






AFRICA ENVIRONMENT OUTLOOK 3

Our Environment, Our Health

UNEP

A complete elaboration of the topics covered in this summary can be found in the Africa Environment Outlook 3 and report and in the fully referenced underlying research, analyses and reports.

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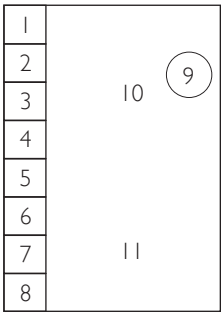

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AFRICA ENVIRONMENT OUTLOOK 3

Our Environment, Our Health

UNEP

Adaptation IDRC CRDI DFID

World Health Organization

Contents

Acronyms

ALRIs	Acute Lower Respiratory Infections
AEO	Africa Environment Outlook
AMCEN	African Ministerial Conference on the Environment
ARIs	Acute Respiratory Infections
ATSDR	Agency for Toxic Substances and Disease Registry
CBNRM	Community-Based Natural Resources Management
CCs	Collaborating Centres
CDM	Clean Development Mechanism
CFSPH	Centre for Food Security and Public Health
COPD	Chronic Obstruction Pulmonary Disease
CWS	Conventional World Scenario
DDT	Dichlorodiphenyltrichloroethane
DEWA	Division of Early Warning and Assessment (UNEP)
EWEs	Extreme Weather Events
FCPF	Forest Carbon Partnership Fund
GEO-5	Global Environment Outlook 5
GMOs	Genetically Modified Organisms
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IEC	Information, Education and Communication
IICAB	Institute for International Cooperation in Animal Biologics
IPCC	Inter-Governmental Panel on Climate Change
IPCS	International Programme on Chemical Safety
IUU	Illegal, Unreported and Unregulated fishing
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goal
MEAs	Multilateral Environmental Agreements
MEO	Mauritius Environment Outlook
MICAO	Ministry for the Coordination of Environmental Affairs (Mozambique)
MMAs	Marine Management Areas
MPAs	Marine Protected Areas
NAPA	National Adaptation Programme of Action on Climate Change
PCBs	Polychlorinated biphenyls
PES	Payment for Ecosystem Services
POPs	Persistent Organic Pollutants
REDD+	Reducing Emissions from Deforestation and Forest Degradation, Forest Conservation, Sustainable Management of Forests and Carbon Stock Enhancement
ROA	Regional Office for Africa (UNEP)
SAICM	Strategic Approach to International Chemicals Management
SIDS	Small Island Developing States
SPM	Summary for Policy Makers
SWS	Sustainable World Scenario
TBNRM	Transboundary Natural Resources Management
UNEP	United Nations Environment Programme
WIOMER	Western Indian Ocean Marine Eco-region

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Purpose, assessment process and key messages

Purpose

The Africa Environment Outlook (AEO) is a tool of the African Ministerial Conference on the Environment (AMCEN) for monitoring environmental management in Africa. It provides a framework for reporting at the national and sub-regional levels and seeks to enable AMCEN member countries to institute environmental management policies and programmes for the sustainable future of the continent. The AMCEN Secretariat partners with the United Nations Environment Programme (UNEP), through its Regional Office for Africa (ROA) and the Division of Early Warning and Assessment (DEWA), in producing periodic series of the report.

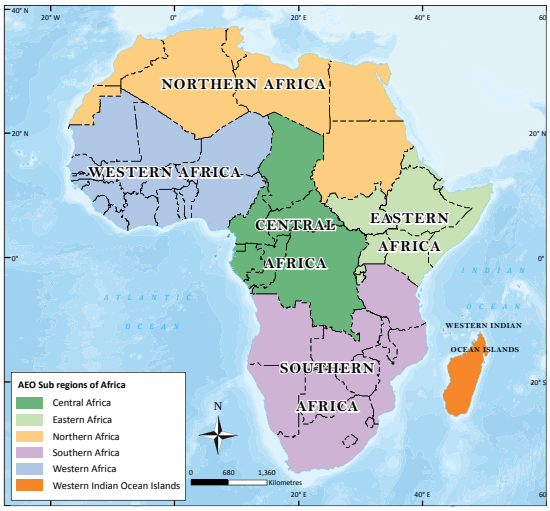
The current issue (AEO-3) focuses on the linkages between environment and health, largely because of the recognition that environmental factors contribute about 28 per cent of Africa's disease burden. This disease burden is dominated by diarrhoea, respiratory infections and malaria which collectively account for 60 per cent of the known environmental health impacts in Africa. Accordingly, the Ministers of Environment and of Health at their 2008 joint meeting in Libreville, Gabon selected the linkages as the principal focus of joint actions. This focus was reemphasized at their 2010 joint meeting in Luanda, Angola and selected by the technical committee as the theme for AEO-3. It is envisaged that this Summary for Policy Makers (SPM) as well as the AEO-3 main report will provide information for evidence-based decision making and spur AMCEN member countries into strengthening their capacity for policy making and advocacy at the national, regional and global levels.

Two earlier reports have been produced under the AEO series and the issues discussed are summarized in Box 1.

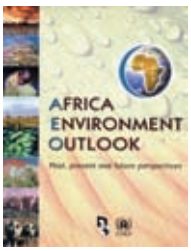
Assessment process

Consistent with the AEO tradition, consultations were made with collaborating centres (CCs) that worked closely with stakeholders in the six sub-regions of Africa (Figure 1) to ensure that relevant priorities and concerns were captured during the AEO-3 assessment and reporting processes. Besides providing relevant data, information and resource

Figure 1: Africa sub-regions



Box 1: Themes of past AEO reports



AEO-1 was launched in Kampala on 4th July 2002 under the theme *Past, present and future perspectives*. It presented:

- Assessment of the evolving state of the environment in Africa including trends, and inter-linkages between natural events and human activities;
- Impacts of environmental change on human vulnerability;
- Future scenarios of Africa's environment with policy options for progress towards environmentally sustainable outcomes.

AEO-2 was launched in Brazzaville on 25th May 2006 under the theme *Our environment, our wealth*. It highlighted:

- A synthesis of the opportunities provided by Africa's natural resource base for sustainable development and improving livelihoods;
- Emerging challenges that required specific policy attention;
- Forward looking strategic management of existing environmental assets for development which would also signal a departure from preoccupation with recounting losses arising from environmental degradation.

materials for developing case studies for the various chapters, the CCs also facilitated networking with the relevant institutions in their respective sub-regions. A regional consultative meeting was held to agree on the themes of the various AEO-3 chapters. Data, scenario and policy analysis working groups, consisting of African experts supported the production process. Besides the Coordinating Lead Author for the entire report, Lead and Contributing Authors were selected for the various chapters. An Editorial Committee together with the AEO-3 Secretariat at UNEP helped to ensure quality assurance. In addition, the AEO-3 draft was subjected to an expert peer review process.

The AEO-3 report begins by highlighting the major drivers of environmental change in Africa and their implications for human health. It also assesses environment and health linkages in the region by focusing on seven priority themes: air quality; biodiversity; chemicals and waste; climate change and variability; coastal and marine resources; freshwater and sanitation; and land. The thematic assessments of these are arranged in alphabetical order. In addition, the report contains a scenario analysis and teases out a series of policy directions. Two scenarios defining plausible futures for Africa and the attendant environment and human health ramifications are compared. Based on the findings of the thematic assessments and scenario analysis, the report concludes by setting forth transformative policy directions to ensure a sustainable future.

Key messages

AEO-3 conveys the following key messages to policy makers and other stakeholders:

- ***Environmental and health issues deserve priority consideration in national development.*** Indoor and outdoor air pollution, unhygienic or unsafe food, improper waste disposal, absent or unsafe vector control and exposure to chemicals are major environmental health hazards in most African countries. About 10 per cent of the disease burden in Africa is attributable to inadequate water, sanitation and hygiene, with children bearing most of it.

- ***Although indoor air pollution is a profound health problem in Africa, it has been inadequately addressed.*** Remedial measures that have been instituted have recorded little success. Rural electrification, for example, has mostly met lighting energy needs, and only to a limited extent. Cooking energy needs continue to be met largely from the use of biomass, which is the predominant contributor to indoor air pollution. Addressing this health hazard therefore requires increased uptake of improved technologies such as efficient cook stoves and cleaner sources of energy such as liquefied petroleum gas (LPG) and solar by addressing the constraints that have hitherto impaired their adoption.

- ***Biodiversity provides goods and services such as food and medicinal plants that promote human health in Africa.*** However, rapid population growth, urbanization, agricultural expansion, invasive alien species, overfishing, overharvesting and destruction of habitats are threatening these services. While command and control measures have ensured sustainable use and management of biodiversity to some extent, there is need to combine these with sustained public awareness campaigns and participatory management approaches such as Community Based Natural Resources Management (CBNRM) and Payment for Ecosystem Services (PES) that, in addition to these benefits, promote equitable benefit sharing.

- ***Chemical use has both beneficial and negative effects on human health.*** Actions are needed to eliminate exposure pathways that contribute to ill health. Chemical users are vulnerable to chemical contamination due to ignorance of the associated risks, non-use of protective gear and ineffective implementation of regulations on storage, transportation and disposal. Informal recovery of fractions from e-waste and illegal disposal of toxic wastes also increase exposure to ill health. Actions to minimize the health hazards include: effective education on chemical use and health risks; rigorous enforcement of relevant laws and regulations; training customs and law enforcement officials; and stepping up border surveillance in order to curb both the importation of obsolete chemicals and the clandestine movement of hazardous chemicals and waste.

- ***Climate change and variability severely impact human health owing to individuals' and communities' limited coping capacities.*** Strengthening adaptive capacities at the national, sub-national and

community levels would better position the region to deal with the vagaries of these changes. Developing multiple crop varieties that can withstand weather variability would enhance food and nutrition security. Effective early warning and disease surveillance systems that alert populations to anticipated disease outbreaks would reduce vulnerability to a number of climate-induced epidemics and facilitate timely and decisive responses.

- ***Coastal and marine resources are integral to the health of coastal populations and need to be conserved and used sustainably.*** Bio-products from marine resources are important ingredients in a range of pharmaceuticals, cosmetics and nutritional supplements. However, these benefits to human health are endangered by the unbridled development of harbours and ports, extractive tourism, offshore oil production and extraction of aggregates, such as sand, gravel and limestone. Oil spills following maritime accidents also pose serious threats to coastal and marine ecosystems. In addition to scaling up Integrated Coastal Zone Management (ICZM), there is need for active surveillance of national territorial seas and exclusive economic zones in order to protect marine resources from degradation.

- ***Access to safe water and adequate sanitation is vital to human health and needs to be scaled up by eliminating impediments such as inadequate infrastructure; pollution of water sources; poor hygiene; retrogressive cultural taboos and gender disparities***. Degradation of water resources typically results from untreated municipal wastewater effluents, seepage into natural wells and springs of faecal matter from latrines located in areas with high water tables, nitrate pollution of groundwater by fertilizers, and eutrophication of dam reservoirs as a result of organic pollution. In addition to strengthening enforcement of regulations against pollution, there is need to institute detailed environmental and health assessments of developments that are likely to pollute water. Expanding and protecting networks of safe water supply and carefully siting boreholes would contribute to gradually correcting glaring rural-urban disparities in access to safe water and adequate sanitation.

- ***Sustainable land management is central to human health because land provides the resource base for the provision of ecosystem services such as food, fibre and medicines***. Land degradation due to inappropriate land use practices, vegetation cover loss, excessive use of chemical pesticides and fertilizers, salinization, contamination by heavy metals, and soil depletion all undermine land productivity, which in turn compromises food and nutrition security. Implementing policies that prevent environmentally detrimental land use changes and inequitable landholding structures enhance food and nutrition security, especially for vulnerable segments of the population which hold land under traditional tenure.

- ***The magnitude of domestic and global uncertainties that decision makers have to grapple with imply that espousing the business as usual model when dealing with environmental problems does not only result in failure to meet internationally set goals and targets, it also undermines human health.*** Adequate adaptation to these uncertainties can benefit from scenario analyses that emphasize the various ways in which environmental management may impact human health well into the future and make it possible to make flexible long-term plans. Although scenarios are neither predictions nor forecasts, they are useful in helping decision makers to reflect on and choose among pathways towards achieving environment and health policy goals.

- ***Although a number of good policies for addressing environmental challenges that affect human health exist, their implementation has been weak. Making policies more effective requires elimination of barriers to implementation.*** Some of the preconditions for successful policy implementation include: adequate data and information systems for decision making; stakeholder engagement and cooperation; clear implementation roadmaps with realistic targets and funding mechanisms; capacity development of all stakeholders; and institutional collaboration to ensure implementation alignment as well as monitoring and review with an emphasis on dissemination of lessons learned.

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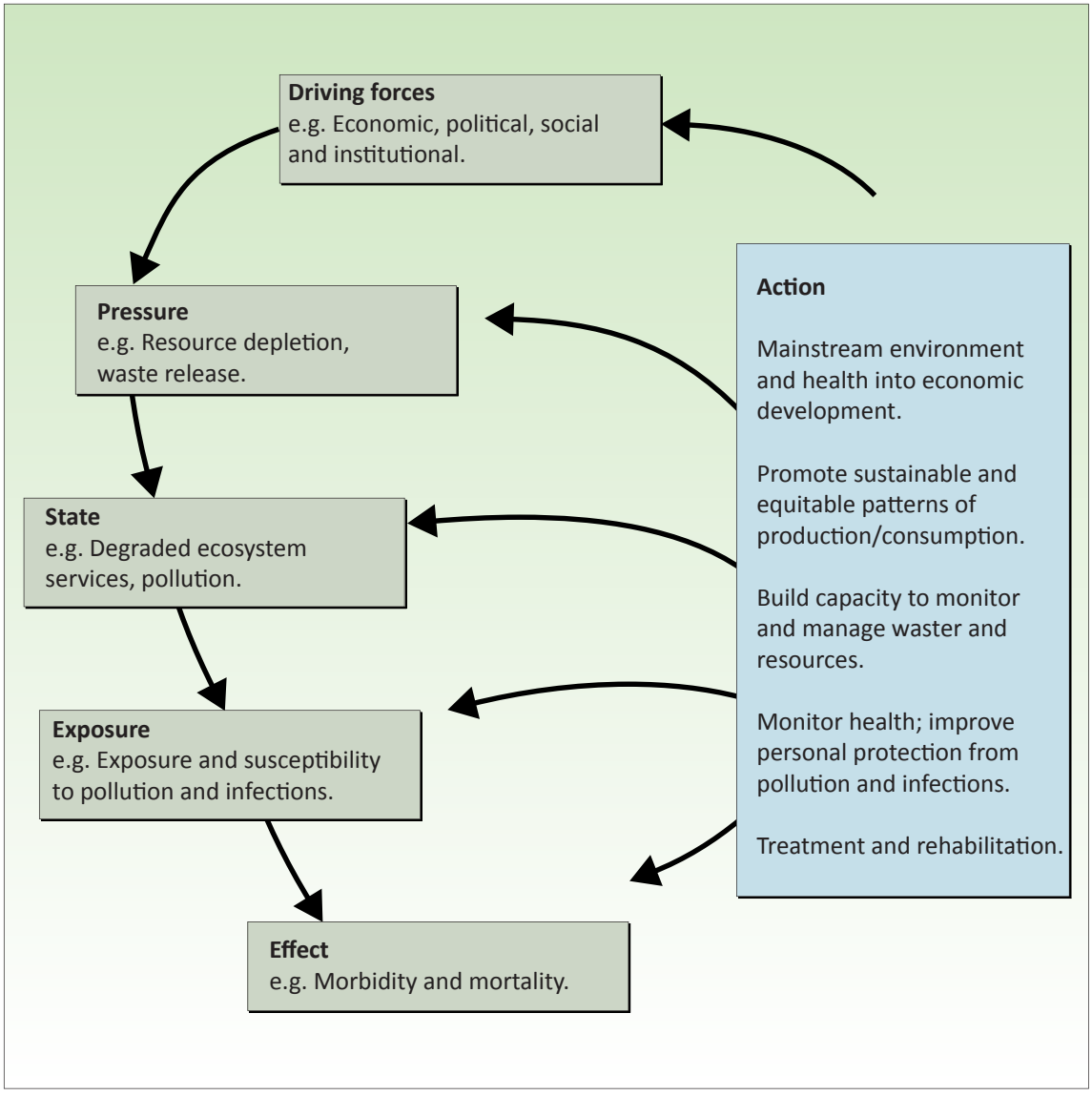
Environment and health inter-linkages

Analytical framework

The framework used for analysis in the report is the Drivers-Pressure-State-Exposure-Effects-Action (DPSEEA) model depicted in Figure 2. This is primarily because it permits a linear or chain approach to mapping a spectrum of environment and health issues from higher level cultural and political **Drivers** of environmental change to **Pressures** which modify the physical environment to produce an environment with defined characteristics – **State**. A particular environmental state will impact humans through varying amounts of **Exposure**, resulting in certain health **Effects**. Society's responses to these effects constitute **Actions** that are applied at the drivers, pressures, exposure and effects levels as part of the management efforts. The actions are aimed at reducing the magnitude of the driving forces, the impact of the pressures, alterations to the state of environment, as well as exposure and effects.

From a policy perspective, the actions or responses can be mapped at any point along the DPSEEA framework chain. The actions may seek to protect or repair the degraded environment, enhance environmental conservation measures or replicate good practices. The DPSEEA framework recognizes that a state of the environment may have positive or negative health effects on certain categories of people depending on the demographic, social, behavioural, cultural or genetic context. To a large extent, the context also determines the vulnerability of a particular category of people to environmental change.

Figure 2: The DPSEEA framework



Source: Modified from WHO (1999)

Thematic assessments: Key findings and messages

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The smog in Cairo is an example of outdoor air pollution

Air quality

Outdoor and indoor air pollution poses considerable health problems in Africa. Outdoor pollution is a challenge in Africa's rapidly urbanizing countries. The transport sector is a major contributor to outdoor air pollution in large African cities such as Addis Ababa, Cairo, Dakar, Johannesburg, Kinshasa, Lagos and Nairobi. The rapidly growing number of second-hand vehicles and poor road infrastructure lead to traffic congestion and air pollution. Forest fires and dust, especially during desert dust storms, are also important sources of outdoor air pollution. Other sources include mining and cement production. Morocco, South Africa, Zambia and Zimbabwe contribute significantly to the region's air pollution mainly through dust and CO_2 from cement production and coal combustion. Outdoor air pollution is estimated to kill 800 000 people per year in the world, mainly in the urban areas, with 40 000 of these deaths occurring in Africa (WHO 2007). The impact of outdoor air pollution on health includes respiratory illnesses, allergies and skin diseases, which are experienced mostly by children (WHO and UNEP 2008).

Indoor air pollution predominates in the rural and low and middle income urban areas where solid fuels are used for cooking and heating. Wood, animal waste, charcoal and coal are often burnt on open fires or in traditional stoves. The low combustion efficiency of these fuels and poor ventilation of the kitchens often results in high concentrations of indoor air pollutants, often 10-30 times higher than WHO limits (Larsen and others 2008). Women and children are disproportionately exposed to this type of pollution. Acute respiratory infections (ARIs), such as rhinitis, laryngitis, asthma and bronchitis, are among the human diseases associated with indoor air pollution. ARIs rank fourth in the share of total burden of diseases in Africa, where they kill 22 per cent of an estimated global figure of 1.6–2.2 million children under the age of 5 years (Zar and Mulholland 2003). Table 1 provides some evidence on the burden of diseases associated with indoor air pollution in Africa.

Photo credit: WHO

The killer in the kitchen

Table 1: Estimated national burden of disease caused by indoor air pollution

Country	Percentage of population using solid fuels	ALRI deaths attributable to solid fuel use (<5 years)	COPD deaths attributable to solid fuel use (≥30 years)	Lung cancer deaths attributable to coal use (≥30 years)	Total deaths attributable to solid fuel use	Total DALYs attributable to solid fuel use	Percentage of national burden of disease attributable to solid fuel use
Angola	>95	21 170	870	-	22 000	747 000	6.9
Botswana	65	100	90	-	200	4 600	0.4
Lesotho	83	260	180	-	400	10 500	0.8
Malawi	>95	12 240	1 060	-	13 300	431 000	5.2
Mozambique	80	8 450	1 230	-	9 700	300 200	2.4
Namibia	65	80	150	-	200	4 000	0.5
South Africa	18	450	560	20	1 000	20 800	0.1
Swaziland	64	320	60	-	400	11 300	1.4
Tanzania	>95	25 050	2 410	-	27 500	885 600	4.4
Zambia	87	8 160	470	-	8 600	285 400	3.8
Zimbabwe	72	1 380	510	-	1 900	50 900	0.6

Source: Bruce and others (2000)

Although air quality standards for transport and industry as well as air quality monitoring mechanisms have been adopted by a growing number of African countries in order to contain the problem of outdoor air pollution, enforcement has tended to be weak. However, indoor air pollution presents a more serious health problem for Africa due to the heavy use of solid fuels (Figure 3). Consequently, a number of interventions have been proposed to reduce it. These include: a) acting on the source of pollution through improved cooking devices; b) improving the living environment through better ventilation, kitchen design and placement of the stove; and c) changing user behaviour to ensure reduced exposure to smoke (Bruce and others 2006).

Cultural and economic impediments constrain the uptake of interventions targeting the source of indoor air pollution. Slow progress in the construction of rural and peri-urban housing due to widespread poverty undermines efforts to improve the living environment. Without adoption of improved cooking devices, alternative fuels or improvements in the living environment, changes in user behaviour would remain severely constrained. Indeed, as generally expected, progress up the energy ladder (Figure 4) has been slow.

While Africa has been successful in phasing out leaded fuel and has progressed well in lowering the sulphur content in diesel, greater attention is needed in addressing the problem of indoor air pollution. Two main policy directions to this end include:

- A rethink of the national electrification programmes to recognize the potential of affordable and decentralised systems, in particular in rural areas, while combining rural electrification with programmes for rural transformation;

- Undertaking rigorous assessments of barriers to the uptake of modern and affordable energy services such as improved cook stoves as well as LPG and solar-energy and then instituting delivery mechanisms and incentives to promote their adoption. These would include partnering in the short-run with the private sector to build a critical mass of technicians to assist with installation and maintenance.

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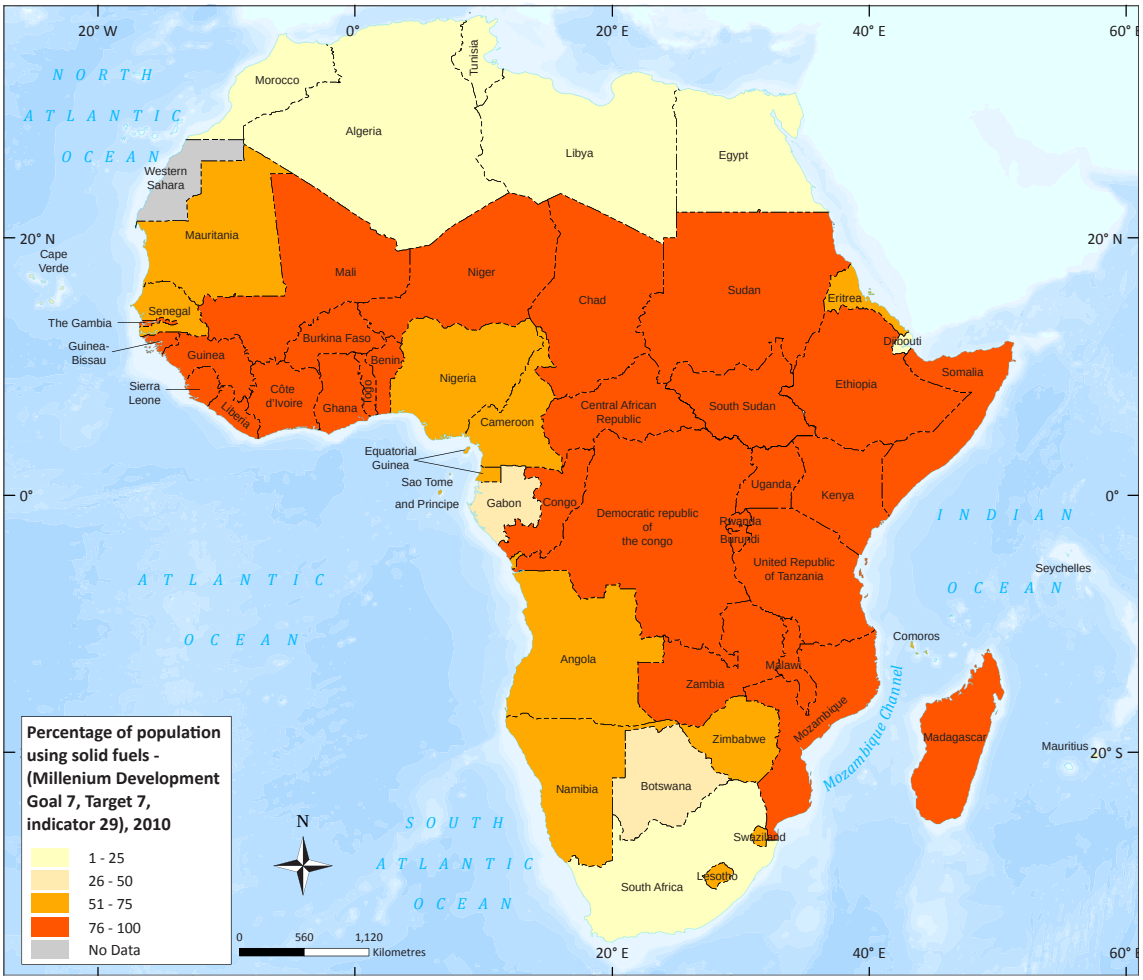
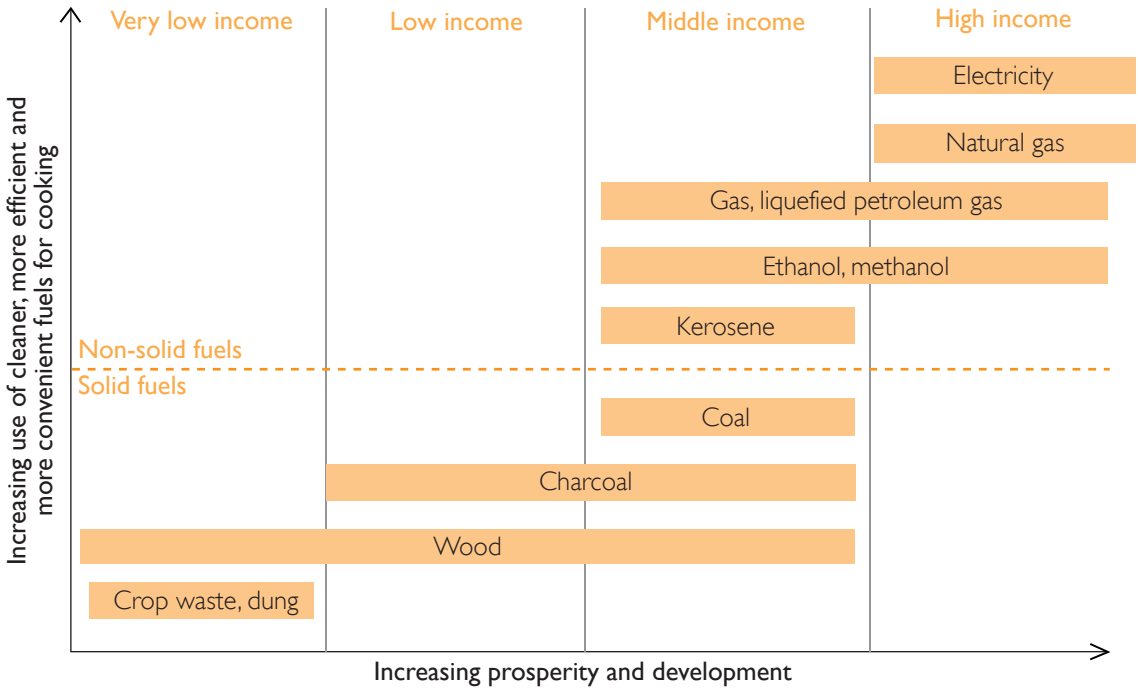
Increased use of solar energy would reduce indoor air pollution

Figure 3: Percentage of population using solid fuels



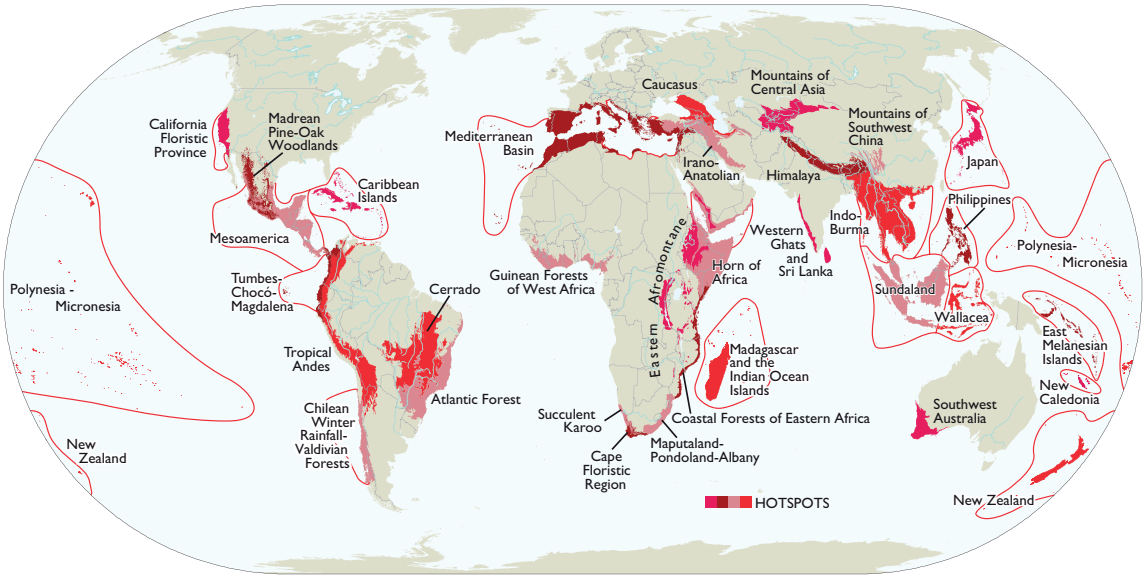
Source: WHO (n.d.)

Figure 4: The energy ladder



Source: WHO (n.d.)

Figure 5: Biodiversity hotspots



Source: Conservation International (2006)

Biodiversity

Africa's rich and varied biological diversity has considerable potential to boost the agriculture, construction, industry, pharmaceutical production and tourism sectors. Figure 5 shows the number of biodiversity hotspots in Africa relative to the rest of the world. Biodiversity supports human health in many ways, including being major sources of food and medicine. The dependence of 80 per cent of Africa's rural population on traditional medicine attests to the importance of biodiversity to human health (WHO 2009). The oils of cedar, cypress, licorice, myrrh and poppy are important traditional medicines while *Prunus africana* is used in the treatment of prostate cancer (Chivian and Bernstein 2008).

A variety of fruits, vegetables, honey, spices, oils, bush meat, fish, edible worms and mushrooms found in Africa's ecosystems contribute to food and nutrition security on the continent. For example, in Zimbabwe, 50 mushroom, 25 fruit and 50 vegetable species are harvested from the wild (Jumbe and others n.d.) while in Mozambique, marine invertebrates are an important food source (MICOA 2009).

Further, Africa's genetic diversity offers opportunities for crop and livestock improvements, especially in enabling breeding varieties that are resistant to drought, pests and diseases that are projected to increase with climate change. It also offers opportunities for the development of pharmaceutical products that would yield both health and financial benefits for Africa. These call for sustainable use and effective management of these resources.

The continent is nonetheless rapidly losing its biodiversity wealth due to uncontrolled exploitation and fragmentation of natural habitats largely due to rapid population growth and agricultural expansion. Increasing rates of deforestation, overgrazing, soil erosion and desertification threaten biodiversity of medicinal and food security value. Overharvesting and climate change also contribute to biodiversity degradation and lead to imbalances in predator-prey relationships that may create conditions for disease outbreak.

Overfishing in Lake Malawi characterized by the increased use of fine-mesh beach seines, for instance, caused a decrease in the density of the snail-eating cichlid *Trematocranus placodon*. The decline of these predators contributed to the rise in proliferation of the schistosomiasis parasites and the attendant increase in bilharzia cases (Stauffer and others 2006; Evers and others 2006). Habitat disturbance typified by damming, destruction of coral reefs through dynamite fishing, and the conversion of natural forests into arable land also create conditions that may favour breeding of disease vectors.

Equally, deforestation raises sunlight, temperature and surface water availability, creating new breeding sites for the *Anopheles* mosquito that transmits malaria.

Other anthropogenic changes that alter forest ecosystems such as logging and road construction through forests can also bring people into closer contact with wildlife, increasing the risk of zoonotic disease transmission (CFSPH and IICAB 2009). Non-human primates are an important human disease reservoir because of their physiological similarity to people and their ecological responsiveness to habitat disturbance (Chapman and others 2005). Ebola and monkey pox are examples of zoonotic diseases that may spread following increased contact between humans and other primates (Patz and Olson 2008; CFSPH and IICAB 2009).

Policy, legal and administrative measures, including designation and co-management of protected areas are some of the actions taken by countries to curb biodiversity loss. Sub-Saharan Africa has over 1 100 national parks and reserves, 36 of which are designated as World Heritage Sites. Worldwide, protected areas now cover nearly 3.06 million sq. km. of terrestrial and marine habitats, nearly double what they covered in 1970. In Africa, they cover 16 per cent of East and Southern Africa and 10 per cent of West and Central Africa.

The challenges of sustainable use and management of biodiversity in line with national, regional and global conservation goals include more effective enforcement of existing policy and legislative measures and equitable benefit sharing regimes for communities whose livelihoods and by extension health depend on the ecosystem services offered by the protected areas. A combination of command and control, and participatory approaches is an important component of this balancing act.

Two main policy directions are suggested for enhancing sustainable use and management of biodiversity for human health:

- A blend of command and control, and participatory management approaches, such as Community-based Natural Resources Management (CBNRM), Transboundary Natural Resources Management (TBNRM) and Payment for Ecosystem Services (PES). However, it is vital that sufficient measures are instituted to avert elite capture of benefits that flow from the implementation of these participatory management arrangements;
- Promoting community access to biodiversity resources needed for livelihoods while monitoring risks of zoonotic diseases associated with human-wildlife contact.

Chemicals and waste

Chemicals are used in a number of economic sectors including health, agriculture, infrastructure, mining, education, research and industrial processes. If not handled carefully and safely, chemical use can lead to environmental pollution and pose serious risks to human health. Potentially hazardous chemicals and their categories whose use is prevalent in Africa are: agrochemicals; mercury; and persistent organic pollutants (POPs) while chemical stockpile, electronic waste (e-waste) and petroleum waste streams are proving to be increasingly problematic in many countries in the region.

Use of agrochemicals, which include insecticides, herbicides, acaricides, fungicides, rodenticides, nematicides, avicides and fertilizers, is growing in Africa due to the large number of people who depend on agriculture. Persistent organic pollutants (POPs) contain extremely toxic properties but also unlike other pollutants, they resist degradation and are known to persist in the environment (IPCS 1995). The 12 POP classes that are of concern include industrial PCBs, polychlorinated dioxins and furans, and the pesticides DDT, aldrin, chlordane, dieldrin, endrin, heptachlor, HCB, mirex, and toxaphene. Chemical stockpiles consist of obsolete pesticides. In Africa, the main pathways to mercury exposure are the food chain and artisanal gold mining, where the heavy metal is used to extract gold from the ore.

The rapid evolution of the ICT sector characterized by fast innovations; and the changing lifestyles of the growing middle class in Africa are contributing to the increased use of cellular telephones and computers. The uptake of these is fuelled by the wide adoption of real time e-commerce solutions such as mobile money transfer and e-banking as well as other initiatives such as telemedicine, e-government, and e-education. These products subsequently contribute to the burgeoning e-waste stream because they are usually disposed of as ordinary waste when they reach the end of their lifecycles.

Industrial growth and petroleum production in Africa portend health risks associated with exposure to

toxic industrial wastes. As other African countries (such as Ghana, Kenya, Tanzania and Uganda) join the league of petroleum producing nations, there is need for them to establish rigorous waste management regimes based on international best practices.

As noted in AEO-2, although chemical production and use in Africa is substantially lower than the global average, the region shoulders a disproportionate human health and environment risk burden (UNEP 2006). This is attributable to accidental spillages, dumping and compromised ecosystems that are then less able to deliver their traditional environmental services.

Accidental contact with chemicals and toxic waste is common among agricultural workers, gold artisanal miners and informal e-waste recycling sector players who usually lack protective clothing and equipment. Table 2 contains examples of pesticide poisoning. Poisoning from Dichlorodiphenyltrichloroethane (DDT) – which is used for indoor residual sprays for malaria control in 13 African countries (WHO 2011) – and other POPs have been implicated in a range of terminal and chronic ailments such as cancer, impaired reproduction, immune-system suppression and endocrine dysfunction.

Table 2: Examples of pesticide poisoning in Africa

Country	Examples of pesticide poisoning
Togo	More than 500 cases of poisoning linked to endosulfan have been recorded each year by the Toxicology Division of the Public Hospital of Lome-Tokoin (Kodjo 2007).
Ivory Coast	The National Centre for Agronomical Research in Abidjan estimates that 65 per cent of the illnesses suffered by market gardeners, cotton growers, mango producers, as well as consumers in Ivory Coast, are due to pesticides (Hala, Kehe, 2009).
Morocco	2 609 cases of poisoning recorded at the Moroccan Anti-Poison Centre over the period 1992-2007 (Rhalem and others 2009).
Mali	In 2000, FAO estimated that acute pesticide poisoning affected 329 people a year with 30-210 deaths resulting from 1 150-1 980 chronic poisonings (FAO/CILSS 2000).
Burkina Faso	100 producers spraying cotton crops in the area of Gourma, experienced severe headaches (92 per cent), dizziness (83 per cent), trembling hands (54 per cent), nausea or vomiting (21 per cent), impaired vision (21 per cent), excessive sweating (13 per cent), blackouts (8 per cent) and hyper salivation (8 per cent). The 2006 study found that the most serious incidents (13 per cent) occurred during pesticide use and other symptoms occurred hours or days after use. The pesticide responsible was not positively identified, but was suspected to be endosulfan. (Glin and others 2006).
Kenya	350 000 people (7 per cent of people in the agricultural sector) suffer pesticide poisoning every year (Saoke 2005). In 1985 the major hospitals treated on average 2 cases of pesticide poisoning each week; in 1996, the Kenyan Ministry of Health estimated that 700 people died due to pesticide poisoning (Shivoga undated).

Source: PAN (2010).

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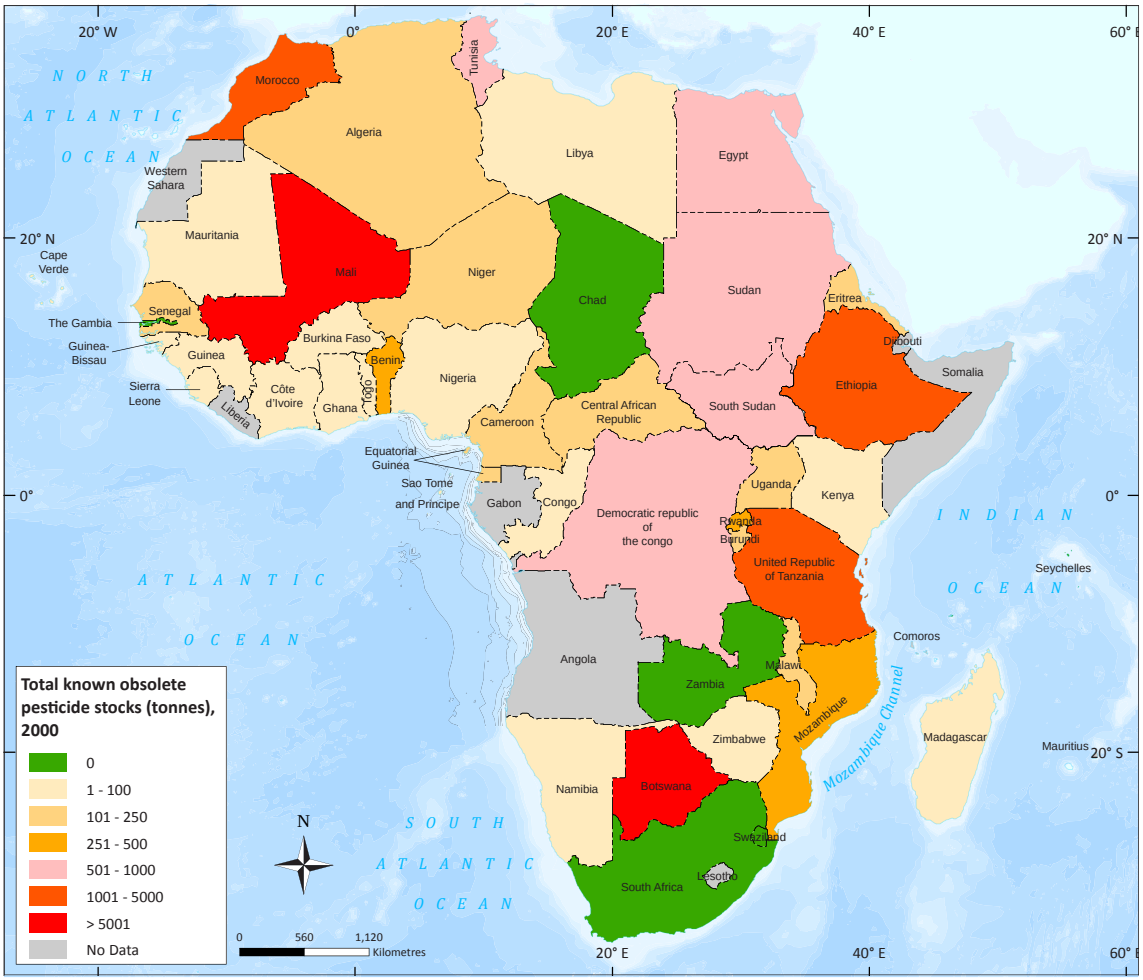
Pesticide poisoning has been reported in some of Africa's cotton growing belts

Figure 6: Pesticide stockpiles in Africa



Source: Adapted from UNEP/GRID-Arendal 2006

Chemical stockpiles primarily consisting of expired pesticides often leak out of their aged and corroding storage containers, contaminating soil and water (World Bank 2010). Children, pregnant women and the elderly are especially vulnerable to this type of contamination. Figure 6 depicts the distribution of pesticide stockpiles in Africa.

Besides direct occupational exposure to metallic mercury, gold-mining communities are exposed to metallic mercury in their diet via ingestion of fish caught from contaminated water bodies (Nweke and Sanders II, 2009). High exposure to mercury has deleterious effects on human organs such as kidneys as well as the cardiovascular and immune systems (ATSDR 1999).

Dumping is another chemical management issue that is prevalent in Africa. It is a symptom of weak regulatory and enforcement regimes that enable highly toxic and mislabelled chemical imports into the region and it is highlighted here because of its far-reaching effects. The dumping of a cocktail of highly toxic chemicals in Abidjan in 2006 that led to 17 deaths and the illness of 30 000 Ivoirians is a poignant reminder of the potentially catastrophic effects of dumping.

Indicators of compromised ecosystem integrity as a result of toxic waste include freshwater pollution and eutrophication. While the rapid growth of the petroleum industry in Africa has the potential to lift millions of people out of the poverty trap, the necessary safeguards need to be instituted. This would help to prevent pollution of water sources at highly harmful scales.

A case in point is the contamination of wells in Nisisioken Ogale in the Niger Delta with benzene, a known carcinogen, at levels over 900 times above the WHO limits (UNEP 2011). The new petroleum producing nations such as Ghana, Kenya and Uganda need to institute petroleum waste management regimes based on international best practices.

Policy directions here would include:

- Adoption of the Strategic Approach to International Chemicals Management (SAICM) framework which promotes sound chemical use by African countries, and establishment of national and sub-regional level initiatives that are geared at protecting human health and the environment;

- Strengthening the knowledge and evidence base on the health risks of hazardous chemicals and wastes and using that evidence for awareness creation, and empowerment of government ministries, communities, civil society and the private sector in advocating for strategic actions that promote human health;

- Accelerating domestication and implementation of, and strengthening of cooperation among the Basel, Stockholm, and Bamako Conventions. as well as strengthening implementation mechanisms at national levels;

- Participating in negotiations on the nascent mercury convention;

- Strengthening legislative instruments for effective application of the polluter-pays principle;

- Including issues related to e-waste, toxic wastes and second-hand goods in national legislation, standard setting and capacity building.

Climate change and variability

Evidence from the Fourth Assessment of the Inter-Governmental Panel on Climate Change (IPCC) reveals that Africa is warming faster than the global average and that it is likely to warm by an average 3°C to 4°C this century. This makes climate change a considerable health and economic challenge for the continent. Weather-sensitive diseases are likely to spread faster with global warming (Guernier and others 2004). These include Rift Valley Fever, which affects both people and livestock; cholera, which is associated with wet conditions such as floods; meningitis, which spreads faster in warm temperatures, and malaria, which is increasingly occurring in the warming highlands of Kenya, Rwanda and Tanzania (WHO 2010) which were previously disease free. In some areas, warming is likely to translate into reduced crop yields and livestock productivity and water scarcity, concomitantly imperilling human health and nutrition. Table 3 shows how climate change is likely to impact Africa's sub-regions.

Another potential impact of increasing average temperatures and changing weather patterns is the loss of biodiversity and associated decrease in the availability of medicinal plants that some of the populations depend on for treatment of ailments. Extreme weather events (EWEs) such as droughts and floods are also projected to be more frequent (Figure 7), with dire consequences for human life and health.

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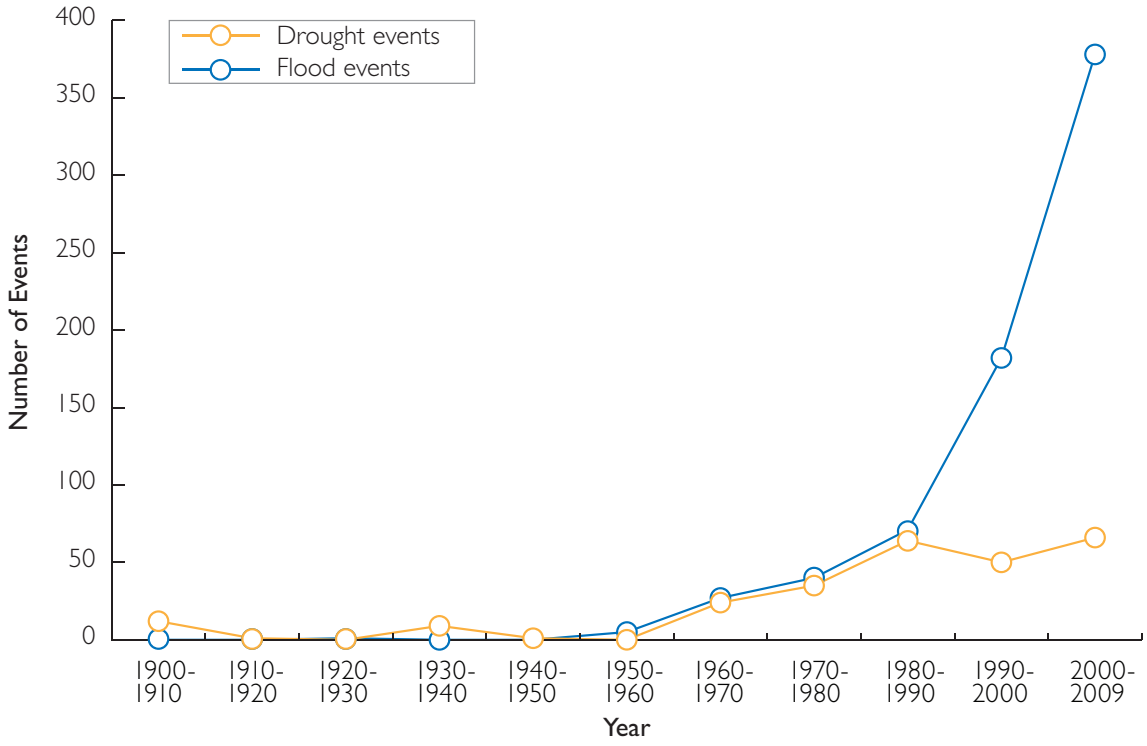
Climate change is expanding the habitat ranges of several disease vectors

Table 3: Examples of interlinkages between climate change impacts and health vulnerabilities in Africa's sub-regions

Sub-region	Interlinkages
Northern Africa	• Sea level rises lead to salt intrusion, flooding and destruction of human settlements and water stress • Over-abstraction of scarcer water leads to deteriorating water quality and higher incidences of water borne diseases • Unpredictable weather conditions lower food yields and quality • Depleted fish stocks lower food security and household incomes • Temperature rises affect the health of vulnerable populations e.g. children, the sick and elderly.
Western Africa	• Higher frequency of EWEs results in increased mortality and morbidity • Prolonged dry spells threaten food and nutrition security and access to medicinal herbs • Warmer temperatures encourage the spread of weather-sensitive diseases e.g. malaria, meningitis, dengue fever and parasites like hookworms and ascaris • More frequent EWEs increase the vulnerability of HIV/AIDS affected persons.
Eastern Africa	• Rising number of EWEs lead to severe food shortages and malnutrition • Rising number of EWEs lead to higher morbidity and mortality • Warmer ambient temperatures extend weather-sensitive diseases e.g. malaria and Rift Valley Fever to previously disease-free zones such as the highlands of Ethiopia, Kenya, Rwanda and Tanzania • Frequent flooding favours the spread of waterborne diseases e.g. cholera, Rift Valley Fever and parasitic infections • Severer drought leads to conflicts over scarcer natural resources e.g. water, forests and pastures.
Central Africa	• Frequent occurrence of EWEs increases human injuries from collapsing buildings and infrastructure, landslides and heat waves • Intensified flooding increases incidences of water-borne diseases e.g. cholera and typhoid • Warmer temperatures lead to the proliferation of disease vectors e.g. ticks, mosquitoes and rodents while scarcer resources lead to increased human-wildlife contact and increased exposure to zoonotic diseases such as Ebola • Unpredictable weather patterns disrupt food and livestock production.
Southern Africa	• Water stress leads to land degradation and lower food and livestock yields • Frequent occurrence of EWEs increases human injuries from collapsing buildings and infrastructure, landslides and heat waves • Intensified flooding increases incidences of water-borne diseases e.g. cholera, typhoid and schistosomiasis • More frequent EWEs increase the vulnerability of HIV/AIDS affected persons.
Western Indian Ocean Islands	• Sea level rises disproportionately affect SIDS such as Seychelles and Mauritius • Salt water intrusion leads to freshwater scarcity • Higher temperatures lead to reduced fisheries and marine biodiversity and the concomitant erosion of medicinal value • Intensified flooding increases incidences of water-borne diseases e.g. cholera, typhoid and schistosomiasis • Higher frequency of EWEs particularly floods lead to inundation and erosion of coastal areas, human injuries and loss of life.

Source: Adapted from Boko and others (2007)

Figure 7: Trends of some Extreme Weather Events associated with climate change



Source: UNEP (2010)

Africa's vulnerability is accentuated by the high dependence of large populations on natural resources. Changes in weather conditions that adversely impact agriculture readily translate into income, food and nutrition insecurity for marginalized communities. Moreover, the sole reliance of most producers on rain-fed agriculture means that small changes in rainfall patterns can significantly jeopardize their livelihoods. Adaptation to climate change is complicated by limited economic diversification, poorly resourced governments and lead agencies and the virtual absence of insurance cover for climate-sensitive investments such as agriculture.

Despite Africa's small carbon footprint, its populations are severely affected by EWEs but have limited coping mechanisms and safety nets. The priority of policy makers should therefore be to enhance the adaptive and coping capacities of national and local governments, communities, and individuals. Admittedly, a growing number of countries have developed National Adaptation Programmes of Action to climate change (NAPA). While this is a crucial step in building climate resilience, the continent is not reaping the potential benefits because implementation of these plans has been rather limited. This has been attributed to insufficient funding and failure to integrate the NAPAs in national budgets and development blueprints.

Some progress has nonetheless been made in developing and deploying agricultural adaptive technologies such as short-season and drought resistant crop varieties, particularly maize. Further efforts are however needed to ensure availability of such technologies to a critical mass of the continent's farmers. Early warning systems have also been strengthened across the region and have improved capacity for preparedness and responsiveness to EWEs.

Policy directions for ensuring better human health amidst climate change and variability include:

- Integrating climate-related scientific findings into decision-making at all levels;
- Enabling vulnerable communities, including women, children and the aged to better cope with changes in their environments by encouraging them to engage in alternative livelihoods and strengthen their adaptive, disaster preparedness and response capacities;

- Sharing information on successes and challenges impinging on climate change;

- Climate proofing investments in climate sensitive sectors such as infrastructure, agriculture, water and health and creating a conducive environment for the use of weather-indexed insurance;

- Enhancing institutional capacities for early warning systems, preparedness and response, especially of Small Island Developing States (SIDS) by, for instance, harnessing ICT in public awareness campaigns and in monitoring the spatial distribution of and progress of epidemics associated with climate change;

- Strengthening countries' governance systems and performance and accordingly enabling them to tap a range of climate change financing mechanisms such as Clean Development Mechanisms (CDM), REDD+ (Reducing Emissions from Deforestation and Forest Degradation, Forest Conservation, Sustainable Management of Forests and Carbon Stock Enhancement) and the Forest Carbon Partnership Fund (FCPF). Where projects funded under these mechanisms already exist, appropriately scaling them up would produce positive outcomes for the environment and human health.

Coastal and marine resources

Thirty three African mainland and six island countries share a 45 649 km coastline (Vafeidis and others 2008). The continent has rich coastal and marine resources that, besides marine life, include mineral deposits, oil and gas. As such, many economic activities such as shipping, transportation and recreation depend on these resources. Bio products from a myriad of marine life have wide applications as important pharmaceutical, cosmetic and nutritional supplement ingredients. Sharks and horseshoe crabs, for instance, contain essential compounds for the treatment of certain forms of cancer, muscle diseases, and chronic pain (Chivian 2008).

Human settlements, infrastructure development (such as harbours and ports), oil production, harvesting of aggregates and extractive tourism along the coastline and in the open ocean risk degrading these fragile ecosystems. Vector control actions such as the periodic spraying of the sea ports and airports with DDT for the control of malaria vectors as is done in Mauritius (MEO 2011) have similar effects. However, over 80 per cent of the marine pollution in Africa comes from land-based activities and comprises agrochemical runoff, oil refinery sludge and untreated sewage (WWF 2011). Oil pollution such as that caused by maritime accidents and resultant shipwrecks (Figure 8) imperils the health of coastal populations and contaminates the marine ecosystem. In addition, deliberate discharge of ballast water by vessels may lead to the introduction of alien species.

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Shipwrecks threaten the integrity of Africa's coastal and marine resources

Figure 8: Shipwreck sites around Africa

Source: WRECKSITE 2012

Extractive and mass tourism in the marine environment and inappropriate fishing methods, such as the use of dynamite alter the habitats for marine biodiversity, thereby affecting field yields. These together with overfishing can affect the food and nutrition security of coastal communities which typically rely on fishing to meet their animal protein needs. This in turn impacts negatively on the health of the affected population. Illegal, unreported, and unregulated (IUU) fishing is particularly a growing concern on the West African coast. Proactive measures to curb this vice include the use of ocean surveillance. Angola, for example, carries out routine naval patrols in its territorial waters which collectively constitute one of the world's four major upwelling systems.

While national efforts to promote Marine Protected Areas (MPAs) and Integrated Coastal Zone Management (ICZM) are contributing to curbing coastal resource depletion and to controlling coastal pollution, there is need to reinforce them with the concerted implementation of the Bamako, Nairobi and Abidjan Conventions.

Policy directions in enhancing the management of coastal and marine resources to benefit human health include:

- Scaling up ICZM and consolidating Marine Protected Areas (MPAs) into the more effective Marine Management Areas (MMAs) (UNEP 2012);
- Accelerating ratification, domestication and implementation of the Bamako, Nairobi and Abidjan Conventions;
- Replicating ecosystem-wide management approaches such as that which underpins the Western Indian Ocean Marine Eco-region (WIOMER) and scaling up the participatory management model such as that used in the

Mafia Islands of Tanzania to halt degradation of coastal and marine resources.

Freshwater and sanitation

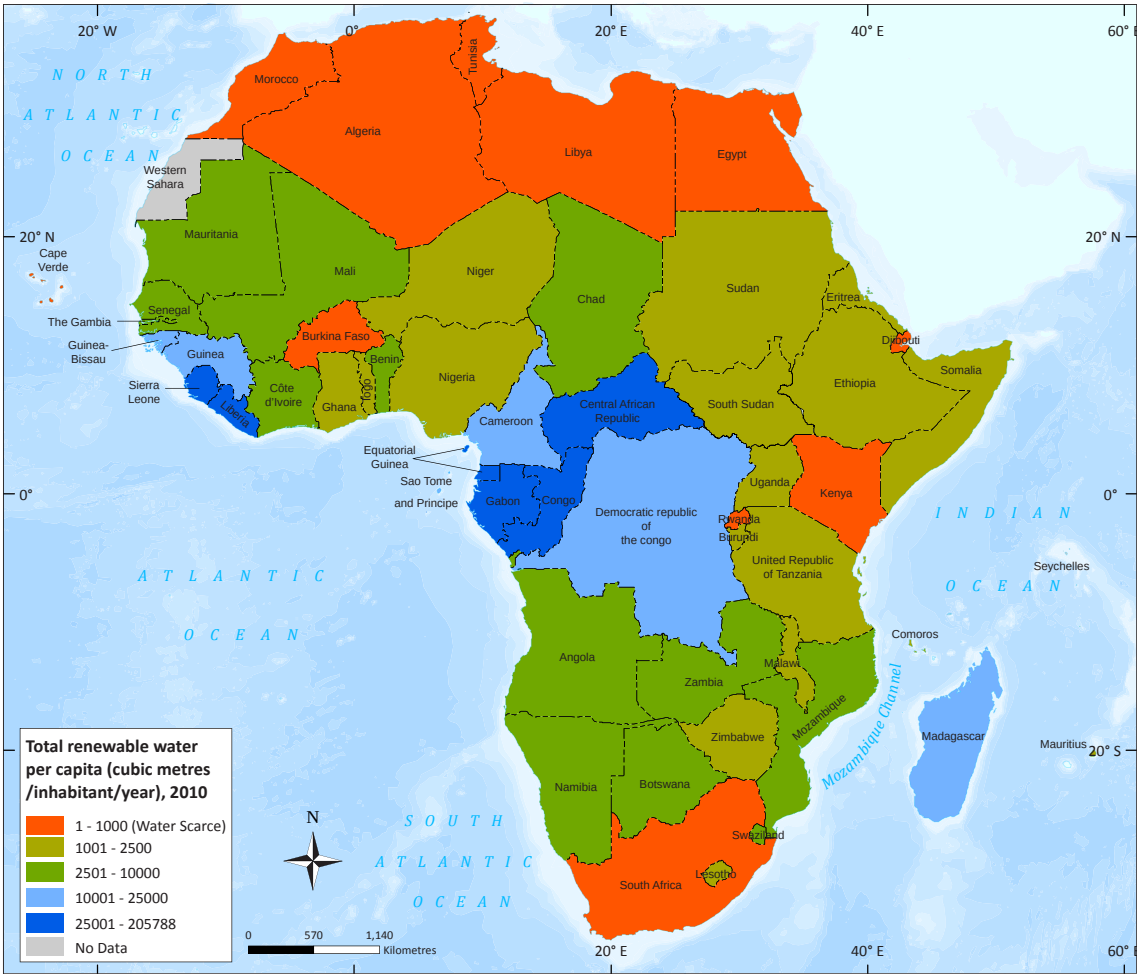
Africa's freshwater resources include 63 transboundary river basins that are home to 77 per cent of the continent's population, as well as 38 shared aquifers. The Nile, Niger, Congo and Zambezi, and large natural lakes including Victoria, Tanganyika and Malawi, are among the world's largest water bodies (UNEP 2010). Many high altitude areas in several watersheds – referred to as 'water towers' and depicted in Figure 9 – are the remote sources of these rivers and lakes. The continent holds an estimated 660 000 km^3 of groundwater, which is more than 100 times the estimated annual renewable freshwater resources in the continent (MacDonald and others 2012). Africa's largest groundwater reserves are located in large sedimentary aquifers in Libya, Algeria, Egypt and Sudan. Groundwater is especially important for the relatively dry Northern and Southern sub-regions.

With an annual population growth rate of 2.3 per cent (UNFPA 2011), rapid urbanization and increasing industrialization, there is greater competition among various water end uses such as human consumption, productive activities and ecosystem maintenance. Yet a considerable population lives in arid and semi-arid areas where rainfall is scanty. In 2008, it was estimated that Africa's annual per capita water availability stood at 4 008 m^3, compared to the global average of 6 498 m^3 (UNEP 2010). Furthermore, water resources are unevenly distributed across geographical zones, with major settlements in countries such as Namibia and Botswana often located far away from water sources. Water scarcity (Figure 10) is projected to increase from 47 per cent in 2000 to 65 per cent in 2025 (Bates and others 2008). Africa experiences wide variations in internal renewable water resources owing to a range of natural and anthropogenic factors. The uneven distribution of rainfall across the continent, its unpredictability and high evaporation losses account for the natural variation (Batisani and Yarnal 2010).

Figure 9: Africa's water towers

Source: UNEP 2010

Figure 10: Total renewable water per capita



Source: FAO (2010)

Climate change is nevertheless accentuating the irregularity of rainfall patterns (NASA 2010). Anthropogenic factors that contribute to inadequate water availability include degradation of water catchment areas, extraction of groundwater at rates that surpass natural replenishment and inefficient use of water for productive purposes.

Safe drinking water and adequate sanitation are vital to human health yet a sizeable population lack ready access to these as water pollution remains a major concern. Human-induced pollution includes pathogenic contamination of surface and ground water sources by untreated municipal wastewater effluents; faecal matter seepage from latrines dug in areas with high water tables; nitrate pollution by fertilizers; cadmium-rich water releases from phosphate mines; and eutrophication of dam reservoirs (AWC 2004). Table 4 illustrates the categories of diseases that are generally associated with lack of safe water and adequate sanitation.

The extent of the water and sanitation challenges vary across the continent depending on the levels of urbanization, industrial activities and the effectiveness of waste management laws and regulations. There are also in-country variations that are mostly manifested through the rural-urban divide. Urban dwellers are 1.8 times more likely than their rural counterparts to use an improved drinking water source (United Nations 2011). However, rapid urbanization is stretching the ability of the existing infrastructure to deliver adequate water and sanitation.

The majority of the continent's population still lacks safe drinking water, with Sub-Saharan Africa accounting for nearly a third of the 884 million people who have no access worldwide (UNEP 2010). Although by 2010 the actual number of people using improved drinking water sources had increased by 11 per cent relative to 1990, only 60 per cent of the Sub-Saharan Africa population had access to safe water (WHO and UNICEF 2010). As illustrated in Figures 11 and 12, Africa's progress towards safe

Table 4: Health effects associated with lack of safe drinking water and adequate sanitation

Selected health effects	General impacts of these diseases
Intestinal diseases spread through unsafe drinking water: • Diarrhoea; • Cholera; • Typhoid; • Guinea worm; and • Dysentery. **Diseases caused by inadequate sanitation and hygiene:** • Intestinal worms (including ascariasis, trichuriassis and hookworm); • Schistosomiasis (bilharzia); • Trachoma.	• Loss of productive time for workers and school children due to illness; • Loss of time and energy spent on collecting water from distant sources; • Loss of productive time attending to the sick; • Premature deaths; • Increased numbers of orphaned children; • Persistence of poverty; and • Poverty and stress-induced criminal activities and conflicts.

Source: Eneh (2011).

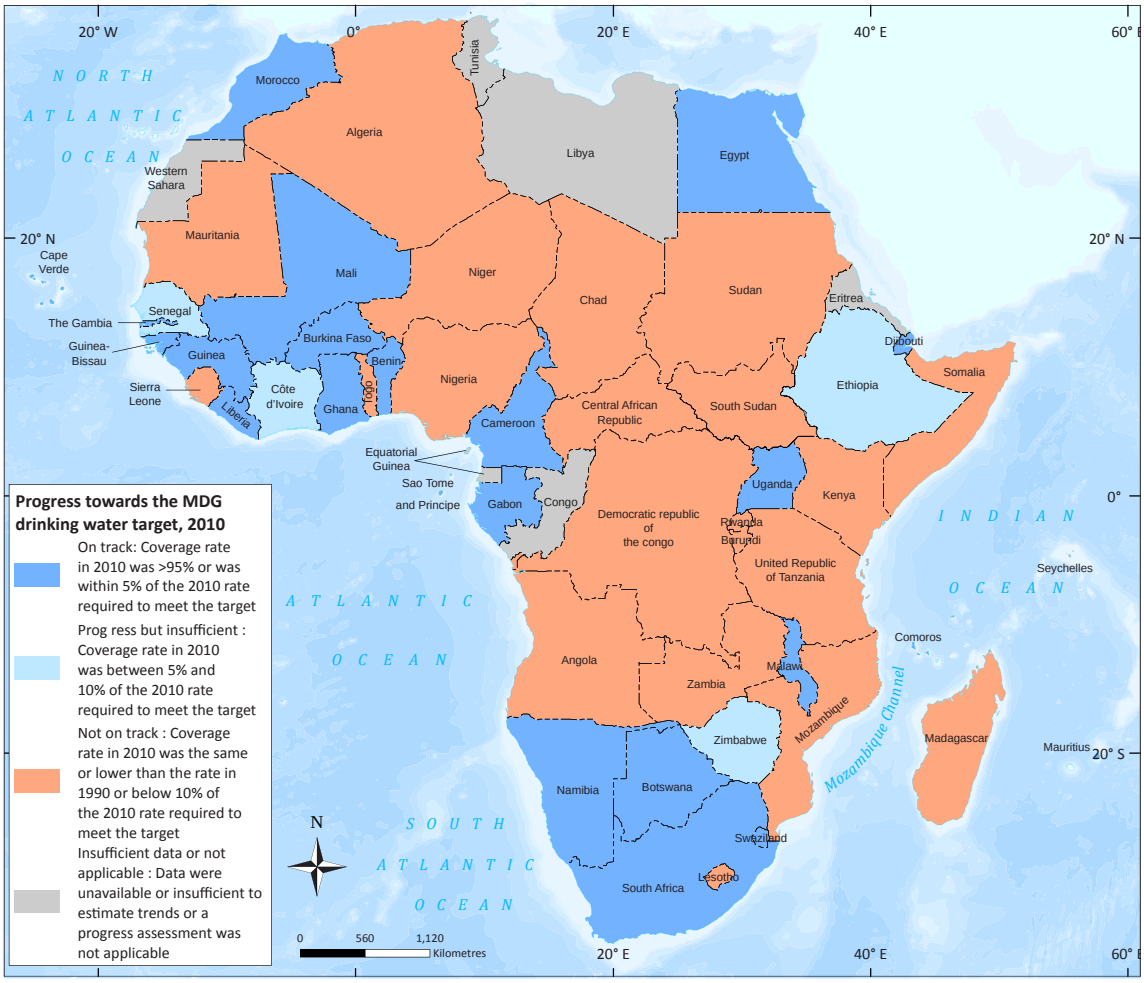
drinking water and improved sanitation is slow. By 2010, only 19 countries were on track to meeting the safe drinking water MDG target and seven were on course to meeting the improved sanitation target. (UNICEF an WHO 2012).

Some sub-regional variations in progress nevertheless exist. In the case of sanitation, North Africa is the only sub-region that has already surpassed the MDG target with access coverage increasing from 72 per cent in 1990 to 89 per cent in 2008 (United Nations 2011). Principally on account of wealth disparities, stark differences also exist between the urban and rural areas of the continent. However, because even the rural and urban populations are not homogeneous categories, perceptible differences exist within them. For example, the poorest 20 per cent urban cohort is nearly six times more likely to obtain water from an unimproved source than the wealthiest 20 per cent. In addition, the urban poor are 12 times less likely than the richest households to have piped water connections on their premises (United Nations 2011).

While progressive national water and sanitation policies are helping to improve water availability and accessibility as well as water use efficiency, this effort is more prevalent in urban areas. Effective improvements in access to safe water and adequate sanitation in rural areas where most marginalized people live therefore require a policy and strategy rethink. In this regard, possible policy directions include:

- Managing watersheds, including Africa's water towers, in order to protect water sources and thereby ensure sustainable supply of the resource;
- Mapping groundwater to determine its overall availability and quality in the various countries. This will better prepare countries to cater for the growing human population but also avert climate induced shortages;
- Instituting water-use policies and tariffs that treat water as an economic good and ensure its equitable availability to meet competing needs without unduly compromising the right of the poor to safe and sufficient water;
- Enforcing environment and health impact assessments of development projects that expose people to water-borne diseases. This would be especially effective for projects planned in rural areas where the communities typically lack lobbying and litigation capacity;
- Sensitizing individuals on Total Sanitation using a combination of information, education and communication (IEC) that target households, schools and communities and aim at changing attitudes and behaviour towards proper hygiene;
- Expanding networks of safe water supplies, especially in the peri-urban and rural areas,

Figure 11: Progress towards improved drinking water



Source: UNICEF and WHO (2012)

while ensuring that sources such as boreholes and protected wells and springs are located in places that are not vulnerable to pollution from pit latrines and other land-based sources and activities.

Land

Africa's 54 countries cover a combined area of 30 million sq. km., making it the second largest continent in the world after Asia (UNEP 2006; UNEP 2007). Africa's landscape is a mosaic of natural resources, including forests and woodlands, grasslands, arable land, mountains, arid lands and deserts, coastal lands and freshwater ecosystems. An estimated 6.7 million sq. km. of the continent is covered by forests and woodlands, while arid zones and deserts account for 66 per cent of the region's total land area. The Sahara, which is the largest desert in the world, and the Kalahari/Kgalagadi are key features of Africa's geography. Arable land covers about 8.07 million sq. km. of which 1.97 million sq. km. are under cultivation (Cotula and others 2009).

Africa's arable land has the capacity to produce adequate food for the majority of the continent's population (UNEP 2007). The region produces a range of crops for the domestic and export markets, including maize, sugar cane, cassava, groundnuts, coffee, cocoa and tea. Land availability to the population depends on the tenure regimes in force in any given country. Incidences of inequitable land distribution exist in some countries, especially those that previously had colonial settler populations. The new rush for land for foreign investment, the production of bio-fuels and establishment of forest plantations for the carbon market is exerting competitive pressure on food production. Overall, it is estimated that Africa contributes 70 per cent (45 million ha) of the global land leased or purchased by foreign enterprises to produce agricultural crops for food and biofuels, with adverse impacts on local food security and livelihoods (Deininger and others 2011; Cotula and others 2009). Yet the expected benefits of these land investments – more jobs, technology transfers, better infrastructure and extra tax revenue

Figure 12: Progress towards improved sanitation

Source: UNICEF and WHO (2010)

– have often proved elusive (Locher 2011; Da Via 2011). Commercial cultivation of genetically modified organisms (GMOs) for food, livestock feed and processing is growing in Burkina Faso, Egypt and South Africa (Moola and Munnik 2007; Omanya 2010).

Africa suffers from considerable land degradation (Figure 13), with severe consequences for agricultural production, nutrition and human health. Since 1950, soils on about 500 000 sq. km. of land have been degraded. Over 60 per cent of the population in Burkina Faso, Ethiopia, Lesotho and Mali live on degraded land. Overall, yield losses from soil erosion in sub-Saharan Africa are between 2-40 per cent, the worst globally (den Biggelaar and others 2004).

Land is central to human health as it is the resource base from which ecosystems services such as food, fibre and medicines are derived. By sustainably using land, people can enhance their health through increased access to a wider range of ecosystem services. Land degradation due to inappropriate land use practices, resulting in loss of vegetation cover, excessive use of chemical pesticides and fertilizers, salinization, contamination by heavy metals, and soil depletion adversely affects land productivity and impacts negatively on food and nutrition security (IFAD and GEF 2002). Changes in land use can also alter the ecology of human diseases, making people more vulnerable to infections (Collins 2001). Indirect health effects of land degradation include the rapid spread of infectious diseases owing to increased internal migration in search of arable land.

Further, the conversion of bush land hitherto infested with tsetse flies through eradication programmes involving DDT application has had both positive and negative effects. Although this DDT application was credited with enabling expanded food production in Ethiopia, Kenya and Zimbabwe, its subsequent detection in the milk of breast-feeding mothers aroused health concerns (Chikuni and others 1997). Even if the cost-benefit effects of DDT remain debat-

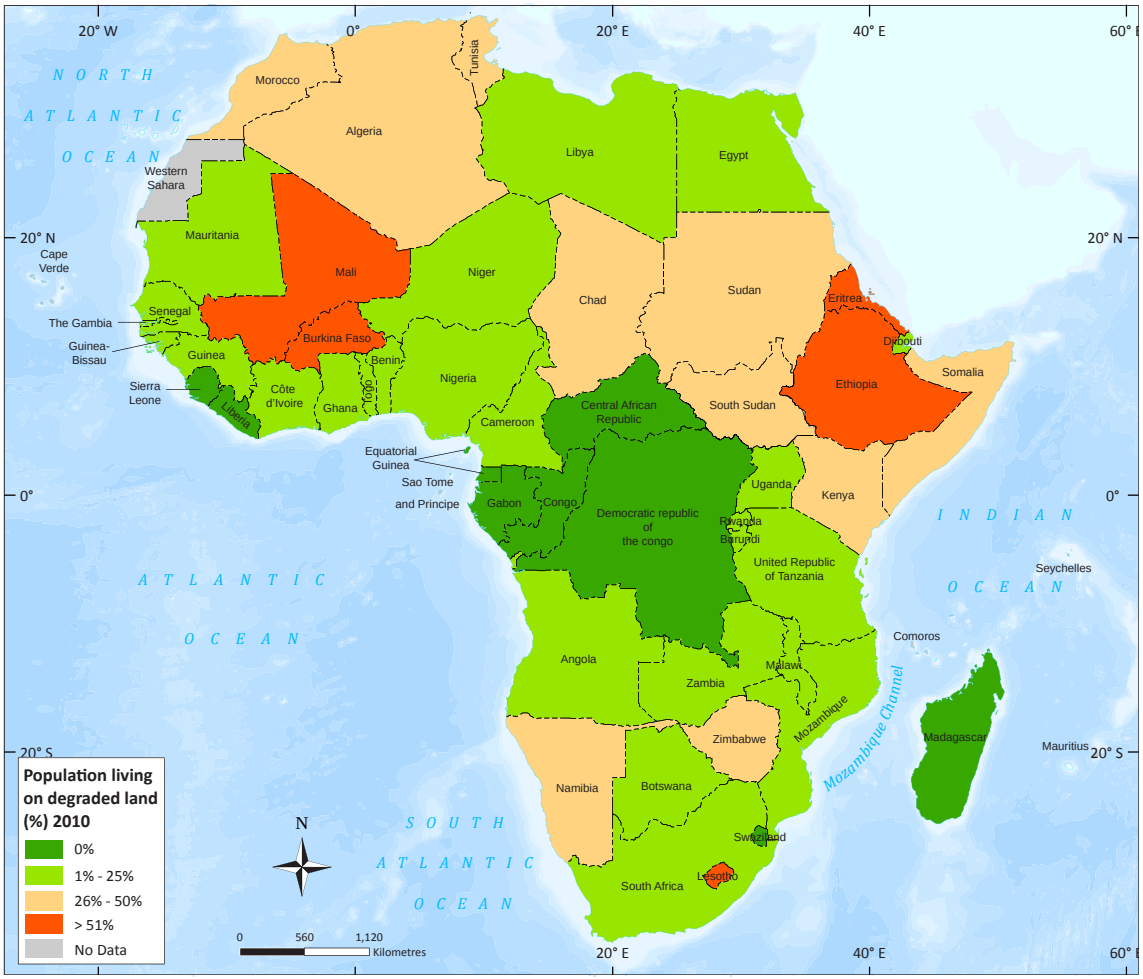
able, it is generally suspected to have carcinogenic effects on the reproductive system (Dalvie 2011).

Adequate land management and enhanced agricultural productivity can make Africa self-sufficient in food and nutrition thereby strengthening the positive link between land and human health. This is especially important given the heavy reliance of the continent's rural population on agriculture for livelihoods. While efforts at increasing areas under irrigated agriculture, intensification of fertilizer use and large-scale production of GM crops have potentially positive effects on food production, and by extension human health, their adverse environmental and health effects need to be considered, monitored and contained. There is also need to promote integrated land management policies and practices that address the entire agricultural value chain from seed quality and supply, soil fertility, water availability, value addition at processing, reduction of post-harvest losses, access to markets and provision of extension services.

Possible policy interventions that would ensure that land use benefits human health include:

- Assessing the suitability of land-use changes and ensuring that they do not contribute to environmental and health risks;
- Regulating large-scale land acquisition and use in order to guard against contracting arrangements that undermine local food and livelihood security, while also ensuring that production of crops and livestock does not compromise water security, soil productivity, health of agricultural workers or raise food prices beyond the reach of low-income consumers;
- Promoting technologies that enhance land productivity and efficient water use as these would increase agricultural yields and improve the region's food and nutrition security.

Figure 13: Population living on degraded land



Source: UNDP (2010)

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3

Towards a sustainable future

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Biodiversity provides important benefits for human health

Understanding the future

The domestic and global environment within which African policy makers are operating is rapidly evolving. The major domestic changes include drastic demographic shifts as well as policy and institutional reforms characterized by decentralization, liberalization, privatization, and public sector reform. The global transformations include technological advances in the fields of biotechnology, medical and biological sciences, ICT and telecommunications. Other international dynamics include the contagion effect of a series of global financial crises; and the push for sustainability mindsets in a bid to advance the sustainable development agenda epitomized by the Rio+20 outcome document, 'The Future we Want'. All these make environmental management using the business as usual model extremely risky, especially in terms of ensuring that the environmental outcomes do not undermine human health.

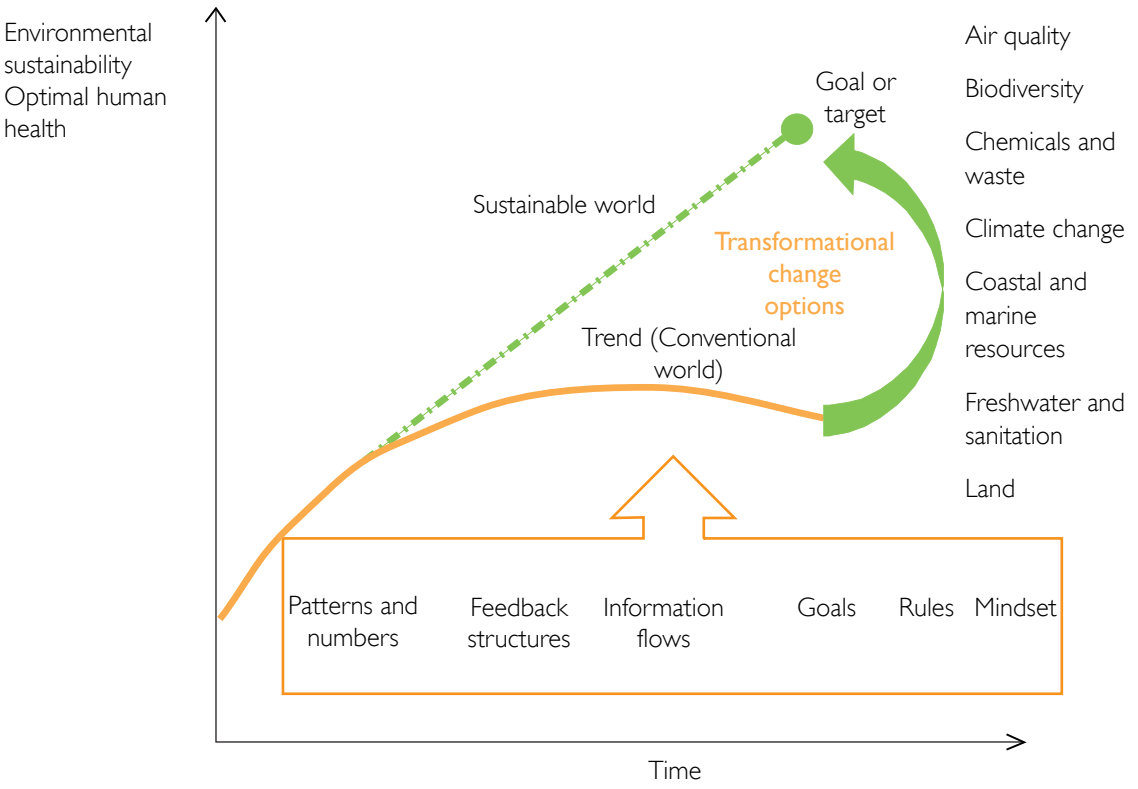
The multifaceted uncertainties that policy makers have to contend with call for careful analysis of how to manage the environment for improved human health. Serious contemporary challenges such as climate change, biodiversity loss, land degradation and general erosion of the natural resource base have long-term implications for human health and require policy solutions based on a far-sighted perspective (Zurek and Henrichs 2007). Making informed choices and strategic decisions for the future requires anticipatory thinking. Scenario analyses meet this need and involve thinking of alternatives as the future unfolds amidst persistent uncertainties. While scenarios are neither predictions nor forecasts, they are useful in highlighting plausible implications of particular environmental developments and actions (Alcamo and others 2008).

The AEO–3 scenario analysis teases out the various ways in which environmental management may impact human health in future. The analysis itself involves exploring a number of trajectories depicting pathways to achieving agreed upon development and environmental goals. Two scenarios, which were borrowed from Global Environment Outlook 5 (GEO-5) [UNEP 2012], have been used in the AEO-3 assessment process. These are the Conventional World Scenario (CWS) and the Sustainable World Scenario (SWS). CWS is based on the business as usual approach to goal attainment with the hope that progress towards set goals would automatically ensue without instituting radical policy shifts. CWS therefore helps to underline the potential health risks that result from continuing the prevailing approach to environmental management.

SWS, on the other hand, recognizes that the changing domestic and global situations present enormous environment and health challenges but also opportunities. In essence, it postulates that transformative changes should be an integral part of the environmental management regime in order to address constraints to sustainable progress towards desired development goals. The main objective of SWS is to specify the options of transformative changes (of policies, institutions and programmes) that jolt the current trends towards a trajectory that enables the attainment of desired environmental and human health outcomes. These changes are targeted largely at the drivers of environmental change. Under this scenario, those outcomes, for each thematic issue, are defined and used to determine the nature of appropriate paradigm shifts that should be implemented if set goals are to be accomplished. Those outcomes help to shape the envisioned pathways and compel deliberate actions that deflect or completely halt unsustainable trends that would otherwise compromise goal attainment.

Figure 14 illustrates the trends under CWS and SWS as well as the shift that transformative changes targeted at the drivers of environmental change make on the CWS trend to tilt it upwards towards the SWS one. The wedge below the deflection point indicates the barriers that need to be surmounted in order to attain sustainability goals (UNEP 2012). The shift is grounded on a shared sense of environmental responsibility for improved health. Its attainment and sustenance depends fundamentally on real change in the mindsets of all stakeholders. Strategic policy and institutional changes can nurture and reward sustainability-driven mindsets.

Figure 14: The Conventional World and Sustainable World Scenarios



Source: UNEP (2012).

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Prudent environmental management would jolt the conventional world trend towards the sustainable world trend.

Table 5 enumerates the adverse effects of delaying the shift from CWS to SWS. It also specifies strategies that could induce the shift towards the SWS trajectory. These possible policy directions are elaborated on in the proceeding section on making promising policies work.

Table 5: Manifestations of CWS and SWS, and strategies for moving towards SWS

Theme	Conventional World Scenario	Sustainable World Scenario	Some important strategies for addressing gaps
Air quality	• Rising use of solid fuels especially in the rural areas and informal settlements • Outdoor air pollution in Africa's megacities rises sharply • Harmattan phenomenon is more recurrent in West Africa • Rising incidences of respiratory diseases associated with both indoor and outdoor air pollution	• Dramatic reduction of use of solid fuels especially in the rural areas and informal settlements • Outdoor air pollution in Africa's megacities reduces sharply • Falling incidences of respiratory diseases associated with both indoor and outdoor air pollution	• Promote uptake of improved cooking devices and of better kitchen ventilation • Carry out sensitization campaigns to reduce user exposure to smoke through behavioural change • Promote uptake of renewable sources of energy through a combination of command and control and fiscal incentives • Make electricity an affordable cooking energy alternative by constructing off-grid power generation systems • Institute and implement outdoor air quality standards and regulations.
Biodiversity	• Accelerating biodiversity loss and extinctions leading to a loss of attendant medicinal value • Dramatic habitat loss especially through deforestation, wetland conversion and aquatic ecosystem degradation leading to a rising number of biodiversity hotspots • Rising incidences of zoonotic diseases due to rising human-wildlife contact • Increasing pathways of invasive alien species	• Extinction of species halted and declines reversed • Sustainable use of biodiversity in health provisioning • Conservation and protection of terrestrial, wetland and aquatic habitats • Incidences of zoonotic diseases are declining • Threats posed by invasive alien species contained through coordinated national, regional and sub-regional initiatives	• Scale up the capacity of lead agencies to rein in poaching, deforestation, wetland conversion and coastal and marine degradation • Foster participatory management approaches e.g. CBNRM, PES and ensure equitable benefit sharing • Strengthening monitoring and early warning systems for zoonotic diseases • Utilize TBNRM to address regional and sub-regional threats e.g. invasive alien species
Chemicals and waste	• Rising cases of human chemical contamination • Stockpiling of POPs, inorganic fertilizers and agro-chemicals continues unabated • Increasing accumulation of e-waste and municipal waste • Dumping and regional generation of toxic waste rising • Non-fuel sources of lead are still a challenge • Region unable to adequately manage waste from increased oil and gas production	• Declining cases of human chemical contamination • Mechanisms for safely disposing of chemical stockpiles instituted • Amount of e-waste and municipal waste generated reduces owing to adoption of the 4Rs: reduction, reuse, recycling and recovery • Illegal dumping of toxic waste is contained • Command and control measures reduce the generation of non-fuel sources of lead • Oil and gas producing countries develop the financial, technical and human resource capacity to dispose of petroleum waste	• Adapt Strategic Approach to International Chemicals Management (SAICM) framework to African context • Accelerate domestication and implementation of, as well as cooperation among the Basel, Stockholm and Bamako Conventions • Sensitize public on the benefits of the 4Rs: reducing, reusing, recycling and recovery • Strengthen national and institutional capacity for chemicals management including recycling and disposal technologies • Strengthen implementation of the polluter pays principle
Climate change, and variability	• Floods, drought, crop failure and other EWEs become more frequent and severe • Incidence of weather-sensitive illnesses e.g. malaria, meningitis, cholera and Rift Valley Fever increase as these expand into hitherto disease-free zones • Adaptation costs amount to over 5 per cent of GDP by 2030	• Adverse effects of EWEs are headed off • Robust adaptation plans have reduced incidences of weather-sensitive diseases • Warming is accompanied by energy savings due to the increased use of renewable energy (notably solar) • Climate change and variability benefits the region as it is able to tap lucrative funding mechanisms e.g. CDM, REDD+ and FCPF	• Encourage vulnerable populations e.g. women to engage in alternative livelihoods • Step up climate resilient national development planning through NAPAs and NAMAs • Climate proof investments in climate sensitive areas such as agriculture and infrastructure through more robust planning, construction and the use of weather-indexed insurance

Theme	Conventional World Scenario	Sustainable World Scenario	Some important strategies for addressing gaps
Coastal and marine resources	• Coastal erosion rises to more than 30m per year by 2050 • Increased marine pollution from land-based sources and maritime accidents • Increased IUU fishing leads to a rapid decline in landed fish quantities • Increased morbidity and mortality from siltation, sea level rise, and coastal erosion	• Coastal erosion and marine biodiversity losses are significantly reduced • Increased monitoring and surveillance reduce pollution of coastal and marine waters and IUU fishing • Adaptation to climate change promotes resilience to sea level and temperature rises • Wider establishment of MMAs is witnessed.	• Enforcement of the concept of integrated coastal zone management (ICZM) • Rigorous application of the polluter pays principle • Coordinated sub-regional ocean surveillance reduces IUU fishing and deliberate dumping of waste at sea • Consolidate MPAs into the more efficient MMAs
Fresh water and sanitation	• Water availability remains below the globally accepted minimum threshold of 1 000 m3 per capita • Rising percentage of inhabitants experience water scarcity by 2030 • Only 26 countries meet the MDG target of halving the proportion of people without access to safe drinking water • Over 35 per cent of the population does not have access to adequate sanitation by 2050 • Organic water scarcity is manifested through falling aquifer levels, persistent water shortages and exorbitant pricing • Total Sanitation proves elusive • Child mortality due to waterborne diseases e.g. cholera and typhoid rises sharply	• MDGs on water and sanitation and other global targets are achieved • Only a negligible proportion of people live with severe water scarcity • Considerable reduction in water withdrawal is achieved through behavioural change and technological innovation that promotes use efficiency • Substantial gains are made in increasing access to safe drinking water and sanitation by 2050 • Remarkable reduction in incidences of waterborne diseases	• Protect watersheds including water towers • Promote education and awareness in water saving, waste water recycling and Total Sanitation • Promote conservation of water in households, industry and agriculture through economic incentives which encourage water harvesting and recycling • Encourage research and technological innovation that promotes water use efficiency • Implement the concept of IWRM
Land	• Land degradation, coupled with climate change lowers crop and livestock yields by over 34 per cent after 2030 • Perennial hunger and famine in some sub-regions coexist with abundant food in other sub-regions • Increased leasing of large scale tracts of land to foreign companies and for biofuels production pushes vulnerable communities to degraded, marginal land and precipitates food and nutrition insecurity and ill health.	• Coordinated holistic shift to sustainable land management • Improved food production is not achieved at the expense of biodiversity • Policies to improve the productivity of the arid and semi arid lands lead to strong gains in food and nutrition security, with positive health outcomes leading to increased life expectancy and reduced child mortality due to malnutrition • Leasing of land to foreign companies and for production of biofuels is well-thought through to ensure that it does not foment land dispossession.	• Regulate large-scale land acquisition and use to ensure that they do not threaten food and livelihood security • Institute land reforms that ensure food security and sustainable land management • Improve irrigation coverage and efficiency in order to increase the proportion of land under agriculture.

Making promising policies work

Simply agreeing on new policy directions is obviously not a panacea for moving towards a sustainable future. As important as this agreement is, it will nevertheless need to be complemented by a range of well-thought through actions. The findings of the AEO-3 assessment point to a number of actions, which if adequately taken, can make promising policies work effectively. These include adequate data and information systems for decision making; stakeholder engagement; institutional mechanisms to ensure alignment and collaboration; capacity development of all stakeholders; and clear implementation roadmaps with realistic targets and funding mechanisms.

Adequate and reliable data and information

Evidence-based decision making, which is more compelling than that based on intuition, is only possible if adequate and reliable data exist on the issues at stake. Strengthening the data and information bases on environment and health linkages would therefore enable adequate assessment and subsequent use of the findings to inform planning, budgeting, reviewing policy performance and evaluating progress towards the desired environment and health outcomes.

Stakeholder engagement

Environmental integrity and human health are inherently cross-sectoral in nature. Formulating and implementing policies in these fields therefore tend to benefit from sufficient stakeholder engagement. This is because the course and outcomes of the policies often depend on the characteristics of both the policies and the actors involved. Stakeholder motivation, information, power and hence strategic interactions on policy matters substantially determine policy outcomes. Some of these stakeholders or their institutions operate as 'policy champions' in the sense that they identify and overcome barriers, build strategic alliances and spur action for sustainable implementation of policies.

Institutional setup and strategic management

In some instances, adequate responses to environmental changes that impact human health have been delayed not necessarily because of policy gaps, but because of the inappropriate organizational structures or institutional setups for implementing existing policies. Effecting transformative change through smooth policy implementation often necessitates employee retooling as well as organizational and institutional reengineering. Resistance to desirable changes simply because they run contrary to tradition can frustrate policy implementation if not adequately managed. Clear mechanisms for cross-sectoral collaboration can, in addition, help to avoid duplication, reap synergies, foster learning and sharing of experiences and build constituencies for managing change.

Clear implementation road maps, and monitoring and evaluation framework

Action plans that specify realistic targets, funding mechanisms, human resource inputs and the framework for monitoring and evaluation are essential for effective policy implementation. Given that environment and health are both inextricably linked and cross-sectoral in nature, action plans would benefit from inter-institutional collaboration that fosters alignment, eliminates duplication and promotes synergies.

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Health is 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'
(WHO 1946)

Environment risks are blamed for about 28 per cent of Africa's disease burden, and this includes diarrhoea, respiratory infections and malaria, which collectively account for 60 per cent of known environmental health impacts in the region.
(WHO and UNEP 2010)

The Third Africa Environment Outlook (AEO-3), analyses the importance of and interlinkages between health and environment and the opportunities and synergies that might be derived from intensified collaboration between the two sectors. It uses the Drivers, Pressures, State, Exposure, Effects and Actions (DPSEEAA) analytical framework to undertake an integrated analysis of the state and trends covering the themes of *air quality, biodiversity, chemicals and waste, climate change and variability, coastal and marine resources, freshwater and sanitation as well as land*. It also illustrates how socio-economic driving forces can generate environmental pressures, leading to altered ecosystem states, personal exposure to risks, and adverse health effects.

AEO-3 also proffers a range of strategies for deflecting untenable business as usual behaviours and mindsets towards sustainable ones.

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