

Our Planet, Our Health, Our Future

Human health and the Rio Conventions:
biological diversity, climate change and desertification



**World Health
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RIO+20
United Nations Conference
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**Convention on
Biological Diversity**



United Nations
Framework Convention on
Climate Change



UNCCD
United Nations Convention
to Combat Desertification

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United Nations
Framework Convention on
Climate Change



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Cover:

Main photo: “Without fire, life multiplies. Put the Cerrado in your heart.” Poster by children, near to Chapada dos Veadeiros, Brazil. The Cerrado is one of the world's most diverse tropical ecosystems, serving as a refuge for species during periods of climate change. Photo credit: Aderita Sena, Ministry of Health, Brazil.

Insert photo: Idrimi refugee camp in Chad: more frequent and intense drought can cause desertification, food shortages, and potentially population displacement and increasing tension between communities. Photo Credit: Olav. A. Saltbones/Norwegian Red Cross.

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Executive Summary

Our Planet, Our Health, Our Future

“Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature”

Health is our most basic human right and one of the most important indicators of sustainable development. We rely on healthy ecosystems to support healthy communities and societies. Well-functioning ecosystems provide goods and services essential for human health. These include nutrition and food security, clean air and fresh water, medicines, cultural and spiritual values, and contributions to local livelihoods and economic development. They can also help to limit disease and stabilize the climate. Health policies need to recognize these essential contributions. The three so-called Rio Conventions arising from the 1992 Earth Summit – the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification – together aim to maintain well-functioning ecosystems for the benefit of humanity.

There is growing evidence of the impacts of global environmental changes on ecosystems and people, and a renewed consciousness among peoples and nations of the need to act quickly to protect the planet's ecological and climatic systems. In the last two decades, the Rio Conventions have brought global attention to the impacts of anthropogenic change on the ecosystems of the planet. Increasingly unsustainable practices are placing pressure on natural resources to meet the demands of our economies and the needs of a rapidly growing global population, resulting in soil, water and air pollution, increased emissions of greenhouse gases, deforestation and land use change, expanded urban areas, introduction of non-native species, and inadequately planned development of water and land resources to meet food and energy needs. These changes are having both direct and indirect impacts on our climate, ecosystems and biological diversity. More than ever, the pursuit of public health, at all levels from local to global, now depends on careful attention to the processes of global environmental change.

Traditional knowledge and scientific evidence both point to the inexorable role of global environmental changes in terms of their impact on human health and well-being. In many countries, anthropogenic changes to agriculture-related ecosystems have resulted in great benefits for human health and well-being, in particular through increased global food production and improved food security. These positive impacts, however, have not benefited everyone, and unsustainable levels of use of ecosystems have resulted in irreparable loss and degradation, with negative consequences for health and well-being. These range from emerging infectious diseases to malnutrition, and contribute to the rapid rise in noncommunicable diseases. Large-scale human transformation of the environment has contributed to increased disease burdens associated with the expansion of ecological and climatic conditions favourable for disease vectors. For all humans, the provision of adequate nutrition, clean water, and long-term food security depend directly on functioning agro-ecosystems and indirectly on the regulating ecosystem services of the biosphere; these ecosystem services can be eroded if overexploited and poorly managed.

Biodiversity, climate change and desertification: three interlinked issues of relevance to health

“Biodiversity underpins the functioning of the ecosystems on which we depend for food and fresh water, health and recreation, and protection from natural disasters”

Biodiversity can be considered as a foundation for human health; its loss undermines this foundation. Biodiversity underpins the functioning of the ecosystems on which we depend for our food and fresh water; aids in regulating climate, floods and diseases; and provides recreational benefits and offers aesthetic and spiritual enrichment. Biodiversity contributes to local livelihoods, medicines (traditional and modern) and economic development. All human health ultimately depends on ecosystem services that are made possible by biodiversity and the products and services derived from them. The loss of biodiversity counteracts our efforts to improve human health. The interlinkages between biodiversity, ecosystem services and human health are complex and we do not generally have a clear understanding of all of the relevant causal relationships. However, the conservation and sustainable use of biodiversity offers significant opportunities to improve health outcomes such as through enhanced provision of diverse foods and medicines, while ecosystem-based approaches to land management and to climate change adaptation and mitigation can reduce the threats to health from climate change and desertification.

“We usually think of climate change as affecting the ecosystems of the earth, and not of the impact on our health”

Climate change threatens to erode the environmental determinants of health, destabilize health systems, and undermine international efforts towards sustainable development. Climate change is faster now than in any period in the last thousand years. Climate change is expected to be associated with large-scale changes in precipitation patterns, and the frequency and severity of extreme weather events. All of these changes will have important implications for human health. Climate change acts as a “force multiplier”, impeding progress on many of the essential indicators of development, including poverty and hunger eradication, maternal and child health, the spread of communicable disease and environmental sustainability. Climate change threatens to exacerbate inequities both between and within communities, with the severest impacts being felt by children, the poor and women. The health issues these groups are most affected by – poor sanitation, infectious vector-borne disease and undernutrition – are expected to intensify as a result of climate change. On the other hand, low-carbon policies that reduce greenhouse gas emissions can directly improve public health via improved local air quality and opportunities for physical fitness from “active” transport. Exercise and reduced air pollution lessen risk from heart disease, cancer, obesity, diabetes, osteoporosis, mental illness, lung disease and traffic-related deaths and injuries.

Climate change is associated with additional health risks. Temperature extremes seen in heat-waves and cold snaps can increase mortality rates, especially among the elderly and people with infirmities. Increases in temperature will alter exposure to air pollutants in many ways, including both the levels of pollutants that are formed and the ways these pollutants are dispersed. Rising ocean temperatures may also result in increased cholera outbreaks as a result of more intense algal blooms (providing nutrients for *Vibrio cholerae* in the natural environment).

“There’s far more to this than food. The things that live in and grow from this irreplaceable and finite resource also keep us clothed, the air and water clean, the land green and pleasant and the human soul refreshed” (Enhancing soils anywhere enhances life everywhere)

The degradation of terrestrial ecosystems and of their functions and services, where land productivity is limited by water availability, is a special case of land degradation called desertification. Desertification is defined as “land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities”. Persistent, substantial reductions in the provision of ecosystem services and biodiversity loss, associated with water scarcity, intensive use of ecosystem services at the expense of others, and climate change, are considered to be the main drivers of desertification. Drylands provide ecosystem services that include the provisioning of food, forage, fuel, building materials, medicines and water for humans and livestock, irrigation and sanitation. They also provide for climate regulation at local and global levels through carbon sequestration.

Impacts of biodiversity loss, climate change and desertification on various determinants of health

Biodiversity loss, climate change and desertification threaten water security. Shifting rainfall patterns, the melting of glaciers and increased evapotranspiration rates will compound existing challenges in the provision of clean water, destabilizing fragile environmental and social systems. Lack of access to safe water increases the risk of diarrhoeal disease and other diseases related to chemical and biological contaminants. Increased frequency and severity of drought and flooding is expected to further destabilize existing vulnerable populations. Rising sea levels could result in the salination of coastal freshwater aquifers and disrupt water treatment services, including stormwater drainage and sewage disposal. Repeat flooding or increased salination may force population displacement, heightening the vulnerability of populations. Forests, wetlands and other ecosystems play a major role in water regulation. Thus the quantity and quality of clean water is also affected by ecosystem loss and degradation. Water availability is the major limiting factor for sustainable development in drylands. Droughts exacerbate water scarcity and, coupled with food deprivation, can result in famines. Droughts may also lead people, mostly men, to migrate, redistributing endemic infectious diseases. Populations in drylands, most of which occur in developing countries, often lag far behind the rest of the world in human well-being and development indicators. Dryland areas, in particular, are most susceptible to drought, though this is a global phenomenon. Droughts in Africa have had particularly tragic consequences. The effects of droughts over large territorial extension of Africa and Asia are often felt globally, such as dust from wind erosion and altered rainfall patterns. Severe dust storms from Africa to the Caribbean and from Asia to North America, for example, may increase the levels of fine particles, pollution and potentially infectious agents in the air and may have serious health consequences for humans and animals.

Biodiversity loss, climate change and desertification threaten food security. Changing climate patterns, including extreme dry and cold periods and erratic rainfall, as well as other factors such as land degradation and biodiversity loss, can have a direct impact on food availability and nutrition in many parts of the world and lead to increased vulnerability to disease, population displacement and malnutrition. Combined with pre-existing issues associated with global food security, climate change threatens to significantly impede sustainable agricultural improvement

efforts, a necessary precondition for sustainable development. In some developing nations, the downstream health impacts of decreased agricultural productivity could be devastating. Biodiversity loss not only impacts current food security, nutrition and livelihoods, but the loss of genetic diversity also limits our future options for species to be used in food production, including for climate change adaptation and for improvements to yields and nutritional quality.

Traditional shifting cultivation has helped to increase the capacity of drylands to produce food and fibre, providing food security for local populations, as well as improved nutrition and overall well-being. Despite this, increasing population pressure in many parts of the world has led to unsustainable agricultural practices that have irreversibly transformed vegetation cover, causing a number of consequences for health.

Global change, including biodiversity loss and climate change, is associated with increased risk to humans from infectious diseases. Agricultural expansion into formerly natural areas increases contact among humans, domestic animals and wildlife, resulting in the greater likelihood of pathogen transfer, as well as changes to the distribution of disease vectors and to the ecology of existing diseases, and the spread of invasive species. The disturbance of forest systems through deforestation and subsequent land use change has resulted in the loss of many functions provided by forests, including disease regulation. While forest cover produces a diversity of pathogens, it also serves to maintain the ecology of such diseases through a greater diversity of hosts, reservoirs, vectors, predators and competitors, which can dilute the effect of any one pathway transmitting the disease. Climate change brings additional risks – it may affect vector-borne diseases such as malaria, dengue fever and Lyme disease, creating conditions favourable to vector breeding sites, impacting reproduction, maturation, biting and survival rates, or influencing pathogens directly. Climate also has a very strong influence on waterborne diseases. Prolonged flooding or drought can often result in water contamination, leading to epidemics from cholera and other forms of diarrhoeal disease.

The loss of traditional knowledge through the displacement of indigenous cultures, and the loss of species through land use change and overharvesting, continue to pose a significant threat to people's health and well-being. The loss of intellectual property rights remains problematic for many indigenous cultures and arises not only through the transfer of traditional knowledge, innovation and practices to the public domain but also through unauthorized access to and appropriation of such knowledge.

Marginalized populations are more likely to face elevated health risks from environmental change. These include lower-income communities and indigenous communities that are coping with environmental changes driven largely by economic processes in other parts of the world. They are often especially vulnerable to disease risk as a result of multiple stresses, have few resources for combating global environmental change, and have little voice in the decision-making processes of local, regional, national or global policy institutions. Because health is a central element in sustainable development, poor communities face a double challenge: their greater risk to environmental health impacts worsens the development challenges they face, which in turn further weakens their ability to respond to health risks.

Opportunities for the future of sustainable development

“Today our planet and our world are experiencing the best of times, and the worst of times. The world is experiencing unprecedented prosperity, while the planet is under unprecedented stress”

The growing confluence of health and global environmental change highlights the need to redouble efforts to improve the lives of the poorest and most vulnerable populations and to protect the planet's ecosystems. Global inequalities are increasing. While all nations face future health risks from global environmental change, such risks are already being felt first and foremost by poorest populations, and by particular individuals within them. Existing health disparities are being exacerbated by the loss of ecosystem services required to support and maintain health and well-being for many people already struggling with poverty, malnutrition and the effects of natural and human-induced disasters. These disparities point to the immediate need to invest not only in more thorough efforts to reduce global environmental change but also in more significant health programmes to assist developing countries reduce their vulnerability to global environmental changes that are already occurring and likely to intensify in the short to medium term.

The Millennium Development Goals (MDGs) represent human needs and basic rights that every individual around the world should be able to enjoy. These include freedom from extreme poverty and hunger; quality education, productive and decent employment; good health and shelter; the right of women to control their fertility and give birth safely; and a world where environmental sustainability is a priority, and women and men live in equality. The Conventions have relevance for and a contribution to make to all of the MDGs. Through stresses on ecosystems and challenges posed to water security, food security and energy security, it is expected that climate change, desertification and biodiversity loss will further intensify the burden on poor people in rural areas, on vulnerable or sick people, and particularly on families, women and children, thereby undermining efforts to accelerate and sustain progress towards all the MDGs. An ecosystem approach towards achieving the MDGs should be taken, including through addressing the social determinants of health. To achieve the MDGs, it should be recognized that the upstream, ecosystem determinants are causally connected, and the conditions that produce the lack of education, vulnerability and poverty, and iniquitous global markets, need to be considered. The Rio Conventions are in a unique position to point out where potential conflicts and opportunities exist in making progress in different dimensions of sustainable development; they also assist in identifying where efforts are required to ensure that achieving one target does not come at the expense of another.

The United Nations Conference on Sustainable Development (Rio+20), Rio de Janeiro, Brazil, June 2012, provides the opportunity for a new emphasis on the human health dimensions of global environmental change, as a strong motivation for concerted global action in support of the Rio Conventions. The opportunity for improving human health outcomes gives an imperative for the Rio Conventions and related multilateral environmental agreements to unite around this theme. Human health is a major component of environmental concern in many countries, and a greater awareness of the linkages between health and environment may help buttress public support for progress towards new, more ambitious global environmental policies. There is also now a more complete understanding of how environmental factors interact with the social determinants of health, in that access to preventive and curative health services defines both the persistent burden of diseases of poverty and the emerging challenge of noncommunicable diseases.

Health is an important outcome in decisions about how to manage natural resources and the environment, but is often left out of environmental assessment and policy processes. Similarly, health actors often neglect the potential to improve health through protection and enhancement of ecosystem services and reduction of environmental risk factors. While the public health community will always face the necessity of responding to the acute health needs of populations, an improved understanding of environment–health linkages has the potential to significantly strengthen capacity to identify and analyse long-term health risks, to encourage participation in policy decisions that have significant health implications and to develop appropriate strategies for disease prevention.

A new partnership among the Rio Conventions and the public health community would provide an impetus to strengthen capacity for research, knowledge management and response to a wide range of health risks. The Rio Conventions are already working together to enhance synergies in the areas of information collection, analysis and exchange. Concerted efforts to strengthen collaborative, cross-sectoral research will facilitate the development of this emerging field, and support the integration of new findings into policy and practice. New health risks from global environmental change highlight the need for a strong infrastructure for public health at both local and global levels. Building the capacity to recognize and respond effectively to environmental threats to human health will have important spillover effects for public health more generally. This seems especially likely in areas such as infectious diseases and disaster preparedness, where awareness of ecosystem services and functions has already demonstrated important insights that can significantly inform disease prevention policies and develop capacity.

Sustainable development goals and indicators must reflect the impacts of biodiversity loss, climate change and desertification on health, in the context of their social, economic and environmental dimensions. The experience of the MDGs, among other goals, has demonstrated the importance of defining standards and tracking progress in achieving a truly integrated vision of sustainable development. A wide range of organizations track a number of indicators that measure environmental conditions, population vulnerabilities and health status. However, there is a need for a coherent suite of indicators that will provide a comprehensive assessment of sustainable development, including indicators related to the various dimensions of health and their social, economic and environmental determinants. There are also opportunities for improved design, selection and standardization of individual indicators, and linkages between monitoring programmes in related domains. These should also be linked to monitoring of the ecosystem services that underpin human health, including biologically diverse and productive ecosystems, and a stable climate. Only then will it be possible to truly measure progress towards “a healthy and productive life in harmony with nature”.

1. Introduction: healthy planet, healthy people

“Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature”

(Principle 1 of the Rio Declaration on Environment and Development, Rio de Janeiro, 1992)

1.1 Background to human health and the environment

Health is our most basic human right and one of the most important indicators of sustainable development. We rely on healthy ecosystems as they support healthy communities and societies. It is therefore critical to understand how biodiversity and ecosystem functioning provides goods and services essential for human health. These include nutrition and food security, clean air and fresh water, medicines, climate stabilization, cultural and spiritual values, as well as contributions to local livelihoods and economic development. There is growing evidence of the impacts of global environmental changes on ecosystems and people, and a renewed consciousness among the world's peoples and nations of the need to act quickly to protect the planet's ecological and climatic systems. During the 21st century, global public health will depend more than ever before on how we manage and respond to global environmental change. In the last two decades, the Rio Conventions on Biological Diversity, Climate Change, and Desertification (Box 1.1) and their protocols have brought to global attention the impacts of anthropogenic change on the ecosystems of the planet. Unprecedented pressure is being placed on natural resources to meet the demands of our economies and the needs of a rapidly growing global population, resulting in soil, water and air pollution, increased emissions of greenhouse gases, deforestation and land use change, expanded urban areas, introduction of non-native species, inadequately planned development of water and land resources to meet food and energy needs, and other unsustainable practices. These changes are having both direct and indirect impacts on our climate, ecosystems and biological diversity (biodiversity).

Box 1.1 Agenda 21 and the Rio Conventions

Agenda 21 is the globally agreed and comprehensive plan of action for sustainable development. Together with the Rio Declaration on Environment and Development, it was adopted by governments at the United Nations Conference on Environment and Development (the Earth Summit), held in Rio de Janeiro in 1992. The so-called “Rio Conventions” – the Convention on Biological Diversity (CBD), the United

Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD) – all derive directly from the 1992 Earth Summit. They contribute to the sustainable development goals of Agenda 21, addressing different but interdependent issues.



Young Salasaca Indians in Ambato, south of Quito, Ecuador – today's children have the most to lose and the most to gain.

Traditional knowledge and scientific evidence also point to the inexorable role of these forces in terms of their impact on human well-being. In many countries, anthropogenic changes to ecosystems have resulted in great benefits for human well-being and health, in particular through improved food security. These positive impacts, however, have not benefited everyone, and the unsustainable use of ecosystems has resulted in irreparable loss and degradation, which in turn results in negative impacts on health and well-being (1). Global environmental changes (including climate change, changing land use and hydrology, ozone depletion, biodiversity and species loss, and transboundary flows of persistent pollutants) pose a wide range of health risks, ranging from emerging infectious diseases to malnutrition, and contribute to the rapid rise in noncommunicable diseases. Outbreaks of infectious diseases such as cholera, malaria and influ-

enza are tightly intertwined with ecological processes. Indeed, most infectious diseases are highly contingent on ecological processes that affect one or more elements of their host–vector relationships. Large-scale human transformation of the environment has contributed to increased disease burdens associated with the expansion of favourable ecological and climatic conditions for disease vectors. Transformations of the environment continue to occur in association with processes as diverse as dam building, forest clearance, irrigation, bushmeat harvesting and urbanization. For all humans, the provision of adequate nutrition, clean water and long-term food security depends directly on functioning agro-ecosystems and indirectly on the regulating ecosystem services of the biosphere; these ecosystem services can be eroded if provisioning services are extracted unsustainably.

There is increasing evidence to show that the connection between health and environmental change is no longer just of future concern. International scientific advisory groups such as the Intergovernmental Panel on Climate Change and the Millennium Ecosystem Assessment (including its biodiversity and desertification synthesis reports) warn that morbidity and mortality from environmental threats are already visible in many parts of the world and will continue to grow rapidly unless major efforts are made to redress the human causes of ecological transformation now under way. Conservative estimates by the World Health Organization (WHO) show that climate change alone is responsible for over 140 000 deaths per year (estimates based on data for 2004), mainly of children in the poorest regions of the world (2, 3). Several million individuals around the globe are at risk from changes in the earth's ecological and biogeophysical processes, including climate change, ozone depletion, biodiversity loss, land use change and ecological degradation (1).

Many of the elevated health risks from environmental change are faced by the most marginalized populations – poor communities and indigenous communities who are facing environmental changes driven by economic processes in other parts of the world, who are often especially vulnerable to disease risk as a result of multiple stresses, who have few resources for combating global environmental change, and who have little voice in the decision-making of local, regional, national or global policy institutions. Because health is a central element in sustainable development, poor communities face a doubly difficult challenge. Their greater vulnerability to environmental health impacts exacerbates the development challenges they face, which in turn further weakens their ability to respond to health risks.

Events such as Hurricane Katrina, the 2009 earthquake in Haiti and subsequent cholera outbreak, and the 2010 Pakistan floods, clearly demonstrate the potentially devastating impacts resulting from natural disasters, most notably when these fall on poor communities.

Human health risks from global environmental change demand a concerted effort among the nations of the world to redress the causes of climate change, land use change and biodiversity loss. Considerable legislation already exists to protect health from environmental risks, particularly in the form of national pollution prevention laws. At the same time, a developing trend has been to broadly focus on livelihoods, poverty alleviation and human well-being in multilateral environmental agreements. To date, however, human health concerns have been largely peripheral to global environmental negotiations, which have focused more on concerns about nature conservation and the impacts of environmental change on economic growth and development. The secondary impacts of environmental changes have received minimal attention at best. Yet this lack of attention is not only unjustified based on the increasing scientific understanding of human health risks and global environmental change, it also misses an important opportunity to strengthen multilateral environmental agreements.



Anamã, a town 160 Kms from Manaus (Amazonas State, Brazil) lays completely flooded by the Solimões (Amazon) river.

Towards the goal of promoting the consideration of the human health dimensions of global environmental change within the Rio Conventions, therefore, this report reviews and synthesizes the growing literature that demonstrates the links between climate change, biological diversity, desertification, and the social and environmental determinants of human health. Drawing on this analysis, the report concludes with a series of recommendations, for the Conventions and to the health sector, to enhance recognition of the relationships between human health and environmental change.

1.2 Determinants of health in the context of the Rio Conventions

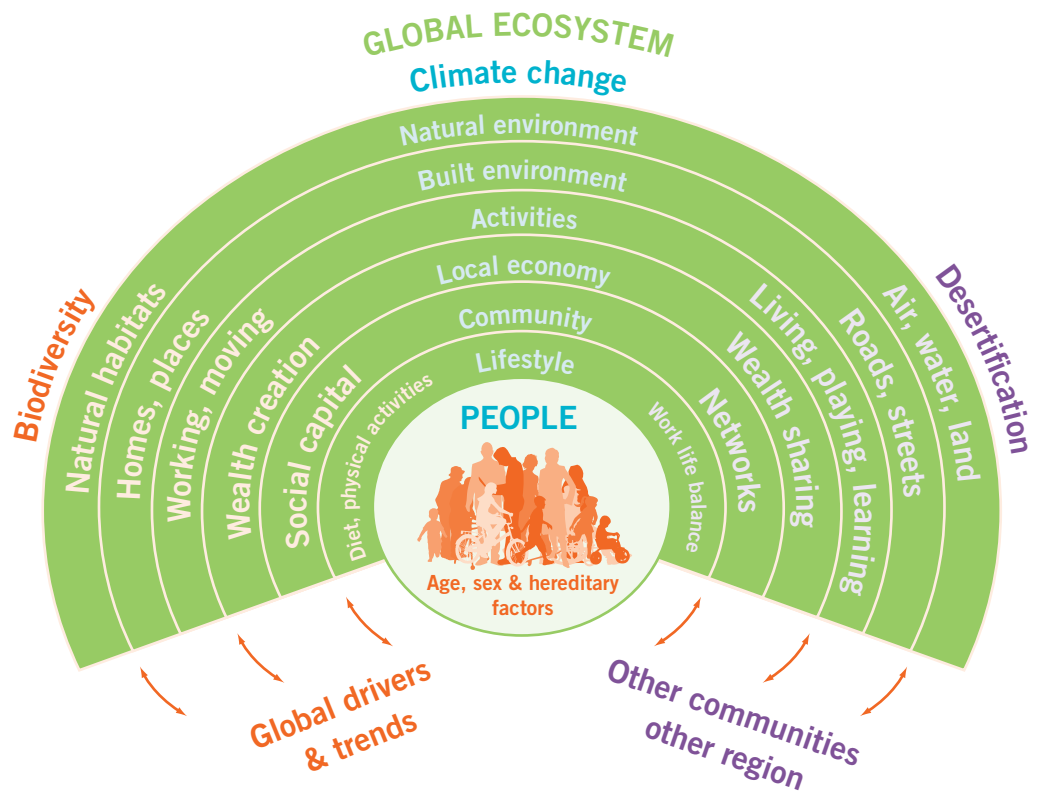
Health determinants are factors that influence our state of health (see Box 1.2 for a definition of health). They can be arranged hierarchically, as demonstrated in Figure 1.1, as concentric spheres that move outwards progressively from the individual. These categories and subcategories of health determinants can be used as a framework to structure the analysis of the association between particular ecosystems and health in specific settings.

Box 1.2 Definition of health

The preamble to the WHO Constitution defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (4). Many indigenous cultures incorporate a broader definition of health to include heritage and association with nature. The United Nations Permanent Forum on Indigenous Issues has emphasized the need to approach health issues “from

a holistic perspective, taking into account [people’s] emotional, physical and social well-being, and to recognize the connections which exist between health and other priorities of human development, such as education, demographic balance, human rights and economic productivity” (5).

Figure 1.1 Determinants of health and well-being



Source: Modified from Barton and Grant (6).

Figure 1.1 examines health determinants as proximal (immediate or direct) or distal (more indirect) influences on an individual's health. While an overall perspective such as this does not seek to prioritize determinants, human health services tend to be focused on more proximal influences, even though everything depends, ultimately, on global ecosystems. The Millennium Ecosystem Assessment (2005) sought to redress this emphasis, highlighting ecosystem services as "the benefits that people receive from ecosystems", and broadly categorizing them as provisioning, regulating, cultural and supporting services (7). Disruption of these ecosystem services has both direct and indirect implications for health that tend to exacerbate existing health inequities, whether through exposure to physical hazards or loss of livelihoods. These inequities characterize the social determinants of health (Box 1.3). Indeed, some of the drivers of ecosystem change (with its adverse health effects) are the same as the drivers of unequal distribution of health-damaging experiences (8). A preventive approach to human health is one that takes an ecosystem approach and that also seeks to address the social determinants of health and inequality.

Box 1.3 Social determinants of health

The inequities of how society is organized mean that the freedom to lead a flourishing life and to enjoy good health is unequally distributed between and within societies. This inequity is seen in the conditions of early childhood and schooling, the nature of employment and working conditions, the physical form of the built environment and the quality of the natural environment in which people reside. Depending on the nature of these environments, different groups will have different experiences of material conditions, psychosocial support and behavioural options, which make them more or less vulnerable to poor health. Social stratification likewise determines differential access

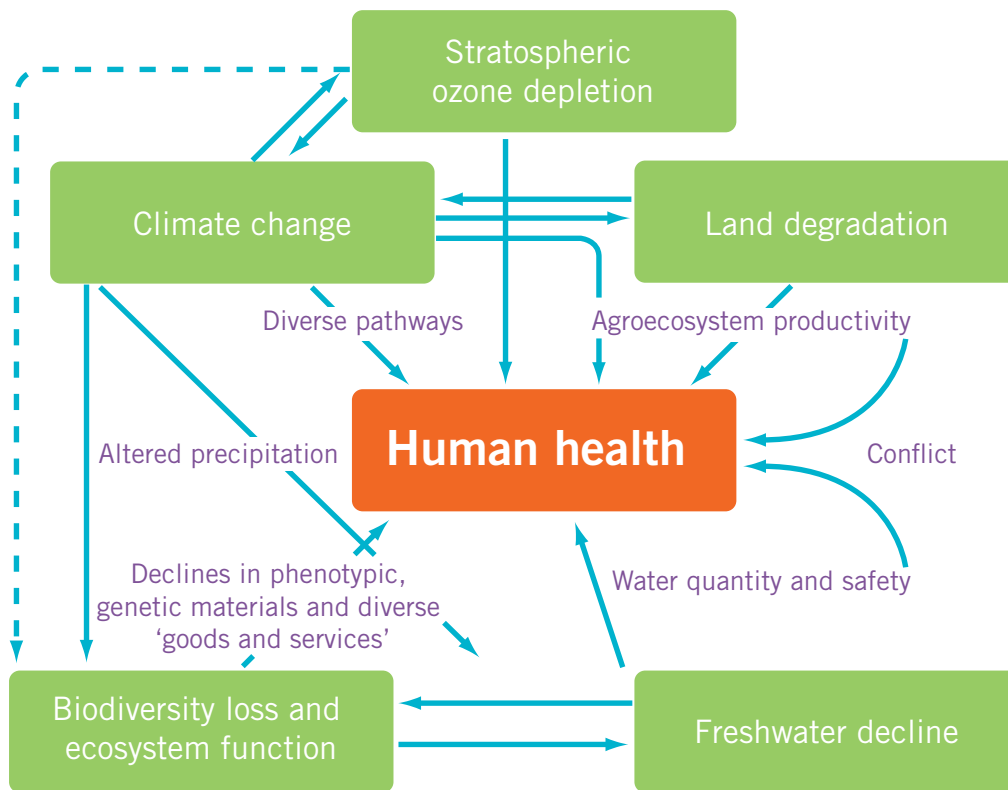
to and utilization of health care, with consequences for the inequitable promotion of health and well-being, disease prevention, and illness recovery and survival.

This unequal distribution of health-damaging experiences is not in any sense a “natural” phenomenon but is the result of a toxic combination of poor social policies and programmes, unfair economic arrangements and bad politics. Together, the structural determinants and conditions of daily life constitute the social determinants of health.

Source: Commission on Social Determinants of Health (9).

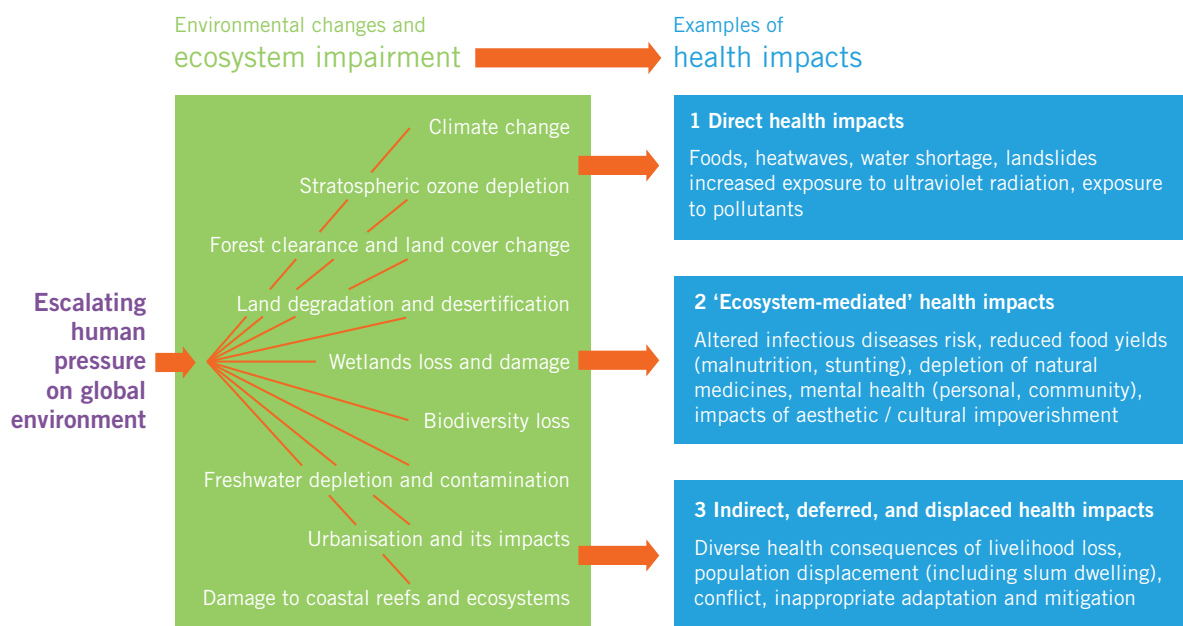
There are complex interactions between global environmental changes and their impacts on health and well-being. Figure 1.2 presents a simplified view of these. Figure 1.3 focuses on the different health impacts, whether direct, mediated by ecosystems, or indirect, including impacts that get displaced in space (impacting on geographically distant populations) or in time (impacting on other populations in the future).

Figure 1.2 Interlinkages between major types of global environmental change



Source: McMichael et al. (10).

Figure 1.3 Examples of health impacts from environmental changes



Source: Corvalan et al. (1).

2. Convention on Biological Diversity (CBD)

“Biodiversity underpins the functioning of the ecosystems on which we depend for food and fresh water, health and recreation, and protection from natural disasters”

Ban Ki-moon, UN Secretary-General, Global Biodiversity Outlook 3

2.1 Introduction

Biodiversity can be considered as the foundation for human health. Biodiversity underpins the functioning of the ecosystems on which we depend for our food and fresh water; aids in regulating climate, floods and diseases; provides recreational benefits; and offers aesthetic and spiritual enrichment. Biodiversity also contributes to local livelihoods, medicines (traditional and modern) and economic development. All human health ultimately depends on ecosystem services that are made possible by biodiversity and the products and services derived from them.

The interlinkages between biodiversity, ecosystem services and human health are complex and we do not generally have a clear understanding of the cause-and-effect relationships. However, our fundamental reliance on biodiversity and ecosystem services offers significant opportunities to more consistently recognize and manage biodiversity services for human health and to contribute to biodiversity conservation and sustainable use at various scales.

Human health and biodiversity interlinkages and potential co-benefits can be considered in a variety of contexts, for example:

- ecosystem integrity, changes to biodiversity and vector-borne diseases;
- climate change, ecosystem change, and a variety of adverse human health impacts;
- drinking water, ecosystem change and restoration, and water-related diseases;
- biodiversity conservation, traditional food practices, and food security and nutrition;
- biodiversity, lifestyle and diet changes, and noncommunicable diseases;
- biodiversity conservation, traditional knowledge, poverty reduction and a variety of health-enhancing impacts.

This chapter underlines some of the significant interlinkages between biodiversity and human health, and discusses important common themes, challenges and opportunities for international collaboration, in the context of the United Nations Convention on Biological Diversity (CBD).

2.2 Interlinkages between biodiversity and health

2.2.1 Background to interlinkages

The reports of the Millennium Ecosystem Assessment (2005) and the Intergovernmental Panel on Climate Change (2007) highlighted that

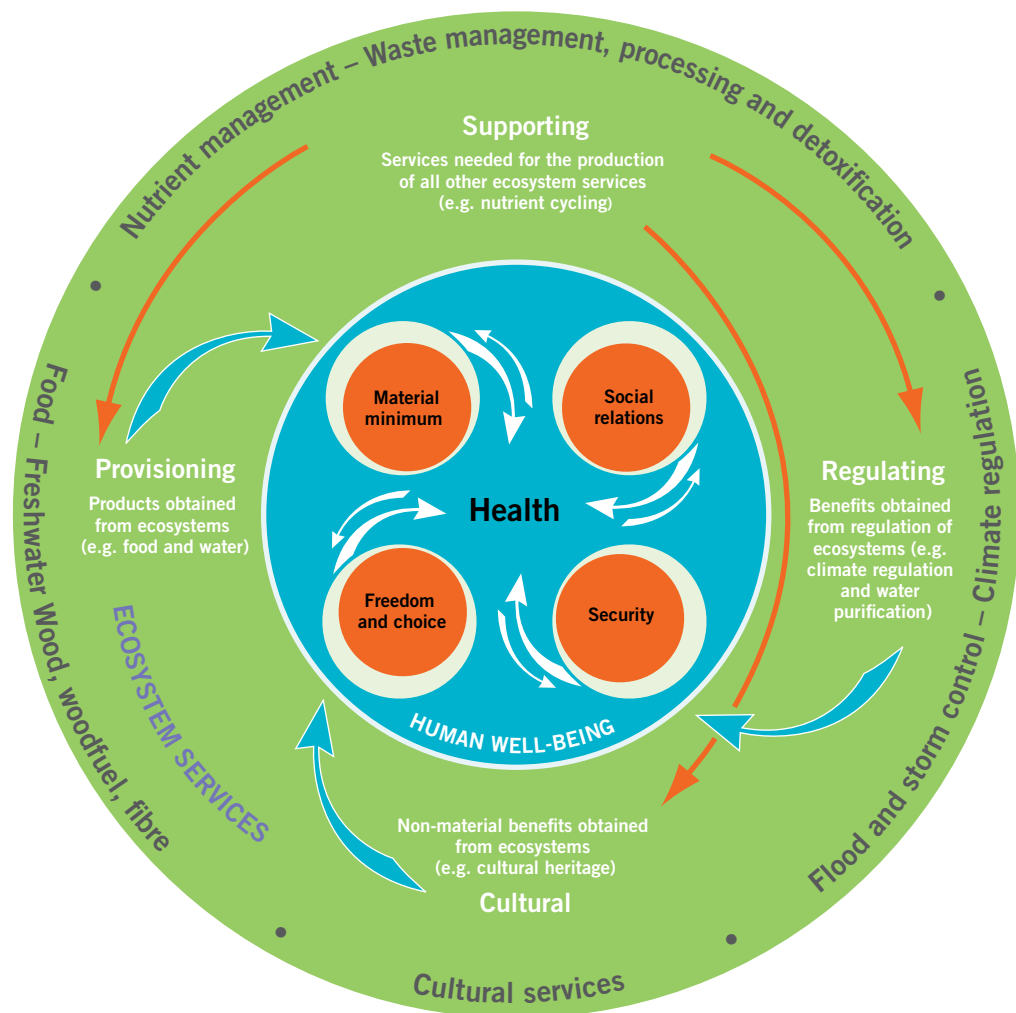


Ugandan journalist interviews local children - strong collaboration with all stakeholders is an important first step towards sustainable development.

human health is affected by the state of the global environment and the health of ecosystems (7, 11, 12). Additionally, the third edition of the Global Biodiversity Outlook (13) concluded that current trends are bringing us closer to a number of potential tipping points that would catastrophically reduce the capacity of ecosystems to provide the essential services upon which we all depend.

The Millennium Ecosystem Assessment (2005) defined ecosystem services as “the benefits that people receive from ecosystems”, and broadly categorized them as provisioning, regulating, cultural and supporting services. These services are themselves underpinned by ecosystem components, functions and processes; biodiversity plays the foundational role in underpinning the services. Human well-being is therefore inextricably associated with the character of ecosystems through the services they provide: in short, ecosystem services are tangible determinants of human health (Figure 2.1).

Figure 2.1 Associations between health, human well-being and ecosystem services



Source: Corvalan et al. (14).

The existing published literature includes a number of proposed mechanisms and evidence-based case studies. Interdisciplinary research is aiming to develop a more thorough understanding of the fundamental interlinkages between ecosystem services and the conditions under which health and environment co-benefits can be achieved, as well as the development of robust predictions of the health impacts of different approaches to ecosystem management.

The linkages between ecosystem services and human health are well articulated in the Ottawa Charter for Health Promotion (1986), which recognized the following prerequisites for health: peace, shelter, education, food, income, a stable ecosystem, sustainable resources, social justice and equity. The Ottawa Charter, and more recently the Bangkok Charter for Health Promotion in a Globalized World (2005) (15), identified five major strategies for promoting health: building healthy public policy; creating supportive environments; strengthening community action; developing personal skills; and reorienting health services.

The linkage between ecosystem services and human health is most clearly expressed in the text for the second major strategy, “creating supportive environments” (16):

Our societies are complex and interrelated. Health cannot be separated from other goals. The inextricable links between people and their environment constitutes the basis for a socio-ecological approach to health. The overall guiding principle for the world, nations, regions and communities alike, is the need to encourage reciprocal maintenance – to take care of each other, our communities and our natural environment. The conservation of natural resources throughout the world should be emphasized as a global responsibility.

The central tenet of the Ottawa Charter is that “health is created and lived by people within the settings of their everyday life: where they learn, work, play and love”. This established the healthy settings approach to health promotion, defined by the World Health Organization as “where people actively use and shape the environment and thus create or solve problems relating to health. Settings can normally be identified as having physical boundaries, a range of people with defined roles, and an organizational structure.”

Accordingly, ecosystems are at the foreground of preventive approaches to human health. From this perspective, a preventive approach to human health is one that takes an ecosystem approach and that also seeks to address the social determinants of health and inequality.

2.2.2 Conservation and use of biodiversity and interlinkages with health

Agriculture

Agriculture today is facing unprecedented challenges and requires innovative, integrated solutions and approaches to ensure food security and meet sustainability needs (17). While food security is fundamental for human survival, unsustainable fishing and agricultural practices have resulted in negative environmental and health impacts. Agricultural expansion into formerly natural areas increases contact among humans, domestic animals and wildlife, resulting in greater likelihood of pathogen transfer, as well as the emergence of new disease vectors or changes to the ecology of existing diseases, and the spread of invasive alien species. Some of the most pervasive human diseases were originally introduced through the domestication of livestock, including tuberculosis, measles and smallpox. The butchering or consumption of bushmeat, which is facilitated by such practices as deforestation and road building into forest wilderness areas, has been implicated in the emergence of HIV/AIDS, Ebola virus, plague and anthrax (18). Outbreaks of bacterial and viral pathogens have resulted from intensive shellfish farming in several countries, including China (Province of Taiwan), India, Indonesia, the Philippines and Sri Lanka (19, 20), effectively closing these trades. Globally, 60% of emerging infectious disease events are diseases transmitted by animals, and 72% of these are attributed to wildlife (21, 22).

Wetlands

Wetland ecosystems contribute to human health and well-being in a number of ways, including by the provision of hydration and safe water, nutrition, and medical products. Dams and irrigation systems have been constructed throughout the world and provide a number of societal benefits, including increased agricultural production, electricity generation for domestic and industrial purposes, flood protection, tourism, fisheries, local employment and water supply. However, these benefits have had unintended costs. Such systems have often contributed to a significant loss of forest and its biota, a reduction in freshwater biodiversity downstream, a loss of downstream fisheries and human resettlement. They may also have negative impacts on human health from diarrhoeal and intestinal diseases caused by microbial agents and helminths, and water-related vector-borne diseases such as malaria, schistosomiasis, onchocerciasis, lymphatic filariasis and Japanese encephalitis (23). There is increasing recognition of the interlinkages between managing wetlands and fostering human health, with the recent release of guidance for practitioners by the Secretariat of the Convention on Wetlands of International Importance (Ramsar Convention) and WHO (24).

Forests

Global forest cover continues to decline around the world, primarily from agricultural expansion into tropical forests. Deforestation has amounted to 130 million hectares over the past decade, an area equivalent to the combined area of France, Spain and Italy. While deforestation trends continue in Africa and South America, the most recent reports suggest that global deforestation rates have declined by nearly 20% since the 1990s, in part due to afforestation efforts reported by China and Europe. The disturbance of forest systems through deforestation and subsequent land use change has resulted in the loss of potential pharmaceutical species. It is estimated that at the current rates of deforestation in the tropics, in the next 30 years at least 20% of species, including about 600 potential drugs, will be lost (25). In addition, the livelihoods and mental health of indigenous forest dwellers is directly impacted by deforestation that displaces settlements

and alters traditional ways of life (26). And while forest cover produces a diversity of pathogens, it also serves to maintain the ecology of such diseases through a greater diversity of hosts, reservoirs, vectors, predators and competitors, which may dilute the effect of any one pathway transmitting the disease. Human disease emergence can occur simply from the forested/deforested interface. For instance, deforestation, along with associated land use changes and human resettlement, has contributed to changes in malaria and its vectors throughout the tropics. The expansion of malaria is also occurring in Amazonia, where deforestation has been shown to provide suitable breeding sites for *Anopheles darlingi*, with deforested breeding sites yielding over a hundredfold increase in biting rates, even after controlling for human population density (27).



The health benefits of the human synergy with the environment are great and varied.

2.3 Value of ecosystems for health

2.3.1 Economic costs of ecosystem change

Ecosystem change and environmental degradation can have considerable environmental, social and financial costs (28). For example, malaria has broad economic and social costs that are

reflected in its close correlation with poverty. Between 1965 and 1990 the per capita annual gross domestic product (GDP) growth in countries with falciparum malaria was 0.4% compared to 2.5% in those without. In countries that have successfully eradicated malaria, economic growth has accelerated (29). If malaria had been eliminated in Africa over 35 years ago, the continent's GDP could be \$100 billion larger today (30). Although the relationship between malaria distribution and intensity is primarily driven by climate and ecology, the disease is both influenced by, and constitutes a major threat to, economic and social dimensions of development.

In addition to the economic losses resulting from disease epidemics, efforts to control human and livestock diseases have also had negative economic and conservation consequences. In Zimbabwe, for example, areas cleared of tsetse fly were opened to subsistence farmers that displaced the local wildlife and developed an area that now depends on food aid in most years. Farmed Atlantic salmon grown in net cages transmit diseases to wild salmon, and treatment of the farmed salmon with antibiotics and pesticides causes environmental pollution. Ideally, integrated efforts that consider conservation and social and economic impacts may offer the best long-term solutions to mitigate potential threats (21).

2.3.2 Economic gains from biodiversity and health co-benefits

With the discovery of many important drugs from natural products, pharmaceutical bioprospecting has increased in high-biodiversity areas such as tropical rainforests and coral reefs. The recent advances in biotechnology, such as the ability to sequence and clone genes, were developed from natural resources (31). With the emergence and re-emergence of diseases, and the growing antibiotic resistance of many current pathogens, maintaining genetic diversity will be increasingly important for pharmaceutical bioprospecting, among others.

Many animal species, mammals in particular, are also highly relevant models in biomedical research for physiological processes such as coping with adverse and extreme conditions, which may have human health applications. For example, hibernating bears can recycle urea and also preserve bone density; these physiological processes could have direct application to patients on kidney dialysis or to the prevention of osteoporosis. Biocontrol, which uses biological alternatives to chemical pesticides, such as viruses, bacteria, fungi and insects, is another growing area potentially beneficial to human health. However, these activities also come with potential risks for both the environment and humans.



A farmer maintains his field of sea-buckthorns in the Altai-Sayan Eco-Region of Uvs Province, Mongolia. Sea-buckthorn is used to prevent soil erosion, for food production and as medicine.

2.4 Status of health in the CBD, and its operational mechanisms

2.4.1 Health within the CBD's legal framework

The CBD has three objectives: (a) the conservation of biological diversity; (b) the sustainable use of its components; and (c) the fair and equitable sharing of benefits arising out of the utilization of genetic resources. The CBD preamble notes that “conservation and sustainable use of biological diversity is of critical importance for meeting the food, health and other needs of the growing world population”. A further reference to health in the preamble concerns risks to human health related to living modified organisms resulting from biotechnology (32).

The governing body of the CBD, the Conference of the Parties, has established seven thematic programmes of work and a number of cross-cutting issues that provide links between the programmes of work. It could be argued that human health is a cross-cutting matter, as it can be applied to each of the programme areas and to each of the global regions. Indeed, the CBD is promoting the interlinkages between human health and biodiversity and the consideration of biodiversity in health strategies and programmes, as well as collaborating to consider how efforts to address implementation of the CBD can best support efforts to address global health issues.

At the tenth meeting of the Conference of the Parties to the Convention, held in October 2010 in Nagoya, Aichi Prefecture, Japan, Parties adopted a revised and updated Strategic Plan for Biodiversity 2011–2020 and 20 Aichi Biodiversity Targets. The purpose of the Strategic Plan is to inspire broad-based action in support of biodiversity over the next decade by all countries and stakeholders. In recognition of the urgent need for action, the United Nations General Assembly has also declared 2011–2020 as the United Nations Decade for Biodiversity.

Another area of activity within the CBD related to human health is the utilization of genetic and biotechnology resources. The Cartagena Protocol on Biosafety “provides an international regulatory framework to reconcile the respective needs of trade and environmental protection with respect to a rapidly growing global industry, the biotechnology industry. The Protocol thus creates an enabling environment for the environmentally sound application of biotechnology, making it possible to derive maximum benefit from the potential that biotechnology has to offer, while minimizing the possible risks to the environment and to human health” (33).

Genetic resources, traditional knowledge and biotechnology

The CBD devotes significant attention to genetic resources and biotechnology, as outlined in articles 15 (Access to Genetic Resources), 16 (Access to and Transfer of Technology) and 19 (Handling of Biotechnology and Distribution of Its Benefits). From agricultural products to medicines, humanity is dependent on the diversity of thousands of species of plants and animals. However, as landscape change and overharvesting threaten wild species and traditional crops become supplanted by hybrid monocultures, genetic diversity and ecosystem resilience to disease is reduced. Notably, food production has lagged behind population growth in many countries. It is estimated that the current trend in population growth and increased consumption will require an approximate doubling of food supplies in the decades to come (17, 34, 35).

In the preamble to the text of the CBD, the Convention recognizes “the close and traditional dependence of many indigenous and local communities embodying traditional lifestyles on biological resources” (32). A large number of compounds found in plant species, used globally as drugs in Western medicine, were originally discovered through traditional knowledge (36, 37). The loss of traditional knowledge through the displacement of indigenous cultures, as well as the loss of species through land use change and overharvesting, continues to pose a significant threat to humanity, as well as to potential drug discoveries. And the loss of intellectual property rights remains problematic for many indigenous cultures and arises not only through the transfer of traditional knowledge, innovation and practices to the public domain but also through unauthorized access to and appropriation of such knowledge (“biopiracy”). The CBD provides some guidance on the value and equitable sharing of traditional knowledge in articles 8, 10, 17 and 18. However, major improvements are necessary to achieve fair and appropriate reimbursements to indigenous groups (38).

While the importance of new medicines and products from biological resources and technologies is one of the leading arguments for the conservation of biodiversity, our knowledge about these resources is still in its infancy. It is estimated that less than half of higher plant species have been screened for pharmaceutical products (39, 40).

An important addition to the CBD has been the adoption of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization at the tenth meeting of the Conference of Parties in Nagoya, 2010. This Protocol recognizes, among other things:

- the importance of genetic resources to food security, public health, biodiversity conservation, and the mitigation of and adaptation to climate change;
- the interdependence of all countries with regard to genetic resources for food and agriculture as well as their special nature and importance for achieving food security worldwide and for sustainable development of agriculture in the context of poverty alleviation and climate change;
- the importance of ensuring access to human pathogens for public health preparedness and response purposes;
- the interrelationship between genetic resources and traditional knowledge, and their inseparable nature for indigenous and local communities.

The Nagoya Protocol requests that Parties pay due regard to cases of present or imminent emergencies that threaten or damage human, animal or plant health.

2.4.2 Health within the Strategic Plan for Biodiversity and the Aichi Biodiversity Targets

The Strategic Plan for Biodiversity 2011–2020 includes 20 biodiversity targets, organized under five strategic goals. Human health is most strongly expressed under strategic goal D: “Enhance the benefits to all from biodiversity and ecosystem services”, and target 14: “By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.”

Seventeen decisions were adopted at the tenth meeting of the Conference of the Parties to the CBD that made reference to human health and well-being. In addition, the Strategic Plan for Biodiversity noted that a healthy planet was vital for “delivering benefits essential for all people”.

Actions that support implementation of the Aichi Biodiversity Targets provide opportunities to improve global human health and ecosystem health. By mainstreaming biodiversity in close collaboration with the health sector, we will better understand these complex linkages, promote co-benefits through jointly developed policies and delivered activities, and improve future activities through collaborative monitoring. Table 2.1 provides a simple summary of the complex interlinkages between health and biodiversity as a means to support communication and as an entry point for cross-sectoral collaboration.



The Convention on Biological Diversity's COP 10, held in Nagoya, Japan (2010) – a landmark conference which helped to tackle the mass extinction of species and loss of habitats around the world.

Table 2.1 Health and biodiversity interlinkages in support of Aichi Biodiversity Targets

Health topic	Health sector opportunity	Benefits to biodiversity (Aichi Targets)
Food <ul style="list-style-type: none"> Species, varieties and breeds incl. domesticated and wild components Diversity of diet Ecology of production systems Total demand on resources 	Direct <ul style="list-style-type: none"> Recognize and promote dietary diversity, food cultures and their contribution to good nutrition Recognize synergies between human health and sustainable use of biodiversity (e.g. moderate consumption of meat) Indirect <ul style="list-style-type: none"> Promote sustainable production harvesting and conservation of agricultural biodiversity 	T1 (values of biodiversity) T4 (sustainable production and consumption) T5 (reduce habitat loss) T6 (sustainable harvesting) T7 (sustainable management) T13 (genetic diversity) T14 (ecosystem services)
Water <ul style="list-style-type: none"> Water quantity Water quality Water supply 	Direct <ul style="list-style-type: none"> Integrate ecosystem management considerations into health policy Indirect <ul style="list-style-type: none"> Promote protection of ecosystems that supply water and promote sustainable water use 	T1 (values of biodiversity) T5 (reduce habitat loss) T8 (reduce pollution) T9 (invasive alien species) T11 (protected areas) T14 (ecosystem services)
Diseases <ul style="list-style-type: none"> Disease source and regulation services Ecosystem integrity and diversity 	Direct <ul style="list-style-type: none"> Integrate ecosystem management considerations into health policy Indirect <ul style="list-style-type: none"> Promote ecosystem integrity 	T1 (values of biodiversity) T2 (poverty reduction strategies) T5 (reduce habitat loss) T8 (reduce pollution) T9 (invasive alien species) T14 (ecosystem services)
Traditional and modern medicine <ul style="list-style-type: none"> Traditional medicines Drug development (genetic resources and traditional knowledge) Chemical and pharmaceutical accumulation in ecosystems 	Direct <ul style="list-style-type: none"> Recognize contribution of genetic resources and traditional knowledge to medicine Recognize and monitor impacts of drug accumulation (human, veterinary and agricultural sources) on ecosystems Indirect <ul style="list-style-type: none"> Protect genetic resources and traditional knowledge and ensure benefit sharing 	T1 (values of biodiversity) T5 (reduce habitat loss) T13 (genetic diversity) T14 (ecosystem services) T16 (Nagoya Protocol) T18 (local/traditional knowledge)
Physical, mental and cultural well-being <ul style="list-style-type: none"> Physical and mental health Cultural and spiritual enrichment 	Direct <ul style="list-style-type: none"> Integrate “value of nature” into health policy, including mental health and noncommunicable diseases Indirect <ul style="list-style-type: none"> Promote protection of values, species and ecosystems 	T1 (values of biodiversity) T2 (poverty reduction strategies) T11 (protected areas) T12 (preventing extinctions) T13 (genetic diversity) T14 (ecosystem services) T18 (local/traditional knowledge)
Adaptation to climate change <ul style="list-style-type: none"> Ecosystem resilience Genetic resources (options for adaptation) 	Indirect <ul style="list-style-type: none"> Promote ecosystem resilience and conservation of genetic resources 	T1 (values of biodiversity) T3 (reduce negative subsidies) T5 (reduce habitat loss) T8 (reduce pollution) T10 (vulnerable ecosystems) T14 (ecosystem services) T15 (ecosystem resilience)

2.5 Opportunities for better linkage of biodiversity and health goals

The interlinkages between biodiversity and human health are becoming increasingly well understood and are generally more easily observed when ecosystem services are interrupted and altered by human activity. As this brief summary demonstrates, there are many opportunities for collaborative cross-sectoral actions that can be taken to achieve co-benefits. The CBD will play a key role in promoting and facilitating activities that support implementation of the Strategic Plan for Biodiversity 2011–2020.

In particular, the Conference of the Parties to the CBD, by paragraph 17 of decision X/20, requested the Executive Secretary to further strengthen collaboration with the World Health Organization, as well as other relevant organizations and initiatives, with a view to promoting the consideration of biodiversity issues in health programmes and plans as appropriate, as a contribution to the achievement of the relevant Millennium Development Goals. It also sought to explore avenues for bridging the gaps between work being carried out to address the impacts of climate change on public health and work to address the impacts of climate change on biodiversity. This decision built on previous decisions of the Conference of the Parties that have called for strengthened collaboration between all subsidiary scientific and technical bodies of multilateral environmental agreements, particularly where there are cross-cutting issues that affect them all and synergies are possible.

3. United Nations Framework Convention on Climate Change (UNFCCC)

“We usually think of climate change as affecting the ecosystems of the earth, and not of the impact on our health”

Margaret Chan, Director-General, WHO

3.1 Introduction

The potential adverse impacts of climate change on the environmental determinants of health threaten to destabilize health systems and undermine international efforts towards sustainable development (41). The central importance of health to climate policy was recognized in article 1 of the UNFCCC, which defines the adverse effects of climate change as those affecting the “resilience or productivity of natural and managed ecosystems, [the] operation of socio-economic systems [and] human health and welfare” (42).

This chapter outlines the intrinsic links between climate change, sustainable development and human health, and the position of health as a central justification for international action on climate change. It summarizes the continually strengthening evidence for the links between human health, climate change, and adaptation and mitigation policies. It further considers the role of health within the UNFCCC process, and the support mechanisms for adaptation and mitigation policies. It concludes by identifying opportunities to improve policy linkages within the implementation of the UNFCCC and related mechanisms in order to promote both climate and health goals.

3.2 Impacts of climate change on health

The Intergovernmental Panel on Climate Change projects that over the next century, average global temperatures will increase by between 1.1°C and 6.4°C and sea level will rise by between 18 and 59 centimetres (11). The rate of change in the climate is faster now than in any period in the past thousand years, and is expected to be associated with large-scale changes in precipitation patterns, and the frequency and severity of extreme weather events. All of these changes will expose populations to changing patterns of climate-sensitive health risks, and also act on health determining sectors such as agriculture and water resources, with important implications for human health.

3.2.1 Impacts on health and health determinants

The direct and indirect impacts of climate change can be best understood when exploring the interactions between climate change and environmental determinants of health. Air quality and sanitation, food and water security, the provision and maintenance of shelter, and freedom from disease are among the most important of these environmental determinants (43). Many of these are interrelated, and are adversely affected by the reduced ability of degraded and fragmented ecosystems and biota to accommodate the impacts of climate change, including heatwaves, air

pollution, flooding and storms, coastal hazards from sea-level rise, impact of droughts on food supplies and water availability, and vector-borne and waterborne infectious diseases (41).

Depending on where and how people live, certain populations will be more vulnerable to the effects of climate change, experiencing its worst impacts. The UNFCCC, in its Decision5/CP.7, identified “low-lying and other small island countries, countries with low-lying coastal, arid and semi-arid areas or areas liable to floods, drought and desertification, and developing countries with fragile mountainous ecosystems” as particularly vulnerable to the overall adverse effects of climate change. The IPCC further identified regions and populations at particular risk of health impacts:

- areas at risk from combined climate impacts relevant to health (for example stress on food and water supplies, risk of coastal flooding);
- areas or populations within or bordering regions with high endemicity of climate-sensitive diseases (for example malaria);
- areas with an observed association between epidemic disease and weather extremes (for example El Niño-linked epidemics);
- areas at risk from concurrent environmental or socioeconomic stresses and with little capacity to adapt (for example local stresses from land use practices or impoverished or undeveloped health infrastructure) (12).

For example, changes in seasonal river flows, increases in floods and droughts, decreased food security, and biodiversity loss are especially of concern for parts of Africa, Latin America and Asia. Further, a number of regions that are at special risk even without climate change find themselves at significantly elevated risk as the global climate warms. These include low-lying, densely populated, coastal and delta regions such as coastal Bangladesh, China and Egypt, low-lying small island states such as coral reef atolls throughout Polynesia, and arid regions such as eastern Africa and central Asia that already suffer from drought (12).

Critically, climate change threatens to exacerbate inequities both between and within communities, with the severest impacts being felt by children, the poor and women (44). The health issues these groups are most affected by are especially sensitive to climate change – poor sanitation, infectious vector-borne disease and undernutrition – and are expected to intensify as a result of unmitigated climate change (43). Climate change acts as a “force multiplier”, impeding progress on many of the essential indicators of development, including poverty and hunger eradication, maternal and child health, the spread of communicable disease and environmental sustainability.

Air

Extremes of air temperature seen in heatwaves and cold snaps have the potential to kill directly; the elderly and people with infirmities are likely to feel the most severe effects of this. In particular, through respiratory and cardiovascular disease it is estimated that the European heatwaves of 2003 resulted in more than 70 000 excess deaths (45).

Urban air pollution currently causes around 1.2 million deaths each year. Rises in temperature will alter exposure to air pollutants in many ways, including both the levels of pollutants that are formed and the way these pollutants are dispersed (3). As the climate becomes increasingly warmer and variable, some kinds of air pollution, particularly ozone, are likely to increase (11). Assuming constant population and dose–response characteristics, ozone-related deaths from climate change are projected to increase by around 4.5% by the mid-2050s compared with 1990 levels (46).

Water

The provision of clean and reliable water, both for drinking and sanitation purposes, is an essential environmental service and determinant of health. Shifting rainfall patterns, the melting of glaciers and increased evapotranspiration rates will compound existing challenges in the provision of clean water, destabilizing fragile environmental and social systems. When combined with predicted growth in global population, the number of people living in water-stressed areas is expected to reach over 3 billion by 2050 (up from 1.5 billion in 1990) (47).

Increased frequency and severity of drought and flooding is expected to further destabilize existing vulnerable populations, as witnessed in the 2011 East African droughts and the 2010 Pakistan floods. If climate change continues unabated, the average duration of extreme droughts may increase sixfold, coupled with a doubling in frequency (48).

Lack of access to safe water increases the risk of diarrhoeal disease and other diseases related to chemical and biological contaminants. Importantly, almost 90% of diarrhoeal disease can be attributed to lack of access to safe water (3, 49). In 2002, over 50% of people living in developing countries lacked access to improved sanitation, and climate change is expected to hinder progress in addressing this basic health requirement (41, 50).



Locals selling fresh produce on a busy Sunday morning at Damnoen Saduak floating markets in Thailand. Climate change threatens agriculture and food production, world-wide.

Food

Changing climate patterns, including extreme dry and cold periods and erratic rainfall, as well as other factors such as land degradation, can impact food security and alter water supplies (51). The last two decades have seen a continuing deterioration of food production in Africa caused in part by persistent drought, and there has been a sustained decline in per capita yields of cereal grain (41). By 2020, rain-dependent agricultural products could decrease by up to 50% in some African countries (12).

This can have a direct impact on food availability and nutrition in many parts of the world and lead to increased vulnerability to disease, demographic displacement and malnutrition. Combined with pre-existing issues with global food security, climate change threatens to significantly impede agricultural improvement efforts, a necessary precondition for sustainable development. In some developing nations, the downstream health impacts of decreased agricultural productivity could be devastating.

Shelter

Climate change will decrease the viability of existing human settlements through increased frequency and intensity of extreme weather events and rising sea levels. For example, a several-fold increase in the frequency of extreme storms, heavy rainfall and heatwaves is predicted to occur by 2050 (11). Extreme weather events were responsible for the deaths of over 600 000 people and billions of dollars in property damage during the 1990s (52).

Sea surface warming will necessarily cause sea level rise. One expected effect would be an increase in flooding and coastal erosion in low-lying coastal areas. Without a significant scaling up of adaptation efforts, sea level rise could increase the number of people exposed to coastal flooding more than tenfold by 2080 (a rise of more than 100 million a year) (12).

Rising sea levels may affect human health and well-being in other ways. Rising seas could result in the salination of coastal freshwater aquifers and disrupt stormwater drainage and sewage disposal. Repeat flooding or increased salination may force population displacement, heightening the vulnerability of populations (41). Refugees suffer substantial health burdens, overcrowding, lack of shelter and competition for resources. Past experience indicates that forced population migration is often associated with conflict (41).

Spread of infectious diseases

Climate-sensitive infectious diseases kill millions every year, including approximately 900 000 from malaria and 2.2 million people from diarrhoea (53). Rising land and ocean temperatures and changing humidity and rainfall patterns have the potential to alter global patterns of such diseases, affecting populations with little to no acquired resistance and destabilizing health systems. Significant change is expected in the global epidemiology of vector-borne and waterborne diseases.

Climate change may affect vectors for malaria, dengue fever and Lyme disease, increasing transmission of disease by creating conditions favourable to breeding sites, impacting reproduction and maturation rates, or influencing pathogens directly. Studies suggest that climate change may see an additional 170 million people at risk of malaria in Africa by 2030, and an additional 2 billion at risk of dengue fever by the 2080s (54, 55). Although the relationship between malaria distribution and disease incidence is strongly affected by climate and ecology, the disease is also both a cause and an effect of poverty, and therefore constitutes a major burden on the economic and social dimensions of development.



Climate change threatens to drastically alter the global patterns of many diseases for the worse, including malaria, spread by the Anopheles mosquito shown above.

Climate also exerts a very strong influence on waterborne diseases. For example, the causative agents of cholera and other forms of severe gastroenteritis are acquired by consuming brackish water or shellfish. Rising ocean temperatures may result in increased cholera outbreaks as a result of more intense algal blooms (essential nutrients for *Vibrio cholerae*) (40). Additionally, prolonged flooding or drought can result in water contamination, leading to epidemics from cholera and other forms of diarrhoeal disease (56).

3.2.2 Financial costs to health systems and the wider economy

Of central importance to adequately informing the UNFCCC process and decision-makers is an understanding of the costs that climate change can impose on health. There are relatively few data available for such costings, though the evidence that is available suggests that damages to health makes up a notable part of total estimated economic loss. Studies from the 1990s suggested that total damages from climate change were between 1% and 3% of global world product. In some scenarios, it was estimated that loss of human life accounted for as much as 50% (57). More recent studies have turned their attention to the cost of adaptation rather than the cost of damages. One significant study conducted by the World Bank estimated that the health-related costs of adaptation accounted for 33.4% of global total costs (58). The study estimated adaptation costs over four 10-year periods between 2010–2050, and included cost estimates from agriculture, forestry and fishing, extreme weather events, and health-care costs. The upper level of these estimates suggests that the total global annual cost of climate change adaptation amounts to \$89.6 billion annually.

Despite this, large gaps still exist in the data, making it difficult to appropriately inform policy. Examples of gaps include the social and economic impacts on global productivity (as a result of changing patterns of disease and heat stress), the costs associated with premature death and additional costs borne by health systems as a result of increased caseloads. Scientific uncertainties in future emission scenarios and temperature rise predictions, and poor baseline health data, further complicate these estimates. Studies also often fail to account for the full breadth of the adverse health effects of climate change, omitting the impacts of (for example) disaster-related weather events or infectious diseases other than malaria and diarrhoea (58). With such significant omissions, it follows that the actual cost of adaptation to the health impacts of climate change is likely to be significantly higher than calculated (59).



The potential health co-benefits benefits to health of climate change mitigation are immense – regular cycling both reduces emissions and significantly improves health.

3.3 Mitigation of climate change and its co-benefits for health

If designed wisely, policies that reduce greenhouse gas emissions have the potential to improve public health substantially, reducing the global burden of a number of diseases, including heart disease, cancer, obesity, diabetes, osteoporosis, mental illness, lung disease and road deaths and injuries. These ancillary benefits (co-benefits) of mitigation highlight that what is good for the environment is often also good for health. However, it is possible for this pattern to be reversed, and some mitigation policies have the potential to harm human health.

There are significant cost savings to be made as a result of improved public health, which has important implications for the cost and viability of mitigation policies. Additionally, a health perspective provides a number of practical applications in its ability to identify the potential negative health impacts of well-meaning response measures and assist in the prioritization of climate change mitigation programmes.

3.3.1 Potential health gains through mitigation in key sectors

The co-benefits of mitigation to health are often looked at from a sectoral approach, and provide a catalytic argument for the reduction of global greenhouse gas emissions. The potential for health co-benefits has been described in recent years in a series of papers examining health implications of case studies of mitigation policies in major sectors, and a WHO series, *Health in the Green Economy*, which reviews the health impacts and benefits of the mitigation policies assessed in the fourth assessment report of the Intergovernmental Panel on Climate Change. Key sectors where such policies are of particular importance include household energy, transport, food and agriculture, and electricity generation.

3.3.2 Economic gains from health co-benefits

Early evidence on economic valuation of the health co-benefits of climate change policy suggests the potential for very large gains for national economies. Valuation studies to date have mainly considered benefits through air pollution, and conclude that even considering only this mechanism, improvements in health could largely cover the economic costs of the mitigation measures.

For example, a recent study in the European Union estimated the health benefits of reaching defined emission reductions targets through potential reductions in chronic respiratory and cardiovascular disease (and resultant loss of productivity) and improvements in life expectancy. It was estimated that reaching the 20% emission reduction target by 2020 would save almost €52 billion in reduced medical bills and avoided ill-health (60). It was further expected that a shift in European Union emission reduction targets from 20% to 30% by 2020 would result in 140 000 additional life-years and 13 million fewer non-productive days due to chronic illness (60). This would add up to an additional €30.5 billion, almost two thirds of the cost of the additional mitigation efforts (€46 billion) (60, 61). Additional savings may be found in increased productivity resulting from healthier environments and a healthier workforce. Including health and economic co-benefits gives a more comprehensive and realistic assessment of the implications of mitigation policies, and generally presents a stronger case for more sustainable choices.

Consideration of the health co-benefits of climate change mitigation brings together the social, economic and environmental dimensions of climate policy, and provides an opportunity for Parties under the UNFCCC to promote a more integrated vision of sustainable development.

3.4 Status of health in the UNFCCC process, and its operational mechanisms

3.4.1 Health within the UNFCCC legal framework

Effective health sector engagement with the UNFCCC requires a strong legal framework and entry point. This exists within the various articles of the Convention and provides an entry point to the process that is either a legal commitment for Parties or a footing for further development of health-relevant policy.

Article 1: Definitions

Article 1 of the UNFCCC clearly states the importance of the health impacts of climate change, defining the “adverse effects of climate change” as those that negatively impact socioeconomic systems or human health and welfare. This provides strong justification for health sector engagement throughout the UNFCCC process, for example implying the inclusion of health indicators and outcomes for national adaptation projects.

Article 4: Commitments

The commitments of Parties to the UNFCCC are outlined in article 4. Here, a legal grounding for health exists in article 4.1(f), where Parties to the Convention commit to “employ appropriate methods, for example impact assessments ... with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, or projects or measures undertaken by them to mitigate or adapt to climate change”. The article affirms a commitment from Parties to the Convention to ensuring that climate change policies are designed in a way that minimizes their adverse effects on public health. This is particularly important in that Parties have formally committed to conduct health impact assessments for national response measures and projects.

Article 12: Communication of information related to implementation

Reporting requirements for Parties to the Convention are outlined in article 12 of the Convention. While there is no mention made specifically to health, the UNFCCC has provided a user manual for Annex I and non-Annex I countries,^I which contains guidelines for national communications and reporting. Of particular interest, Annex I Parties are expected to report on the non-greenhouse gas benefits, such as co-benefits to health, of all national mitigation policies.

The strong representation of health in the UNFCCC is now matched in formal commitments through health mechanisms. These include World Health Assembly resolution WHA61.19, and regional declarations, resolutions and action frameworks agreed by health and environment ministers (62, 63).



Awareness of the links between climate change and health is rising, as was seen at the UNFCCC's COP 17 in Durban, South Africa.

Despite the strong representation of health in the UNFCCC, and new engagement from the health side, two decades on, health is not yet a prominent feature of climate negotiations. In 2010, over 450 delegates to the sixteenth session of the Conference of the Parties to the UNFCCC in Cancún (Mexico) were surveyed on their attitudes and knowledge towards the linkages between climate change and health. Results showed that civil society and government delegations alike believed that health should play a more central role in the UNFCCC negotiations than it currently did (64). This was reflected in the increased number of countries that made reference to human health in their opening statements at the seventeenth session of the Conference of the Parties in 2011. The growing level of awareness and understanding about the linkages between climate

change and health provide an excellent platform from which public health considerations can be fully integrated into the future discussions and outcomes of the UNFCCC.

3.4.2 Health within the adaptation mechanisms of the UNFCCC

The impacts of climate change on many of the environmental and social determinants of health will prove devastating for communities, undermining international efforts to promote sustainable development. These impacts are concentrated on the poorest populations, and affect some of the largest disease burdens, including malnutrition, diarrhoea and malaria, which together kill over 5 million people a year (53, 65). In this regard, health is an important direct and indirect output of successful adaptation. As such, building resilience and addressing the health impacts within the UNFCCC framework is an essential first step to ensuring the protection of the most vulnerable populations and the advancement of sustainable development. Adaptation policies that fail to recognize and account for such a perspective risk being either ineffective or even damaging to the well-being of communities.

Important opportunities for adopting a health perspective exist within the adaptation policies and operating mechanisms of the UNFCCC, most importantly the commitment of Parties through article 4.1(f) to employ appropriate methods (for example impact assessments) with a view to minimizing the adverse effects of their adaptation (and mitigation) policies. This commitment to undertake health impact assessments or other methods to minimize the adverse effects

^I The Annex 1 countries are the industrialized countries, and countries with economies in transition, which have committed to emissions reductions targets under the UNFCCC.

of climate change on health could be more explicitly linked with the UNFCCC implementation and financial architecture. This may include the prioritization of funding to health adaptation programmes or the presence of health expertise on key committees and work programmes.

3.4.3 Support for national adaptation programmes of action (NAPAs) and national adaptation plans (NAPs)

The UNFCCC has assisted national adaptation planning, initially by providing support to the least developed (LDCs) countries to develop national adaptation programmes of action (NAPAs). It is intended that these are country-driven, action-oriented programmes that require no further research, and aim to respond specifically to urgent and immediate threats. The NAPAs represent the first generation of adaptation plans under the UNFCCC, with mechanisms for middle- and long-term adaptation agreed upon in Cancun at COP16. These medium- and long-term plans are known as National Adaptation Plans (NAPs) and are designed to help LDCs to formulate and implement adaptation. The integration of the NAPs with efforts to strengthen national health systems and adapt to changing patterns of disease is an important opportunity to address the long-term health implications of climate change.

A review of the submitted NAPAs from the least developed countries confirmed the relevance of health, with more than 95% of the submissions citing the protection of public health as a national priority within their adaptation strategy (66). It was found that only 30% of the NAPAs adequately included health assessments and comprehensive plans for tackling these impacts given that their focus is on urgent and immediate needs (66). Gaps included a widespread lack of the required baseline epidemiological data on diseases, medical conditions and the environmental determinants of health that interact with climate change. Further, while citing its importance, many submissions were unable to articulate specific health protection targets or strategies for disease control measures.

The evidence therefore indicates a lack of resources to adequately respond to the adverse health effects of climate change. Work is now beginning in this area, but most is not directly connected to the UNFCCC process. For example, an international systematic scoping review found over 40 intervention projects seeking to protect human health, but none were a direct response to the NAPA documents. Finally, central to adaptation to the adverse effects of climate change is the provision of adequate funding necessary to protect vulnerable populations. Based on current estimates of the health costs of climate change, only 0.5% of the estimated damage is currently covered by international funds from any source. There are therefore significant weaknesses in the international effort to support national governments to assess health vulnerabilities, and to plan and implement health adaptation. However, as the NAPs will have a longer time horizon, and be country driven, they should provide a key opportunity to incorporate health interventions into medium- and longer-term planning, depending on national priorities.



Embroidery by the Brazilian group "Matizes Bordados Dumont", based on an original design by Gilles Collette, created as visual identity for the theme of World Health Day 2008 "Protecting Health from Climate Change"

3.4.4 Health within the mitigation mechanisms of the UNFCCC

The health co-benefits of climate change mitigation provide one of the strongest overlaps and catalysts between mitigation and adaptation negotiations. Within the operational mechanisms of the UNFCCC the importance of health is evident in an analysis of the Clean Development Mechanism (CDM) and the national communications provided by Parties to the Convention.

The CDM, established in Article 12 of the Kyoto Protocol, was designed as a mechanism to facilitate GHG reductions with the aim of facilitating a cost efficient global response to climate change, by providing developed countries with the opportunity to meeting some of their emissions reduction targets through projects in developing countries, where it is cheaper to do so. The other main purpose of the CDM was to assist non-Annex I developing country Parties, in achieving sustainable development (which includes health co-benefits). The design of the CDM specifies that the host countries have the authority to both establish the criteria for achieving sustainable development, and determine whether they are met by a CDM project.

There is evidence to suggest that CDM projects are making a contribution to sustainable development over and above the mitigation of GHG emissions in the host country. However, on the whole there is an observed trade-off between the goals of the CDM, in favour of producing low-cost emission reductions at the expense of achieving sustainable development co-benefits (see CDM website, UNFCCC 2011).

As described above (and in the 2007 4th Assessment Report of the IPCC) the health benefits of mitigation policies partially or wholly account for their costs, whilst unmanaged health impacts of climate change may seriously undermine the viability of CDM projects.

As with climate change adaptation policies, health impact assessments can hence be used to help prioritise resource allocation to CDM projects. The health and economic co-benefits of mitigation would also act as a useful indicator of a preferable CDM project.

While only 6 out of over 3000 projects seeking funding from the CDM or Joint Implementation (JI) mechanism were from the health sector, several CDM projects are reported to have provided necessary infrastructure for health services, and improving community health, for example through increased access to potable water, and to low-emission cookstoves. They also report success in managing environmental health risks and improving working conditions within the project, for example through reducing noise or dust pollution (see CDM website, UNFCCC 2011).

With the rise of non-communicable diseases worldwide, the energy needs of the health sector will grow substantially. The CDM offers an important platform for enabling country driven changes to health conditions and health services. Prioritising CDM project development to benefit the health sector and provide for essential services to ensure community health, welfare and empowerment, such as through energy security for housing, hospitals, transport, cooling/heating and lighting will both increase access to health services and directly improve health conditions in impoverished regions. Energy efficiency programs and (off-grid) renewable energy supply as a result of CDM, will also help to strengthen health systems. The CDM can, but does not yet, take full advantage of the health co-benefits of climate change mitigation.

3.5 Opportunities for better linkage of climate and health goals

The UNFCCC provides a number of important opportunities for the public health community to engage with climate change at local, national and international levels. However, since the 1992 Rio Earth Summit the representation of health within the UNFCCC has been relatively weak. Progress towards the UNFCCC goals, and overall sustainable development, could be enhanced by better utilizing the capacities of the health community.

3.5.1 Framing health and climate change

The health impacts of climate change act as a tangible indicator of global progress on climate change efforts. In this regard, health is a more readily accessible concept than, for example, either carbon dioxide emissions or sustainable development. Health provides a strong link between climate change and sustainable development. Together with the health co-benefits of climate change mitigation, this forms a positive message around climate change mitigation and adaptation. It can serve as an important reminder to governments and civil society alike that there are significant health-care savings to be had from mitigation efforts, and that the ultimate objective of the UNFCCC is not only to avoid the worst impacts of climate change but also to create a healthier sustainable future.

Within the UNFCCC negotiations themselves, this aim could be promoted by recalling the original article 1 definition of “adverse effects”, and adopting health indicators as an additional marker of global progress to enhance public understanding and political accountability.

3.5.2 Health expertise within the UNFCCC work programmes

A number of the work programmes and committees of the UNFCCC would benefit from health expertise – this is particularly true of the committees and work programmes focused on adaptation. Where this does not occur, it is possible that well-intentioned adaptation efforts in non-health sectors could indeed harm public health.

Health expertise would provide significant benefit to Parties:

- in the assessment of current and future human health risk under climate change and appropriate public health response measures;
- in identification and prioritization of policies and programmes to address such risks;
- in the establishment of monitoring and surveillance processes for the health risks of climate change.

A range of UNFCCC mechanisms could benefit from stronger health input. For example, the Nairobi Work Programme on Impacts, Vulnerabilities and Adaptation provides policy-relevant scientific advice that informs the ongoing processes. It aims to improve understanding and assessment of impacts and vulnerabilities to climate change, and consequently assist Parties in making informed decisions. The formation of a subprogramme on health impacts to work under the Nairobi Work Programme would provide public health expertise to inform policy-makers about necessary and urgent response measures. Other options include specifying the need for consultation with the health sector within UNFCCC programme guidelines. Parties to the Convention can also advance this aim by nominating public health professionals to the UNFCCC



The international health community has an essential role to play within the UNFCCC, providing national and international health expertise for both adaptation and mitigation policy.

process either as part of the roster of experts or as an adaptation expert for the Nairobi Work Programme. These experts provide in-depth reviews of the national communications of Annex I Parties, and play a role in advising the UNFCCC and its Parties to the Convention about matters pertaining to adaptation, technology transfer and greenhouse gas inventories. Similar approaches could be taken with regard to other aspects of the UNFCCC, such as the Adaptation Committee or the Work Programme on Loss and Damage.

3.5.3 Linking health to mitigation and adaptation efforts

The project based flexibility mechanisms under the Kyoto Protocol such as the CDM and JI provide an excellent opportunity for accelerating investment in climate change mitigation and assisting developing countries in sustainable development co-benefits, in particular health. The design and regulations of these mechanisms for sectors that offer significant health and economic co-benefits, such as the transport, housing, health infrastructure and mining sectors – could better promote health focussed sustainable development. In doing so, it is essential that regulations governing these projects facilitate the declaration, assessment, monitoring and verification of all co-benefits in particular those related to health and safety. Combined with a strong demand for offsets from an international carbon market, the continued use of flexible mechanisms like the CDM can facilitate co-benefits such as energy security, which is essential for robust and autonomous health care facilities in rural and low-income areas, benefiting both the environment and the economy of the host country.

Ensuring that the adverse effects of climate change on public health and social systems are considered within the NAPs is also a critical step to enable LDCs to adequately plan and prepare for the destabilizing effects of climate change on health and health systems. A number of appropriate responses will help to remedy these imbalances. In particular, the integration of adaptation measures with efforts to strengthen health systems and stronger engagement with the health sector at all levels in strategic planning and implementation would prove beneficial. Technical and policy support could be provided to the least developed countries through health agencies to help strengthen response measures. The Conference of the Parties to the UNFCCC has agreed that adaptation policies should be in part assessed and prioritized such that potential negative impacts on human health are minimized.

3.5.4 Health impact assessments

Article 4.1(f) of the Convention affirms a commitment from Parties to the Convention to ensuring that climate change policies are designed in a way that minimizes their adverse effects on public health (42).

While there is the potential for major co-benefits between environmental and social development, they will not be unlocked without the design of integrated policies that promote health gains and manage health risks, alongside the drive to reduce environmental impact. Mandated by resolution WHA61.19 of the World Health Assembly (62) and an action plan endorsed by its Executive Board, WHO has developed a number of relevant tools, ranging from disaster preparedness and risk reduction to climate change-specific health impact assessment guides. Within the UNFCCC, these can be used for:

- assessment of global progress on tackling the issue of climate change;
- determining whether or not implementation strategies are appropriate;
- prioritization and evaluation of mitigation and adaptation programmes.

Use of these tools can help ensure that UNFCCC policies, designed to benefit the environment and stabilize global emissions, are not simultaneously detrimental to health.

3.5.5 Reporting on climate change mitigation

Under the UNFCCC, Parties to the Convention have a number of reporting commitments that are intended to document the implementation of the Convention's mitigation and adaptation policies. These national communications vary in content and frequency for Annex I and non-Annex I countries (67).

In the case of Annex I countries, a number of sections exist within the reporting guidelines that are relevant to health. For example, Parties are expected to report on the non-greenhouse gas benefits, such as for health, of all mitigation policies. However, this expectation is not always met by all Parties (68). The UNFCCC Secretariat has a key role to play in providing guidance and support for Annex I countries in their reporting obligations of the social impacts and benefits of mitigation policies. Importantly, the user manual for national communications by non-Annex I Parties provides more detailed guidance, recommending reporting on the health sector in both mitigation and adaptation sections (69).

4. Convention to Combat Desertification (UNCCD)

“There’s far more to this than food. The things that live in and grow from this irreplaceable and finite resource also keep us clothed, the air and water clean, the land green and pleasant and the human soul refreshed”

Luc Gnacadja, Executive Secretary of the UN Convention to Combat Desertification on the 2010 World Day to Combat Desertification and Drought.

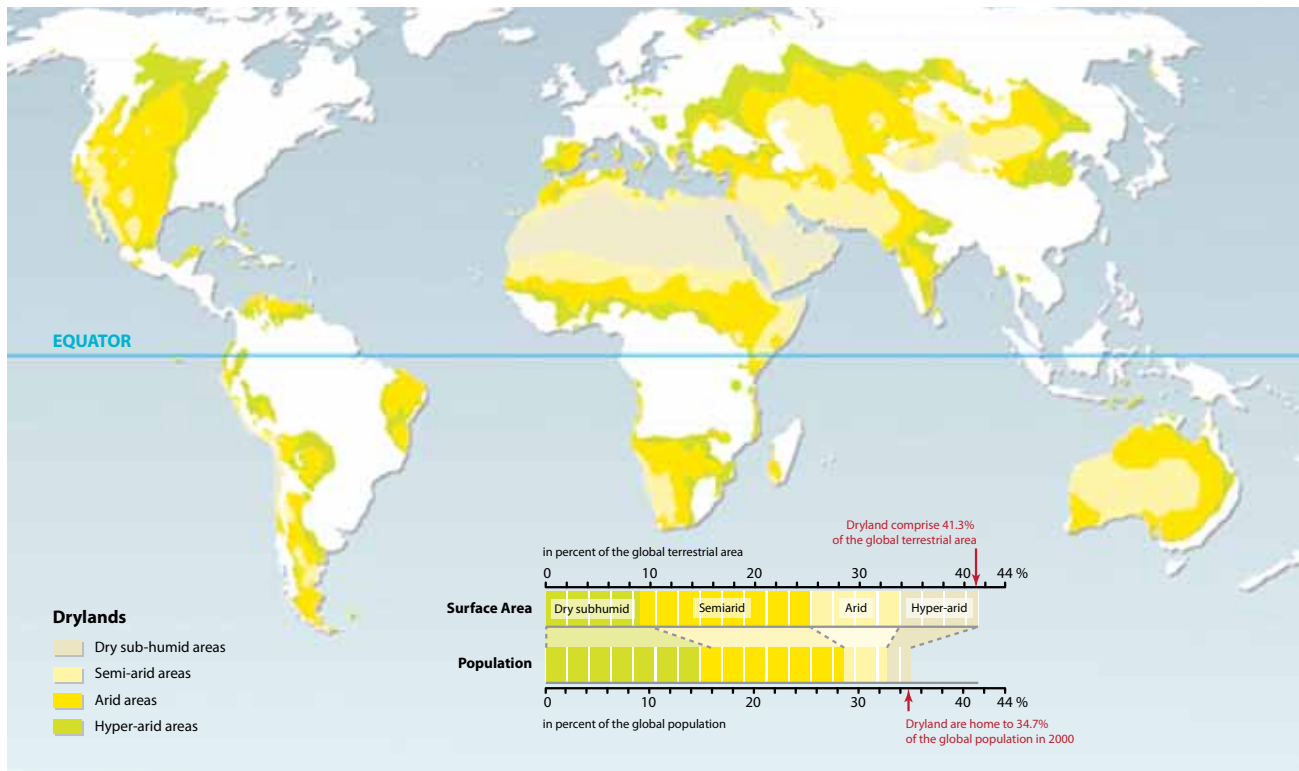
4.1 Desertification and its interactions with sustainable development

The Parties to the United Nations Convention to Combat Desertification (UNCCD) declared desertification a growing global crisis. Desertification is defined by the UNCCD as “land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities” (70).

Drylands occupy a large portion of the earth’s surface – 41% of the earth’s land area – and are home to more than 2 billion people, a third of the human population in 2000 (71). Occupants of dryland areas are disproportionately the most vulnerable and poor. There is therefore a critical need to manage the demand for, and the supply of, ecosystem services in the drylands. Figure 4.1 shows the extent of dryland systems worldwide.

Drylands provide a number of ecosystem services, including the provisioning of food, forage, fuel, building materials, and medicines, and water for humans and livestock, for irrigation, and for sanitation. They also provide local climate regulation and global climate regulation through carbon sequestration. Although carbon sequestration in drylands is low compared to most other terrestrial ecosystems, their large surface area makes them globally important (72). The carbon reserve of soils is particularly high in drylands, with the total organic carbon reserve comprising 34% of the world’s soil organic reserve, and 97% of the global soil inorganic reserve. This is particularly valuable to humans through local and global climate regulation, as well as through the enhancement of soil quality. Because good soil quality enhances agricultural productivity and water quality, enhancing crop yields through soil carbon sequestration contributes to poverty alleviation and overall human well-being in drylands.

Figure 4.1 Extent of dryland systems worldwide



Notes: Overall 41.3% of the global terrestrial areas are categorized as drylands and 34.7% of the global population lived in drylands in 2000. The long-term mean of the ratio of an area's average annual precipitation to its average annual potential evapotranspiration is the Aridity Index (AI).

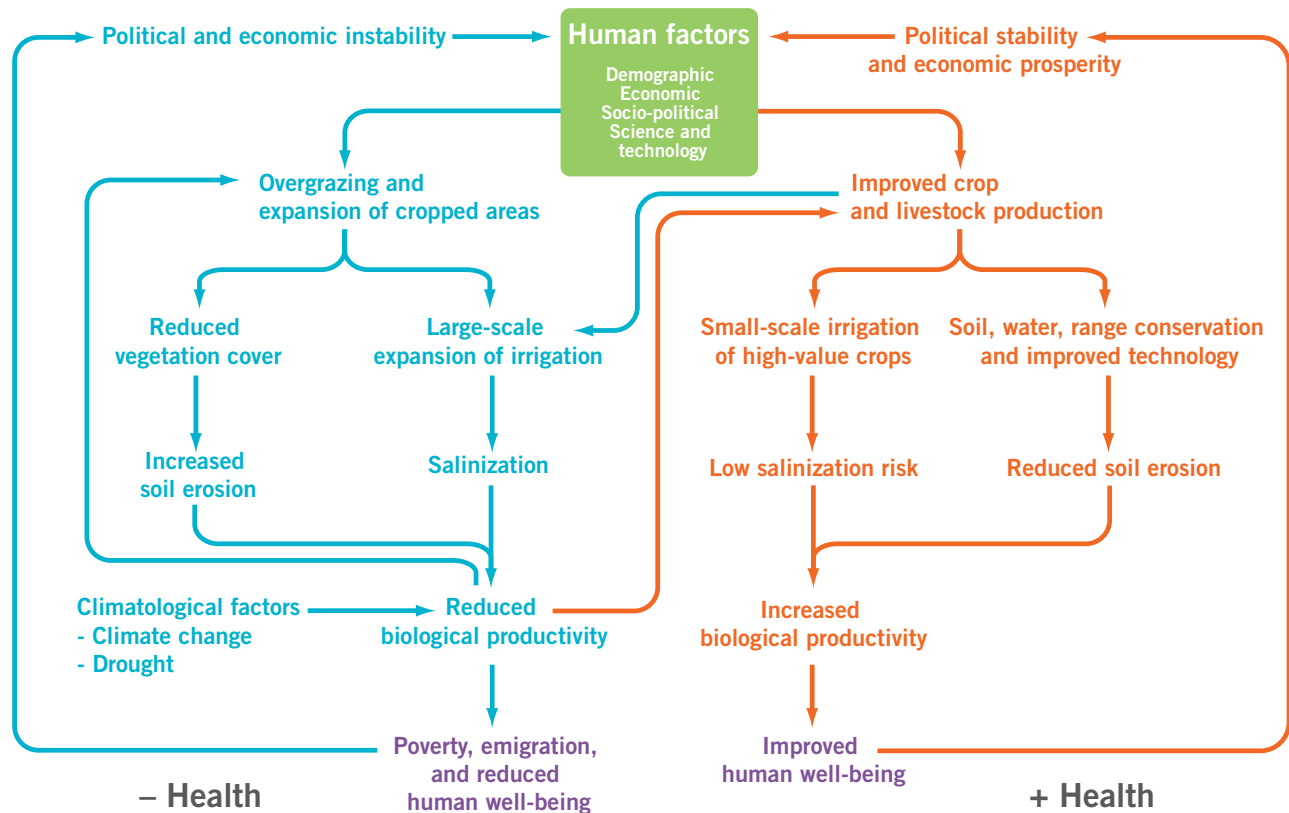
Source: Millennium Ecosystem Assessment (2005, appendix A, p. 23, from data sources cited therein).

The degradation of terrestrial ecosystems and of their functions and services, where land productivity is limited by water availability, is a special case of land degradation called desertification. Persistent, substantial reduction in the provision of ecosystem services, biodiversity loss, water scarcity, intensive use of services and climate change are considered to be the main drivers of desertification (Figure 4.2). While drought is a feature of arid, dry and subhumid environments, the added pressure on land from unsustainable cultivation and pastoral practices has resulted in sharp declines in ecosystem productivity. Some unsustainable practices include overcultivation, overgrazing and deforestation, which lead to vegetation degradation, water and wind erosion, soil nutrient loss, and salination of soils. Other impacts include air pollution from fires for clearing land, unsustainable exploitation of water resources, chemical pollution, and exhaustion and salination of aquifers. In the last century, unsustainable land management practices, coupled with drought, have led to desertification throughout many of the driest regions of the earth. Over the past 90 years, almost 50% of drylands have been converted to agriculture (73). Of these agricultural lands, approximately 70% have been degraded by erosion, salination, compaction, nutrient depletion, biological degradation and chemical pollution (74).

Figure 4.2 Main drivers of desertification

Downward spiral leading to desertification

Approach to avoid desertification



Note: The figure is a schematic graphic showing options for dryland development in response to changes in key human factors. The left-hand side of the figure shows development options that lead to a downward spiral of desertification. The right-hand side shows development choices that can help stop, reverse and reduce desertification. In the latter case, land users respond to stresses by improving their agricultural practices on currently used land. This leads to increased livestock and crop productivity, improved human well-being, and political and economic stability. Both development pathways occur today in various dryland areas.

Source: Adeel et al. (71).

Poverty is one of the foremost consequences of the drivers of change, which include population growth, urbanization, increased consumption, and increased demand for goods and services provided by the land. With desertification, the dual biophysical and socioeconomic aspects of reduced productivity of the land and impoverishment of households is exacerbated; populations affected by desertification and land degradation are less able to adapt to extreme climate events such as droughts. Periods of drought often promote a continuation of unsustainable agricultural practices, leading to a cycle of further land degradation, poverty, and greater impacts on human health and well-being. Some of these processes are shown in Figure 4.2.

Areas prone to desertification, land degradation and drought are expected to increase in the future, causing severe impacts on the economies of developing countries, including least developed countries and small island developing states. Desertification, land degradation and drought are expected to also impact developed countries due to lower crop yields, damaged crops, increased water stress, food insecurity, malnutrition and the resulting increased risks to the health of poor populations, with women, children and the elderly being particularly at risk. Migration from degraded areas is predicted to increase globally.



The impact of drought and desertification on food availability generates a cycle of poverty, land degradation and ill-health.

While poverty in itself has consequences for human health, the focus in this section is on the health effects of ecosystem degradation, particularly due to water insecurity in dry ecosystems, the decline in productivity leading to food security, and land and soil degradation.

4.2 Effects of desertification, land degradation and drought on human health

4.2.1 Water Security

The *World Water Development Report 4* states that “desertification, land degradation and drought ... are specifically, but not exclusively, related to drylands. Drylands are by definition water limited environments. Water is a key resource that is under high pressure from increasing demand and decreasing quality. Productivity of drylands is determined by water availability and quality. Any further degradation of this essential resource will have detrimental effects for the people and the economy of dryland countries” (75).

The related health effects from extreme weather events include malnourishment and dehydration from reduced food, water supplies and energy; waterborne and foodborne diseases resulting from poor hygiene and contamination; and the spread of infectious diseases through population movements. “Dryland populations, at least 90% of whom live in developing countries, on average lag far behind the rest of the world in human well-being and development indicators” (71). While some of these conditions are caused by natural events such as drought or floods, others are the result of human-driven attempts to adapt to desertification. For example, unsustainable land use practices change vegetative cover and the water content of soils. Water scarcity, in particular, is increasingly recognized as a priority problem that needs to be urgently addressed, with both direct and indirect health impacts (75).

Water availability is the major limiting factor for sustainable development in drylands. One of the biggest impacts of desertification is the exhaustion of available clean water sources. Between 5% and 25% of current global water consumption and up to 35% of global irrigation withdrawals exceed sustainable levels (7). Water resources in dryland countries are already highly overutilized (75). Water scarcity and poor water quality can increase vulnerability of humans to diarrhoeal and intestinal diseases, particularly children. Hygiene-related infections, as well as other air and waterborne diseases, may also be aggravated by existing chronic problems, such as malnutrition.

A projection for 2025 in such water catchments in the global drylands concludes that seven major basins in the drylands – mostly in Asia, one in Africa and another in North America – are expected to experience water scarcity; and fourteen major basins are projected to be water stressed by 2025. In total, half of the major basins found in the drylands are expected to experience either water stress or water scarcity.

Droughts exacerbate water scarcity and, coupled with food deprivation, can result in famines. Droughts may also lead populations, mostly men, to migrate, redistributing endemic infectious diseases. For example, major droughts in north-eastern Brazil during the 1980s and 1990s caused



Poor water quality and water availability represent two of the biggest issues associated with desertification. The health impacts range from increased susceptibility to infectious disease, to chronic malnutrition.

a large-scale migration of people from rural to urban areas, leading to outbreaks of leishmaniasis (kala-azar) in major cities (76). In southern Sudan, around the upper Nile, leishmaniasis was not formerly endemic. However, an outbreak may have occurred due to the introduction of the *Leishmania* parasite by immigrants from an area with endemic leishmaniasis accompanied by ecological changes favourable to the sandfly vector (77).

In addition to droughts, desertification processes also negatively impact ecosystems and their populations, making them more vulnerable to other climatic extremes, such as El Niño events, dust storms and floods, which are becoming more frequent due to climate change and other factors. A season of particularly high rainfall may contaminate water sources and alter the population dynamics of host, vector or reservoir species, increasing the risk of vector-borne and waterborne diseases.

One of the best-known outbreaks of hantavirus occurred in the spring and summer of 1993 in south-western United States, where acute respiratory distress with a high fatality rate was recognized among formerly healthy individuals. The disease, hantavirus pulmonary syndrome, was traced to a previously unrecognized hantavirus, which was found to be maintained and transmitted primarily within populations of the deer mouse. Unseasonal rains from El Niño during the usually dry summer months in 1992 produced favourable environmental conditions that led to an increase in the reservoir populations of the rodents and the subsequent outbreak of hantavirus pulmonary syndrome (78).

The UNCCD cites the need for “development of sustainable irrigation programmes for both crops and livestock” (70). Dams and irrigation systems, in the effort to increase food production and provide water to cultivated areas and rangelands, have contributed to a number of health problems. While they may increase food security, they have also led to the emergence and spread of some infectious diseases by providing ecological niches for vector and reservoir species and altering microclimates.

The development of irrigated agriculture in the Thar Desert, Rajasthan, north-western India, is an example of an instance where malaria increased due to the provision of surface water to a desert area (79). The Thar Desert was traditionally only mildly prone to malaria, but in the last six decades irrigation development has corresponded with a rise in malaria. *Anopheles stephensi* (a poor malaria vector) occurs primarily in the desert, whereas *Anopheles culicifacies* (an efficient vector) occurs primarily in irrigated areas. With the introduction of an irrigation scheme in the 1960s, the prevalence of malaria increased almost fourfold in the following 40 years, with several epidemics in the last 15 years of that period (79).

Desertification and linked health consequences are not confined to developing countries. Greece, Italy and Spain face severe problems rooted in natural sedimentary characteristics, climate, agricultural practices and economic development policies. Renewable water availability is near the 1000 square meters per person per year scarcity benchmark in Belgium, the Czech Republic, Germany and Poland, and many eastern European countries are dependent on foreign sources for renewable water supply (80).

With this scarcity and worsening water pollution, efforts to intensify water reuse options create additional health risks. Dissolved nitrogen in Europe is six times more concentrated than in North America or Asia and has increased over the last two decades (79). Elevated levels of nitrogen and associated compounds cause blue baby syndrome, aquatic eutrophication, and stomach,

ovarian, bladder and liver cancers (82). Desalination plants are increasingly being developed, but although new technology is improving efficiency, they have high investment costs and energy requirements – Kuwait consumes 3.6 billion tonnes of fuel annually to produce around 900 million litres of water per day (83). They also have multiple environmental and health risks. Toxic chemicals and concentrated brines from plants are discharged back into the sea, mixed with other wastewater, or dried and buried in landfills. Desalinated water has poor taste, alters metabolism and mineral homeostasis, halts uptake of calcium and magnesium (nutrients related to prevention of cardiovascular diseases), easily absorbs toxic metals and substances from pipes, and when used in cooking reduces essential nutrients from food (84).

4.2.2 Food security

Traditional shifting cultivation has helped to increase the capacity of drylands to produce food and fibre, providing food security for local populations, as well as improved nutrition and overall well-being. Despite this, increasing demographic pressure in many parts of the world has led to unsustainable agricultural practices that have irreversibly transformed land cover, causing a number of negative health impacts.

While large portions of drylands have been converted to croplands, 88% of drylands are covered by rangelands, of which a high percentage are now degraded (72). Improper rangeland management practices, such as farming livestock beyond the land's carrying capacity, reduce soil productivity. This has occurred throughout Africa, where in many parts it is not economically feasible to raise cattle due to the prevalence of tsetse flies. However, because tsetse flies cannot survive in dry areas, cattle ranching is often confined to these areas, resulting in land degradation from overstocking (85). Other health impacts have come from the ranching of certain domestic species in dryland systems, which has led to the transfer of zoonotic diseases. Sheep breeding, for example, has historically created endemic disease foci in both human and domestic animal populations in countries such as in Argentina, Australia and South Africa (76).



Food security provides a stable platform from which to build a healthy community. Desertification transforms threats to destabilise this platform by making large areas of land unviable for agriculture.

4.2.3 Air pollution and dust storms

Dryland areas are particularly susceptible to drought, though this is a global phenomenon that can occur anywhere. Droughts in Africa have had particularly tragic consequences. The effects of droughts over large territorial expanses of Africa and Asia are often felt globally, for example due to dust from wind erosion and altered rainfall patterns. Severe dust storms from Africa to the Caribbean and from Asia to North America, for example, may increase the levels of fine particles, pollution and potentially infectious agents in the air and may have serious health consequences for humans. A review of these consequences (86) highlighted four broad categories of problematic materials in dust, where evidence exists for adverse health outcomes:

- Fine particulate matter comprising particles with a diameter of 10 micrometres or less (PM₁₀) may penetrate the lungs. It has been found to exacerbate respiratory disease and has been linked to increased rates of death from respiratory and cardiovascular diseases. Exposure to much smaller particles with a diameter of 2.5 micrometres or less (PM_{2.5}) increases risks.

- Bacteria, fungi and allergens also occur in dust and exposure to dust carrying the *Coccidioides* fungus causes coccidioidomycosis (with its flu-like symptoms).
- Toxic chemicals can be mobilized particularly from exposed, drying lake sediments, where they have accumulated for many years (often where industrial or agricultural discharge has occurred).
- Climate synergistic effects can occur: for example, where outbreaks of meningitis have occurred in sub-Saharan Africa, researchers have argued that dust and low humidity might make it easier for bacteria to penetrate the lining of the nose and throat and enter the bloodstream, where they spread to the meninges. Deforestation can be associated with these outbreaks.

In the Sahel of western Africa, agricultural intensification and higher population density have contributed to a reduced fallow period, leaving soil more exposed to wind erosion during the long dry season. The region receives between 200 and 600 millimetres annual rainfall. Agricultural intensification, coupled with increasing population density in many areas, has led to a fallow period that is insufficiently long to recuperate the soil. This has increased the amount of soil exposed to wind erosion during the long dry season, increasing sources of atmospheric dust (87–89).

4.2.4 Synergistic effects: livelihoods, migration and psychosocial health

Synergistic combinations of the main desertification factors can be addressed through sustainable land management mechanisms that continually improve environmental conditions. Overcultivation permanently changes vegetative cover, water content and soil organic matter, leading to erosion (loss) of topsoil and decreased productivity, as well as biodiversity loss and habitat fragmentation and degradation. Salination also reduces the productivity of the soil. These drivers, coupled with drought, can lead to new migration patterns of populations from marginal lands, increasing their vulnerability to starvation, respiratory ailments, food and waterborne diseases in children and other vulnerable members of the population, as well as increasing the spread of infectious diseases.

The current state of the Aral Sea, described as “one of the world’s greatest environmental disasters” (90), demonstrates how the drivers of drought, agricultural irrigation and farming practices can produce toxic environmental consequences. Beginning in the 1950s, water was massively diverted from central Asia’s largest rivers, the Amu Darya and the Syr Darya, to irrigate extensive fields of cotton. In response the Aral Sea underwent a rapid retreat, losing 90% of its volume, and experienced the collapse of a 50 000 tonnes per year fishery. Additional water diversion for subsistence agriculture compounded the desertification, and a drought in 2000 led to dust storms spreading residual salt, pesticides, herbicides and chemical fertilizers that swirled through local villages and homes. Highly adverse health impacts include elevated rates of respiratory diseases, hypertension, cancer, anaemia, heart and kidney disease, fetal developmental effects, and neurological problems (90–92). Crop yields have decreased, and salination of the water table makes water unfit to drink – in 1996 the level of salination was over 3.5 times the international standard. Those unable to relocate to new areas suffer psychosocial stress and may be less able to adapt to deteriorating conditions (93).

Studies in Australia outline a potentially serious range of adverse health impacts of more severe droughts and long-term drying conditions on rural communities. These include mental health problems (depression and suicides); negative child emotional and developmental experiences;

exposure to extremes of heat, dust and smoke; freshwater shortages and hygiene problems; local food unavailability; and changes in health-related behaviours (for example with regard to alcohol, smoking and self-medication) (94, 95). A study of the effects of a long-running Australian drought, particularly the social consequences affecting the farm families and communities reliant on agricultural production and the mental health outcomes for farm men, found that men were more vulnerable to extreme measures such as suicide (96). The study argued that this emanates from a stoicism typical of normative rural masculinity that prevents men from seeking help when their health is severely compromised (in this case, when there is a sense of helplessness and hopelessness caused by lack of rain).

A Brazilian study identified several measurable psychological responses to the cumulative effects of drought and also found gendered responses; women were significantly more anxious in a drought-affected area in north-eastern Brazil compared to a non-drought area, and were significantly more anxious and emotionally distressed than men in general (97). To interpret these findings the authors explained the gender roles and responsibilities within this social and cultural context:

The effects and consequences of drought undermine women's roles as producers and providers. Women are typically responsible for provision and preparation of food, collection of water, and the management of the home. In the drought context, all of these activities are disrupted and become a daily challenge. Crop failure impacts on the quantity and quality of food available, and not being able to feed the family properly increases women's frustration. Women may frequently deprive themselves of food in order to feed their dependents. The reduction of water supplies contributes to health problems. These typically affect children first, increasing women's concerns and workload. In addition, because of the drought, husbands may look for better jobs elsewhere, thus aggravating these conditions. The woman takes on responsibility for the total care of the household, in addition to the work for which their partner was responsible. All these factors likely contributed to the significantly higher levels of anxiety for women in the drought area.

These psychosocial effects may be exacerbated by other forms of land degradation. For example, a geospatial analysis of health and environmental degradation in south-western Australia found that dryland salinity was associated with increased relative risk of hospitalization for depression (98).

4.3 Health within the UNCCD: opportunities to improve health and address desertification

The text of the UNCCD places humans “at the centre of concerns to combat desertification and mitigate the effects of drought”. It notes that desertification, land degradation and drought are “caused by complex interactions among physical, biological, political, social, cultural and economic factors”, and are interrelated with a number of factors including poverty, poor health and nutrition, and lack of food security (70). The 10-year strategy 2008–2018 of the UNCCD (99) reconfirms this mission orientation, as reflected in its science-related strategic objectives (objectives 1–3) and their associated expected impacts. The most relevant to human health, although generally stated, is the first, strategic objective 1: To improve the living conditions of affected populations. Two expected impacts are derived from this objective. People living in areas affected by desertification, land degradation and drought will have an improved and more diversified livelihood base and will benefit from income generated from sustainable land management. The

socioeconomic and environmental vulnerability of affected populations to climate change, climate variability and drought is expected to be reduced. Three indicators that then seek to measure progress against this strategic objective include the numbers of people negatively impacted by the processes of desertification, land degradation and drought; the proportion of households living above the poverty line in affected areas; and the proportion of the population below the minimum level of dietary energy consumption in affected areas.

At the tenth session of the Conference of the Parties to the UNCCD (Changwon, Republic of Korea, October 2011), Parties adopted an Advocacy Policy Framework on Gender, based on the fact that this Rio Convention is the only one that highlights in its text the differentiated roles of men and women when managing natural resources such as land and soils. The aims of the Advocacy Policy Framework on Gender are to address the drivers of land degradation and promote gender equality through partnerships, forums, enhancing capacities, fostering equal access to education opportunities and health care, and giving due attention to women's rights and ownership of land, thereby recognizing these issues as priorities in tandem with the Millennium Development Goals.

Strategic objective 1, and entry points such as the Advocacy Policy Framework on Gender, provide a clear opportunity to develop equitable health policies integrated with sustainable land and water management. The focus of a long-term vision on public health, economic development, education and environmental management (including biodiversity conservation and adaptation to climate change) must appropriately include risk management and planning for drought, water scarcity and desertification. Such risk management measures should include monitoring the health impacts of drought and developing capacity for prevention of, preparedness for and response to associated negative health impacts. Over the longer term, it also includes fostering food security and livelihood diversification to ensure the resilience of communities to hazards that can weaken agriculture-based livelihoods. Such integrated policies can provide the expected long-term benefits of improved livelihoods as called for by the 10-year strategy of the UNCCD.

5. Integrating health and global environmental change into sustainable development

“Today our planet and our world are experiencing the best of times, and the worst of times. The world is experiencing unprecedented prosperity, while the planet is under unprecedented stress”

Report of the United Nations Secretary-General's High-Level Panel on Global Sustainability

5.1 Role of the Rio Conventions in health

Both human health and environmental protection are central to the concept of sustainable development, which is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (98). The growing confluence of health and global environmental change highlights the urgent need to improve the lives of the poorest and most vulnerable populations while ensuring ecosystem services over the long term.

Growing evidence of the acute impacts of global environmental change is driving renewed consciousness among the world's peoples and nations of the need to act quickly to protect the planet's ecological and climatic systems. In this context, new emphasis on the human health dimensions of global environmental change offers a strong motivation for concerted global action to address challenges such as climate change, biodiversity loss and land degradation. Health is a major component of environmental concern in many countries, and a new focus on health may help shore up public support for progress towards new, more ambitious global environmental policies. Without such action, millions of people in all countries are likely to face new, and in many cases greater, health risks.

The incorporation of health into the Rio Conventions in 1992 provides entry points for health, environment and development actors to promote coherent policies, achieve synergies and optimize trade-offs between their goals while avoiding duplication of effort. This field has made major advances since the first Rio conference, raising awareness of the linkages between health and environment. There is also now a more complete understanding of how environmental factors interact with the social determinants of health. This more holistic approach can make important contributions in addressing both the persistent burden of diseases of poverty, and emerging challenges, such as the threat of pandemics and the rise of noncommunicable diseases.

5.2 The unfinished agenda: the Millennium Development Goals

Although the global economy has grown rapidly since 1992, inequalities persist, and are rising in many societies. While all nations face future health risks from global environmental change, such risks are already being felt first and foremost by the world's poor, and particular individuals within them. WHO estimates of current health impacts from global environmental change are sobering in their indications that poor populations are already experiencing significant negative health risks from ecosystem degradation (7, 101). Existing health disparities are being exacerbated by the loss of ecosystem services required to support and maintain health and well-being



Working towards sustainable development through the three conventions within framework that emphasises the social determinants of health will help achieve the MDGs.

for many people already struggling with poverty, malnutrition and the effects of natural and human-induced disasters. These disparities point to the immediate need to invest to assist developing countries to improve health now, and to reduce their vulnerability to global environmental changes that are already occurring and are likely to intensify in the short to medium term.

The Millennium Development Goals (MDGs) express these requirements. They represent human needs and basic rights that every individual around the world should be able to enjoy – freedom from extreme poverty and hunger; quality education, productive and decent employment, good health and shelter; the right of women to control their fertility and give birth safely; and a world where environmental sustainability is a priority, and women and men live in equality (102). While the MDGs are set only until the year 2015, they will remain a benchmark of basic standards of human development that will be relevant beyond this date.

Table 5.1 shows that the Rio Conventions have relevant contributions to make across the MDGs, with varying degrees of emphasis. The CBD has a major role to play in guiding contracting Parties towards the reduction of biodiversity loss. Through its alliance with various international conventions and organizations and its strategic emphasis on ecosystem services and human health, the CBD can make substantive contributions to promoting inter-linkages between biodiversity and health ranging from the monitoring of health-related MDGs to access to essential medicines and from containment of infectious diseases to promoting sustainable agricultural practices and systems. The UNCCD pays specific attention to sustainable livelihoods and reducing poverty with a focus on land and terrestrial ecosystems, helping to reduce the health burdens of malnutrition. The UNFCCC, through its mitigation and adaptation strategic priorities, seeks to ensure that climate change does not impede progress towards these goals.

Ecosystem approaches can complement action on the social determinants of health to achieve the MDGs. The upstream ecosystem determinants are causally connected and the conditions that produce the lack of education, vulnerability and poverty, and iniquitous structures for global trade, need to be considered.

In addition, the analysis shows how the Rio Conventions and other multilateral environmental agreements are in a unique position to point out where potential conflicts and opportunities exist in making progress in different dimensions of sustainable development; also they assist in pointing the direction where efforts are required to ensure that achieving one target does not come at the expense of achieving another.

Table 5.1 Millennium Development Goals and targets, and relevance to Rio Conventions

MDGs	Targets	Relevance to, or roles and responsibilities for, Rio Conventions
1. Eradicate extreme poverty and hunger	Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day. Halve, between 1990 and 2015, the proportion of people who suffer from hunger. Achieve, full and productive employment and decent work for all, including women and young people	Food security of the poor often depends directly on healthy ecosystems, and the diversity of goods and ecological services they provide. Diverse ecosystems are self-sustaining and provide more nutritious food than, and the essential genetic material for, agriculture, horticulture, aquaculture and silviculture. Sustainable livelihoods by definition seek to ensure that the core requirements of food, energy and water are provided to those dependent on the provisioning of ecosystems.
2. Achieve universal primary education	Ensure that by 2015 children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	Ecosystem management, for terrestrial ecosystems, wetlands and land- and water-based resources in particular, must address the disruptions to ecosystem services that result in water-related diseases. Water-related diseases such as diarrhoeal infections cost millions of school days each year, diminish learning potential and reduce the coping capacity of local populations for current predicaments and future ecosystem changes.
3. Promote gender equality, and empower women	Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education by 2015	Poverty and rural living put girls at a disadvantage in terms of education. Women and girls bear the brunt of collecting water and fuelwood for food production. Women and girls are more vulnerable members of populations to waterborne diseases and psychosocial stresses associated with climatic extremes and other disasters. Policies and programmes that focus on mainstreaming gender into sustainable livelihoods, ecosystem management and disaster reduction strategies are needed to concomitantly address these disparate burdens, and thereby allow full access to education. Implementation of gender mainstreaming methodologies can ensure the integration of a gender approach into development and environmental action. Gender mainstreaming seeks to recognize the diverse roles and needs of women and men and bring them to bear on the sustainable development agenda. Rather than merely adding on women's participation to existing strategies and programmes, mainstreaming gender aims at transforming unequal social and institutional structures by recognizing the promotion of gender equality as a central driving principle, reducing vulnerability, and enhancing both the efficiency and effectiveness of programmes, policies and projects.
4. Reduce child mortality	Reduce by two thirds, between 1990 and 2015, the under-5 mortality rate	Four diseases – pneumonia, diarrhoea, malaria and HIV/AIDS – accounted for 43% of all deaths in children under 5 worldwide in 2008 (102). Wetland management will become an essential operational requirement to reduce exposures to waterborne disease (diarrhoea, including cholera) and vector-borne disease (such as malaria). Prevalence of these diseases is a result of disruption to regulatory services (due to overextraction of water and inappropriate water resource management). Ecosystem approaches are underemphasized in addressing this goal.
5. Improve maternal health	Reduce by three quarters, between 1990 and 2015, the maternal mortality rate Achieve, by 2015, universal access to reproductive health	Provision of clean water reduces the incidence of diseases that undermine maternal health and contribute to maternal morbidity and mortality. Addressing land degradation will reduce psychosocial stresses for some women and enhance empowerment. Renewable energy policies may help to reduce indoor air pollution and carrying heavy loads during late stages of pregnancy that put women's health at risk before childbirth.

MDGs	Targets	Relevance to, or roles and responsibilities for, Rio Conventions
6. Combat major diseases	<p>Have halted by 2015 and begun to reverse the spread of HIV/AIDS</p> <p>Achieve, by 2010, universal access to treatment for HIV/AIDS for all those who need it</p> <p>Have halted by 2015 and begun to reverse the incidence of malaria and other diseases</p>	<p>Direct relevance to all three Rio Conventions as argued in this report; ecosystem approaches to human health need to play a larger role in achieving this goal. Approximately a quarter of the total burden of disease in developing countries may be associated with environmental risk factors. Preventive environmental health measures are as important and at times more cost-effective than health treatment. Policies and measures that aim at sustainable management that enhances ecosystem services help prevent and reduce the likelihood of human exposure to pollutants and infectious diseases, attending to upstream environmental determinants of health. New biodiversity-derived medicines as well as tapping the traditional knowledge held by rural communities hold future promise for fighting major diseases.</p>
7. Ensure environmental sustainability	<p>Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources</p> <p>Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss</p> <p>Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation</p> <p>By 2020, achieve a significant improvement in the lives of at least 100 million slum dwellers</p>	<p>Direct relevance to the Rio Conventions. Current trends in environmental degradation must be stopped, reversed and restored in order to sustainably increase the health and productivity of the world's ecosystems. Considerable effort is required to ensure that achieving one target must not come at the expense of achieving others. For example, addressing biodiversity loss must not increase susceptibility to poverty, or further jeopardize the lives of slum dwellers. Likewise, adaptation and mitigation measures must include measures that attend such biodiversity concerns, including the most vulnerable ecosystems, such as drylands. Therefore coordinated approaches for implementation at the national and local level are a must for this synergy to work. Almost 10% of the global disease burden could be prevented by improving water supply, sanitation, hygiene, and management of water resources (49).</p>
8. Develop a global partnership for development	<p>Address the special needs of the least developed countries, landlocked countries and small island developing states</p> <p>Develop further an open, rule-based, predictable, nondiscriminatory trading and financial system</p> <p>Deal comprehensively with developing countries' debt</p> <p>In cooperation with the private sector, make available the benefits of new technologies, especially information and communications</p>	<p>Due to external and internal conditions, developing countries and regions, especially the least developed countries, landlocked countries and small island developing states, are forced to unsustainably use and exploit their natural resources in order to generate revenue, make debt repayments and still achieve their own economic growth. Globalization practices asymmetrically and in an unbalanced way generate and transfer harmful side-effects to countries that often do not have effective public policies or governance structures in place to counter or to adapt to these impacts. As developed (rich) countries consume far more environmental resources and produce more waste than developing (poor) countries, many environmental problems (such as climate change, loss of species diversity, management of global fisheries, deforestation and land degradation) must be solved through a global partnership of developed and developing countries.</p> <p>Considerable efforts are required to ensure that achieving one target does not come at the expense of achieving another. Trade and market mechanisms must address the enhancement of provisioning services in relation to regulating and supporting services in accordance with the specific conditions of each country. Full cost accounting (using ecosystem services), including the cost of inaction, should be emphasized in global market restructuring and development.</p>

Sources: Millennium Ecosystem Assessment (7), Horwitz et al. (24), United Nations (102), Molden (103), Department for International Development et al. (104), United Nations Development Programme (105), United Nations Convention to Combat Desertification (106).

5.3 Opportunities for the future of sustainable development



Twenty years have passed since the 1992 Earth Summit. In June 2012, leaders of the world will meet once again in Rio de Janeiro, to discuss and find ways to accelerate our path to sustainability. This gathering – the United Nations Conference on Sustainable Development (Rio+20) – is crucial for our planet, our health and our future.

5.3.1 Improving synergies in policy design and support

Health is an important outcome in decisions about how to manage natural resources and the environment, but is often left out of environmental assessment and policy processes. Similarly, health actors often neglect the potential to improve health through protection and enhancement of ecosystem services, and reduction of environmental risk factors. An improved understanding of environment–health linkages has the potential to significantly strengthen capacity to identify and analyse long-term health risks, to participate in policy decisions that have significant health implications, and to develop appropriate strategies for disease prevention.

Many of the environmental and ecological factors that impact human health also cut across more than one of the multilateral environmental agreements and treaty domains, demanding an integrated approach. At the same time, synergies can help boost public support where strategies simultaneously address multiple societal goals. For example, if well-designed afforestation and reforestation programmes can, in addition to helping to mitigate greenhouse gas build-up in the atmosphere, also restore watershed functions, establish biological corridors, provide local livelihoods, and offer recreational values and other cultural services, they will be more likely to receive broad-based political and financial support.

The United Nations system is uniquely positioned to improve coordination by aiming at delivering as one on sustainable development. Further integration of global environmental change and human health would also be enhanced by a reinvigorated partnership both between the major global multilateral environmental conventions and with partners such as the World Health Organization, the Food and Agriculture Organization of the United Nations, the World Organization for Animal Health, the United Nations Environment Programme, the United Nations Development Programme, Diversitas, and the International Union for Conservation of Nature. Such partnerships would not only give the prominence this issue deserves but also bring together the necessary expertise for identifying policies that enhance both ecological sustainability and public health.

This is now beginning to occur. In 2010, the tenth session of the Conference of the Parties to the CBD adopted a resolution to further strengthen collaboration with WHO as well as other relevant organizations and initiatives with a view to promoting the consideration of biodiversity issues in health programmes and plans, as appropriate. It also sought to explore avenues for bridging the gaps between work being carried out to address the impacts of climate change on public health and work to address the impacts of climate change on biodiversity. This decision

builds on previous cooperation resolutions of the CBD that have called for strengthened collaboration between all subsidiary scientific and technical bodies of multilateral environmental agreements, particularly where it concerns cross-cutting issues that affect them all.

Such partnerships can assist not only in general policy coherence but in addressing specific practical challenges. Box 5.1 illustrates how the establishment of a cooperative task force could leverage capacity from a range of institutions and disciplines and help reach agreement on common positions on a rapidly emerging issue of common concern – potentially serving as a model for similar challenges in the future.

Box 5.1 Multilateral environmental agreements and highly pathogenic avian influenza H5N1

Although the emergence of highly pathogenic avian influenza (HPAI) of subtype H5N1 in China in 1997 had caused human fatalities and major impacts on the poultry industry, it was not until it re-emerged in 2003 and spread westwards in 2005 that it gained wider public attention. In 2005, cases of infection in wild birds were reported spreading through Asia and it reached Europe in late 2005, and Africa in 2006.

Before the emergence of HPAI H5N1 in East Asia, the control of previous outbreaks of HPAI (of other H5 and H7 subtypes) had caused huge economic losses to the commercial poultry sector on several continents. HPAI H5N1 was, additionally, of concern to the human health sector (given the ability of the virus to cross the species barrier and assessed risk of mutating into a form that could spread as a human pandemic). It was also of concern to wildlife conservationists, given its disease-causing ability (pathogenicity to wild waterbirds in particular and to some mammal species), and given the negative implications for wild birds of ill-defined responses. Triggered by these negative implications for wild birds, and as wild waterbirds are the natural hosts of other, less disease-causing forms of avian influenza viruses, there was an understandable interest in the

complex implications of this emergent disease for the conservation of waterbirds and their wetland habitats along the major flyways in Europe, Asia and Africa.

Key issues that arose for decision-makers within governments and also for other nongovernment wetland conservation organizations consequent on the spread of this disease informed resolutions at Conferences of the Parties to the Ramsar Convention, the Convention on Migratory Species (CMS) and the African-Eurasian Waterbird Agreement (AEWA) (in 2005 and 2008).

Central to the development of common positions was the creation of a Scientific Task Force on Avian Influenza and Wild Birds to act as a coordinating forum between interested international organizations and treaties. The Task Force involved members from AEWA, Birdlife International, CBD, International Council for Game and Wildlife Conservation, CMS, FAO, United Nations International Strategy for Disaster Reduction, Ramsar Convention, Wetlands International, Wildlife Conservation Society, Wildfowl and Wetlands Trust and Zoological Society of London. Observers on the Task Force were OIE, UNEP and WHO.

Source: Cromie et al. (107).

5.3.2 Strengthening research and operational capacity on environmental change and human health

There is an equally important opportunity for synergy in the field of global environmental change and human health research. The Rio Conventions are already working to enhance opportunities for synergy in the area of information collection, analysis and exchange, and many of these opportunities are already advancing the agenda of health and environmental research.

Initiatives in this field are flourishing, and six examples are given in Box 5.2. Concerted efforts to strengthen research will acknowledge these emerging fields, facilitate their development and coordinate them as required. The Rio Conventions have a role to play in these contexts.

Box 5.2 Ecosystem approaches to human health: examples of initiatives from international organizational collaborations

Diversitas: Earth System Science Partnerships

The Diversitas programme of the International Council of Scientific Unions has promoted the establishment of one of their Earth System Science Partnerships (ESSP) to focus on global environmental change and health. A science plan has been accepted and this topic of global environment and health was represented across several scientific sessions at the ESSP Open Science Conference in November 2006.

One Health

A recognition that there is an inextricable interconnection of humans, pet animals, livestock and wildlife and their social and ecological environment has drawn together the fields of public health and medicine, the veterinary sciences and social ecological thought to produce a movement characterized as “One Health” (108). The One Health concept is a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment. The movement involves public health agencies, disease control agencies, and veterinary and medical associations. Supported by the World Organization for Animal Health, WHO and FAO, the movement's first International One Health Congress was held in Melbourne, Australia, in early 2011.

EcoHealth

The International Association for Ecology and Health (EcoHealth) is a professional organization that promotes research, education and practice (including policy development) on the linkage between health of all species and ecosystem sustainability. The association's mission is to strive for sustainable health of people, wildlife and ecosystems by promoting discovery, understanding and public engagement. The association has held three biennial international conferences since 2006, provides a gathering point for communities of practice, regional groups and chapters, and has published an international journal *EcoHealth* since 2004 (109).

Ecosystem approach to human health, Canada

The Canadian Government International Development Research Centre's “ecosystem approach to human health” (Ecohealth) inherently involves three groups of participants: researchers and other specialists; community members; and decision-makers. The approach is based on

three methodological pillars: transdisciplinarity implies an inclusive vision of ecosystem-related health problems, requiring the full participation of each of the three groups mentioned above and validating their complete inclusion; participation aims to achieve consensus and cooperation, not only within the community, scientific and decision-making groups but also among them; and equity involves analysing the respective roles of men and women, and of various social groups. The gender dimension recognizes that men and women have different responsibilities and different degrees of influence on decisions; it is therefore important to take gender into account when dealing with access to resources. For their part, various castes, ethnic groups and social classes often live in completely separate worlds; this isolation has its own repercussions on health and access to resources (110).

Central America malaria vector control

The Pan American Health Organization (PAHO), together with the United Nations Environment Programme and the Global Environment Facility (UNEP/GEF), initiated in 2003 a project to address the adverse effects of the use of DDT and other persistent insecticides on both human health and the environment. They jointly implemented the Regional Action Programme and Demonstration of Sustainable Alternatives for Malaria Vector Control without Using DDT in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama (DDT/UNEP/GEF/PAHO Project). Respect for cultural diversity, involvement of local government, the empowerment of participating communities and local capacity building have been key elements in the implementation of the project's integrated actions. Similar initiatives are now being implemented in Asia and Africa.

Health Parks Healthy People

The Healthy Parks Healthy People philosophy aligns with the following principles (111):

- Parks are integral to healthy people and a healthy environment.
- Human health depends on healthy ecosystems.
- Parks conserve healthy ecosystems.
- Contact with nature can improve human health.
- Parks contribute to economic growth and well-being.
- Parks contribute to cohesive, vibrant and healthy societies.

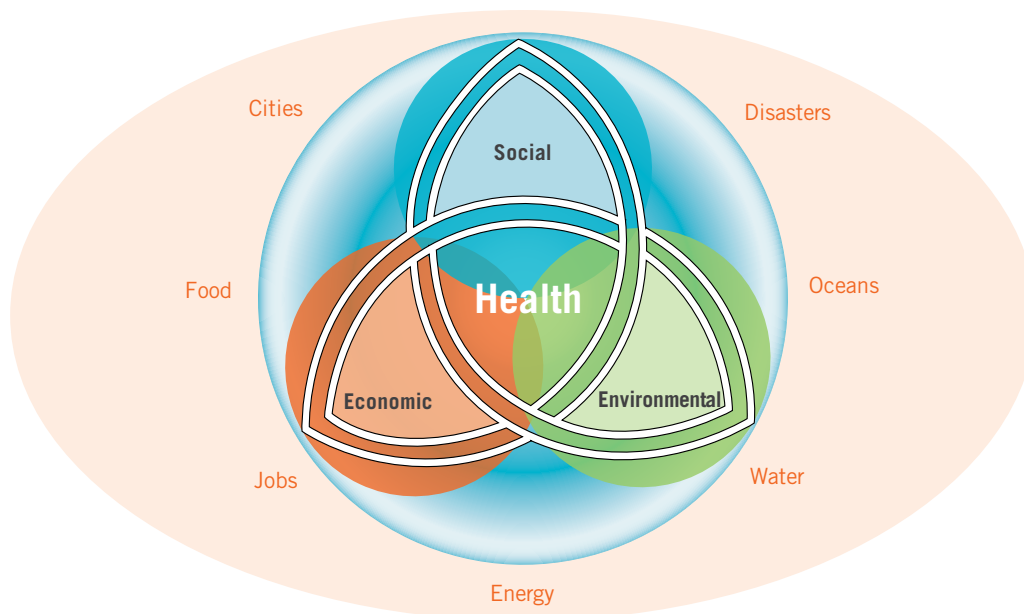
A new partnership among the Rio Conventions and the public health community would also provide an impetus to strengthen the capacity of the globe's public health infrastructure to respond to a wide range of health risks and opportunities. New health risks from global environmental change highlight the need for a strong infrastructure for public health at both local and global scales. Building the capacity to recognize and respond effectively to the complex interactions between social, economic and environmental conditions, which can impact positively or negatively on human health, will have important spillover effects for public health more generally. This seems especially likely in areas such as infectious diseases and disaster preparedness, where awareness of ecosystem services and function has already demonstrated important insights that can significantly inform disease prevention policies and develop capacity.

This work underscores the importance of collecting and sharing information to develop early warning systems for droughts and floods and better understand the causes and effects of biodiversity loss, climate change, desertification and land degradation. Addressing these objectives, the health, space and environmental sectors have developed a number of tools in this area that look at climate change, desertification and land use variables to develop early warning systems for disease tracking. With advances in technology (for example satellite imagery and geographic information system (GIS) mapping), scientists are starting to address the complex causal relationships among ecosystem change, climate change, biodiversity and health. These global problems require coordinated efforts and data sharing among the conservation, veterinary, health, development and remote sensing communities, among others, at all levels.

5.3.3 Monitoring and evaluating progress across health, environment and sustainable development

Among the preparations for Rio+20, sustainable development goals are being discussed in many forums. An overarching goal is the need to address, in a balanced manner, the three dimensions of sustainability: social, economic and environmental. Concerns focus on key themes where advances are sorely needed: jobs, energy, cities, food, water, oceans and disasters. These themes are interlinked. Addressing them will address the three dimensions of sustainability. They would respond to the needs of the Rio Conventions, and they would contribute to enhancing health.

Figure 5.1 Rio+20 Critical issues



Credit: C. Corvalan (<http://bit.ly/IQGhgE>)

Health is a pre-condition as well as an outcome of all three dimensions of sustainable development (environmental, social and economic). Human beings are central to sustainable development and health is a cross cutting issue to the seven critical themes (energy, food, water, cities, jobs, disasters and oceans) identified for the Rio + 20 conference.

Sustainable development goals and indicators must reflect the impacts of biodiversity loss, climate change and desertification on health, in the context of their social, economic and environmental dimensions. The experience of the MDGs, among others, has demonstrated the importance of defining standards and tracking progress in achieving a truly integrated vision of sustainable development. A wide range of organizations track a range of indicators that measure environmental conditions, population vulnerabilities and health status. However, there is a need for a more coherent vision of the suite of indicators that will provide a comprehensive assessment of sustainable development and the place of human health within the three Rio Conventions. There are also opportunities for improved design, selection and standardization of individual indicators, and linkages between monitoring programmes in related domains. These should also be linked to monitoring of the ecosystem services that underpin human health, including biologically diverse and productive ecosystems, and a stable climate. Only then will it be possible to truly measure progress towards “a healthy and productive life in harmony with nature”.

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PUBLIC HEALTH AND ENVIRONMENT

This discussion paper is the result of collaboration between the World Health Organization and the Secretariats of the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification. The report reviews the scientific evidence for the linkages between health and biodiversity, climate change and desertification, the representation of health in the corresponding Rio Conventions, and the opportunities for more integrated and effective policy. The report demonstrates the importance of human health as an integrating theme across sustainable development, and a strong motivation for concerted global actions to address global environmental change.



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