UNEP YEAR BOOK

EMERGING ISSUES IN OUR GLOBAL ENVIRONMENT

2012

UNEP

United Nations Environment Programme

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EMERGING ISSUES IN OUR GLOBAL ENVIRONMENT

2012

United Nations Environment Programme

Year in Review

Environmental events and developments

2011 was a year of environmental extremes. Major droughts and flooding were prominent in the news, and leading climate scientists continued their work to establish whether there is a clear relationship between extreme weather events and climate change. In the ocean, as few as 9 per cent of all species may have been identified, yet new studies show that overfishing, pollution and climate change severely threaten the future of ocean life. Despite the economic recession, global investments in green energy grew by nearly a third to US$211 billion in 2010. An investment of 2 per cent of GDP in ten key sectors could significantly accelerate the transition to a more sustainable, low-carbon economy.

Some 13 million people in Djibouti, Eritrea, Ethiopia, Kenya and Somalia have been experiencing one of the worst humanitarian crises in decades. The region's most severe drought in 60 years has caused widespread starvation and made access to clean water and sanitation extremely difficult (**Box 1**). These conditions not only directly affect local communities today, but also weaken their resiliency to cope with future droughts, diminishing prospects for water and food security in the years to come (Munang and Nkem 2011). Temperatures in the region are expected to continue rising while rainfall patterns change (Anyah and Qui 2011).

The crisis in the Horn of Africa is only one of the events in 2011 that exemplify the challenges to be met in the face of an increasingly variable and changing climate worldwide. Many regions need innovative strategies to address pressures on land and water resources and on agricultural productivity – from building resilience in small-scale farming communities to global commitments to mitigate climate change.

Climate change, extreme weather events and disaster risk management

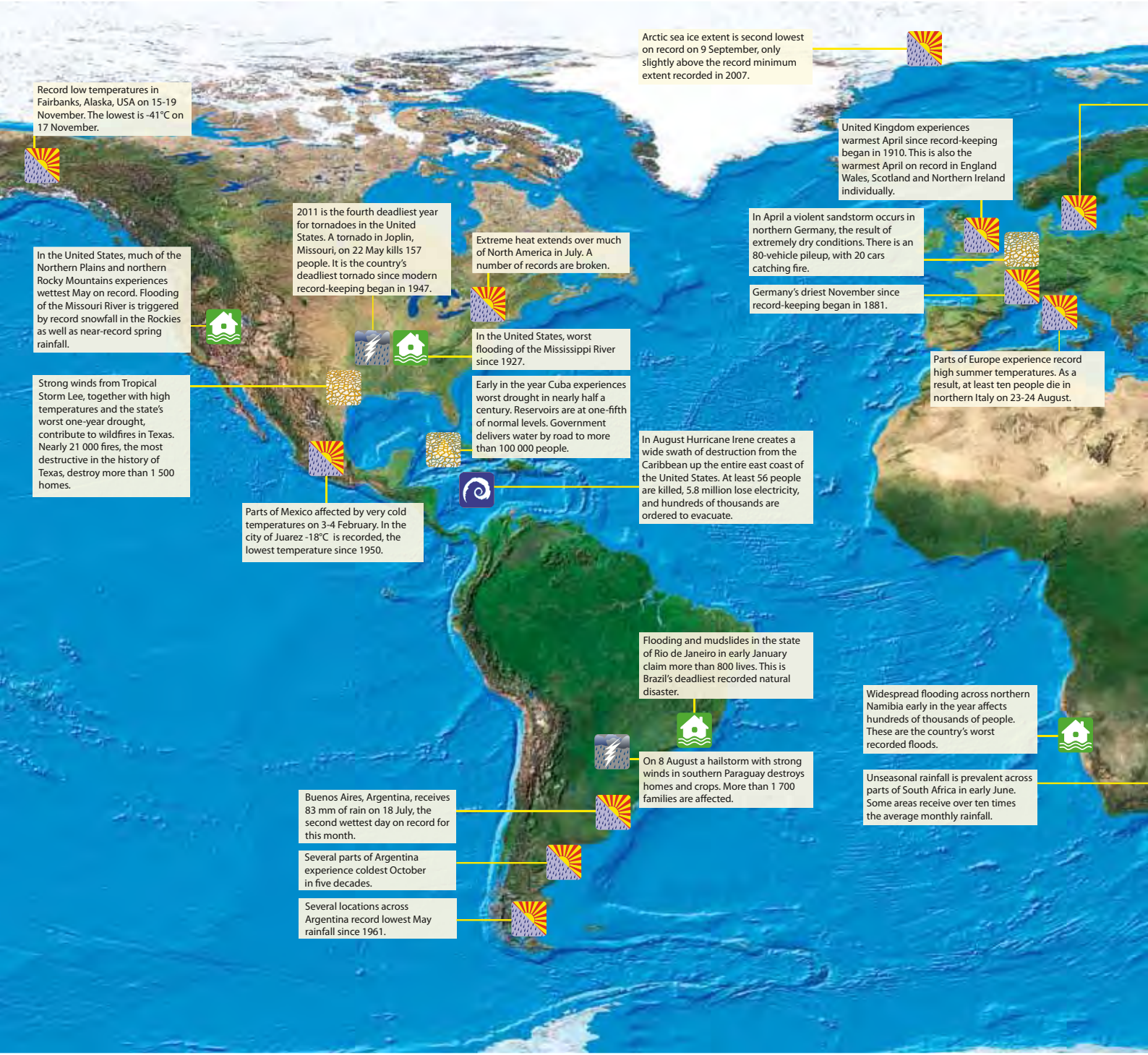
2011 was a year of record-breaking weather events, which caused a large number of deaths and billions of dollars in damage (**Figure 1).** It was also the tenth warmest year and the warmest La Niña year on record, as well as the year in which the

◀ Hydro-thermal vents are geysers on the seafloor supporting unique communities. Trawling and mineral mining can cause serious damage to deep sea ecosystems. *Credit: Charles Fisher*

Box 1: Drought response in the Horn of Africa

In 2011 the Dadaab refugee camp in Kenya became the home of 400 000 people fleeing drought and famine. *Credit: Linda Ogwell, Oxfam*

Drought, accompanied by high food prices, insufficient humanitarian action and restrictions on aid acceptance, has induced mass migration to refugee camps in the Horn of Africa. Famine warnings were issued for this region at the beginning of 2011, but the drought still had an extreme impact. In July the rate of acute malnutrition in southern Somalia had gone up to 38-50 per cent (FEWSNET 2011). Many early warning systems assess conditions on a country-by-country basis. Their ability to see the larger regional picture is therefore limited, which can affect the adequacy of response efforts (Ververs 2012).



drought | temperature/ precipitation records | severe storm/ tornado | tropical cyclone | flood

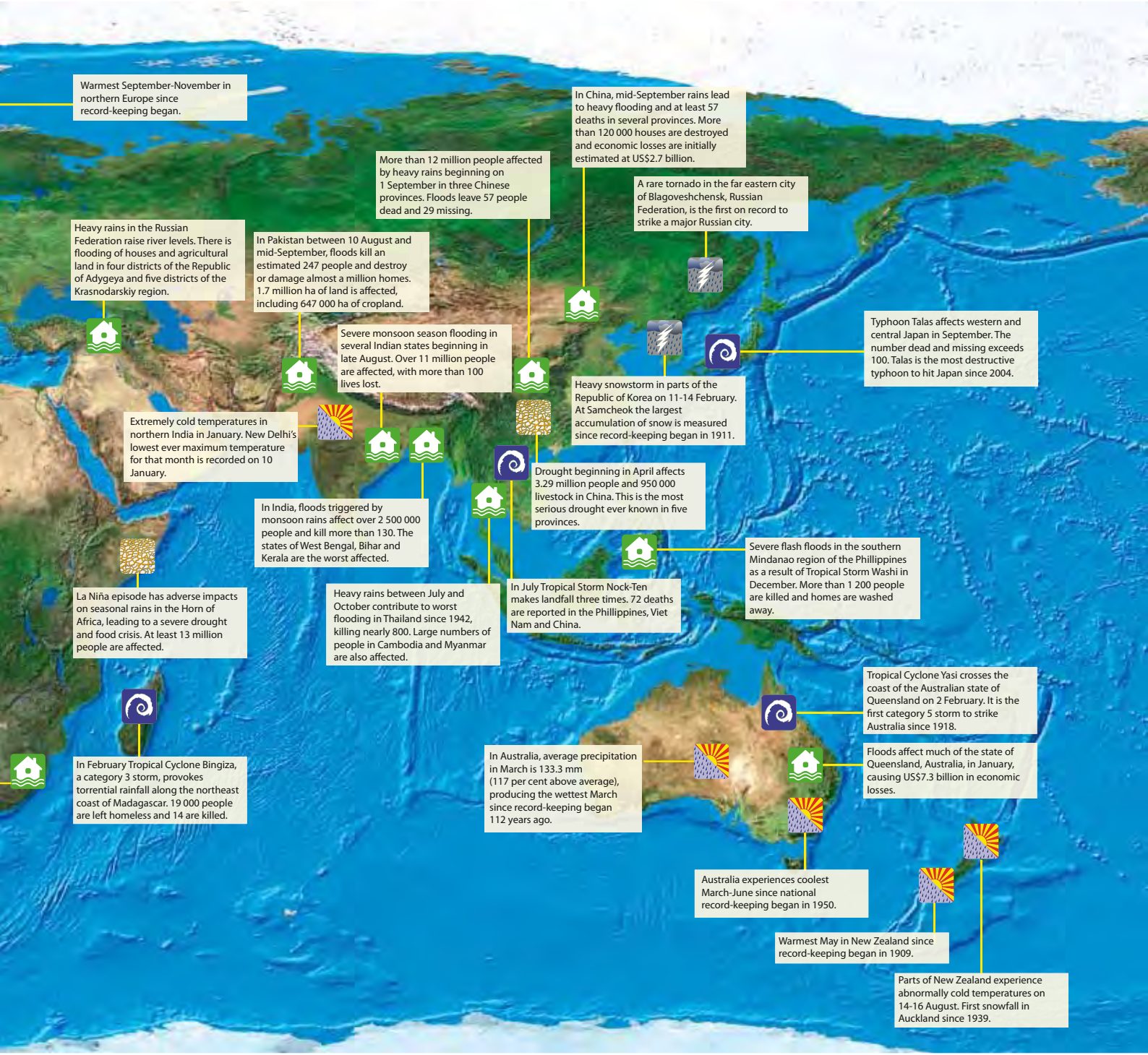


Figure 1: Major extreme weather and climate events in 2011 caused a large number of casualties and billions of dollars in damage across the world. Record-breaking temperatures and precipitation, as well as intense storms, tropical cyclones, floods, droughts and wildfires, resulted in many deaths and widespread destruction. According to the IPCC, climate change contributes to changing patterns in the frequency and intensity of extreme weather events (IPCC 2011a). A connection between climate change and geophysical events, such as earthquakes, has not been established.

second lowest seasonal minimum extent of Arctic sea ice was recorded (NSIDC 2011, WMO 2011a). Scientists have established a new international partnership to assess, on a case-by-case basis, the likelihood that exceptional weather events are caused or exacerbated by the global temperature increases observed during the past century (Stott et al. 2011). In addition, by investigating rainfall variability, scientists have already found evidence that anthropogenic greenhouse gas emissions substantially increase the risk of extreme events occurring (Pall et al. 2011).

An extreme weather event is defined as one that is rare within its statistical reference distribution at a particular location (IPCC 2011a). While natural variability makes it very difficult to attribute individual extreme weather events to climate change, statistical analyses show that the overall trends of many extreme events are changing. A new report of the Intergovernmental Panel on Climate Change (IPCC) concludes that climate change is leading to changes in the frequency, intensity, length, timing and spatial coverage of extreme events (IPCC 2011a). According to this report, it is virtually certain (99-100 per cent probability) that the frequency and magnitude of daily high temperatures will increase during the 21st century while those of cold extremes will decrease. The IPCC report expresses great confidence that there will be increases in events related to heavy precipitation and coastal high water, the latter due to rising sea levels. But despite a number of devastating floods in 2011, such as those in Australia, Pakistan and Thailand, evidence concerning regional long-term changes in flood magnitude and frequency is not as prevalent, partly because of a lack of available observational data at the appropriate time and spatial scales (IPCC 2011a).

The United States National Oceanic and Atmospheric Administration (NOAA) reported that in the first six months, 2011 had broken the record for the costliest year in terms of weather disasters in the United States (NOAA 2011). By the end of 2011, the United States experienced 14 "billion-dollar disasters" – disasters causing at least US$1 billion in damage (NOAA 2012). At the global level, in the first half of 2011 alone, costs arising from severe natural events exceeded those in the total previous costliest year, 2005 (UNISDR 2011). Munich Re, the world's largest reinsurance company, reported US$380 billion in losses in 2011 from natural disasters, which include weather and climate related events, as well as geophysical events such as earthquakes (Munich Re 2012). These staggering figures demonstrate the potential economic impact of an increase in frequency and severity of extreme weather events. They also suggest the degree of associated human suffering and the need for better risk reduction and preparedness strategies to increase resiliency to these events in both developed and developing countries.

Economic losses due to disasters are higher overall in developed countries than in developing ones. As a proportion of GDP, however, losses are much higher in developing countries. Over 95 per cent of extreme event fatalities in the past several decades have occurred in developing countries. Developed countries often have better financial and institutional mechanisms to cope with extreme events and their impacts. Future exposure and vulnerability to such events can be mitigated by integrating disaster risk reduction planning with economic development and climate change adaptation planning. Early warning and disaster risk reduction plans and strategies are essential, while documentation of individual events adds to the pool of knowledge and lessons learned (IPCC 2011a). Many regions are already carrying out disaster risk reduction and preparedness activities, including public awareness initiatives and improvements to early warning systems and infrastructure.

Population dynamics and resource scarcity

Extreme events can cause internal and external displacements of populations. In view of ongoing climate change and the likely increase in certain types of extreme events, the impact of these events on migration needs to be considered. More generally, there is the question of the implications of climate change for international security. In July 2011, the United Nations Security Council formally debated this issue, discussing ways in which climate change could be a "threat multiplier" in regard to maintaining global peace and stability. Environmental refugees displaced by water shortages and food crises are reshaping the world's human geography. While there was debate among the 15 Security Council members on the level of priority that should be associated with climate change, a statement was agreed

Secretary-General Ban Ki-moon (centre) with students from the New Explorations into Science, Mathematics and Technology School holding "7 000 000 000" signs the week the world population reached 7 billion. *Credit: Eskinder Debebe*

which expressed "concern that possible adverse effects of climate change may, in the long run, aggravate certain existing threats to international peace and security" (UN Security Council 2011).

A study published in December by four UN agencies looking at climate change, migration and conflict in the Sahel region of West Africa found that the Sahel is already experiencing changes in climate trends (UNEP 2011a). These changes are having an impact on the availability of natural resources and on food security, and are leading to shifts in migration patterns. The study looked at increased competition for natural resources, mainly land and water, resulting in conflicts among different communities and livelihood groups. In Darfur in East Africa, migration patterns are also putting a great strain on natural resources, including water. Half of Darfur's population now lives in and around urban areas. Before the civil conflict, only 20 per cent of the population was urban (UNHCR 2010). This unplanned urbanization has led to informal settlements with poor sanitation and waste management.

In 2011 the world population reached 7 billion. It is expected to grow to 9 billion by 2043, placing high demands on the Earth's resources (UN DESA 2011) **(Figure 2)**. Climate change exacerbates pressures to meet a growing and wealthier population's need for food. Global agricultural production may have to increase 70 per cent by 2050 to cope with this demand (FAO 2011a). A recent analysis of historical data shows that observed climate trends have had negative impacts on wheat and maize yields in the past 30 years (Lobell et al. 2011). Resource consumption could triple by 2050, while current consumption trends differ greatly between developed and developing countries (UNEP 2011b). For many agricultural systems there is the danger of a progressive breakdown of productive capacity under a combination of excessive population pressure and unsustainable agriculture use and practices (FAO 2011b).

Climate change, which will affect rainfall patterns in many regions, is expected to exacerbate water scarcity. This is of particular concern in high-intensity food-producing regions. Farming methods that are more environmentally sound need to be used, such as improved irrigation techniques and planting of vegetative cover including trees and shrubs to reduce water runoff and increase protection against drought (UNEP and IWMI 2011). Bioenergy production can put increased stress on land and water, competing with the need to feed the world's increasing population. The use of biofuels instead of fossil fuels, however, can also help reduce greenhouse gas emissions. Sustainability standards need therefore to be carefully defined

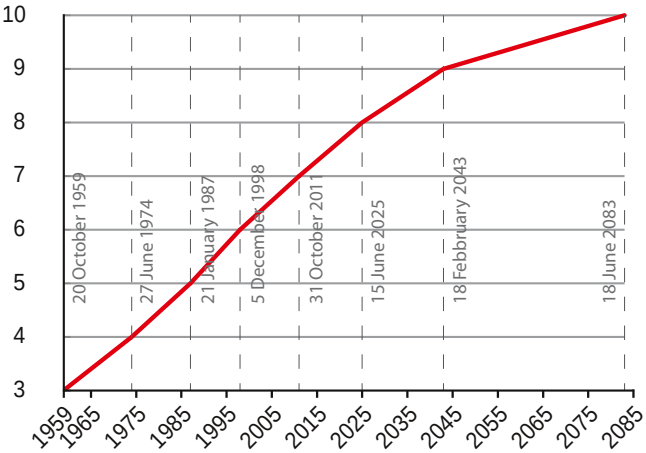
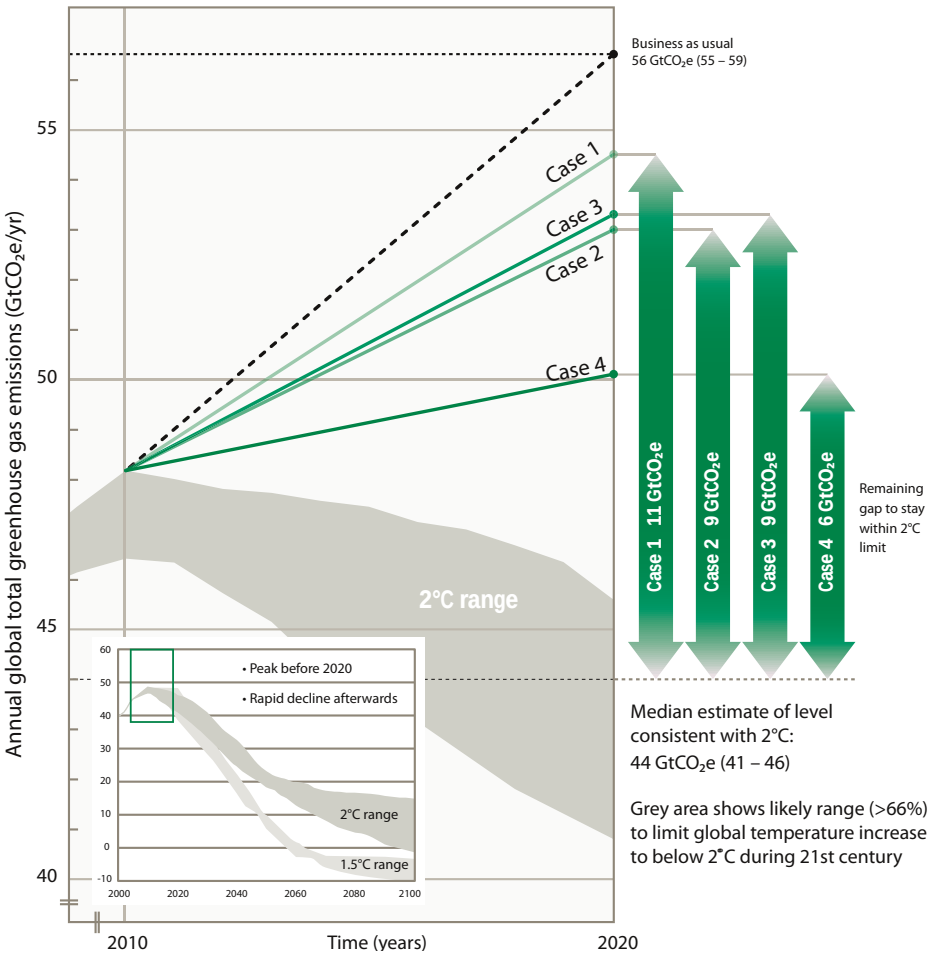


Figure 2: World population prospects in billions of people, 1959-2085. *Source: UN DESA (2011)*

and applied to ensure that rising demand for bioenergy does not lead to greater stress on land, water and food production (UNEP 2011c). Policies that protect both the land used for bioenergy production and surrounding ecosystems are necessary to maintain food and water security. Integrated planning and management can reduce the risks associated with the use of biofuels and still contribute to the building of a green economy (UNEP 2011c, UNEP et al. 2011).

In June 2011 governments attending the World Meteorological Organization (WMO) congress endorsed the Global Framework for Climate Services (GFCS), a co-ordinated effort by many stakeholders to make climate information for decision making and adaptation more accessible. The goal of the GFCS is to mainstream climate information for use across all countries and climate-sensitive sectors. Good co-ordination with climate financing activities and several tens of millions of dollars would be necessary to kick-start implementation of the GFCS to better support developing countries (WMO 2011b). One initiative that supports the GFCS is the Programme of Research on Climate Change Vulnerability, Impacts and Adaptation, launched in 2011 (PROVIA 2011). Developing countries have repeatedly asked for more co-ordinated science development to help national and sectoral adaptation strategies, plans and programmes. This initiative has the potential to meet some of these demands.



Case 1 – Unconditional pledges, lenient rules
If countries implement their lower-ambition pledges and are subject to "lenient" accounting rules, then the median estimate of annual GHG emissions in 2020 is 55 $GtCO_2e$, within a range of 53 – 57$GtCO_2e$.

Case 2 – Unconditional pledges, strict rules
This case occurs if countries keep to their lower-ambition pledges, but are subject to "strict" accounting rules. In this case, the median estimate of emissions in 2020 is 53 $GtCO_2e$, within a range of 52 – 55 $GtCO_2e$.

Case 3 – Conditional pledges, lenient rules
Some countries will be more ambitious with their pledges. Where this is the case, but accounting rules are "lenient", median estimates of emissions in 2020 are 53 $GtCO_2e$ within a range of 52 – 55 $GtCO_2e$. Note that this is higher than in Case 2.

Case 4 – Conditional pledges, strict rules
If countries adopt higher-ambition pledges and are also subject to "strict" accounting rules, the median estimate of emissions in 2020 is 51 $GtCO_2e$, within a range of 49 – 52 $GtCO_2e$.

All emission values shown in the text are rounded to the nearest gigatonne.

Figure 3: Country pledges to reduce their emissions by 2020 are currently not adequate to stay below a target global temperature rise of 2°C by the end of the 21st century, resulting in a gap. The size of the gap depends on the extent of pledges that are implemented and how they are applied. Four cases are considered in the figure: Case 1 reflects lower-ambition reduction pledges by countries and "lenient" accounting rules; Case 2 reflects lower-ambition reduction pledges and "strict" accounting rules; Case 3 represents more ambitious reduction pledges and "lenient" accounting rules; and Case 4 reflects more ambitious reduction pledges and "strict" accounting rules. Under "lenient" rules, allowances from land use, land-use change and forestry (LULUCF) accounting and surplus emissions credits can be counted towards a country's emissions pledges. Under "strict" rules, they cannot be used. *Source: UNEP (2011d)*

Energy and climate change mitigation

While many countries are taking steps to adapt to climate change, curbing global greenhouse gas emissions remains crucial to avoid the most severe and irreversible climate change impacts. In 2010, greenhouse gas levels were the highest recorded since preindustrial times (WMO 2011c). Many countries made pledges in 2009 to reduce their emissions of greenhouse gases by 2020, with the aim of keeping global warming below 2°C by the end of the 21st century. However, a significant gap of 6-11 Gt of CO_2 equivalent remains between expected levels of emissions in 2020 (based on current trends) and levels consistent with keeping the increase in the global average temperature by the end of the century from exceeding 2°C (**Figure 3**).

Cutting emissions by 2020 in a way that would limit the temperature rise to 2°C or less is economically and technologically feasible (UNEP 2011d). To cut emissions, countries need to shift their energy systems by increasing the use of existing low-carbon renewable energy sources and improving energy efficiency. Sector-specific policies to reduce emissions can be implemented, especially policies related to electricity production, industry, transport, forestry and agriculture. Such actions can help close the gap between current emission levels and emission

Box 2: The Durban climate change negotiations

The 17th Conference of the Parties to the UNFCCC (COP17) and the 7th Session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP7) were held in Durban, South Africa, on 28 November–9 December 2011. At stake was the need to reach a decision on a successor to the Kyoto Protocol (adopted in 1997), under which developed countries are committed to quantified emission reductions, as the first commitment period of the Protocol was scheduled to end in 2012.

After prolonged debate, the Kyoto Protocol was extended into a second commitment period. Arrangements are to be finalized by the end of 2012 for its entry into force from 1 January 2013. Without several big emitters and with a bottom-up approach to setting emission reduction commitments, the second period of Kyoto may only serve as a transition to the universal and comprehensive agreement. Shortly after the Durban climate talks, Canada announced its withdrawal from the Kyoto Protocol.

Complementary to the extension of the Kyoto Protocol, there was a landmark decision to start negotiating a protocol or a legal instrument or an agreed outcome with legal force under the Convention under the new track of the Durban Platform, which would include both developed and developing countries. Emission reductions under the new global agreement should start in 2020. Another important part of the agreements in Durban was the operationalization of the Green Climate Fund. Broad agreement was reached on the structure of this Fund. There was also a reiteration of the earlier goal of mobilizing jointly US$100 billion per year by 2020 to address the needs of developing countries. With the operationalization of the Green Climate Fund, climate finance may become more centralized and coherent.

While some progress was made in Durban in ensuring that climate negotiations remain on track, there is concern that not enough progress was made in addressing the emissions gap. Current voluntary emission reduction pledges have so far not resulted in a reduction of global greenhouse gas emissions. Instead, these emissions have increased. The next meeting of COP18/CMP8 is planned for 26 November-7 December 2012 in Doha, Qatar.

Credit: Siemens AG

targets, along with more ambitious reduction pledges and stricter accounting. Green procurement can also contribute to emission reductions by the public and private sector. It can be practised by individual businesses and organizations. Green procurement involves selecting those services and products that minimize impacts on the environment, including through greenhouse gas emission reductions. It results in organizations that are more environmentally responsible and often results in cost savings for these organizations as well (IISD 2011).

International negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) are playing an important role in setting greenhouse gas emission reduction targets for countries. The Durban climate talks resulted in agreements on a second commitment period for the Kyoto Protocol and a process to start negotiating a legal instrument or an agreed outcome with legal force under the Convention covering all countries **(Box 2)**. In many ways these two agreements symbolize a breakthrough. In addition, the Durban decisions operationalized the Green Climate Fund and furthered the established Cancun architecture for climate change, including a process to establish details of the Climate Technology Centre and Networks. However, the Durban decisions did not help to put in place a process for reducing emissions in line with what the science says is required to keep temperature increase below 2°C. There still remains a major emissions gap.

Limiting emissions of hydrofluorocarbons (HFCs) can make an important contribution to reducing total greenhouse gas emissions to prevent dangerous climate change (UNEP 2011e). Although HFCs are potent greenhouse gases, they have been used increasingly as substitutes for ozone-depleting substances such as chlorofluorocarbons (CFCs) and hydrochloroflurocarbons (HCFCs). The contribution of HFCs to total climate forcing is less

than 1 per cent of that of all other greenhouse gases combined, but between 2004 and 2008 their use increased by about 8 per cent per year. The increase in HFC emissions could therefore have a noticeable impact on the climate system. HFC use can be reduced through the implementation of technical options, such as the substitution of architectural designs that avoid the need for air conditioning and the use of low global warming potential HFCs, which scientists are currently developing and introducing (UNEP 2011e).

Multiple immediate benefits can be obtained by reducing emissions of black carbon and chemicals that are precursors to ground-level ozone formation (Shindell et al. 2012). Black carbon is particulate matter formed through incomplete combustion of biomass and fossil fuels. Tropospheric ozone is a secondary pollutant, produced by chemical reactions of certain compounds in the presence of sunlight. One of the main precursors of tropospheric ozone is methane, which is also a powerful greenhouse gas. Both tropospheric ozone and black carbon affect the climate system and have significant impacts on human and ecosystem health (UNEP and WMO 2011). They also affect rainfall patterns and regional circulation patterns, such as the Asian monsoon. Black carbon darkens snow and ice, reducing the amount of sunlight reflected back into space. This causes warming and increased snow melt and consequently flooding. Targeting emissions of black carbon and ozone precursors has immediate benefits for human health and could help to mitigate climate change in the near term (Shindell et al. 2012). Effective actions to reduce CO_2 emissions are, however, still required in order to remain within a 2°C temperature rise.

A global view of black carbon on 26 September 2009, using data from NASA's GEOS5 GOCART climate model. Although challenges in measuring the global distribution of black carbon remain, scientists are using satellite data and computer models to better understand how black carbon particles influence the Earth's clouds and climate on a short-term basis. Aerosol optical thickness ranges non-linearly from 0.002 (transparent) to 0.02 (purple) to 0.2 (white). *Source: NASA (2010)*

Several approaches, such as improved energy conservation and efficiency, can be used effectively in conjunction with renewable energy technologies to reduce total greenhouse gas emissions. Some investment is required to obtain the maximum benefit of these approaches. According to a new study, an investment of 2 per cent of global GDP across ten key sectors is necessary to prompt a shift to a low-carbon, resource-efficient and socially inclusive green economy **(Box 3)**. While job losses in some sectors would be inevitable, job creation in the longer term is expected to offset short-term losses. In 2011 several UN and other organizations jointly published guidelines for the transformation to a green economy (UN 2011a, UNEP 2011f).

Box 3: Ten key sectors for a green economy

An investment of 2 per cent of global GDP across ten key sectors is necessary to prompt a shift to a low-carbon, resource-efficient and socially inclusive green economy. These sectors are:

- Agriculture
- Fisheries
- Water
- Forests
- Renewable energy
- Manufacturing
- Waste
- Building
- Transport
- Tourism

A host of renewable energy solutions exist or have been proposed and are at various stages of development. Six categories of renewable energy technologies, in particular, have potential to mitigate climate change in the present or in the near future (IPCC 2011b) **(Box 4)**. In 2008 renewable energy accounted for 12.9 per cent of total primary energy supply. Investment in renewable energy grew by 32 per cent between 2004 and 2008 to US$211 billion, with China emerging as a leader in the development of renewable energy technologies (REN21 2011, UNEP 2011f). Investment in renewable energy is projected to double to US$395 billion by 2020 (Bloomberg 2011). Renewable energy could account for 77 per cent of total primary energy supply by 2050 (IPCC 2011b).

In April 2011 the first session of the International Renewable Energy Agency (IRENA) assembly took place. This organization is focusing on the use of renewables as a tool for development, as well as on facilitating knowledge and technology transfer, adopting policies that promote renewable energy, and creating partnerships with relevant stakeholders to promote financing of renewable energy projects. As part of the UN Secretary-General's initiative to promote renewable energy, energy efficiency and universal access to modern sources of energy by 2030, the year 2012 has been declared the Year of Sustainable Energy for All (UN 2012).

Box 4: Renewable energy technologies to combat climate change

Hydropower projects need solid planning and management to avoid unintended environmental and social impacts. *Credit: Hydro Pacific*

- **Bioenergy** can be produced from agricultural, forestry and livestock residues, energy crops, and other organic waste streams. A wide range of these technologies exists, and they vary greatly in their technical maturity.
- **Direct solar energy** technologies harness the sun's energy to produce electricity and heat. Solar energy is variable and intermittent, producing different amounts of power on different days and at different times of the day. Relatively mature solar energy technologies exist.
- **Geothermal energy** is produced from the thermal energy in the Earth's interior. Geothermal power plants, which extract energy from reservoirs that are sufficiently permeable and hot, are fairly mature technologies. Geothermal energy can also be used directly for heating.
- **Hydropower** is produced by harnessing the energy of water that moves between different elevations. Hydropower technologies are very mature. Reservoirs often have multiple uses in addition to electricity production, such as support for drinking water availability, drought and flood control, and irrigation.
- **Ocean energy** harnesses the thermal, kinetic and chemical energy of seawater. Most ocean energy technologies are still in the research and development or pilot phases.
- **Wind energy** is produced from the kinetic energy of moving air, using large on- and offshore wind turbines. Onshore technologies are widely manufactured and used, and further development of offshore technologies is promising. Wind energy is variable, and in some locations unpredictable, but research indicates that many technical barriers can be overcome.

As the generation of nuclear energy does not produce emissions of greenhouse gases like the burning of fossil fuels, there has been increased interest in this type of energy in the past decade. The Fukushima nuclear power plant accident in March 2011, a series of equipment failures that followed a devastating 8.9 magnitude earthquake and tsunami, has further stimulated debate on nuclear energy's role in a secure and sustainable energy future. In 2010, 13.5 per cent of total global energy production came from nuclear power plants. At 74.1 per cent, France has the highest proportion of electricity generation from nuclear sources (NEI 2011).

Germany has announced plans to shut down all its nuclear power plants by 2022. Nuclear energy made up 27.3 per cent of its total electricity production in 2010 (NEI 2011). Germany plans to invest much more in renewable energy. France, on the other hand, has announced that it will invest US$1.4 billion in additional nuclear power development. This will include investments in research on safety. The closing and decommissioning of nuclear power reactors – an emerging international issue – is the topic of Chapter 3 of this *Year Book*.

Most human-induced greenhouse gas emissions derive from fossil fuels, which are still the world's main energy source. The expansion of oil exploration activities continues, particularly in the Arctic region. For instance, in 2011 the United States government announced that it would move forward with leases for exploration off the coast of Alaska. It released a five-year plan under which 75 per cent of estimated oil and gas resources would be made available for exploration off the Alaskan coast and in areas of the Gulf of Mexico (US DOI 2011). Oil exploration in the Arctic is increasing partly because melting sea ice is allowing oil tankers to expand their routes into previously inaccessible areas. Human activity is expected to continue to increase in the polar regions. Environmentalists have expressed concerns about this development, mainly related to possible oil spills **(Box 5)**.

Improvements in technologies for horizontal drilling and hydraulic fracturing have made it economically feasible to produce large volumes of natural gas, particularly shale gas, from low-permeability geological formations (a process known as "fracking"). Fracking typically involves high pressure injection of chemicals deep underground, blasting fractures in geological formations to release gas **(Figure 4)**. The most significant development and exploitation of shale gas and other unconventional types of natural gas has taken place in North America.

Despite the considerable economic benefits of producing and using shale gas and other types of unconventional gas (e.g. job

Box 5: Impact of oil spills

Oil contamination at the Bomu flow station in K-Dere, Ogoniland, Nigeria. *Credit: UNEP*

The expansion of oil drilling in the Arctic brings with it potential risks. A major well blowout is more likely during drilling of the first exploratory well of a geological structure than at any other time. Off-shore spill preparedness is not always in place to deal with such a risk (Porta and Bankes 2011). Specific standards are important to avoid the most negative impacts of oil spills. The 2010 spill in the Gulf of Mexico received widespread media attention and provoked public outcries. Oil spills in Nigeria have received far less international attention, although they have been at the heart of social unrest for decades. A study conducted at the invitation of the Nigerian government evaluates the environmental and health impacts of oil contamination in the country's Ogoniland region (UNEP 2011g). It concludes that widespread oil pollution in Ogoniland is severely impacting the environment and is posing serious health risks in some communities.

Hydrocarbon pollution has reached very high levels in soil and groundwater at a majority of the sites examined. Residents of Ogoniland have been exposed to chronic pollution as a result of oil spills and oil well fires, increasing cancer risks. Crops have been damaged and the fisheries sector has suffered due to persistent hydrocarbon contamination of many of the region's creeks. The study estimates that cleaning up the pollution and catalyzing a sustainable recovery of Ogoniland could take between 25 and 30 years. It therefore calls for emergency measures to minimize dangers to public health, and for long-term co-ordinated action to achieve environmental restoration.

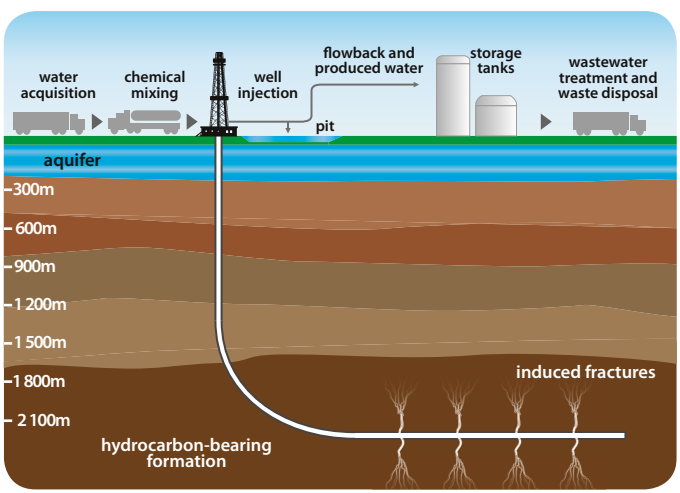


Figure 4: In typical hydraulic fracturing operations, millions of litres of water, chemicals and sand are injected at high pressure down a well. The pressurized fluid mixture causes the rock formation to crack, allowing natural gas or oil to flow up the well. *Source: Adapted from US EPA (2011)*

creation, greater energy independence), fracking is controversial because of widespread concerns about its health and environmental effects (Osborn et al. 2011, US EPA 2011, Cathles et al. 2012). These concerns include:

- drinking water contamination, which can result from the injection of chemicals deep underground during the fracking process;
- the greenhouse footprint of fracking operations, especially fugitive methane emissions; and
- seismic activity, which can occur when water or other fluids are injected deep underground during this process.

The United States Energy Information Agency has published assessments of 48 shale gas basins in 32 countries, containing almost 70 shale gas formations (US EIA 2011). While these assessments are likely to change as additional information becomes available, they show that the international shale gas resource base is potentially vast. As fracking spreads to new parts of the world, consideration needs to be given to its impact on health and the environment in countries where, among other differences, there is little experience with fracking operations.

Global biodiversity conservation

2011 was the International Year of Forests, during which a number of events were dedicated to their protection and sustainable development. Forests are of vital importance to biodiversity and the global economy. The livelihoods of 1.6 billion people depend on them (UN 2011b). Deforestation and forest degradation contribute 15-17 per cent of global greenhouse gas emissions (UN-REDD 2011). In 2010, the UNFCCC Cancun Agreement supported Reducing Emissions from Deforestation and forest Degradation (REDD+) in developing countries as a means of placing financial value on the carbon stored in forests. At the climate meeting in Durban further progress was made on the full mechanism, with safeguards and options for results-based financing for which market-based approaches could be developed.

Not only does vegetation on land, especially that in forests, absorb CO_2, but sea grass beds, mangroves, mudflats and other coastal wetlands also sequester it. However, the increasing human impacts on coastal areas, for instance from settlements and aquaculture, have destroyed an estimated 65 per cent of sea grass and wetland habitats (Lotze et al. 2006). Coral reefs are one of the world's most biodiverse ecosystems, providing a range of benefits to society. They supply resources for the development of new products by the international pharmaceuticals industry, provide habitat for a quarter of the world's fish biodiversity and support local economic development. Scientists warn that life in the ocean is being severely threatened by overfishing, pollution and climate change (Rogers and Laffoley 2011). For instance, one-third of fish in the Indian Ocean are at risk of local extinction (Graham 2011). The combined impacts of factors such as higher sea temperatures, ocean acidification and lack of oxygen may lead to the collapse of coral reefs and the spread of ocean dead zones (Rogers and Laffoley 2011). In August 2011 leading scientists associated with the Census of Marine Life project, a decade-long assessment of the world's oceans completed in 2010, presented their findings concerning human impacts on the deep seas (Ramirez-Llodra et al. 2011) **(Box 6)**.

Recent research indicates that only 14 per cent of the world's species are known (Mora et al. 2011). In the ocean, as few as 9 per cent of all species may have been identified. This lack of knowledge raises critical questions about how we can adequately conserve global biodiversity, especially in the face of climate change. Gaps in scientific knowledge can make it difficult to protect the deep sea environment. Moreover, an overarching legal framework for the protection of oceans is lacking. This gap has been identified as an emerging challenge for the 21st century through the UNEP Foresight Process (UNEP 2012).

Box 6: Human impacts on the deep seas

Bioluminescent creatures create their own light in deep sea environments. *Credit: Monterey Bay Aquarium Research Institute*

- Around 6.4 million tonnes of litter per year ends up in the ocean. Plastic in the ocean is of particular concern, as it persists and not enough is known about the effects of microplastics in the ocean environment. Concerns have been raised that chemicals transported by such particles may enter the food chain (UNEP 2011h).
- Deep-sea trawling and mining practices are damaging the habitats of species that are often long-lived and reproduce slowly, and hence not well equipped to respond to increasing pressures.
- The main concern for the future is climate change, as the ocean's increasing acidity affects the ability of corals and shellfish to make skeletons and shells.

One way to stop some of the damage to ecosystems is to create protected areas. Governments at the meeting of the Convention on Biological Diversity (CBD) in October 2010 set a goal of increasing the coverage of marine protected areas ten-fold, from 1 per cent to 10 per cent, by 2020 (CBD 2010). The target for terrestrial protected areas is to increase their extent to 17 per cent. However, the effectiveness and current rate of establishing new protected areas may not be sufficient to overcome current trends in biodiversity loss (Mora and Sale 2011). There are problems related to gaps in the coverage of critical areas and to management effectiveness where there is strong pressure to develop.

On land, poaching took a high toll on large mammals in 2011. The western black rhinoceros was officially declared extinct by

the International Union for Conservation of Nature (IUCN) following decades of poaching (IUCN 2011). In South Africa, 448 rhinos were killed in 2011 – up from 13 in 2007. At the time of writing, the number of rhinos poached in 2012 in South Africa had already reached 28 (SA DoEA 2012). Globally, 2010 saw the highest levels of elephant poaching since 2002, with central Africa causing the greatest concern (CITES 2011a). Poverty, poor governance, and increasing demand for ivory continue to drive poaching activity. The value of the ivory from a large male elephant is equivalent to 15 years' salary for an unskilled worker (Wittemyer et al. 2011).

Despite international agreements on ivory trading and the progress made in some countries, domestic and international trade bans are not enforced to the extent necessary to protect species. 2011 was the worst year in decades, with a number of large ivory seizures. An estimated 23 tonnes, for which some 2 500 elephants had been killed, was impounded from the year's 13 largest ivory seizures (TRAFFIC 2011). For the most part, this ivory was reportedly destined for Asia.

Illegal trade involves fraudulent applications for CITES documents, abuse of legal trophy hunting, and the use of couriers to smuggle horns. The African Elephant Action Plan, launched in 2011, is expected to enhance law enforcement capacity to protect against elephant poaching and illegal ivory trade. The International Consortium on Combatting Wildlife Crime began a programme in 2011 under which perpetrators of serious wildlife crimes will face a strong co-ordinated response, in contrast to the current situation where the risk of detection and punishment is low (CITES 2011b).

In Malaysia more than 3 000 tusks were seized in a period of three months in 2011, demonstrating a marked improvement in enforcement in that country. The increase in poaching rates correlates with that in ivory prices. *Credit: ©TRAFFIC Asia*

The plummeting numbers of animals at the top of the food chain, such as wolves, lions and sharks, is one of humanity's most pervasive influences on the natural world (Estes et al. 2011). The loss of such "apex consumers", largely due to hunting and habitat fragmentation, triggers a complex cascade of changes in ecosystems. The extent to which this is reshaping ecosystems is undervalued, as such top-down effects are difficult for scientists to demonstrate. However, as changes in the environment occur more rapidly, the need to strengthen the interaction between science and policy in order to ensure that decision making is based on sound science is becoming even greater.

Climate change, considered a threat multiplier for biodiversity, could drive the mass migration of numerous plant and animal species in coming years. These changes could further threaten species survival, significantly impacting the Earth's energy, carbon, water and biogeochemical cycles. By the year 2100, 40 per cent of land areas such as grassland or tundra could shift to a different state (Bergengren et al. 2011). For the first time, scientists have developed a model that assesses how animals respond to climate change in terms of both behaviour and genetics (Coulson et al. 2011). The model was developed based on longitudinal data from studies of grey wolves in Yellowstone National Park in the United States. It is expected that this model can help predict the climate change responses of many groups of animals.

Looking ahead

Scientists warn that the environment has been changing quickly from a period of stable state in which civilization developed during the past 12 000 years (the Holocene) to an unknown future state with significantly different characteristics (which some refer to as the Anthropocene) (Steffen et al. 2011). With population growth, some of the short-term solutions of the past, such as migrating when the environment is badly damaged or becomes less productive, are no longer viable. As demonstrated in the Arctic and on the ocean floor, today the impacts of human activities are felt far beyond our immediate surroundings.

The Earth is a complex system with highly interlinked components, some of which (such as soils) are greatly undervalued. For instance, the multiple benefits of soil carbon, described in Chapter 2 of this *Year Book*, are just starting to receive attention outside the realm of soil scientists. Earth system science is still in its infancy, but some scientists claim that humanity has already gone beyond the boundaries for climate change, biodiversity loss and excess production of nutrients, notably nitrogen and phosphorus (Rockström et al. 2009). Other areas identified as most in need of limitation are stratospheric ozone depletion, ocean acidification, global consumption of freshwater, changes in land use for agriculture, and air and chemical pollution.

Thanks to new methods of communication and observation, our understanding of the complexity of environmental issues is increasing. Many of the decisions we make affect the ecosystems that form the life support system upon which we depend. Scenarios for the future can help us look ahead and weigh the impact of our choices. For instance, a study in the United Kingdom examined scenarios of urban growth patterns (Eigenbrod et al. 2011). Under a scenario of dense housing growth, urban areas would experience a reduction in their abilities to cope with floods – a service considered important in light of the predicted climate change impact of more frequent and intense extreme weather events. They would not experience this effect under a low-density housing scenario, but there would be a reduction in the amount of land available for food and for carbon storage in the soil, services important for feeding a growing population and mitigating climate change. With smart planning and informed decision making guided by science, there are opportunities to maximize the benefits under both scenarios.

Such trade-offs, and the cost of actions versus the cost of inaction, also need to be considered from an international viewpoint. At the global level, discussions on many such actions will take centre stage at the United Nations Conference on Sustainable Development (Rio + 20) in June 2012. There will be a focus on the institutional framework for sustainable development and on the development of a green economy in the context of sustainable development and poverty eradication.

Reviewing new science and developments during the past year, concerns about population growth, resource use, climate change, widespread pollution and biodiversity loss all call for actions from the local to global levels to respond to sustainable development challenges. One of the world's champions of on-the-ground action, Professor Wangari Maathai, Nobel Peace Prize Laureate and founder of Kenya's Green Belt Movement, sadly passed away in September 2011. There is a need to continue her environmental work. Local leaders, civil society, companies and policy makers worldwide have an important role to play in overcoming some of the greatest environmental sustainability challenges.

A crowded market in Dhaka, Bangladesh. While the world's population is rapidly growing, action to address environmental challenges is critical to meet growing demands for food and ensure sustainable development. *Credit: IFPRI*

2011

At a glance

January — World food prices reach a historic peak for the seventh consecutive month.

February 2 — The United Nations International Year of Forests begins with the launch of FAO's 2011 State of the World's Forests report, which emphasizes that the forest industry can play an important role in a greener economy.

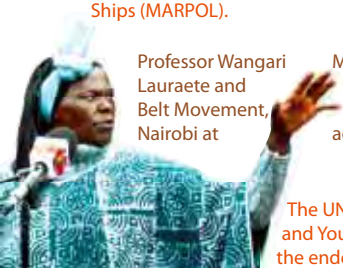
March 22 — The Roundtable for Sustainable Biofuels launches a global certification system during the World Biofuels Markets Congress in Rotterdam, the Netherlands. It is expected that this system will advance the sustainability of the global biofuels industry.

May 14-15 — The UN backs World Migratory Bird Day with a focus this year on land use and land sustainability.

May 16 - June 3 — The WMO Congress, the organization's supreme body, meets in Geneva to discuss the WMO's strategic direction for 2012-2015.

July 20 — The UN officially declares famine in two regions of Somalia, the first time a famine has been declared by the UN in almost 30 years.

August 1 — A new ban on pollution from heavy grade fuel oils goes into effect in the Antarctic region, through amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL).



Professor Wangari Maathai, Nobel Peace Prize Lauraete and founder of Kenya's Green Belt Movement, passes away in Nairobi at age 71.

Sept 26 — The UNEP Tunza International Children and Youth Conference concludes with the endorsement of the Bandung Declaration, which calls on participants in the Rio+20 meeting to consider the needs of children and youth.

Oct 1 — Representatives of the 118 members of the Basel Convention reach an agreement to unblock an amendment banning the export of hazardous wastes from OECD to non-OECD countries.

Oct 21 — UNEP announces that the Billion Tree Campaign has reached its 12 billion landmark. The campaign aims to improve the quality of life in communities through multiple benifts.

Nov 8 — The United Arab Emirates Ministry of Environment and Water, the Environment Agency-Abu Dhabi, and UNEP sign the Eye on Earth Declaration in Abu Dhabi, which stresses the importance of sharing environmental data and using it for decision making.

March 11 — The Fukushima nuclear power plant in Japan experiences a series of equipment failures following a severe earthquake and tsunami.

March 20-25 — Participants in the Fifth International Marine Debris Conference agree to the Honolulu Commitment, which outlines several approaches to the reduction of marine debris and calls for public awareness campaigns.

May 8-13 — The Third Global Platform for Disaster Risk Reduction results in pledges to improve disaster preparedness.

July 20 — The UN Security Council holds a special meeting to consider its role in addressing climate change. The Secretary-General warns of climate change threats to international peace and security.

August 26 — Participants in World Water Week release the Stockholm Statement, calling for an increase in water use efficiency and availability of water for all.

Sept 7-9 — The Global Soil Partnership is launched at FAO. The partnership aims at fostering favourable policies that provide technical expertise for soil protection and management.

Oct 3-7 — The Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), the new UN biodiversity forum, holds its first session in Nairobi, Kenya.

Oct 10-21 — The UNCCD COP10 meeting takes place in the Republic of Korea, exploring ways to advance efforts on desertification, land degredation and drought.

Oct 31 — The world's population reaches 7 billion, increasing concerns about how the world will provide food and water to its growing population in the future.

Nov 7 — The IUCN and the CBD secretariat sign an invasive species agreement that will work towards identifying invasive species and their pathways.

December 11 — The Durban Platform is adopted at the UNFCCC COP17/CMP7 in Durban, South Africa. The Platform extends the life of the Kyoto Protocol and establishes the structure of a Green Climate Fund.

January | February | March | April | May | June | July | August | September | October | November | December

2012 Calendar of events

January

January 12-13
2nd Session of the International Renewable Energy Agency (IRENA) Assembly in Abu Dhabi, United Arab Emirates (UAE)

January 16-19
5th World Future Energy Summit, Abu Dhabi, UAE

January 22-27
Arctic Frontiers Conference: Energies of the High North, Tromsø, Norway

January 23-27
Global Conference on Land-Ocean Connections/3rd Intergovernmental Review on the Implementation of the Global Programme of Action for the Protection of the Marine Environment, Manila, the Philippines

January 31-February 3
Forum of Environment Ministers of Latin America and the Caribbean, Quito, Ecuador

February

February 5-6
Second Asia-Pacific Water Summit, Bangkok,Thailand

February 20-22
12th Special Session of the UNEP Governing Council/Global Ministerial Environment Forum, Nairobi, Kenya

February 27
OECD Green Skills Forum, Paris, France

March

March 12-17
6th World Water Forum, Marseille, France

March 19-22
International Atomic Energy Agency (IAEA) International Experts Meeting on Reactor and Spent Fuel Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, Vienna, Austria

March 26-27
3rd Intersessional Meeting of the UN Conference on Sustainable Development, New York, USA

March 26-29
"Planet under Pressure" conference, London, UK

April

April 16-21
2nd Session of the Plenary Meeting on the Intergovernmental Platform on Biodiversity and Ecosystem Services, Panama City, Panama

April 22-25
B4E Business for the Environment – Global Summit, Berlin, Germany

April 22-27
International Polar Year 2012 conference: From Knowledge to Action, Montreal, Canada

May

May 8-9
26th Session of North American Forest Commission, Quebec City, Canada

May 12-August 27
Expo 2012 World's Fair with focus on "The Living Ocean and Coast", Yeosu, Republic of Korea

May 21-23
Global Conference on Oceans, Climate and Security, Boston, USA

May 29-31
2nd International Climate Change Adaptation Conference, Tucson, USA

June

June 5
World Environment Day - "Green Economy: Does it include you?"

June 13-15
3rd PrepCom for the UN Conference on Sustainable Development, Rio de Janeiro, Brazil

June 20-22
United Nations Conference on Sustainable Development (Rio +20), Rio de Janeiro, Brazil

July

July 6-13
11th Meeting of the Contracting Parties to the Ramsar Convention on Wetlands of International Importance (COP11), Bucharest, Romania

July 9-13
30th Session of the FAO Committee on Fisheries, Rome, Italy

July 23-27
62nd Meeting of the CITES Standing Committee, Geneva, Switzerland

July 27-29
From Science to Policy conference marking the 40th anniversary of the International Institute for Applied Systems Analysis , Vienna, Austria

August

August 6-9
Pacific Rim Energy and Sustainability Congress, Hiroshima, Japan

August 29-31
International Union for Conservation of Nature World Conservation Congress 2012, Jeju, Republic of Korea

International Sustainability Conference, Basel, Switzerland

September

Sept 6-15
14th Session of the African Ministerial Conference on the Environment, Dar es Salaam, Tanzania

Sept 17-21
Joint FAO/ WHO Meeting on Pesticide Residues, Rome, Italy

Sept 6-20
3rd Session of the International Conference on Chemicals Management, Nairobi, Kenya

Sept 17-21
Third International Symposium on the Ocean in a High-CO_2 World, Monterey, USA

Sept 24-27
UNEP/GEF International Waters Science Conference, Bangkok, Thailand

Sept 24-26
11th Meeting of the Conference of the Parties to the UN Convention on Biological Diversity, Hyderabad, India

October

Oct 8-19
18th Session of the Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) and 8th Session of the Meeting of the Parties to the Kyoto Protocol (COP18/CMP8), Doha, Qatar

November

Nov 26-Dec 7
4th International Conference on Sustainable Irrigation and Drainage: Management, Technologies and Policies, Adelaide, Australia

December

Dec 11-13

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