 chapter.

A.2 Design and preparatory phase

First ideas for the storyline for this chapter were discussed at the GEO-design meeting in Nanyuki, Kenya (10-12 November 2004), where the possibility was discussed of using vulnerability analysis as a framework for considering cross-cutting issues, such as poverty, trade, institutions and governance, science and technology, and health.

To start further preparations for the vulnerability analysis for GEO-4, UNEP asked the Netherlands Environmental Assessment Agency, a GEO-collaborating centre, to organize a scientific meeting to explore these topics in greater detail. In line with the ambition of UNEP to strengthen the links with the scientific community, this was done in close collaboration with the International Human Dimensions Programme and its Global Environmental Change and Human Security Project (IHDP/GECHS). This meeting was held in January 2005 in Nicoya, Costa Rica (Wonink, Kok and Hilderink 2005).

The Costa Rica meeting looked in depth at:

- various concepts and frameworks prevailing in the field of vulnerability research;
- the relation between vulnerability and human well-being;
- the applicability of the vulnerability framework for the analysis of the selected cross-cutting issues, as identified in the Nanyuki meeting.

The aim of the meeting was to come up with a consistent approach to assess the cross-cutting issues that UNEP wanted GEO-4 to cover. It was concluded that the vulnerability approach could indeed be a valuable and useful lens to assess the selected cross-cutting issues. With respect to the methodological framework, it was suggested to keep it as simple as possible. No single framework would be able to cover all elements from any comprehensive assessment. However, the more complex frameworks (see Wonink, Kok and Hilderink 2005 and Chapter 2 of this report) could be used as a frame of reference to ensure that all relevant elements of vulnerability would be included in the analysis.

The meeting identified a number of challenges that the further development of the chapter would face:

- reconciliation of the selected "cross-cutting issues" with the need for scientific rigour in an assessment based on a conceptual framework and clear criteria to select the relevant cross-cutting issues;
- inclusion of both global perspectives, as well as local/sub-national detailed studies, showing the dynamics of vulnerable places and people;
- the need to develop a typology of "cross-cutting issues" – as stressors, as modifiers of adaptive capacity, as outcomes (e.g. health), and as part of responses – to show the different character of these issues;
- showing the added value of the GEO-4 assessment, as it built on GEO-3 and other assessment processes (especially IPCC and MA), explicitly considering the human-environment system, framed in the context of sustainable development (and existing goals and strategies) and addressing missed opportunities;
- the importance to show trade-offs between multiple goals. The view was that the goal of policy for vulnerability reduction helps define acceptable balances of risk and benefit, based on improved assessment of the patterns of exposure, sensitivity, and resilience;
- introducing the role for vulnerability analysis in showing trade-offs in the beginning of the chapter, could be a better way of dealing with trade-offs;
- to make the chapter interesting for developing, industrialized and transition countries and to ensure that messages were brought in a positive manner (outline opportunities for intervention, show bright spots and not only hot spots).

After the GEO-4 regional consultations, held in 2004, and discussions at the Nanyuki meeting (which aimed to reflect regional priorities), the following cross-cutting issues were selected for the vulnerability chapter: health, poverty, governance, science and technology, and trade. It was accepted that for practical reasons only a limited number of issues could be covered in the chapter. The terminology "cross-cutting issues" was not considered appealing for the target audience of GEO-4. Furthermore, within a vulnerability framework

the selected cross-cutting issues have different entry points and/or roles. It was, therefore, suggested to drop the use of the phrase "cross-cutting issues" and to address the issues as "Challenges and Opportunities" for sustainable development. It was also emphasized that an important distinguishing aspect of this chapter was to recognize the complex inter-relationships among the various dimensions of vulnerability, as an overarching framework for analysis, compared with the relatively simple and linear analyses adopted in frameworks, such as the drivers-pressure-state-impacts-response framework.

The Global Intergovernmental and Stakeholder Consultation, held in Nairobi in February 2005, confirmed the priorities set for Chapter 7, after having ensured that they were consistent with UNEP plans for capacity building, as described in the Bali Plan of Implementation. It also identified the core set of questions for this chapter (see Box 1.1). After the global consultations, UNEP formed a chapter working group based on regional representation and inter-disciplinary expertise necessary to cover the different issues the chapter had to address. At a preliminary meeting of the authors' team, organized at Scheveningen, the Netherlands, on 21 to 23 March 2005, the questions set by the Governing Council were further explored and a storyline and a draft annotated outline for the chapter was developed. At this meeting it was also decided that the chapter would not use the words "cross-cutting issue" but would aim at a coherent analysis that included these issues throughout the chapter.

A.3 Production phase

The first plenary Production and Authors Meeting for GEO-4 was held in Nairobi in June 2005. This provided an opportunity for discussion with the authors of other chapters and for refining the proposed content of the Vulnerability chapter. At this meeting, it was agreed to add the topic of "Conflict and Cooperation" to the chapter. An annotated outline of the chapter was produced, to guide the writing over the subsequent months. A major outcome of this meeting was the shared definition of the term "archetypical pattern of vulnerability" (or *archetype* in short), a concept that became central to the further development of the chapter.

The first Authors Meeting for the Vulnerability chapter was held in Hua Hin, Thailand, in October 2005. By this time, drafts of each section had been produced and these were discussed intensively at the meeting. Particular attention was paid to the archetypes of vulnerability, the section on well-being and the challenges and opportunities. Between the end of October and the end of December 2005, the text was expanded and refined, so that a zero-order draft could be sent to UNEP for internal review during the first week of January 2006. This draft was, in fact, much longer than what could be accommodated in the final version of the chapter and much of the deleted material has found its way into this Background Report.

Between the end of January and the beginning of February 2006, a week-long meeting on Human Well-Being was held in Nairobi, Kenya, which was attended by representatives from each chapter. There were detailed discussions on human well-being and indicators, governance, equity, economic evaluation and the conceptual framework for GEO-4, resulting in a guidance note on definitions to be used in the preparation of the draft chapters.

The second Production and Authors Meeting was held in Nairobi, in March 2006. Again, there were discussions with the authors of other chapters. Of particular value to the Vulnerability chapter were the discussions with the regional groups, both to identify common points of interest and to ask for regional examples to be used in the chapter.

During the month after the Second Production and Authors meeting, there was a lot of work to be done to convert the zero-order draft into the next (first) draft of the chapter, which was to go out for review. The review process included a scientific peer review, a governmental review and a series of regional multi-stakeholder consultation meetings. Authors of the Vulnerability chapter had identified some 50 reviewers, to cover both the broad content of the chapter, as well as the GEO regions. Unfortunately, most of these reviewers did not send back a review of the chapter, which was disappointing. In total, we received over 700 review comments from about 40 people. These reviews were made available to the authors in July 2006. Some of the chapter authors were able to attend the regional consultations that took place in June and July 2006.

A second authors meeting was held in Potsdam, Germany, at the beginning of September 2006. Due to budget constraints, attendance at this meeting was limited to a selection of Lead Authors together with the two Coordinating Lead Authors (CLAs). The main purpose of this meeting was to go through all the review comments and prepare responses to them, as well as deciding on further writing tasks in order to respond to the comments of the reviewers. A second draft of the chapter was completed after the Potsdam meeting and sent out by UNEP for another round of review. This time a relatively small number of reviews comments (about 50) was received.

In November 2006, the third Production and Authors meeting was held in Cairo. In addition to a small group of the Lead Authors and the CLAs, this meeting was also attended by the Chapter Review Editor, Katharina Thywissen, who had read all of the responses to the first round of reviews and discussed these responses with the authors. The discussions with the Chapter Review editor were extremely constructive and led to considerable improvements in the chapter. After the Cairo meeting there was yet another intense period of work revising the chapter to produce the third draft, which was submitted at the end of November 2006. On the basis of comments from UNEP, a final draft was submitted in early January 2007.

In May 2007, the CLAs attended the final Production and Authors meeting and the meeting with the GEO-4 High Level Group in Copenhagen, Denmark. Preceding this meeting, the first edited version of the chapter had been circulated. The Copenhagen meeting provided the opportunity to discuss the chapter with the editors and to review the main messages in the light of the key messages for GEO as a whole. The final version of the chapter, incorporating all comments from the editors and UNEP, was submitted to UNEP at the beginning of July 2007.

Appendix 2 Challenges in measuring well-being

Indicators for measuring well-being can be identified in relation to the three approaches (inputs, objective well-being, subjective well-being) and to the five selected components of well-being (Matrix 1). This matrix helps capture key objective and subjective elements beyond (but not excluding) income, across the range of component areas.

The first step in the discussion of indicators within the Chapter 7 Working Group was to get a bird's eye view of some of the indicators available. The next step was to identify the types that are relevant, feasible and appropriate in particular cases.

In assessing well-being, our main focus is the domain of objective well-being. However, for some purposes and assessment – including understanding processes and their connections – it is important to have indicators from the approaches 'inputs' or 'subjective well-being'. For some components only input indicators are available and these must function as proxies for the well-being outcomes. Inputs are of course also an essential focus for policy instruments.

Research and policy implementation activities have, until recently, focused on input indicators; consequently, these sets are better developed. For example, many indicators relevant to the interface between the physical environment and human well-being occur in the category of Inputs to well-being: such as the quantity and quality of water availability per person. There is some correlation between the human well-being component, "Basic Material Conditions" (derived from the MA) and the Inputs category. However the MA list is not complete, and we can usefully identify further inputs for each of the five component areas.

Some components are closely related to others and, consequently, there is some overlap between indicators. Security aspects apply to each of the other four component areas also, not only to physical and environmental security. This is not a problem for the typology used; in the other four columns we consider amounts, and in the security column we consider questions of stability and security of the levels.

Similarly, freedom/opportunity aspects apply in each of the other four areas also, and not only to civil rights and participation; for instance, the real opportunities one has for good health (whether or not one uses those opportunities well and converts them into good health). Each area of objective well-being can be looked at in terms of achieved functionings or of capabilities (attainable functionings, or, in other words, real opportunities to attain). Within the freedoms and opportunities column we have not highlighted every opportunity (for example, the opportunity to live a long life), but specifically the freedoms to learn, express, and participate.

The overview of indicators provides a typology, which shows types of indicators and their contribution to measuring well-being in the identified components (Table A2.2). This is supported by examples of sound, relevant indicators for the respective combinations. It is not intended to provide a definitive specification of the only acceptable indicators for each combination. The set of indicators surveyed here, provides a basis for identifying relevant and feasible indicators; for some

MATRIX 1 The approaches to well-being **Table A2.1**

	BASIC MATERIAL CONDITIONS	HEALTH	SECURITY	GOOD SOCIAL RELATIONS	FREEDOMS AND OPPORTUNITIES
Other Indicators for Env-HWB Interface					
INPUT INDICATORS					
OBJECTIVE WELL-BEING INDICATORS *a) Achievements* *b) Opportunities*					
SUBJECTIVE WELL-BEING INDICATORS					

MATRIX 1: the approaches to well-being and the components of well-being, as a basis for classifying indicators

Indicators in different approaches for human well-being **Table A2.2**

	BASIC MATERIAL CONDITIONS	HEALTH	SECURITY	GOOD SOCIAL RELATIONS	FREEDOMS AND CHOICE
INPUTS	**Income:** - Real gross national domestic product per head - Gini coefficient - Ration-based and economic distance ratio - % of population below one and two dollars a day **Consumption:** - Per capita consumption of energy (kilojoules) in constant dollars * Please note that this is an illustration and it is valid for most of the provisioning services, a.i. land, water, firewood, fibre, energy, medicines, and minerals. - Effective per capita consumption flow in constant dollars in per capita bases	**Access to resources:** - Per capita food production index. Average calory intake per capita (FAO) **Health expenditure:** - Government expenditures on health - Government expenditure on preventive health (WHO) **Inputs of social services:** - % of people having access to health care and education, based on availability of physicians and teachers per 1000 inhabitants (WHO, UNESCO) **Access to services:** - % of population with access to health services and health care and social programme coverage - *Clean air*: NO_x, SO_2, emissions per capita and per unit of economic output - *Fresh Water*: Annual fresh water consumption per capita Annual internal renewable water resources per capita	**Resilience to shocks and stress:** - % of people under certain poverty line and susceptible to monetary shocks (expressed in PPP dollars) - Proportion of government expenditure allocated to cope with extreme events (measured as % of GDP) - Annual rate of inflation - External public debt as % of GDP	**Good governance:** - Inequality and equality measures (well-being index)	**Command over resources:** - Measure of economic welfare - Genuine progress indicator - Index of economic well-being [These are measures of economic product, modified to remove items that are costs not benefits] **Education:** - Government expenditure on (1) basic education based on per capita GDP (WB) and (2) all education
OBJECTIVE RESULTS Objective results (cont.)	Safe shelter: - % of households with homes made from permanent materials, and electrical supply (based on PPP dollars)	**Adequate and safe water:** - Morbidity due to water-borne diseases - Population with water stress (percentage) - Per capita actual renewable water resources and per capita annual withdraws (m3/person/year, WRI) - % of population with access to safe potable water **Sanitation:** - % of population with access to sanitation (WHO) - % of population with improved sanitation (WRI, MDG7) - % of population living close to dumps and waste sites (OECD, social indicators) *Clean air:* (PM, SO2, O3) (emissions per capita) - Mortality and morbidity rates due to respiratory infections **Adequate nourishment:** - Malnutrition in children under 5 years of age - Stunting prevalence **Health and Ability to be free from avoidable disease:** - Perinatal mortality - Short-tem disability\ Long-term disability (OECD, social indicators)	**Access to resource:** - Crime indexes based on lack of access to resources **Safe shelter:** - % of population living in high risk areas **Resilience to shocks and stress:** - % of people with high vulnerability to extreme events (e.g. flooding, landslides) - Violations of political rights index and civil liberties index	**Equity index:**	**Opportunities:** - Opportunity to observe, study and learn about the environment - Opportunity to express aesthetic and recreational values associated with ecosystems - Opportunity to express cultural and spiritual values associated with environment **Functionings:** - Based on Sen's priority freedoms (political opportunities, transparency guarantees, participation and social opportunities) **Publicparticipation:** - Freedom of expression (Transparency International and freedom index) - Economic participation and decision-making (% of male and female shares in positions as legislators and senior officials and managers (HDI)
SUBJECTIVE RESULTS	Felt increase or decline in economic power	**Subjective health**	**Subjective security index**	**Good governance:** - Corruption perception index	**Felt quality of lifeindex**

studies, these will be insufficient and new variants will need to be identified. Possible additional indicators can be judged by reference to this overview, checking on whether they are Input/Objective well-being/Subjective well-being indicators and how they compare to more standard indicators.

In some cases, we have identified important gaps, where required data appeared to be not yet sufficiently available. Important issues concerning the choice of scale and/or geographic level arise. There are considerable dangers of over-generalisation, but feasibility of obtaining data and connection to the relevant needs of decision-makers, must also be considered.

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Vulnerability of people and the environment – challenges and opportunities

Background Report on Chapter 7 of the Fourth Global Environment Outlook (GEO-4) assessment report published by UNEP in 2007.

There are strong causal relationships between the state of the environment, human well-being and vulnerability of people. Vulnerability analysis is widely used in the work of many international and national organizations concerned with poverty reduction, sustainable development and humanitarian aid. Vulnerability analysis helps to identify places, people and ecosystems that may suffer most from environmental change and identifies the underlying causes. It is used to develop policy recommendations on how to reduce vulnerability and to adapt to change. In the United Nations Environment Programme (UNEP) Fourth Global Environment Outlook: environment for development (GEO-4) vulnerability analysis provided an innovative basis for addressing challenges and opportunities for sustainable development.

This report provides the background to GEO-4's Chapter 7 "Vulnerability of people and the Environment: Challenges and Opportunities" published by UNEP in October 2007. It includes a more detailed explanation and elaboration of the analyses in GEO-4, as well as some additional analyses.

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