9 Increasingly severe consequences of climate change

Accelerating climate change impacts will threaten food and water supplies, human health, and terrestrial and marine life. Europe may also see more human migration and aggravated pressure on resources supplies.

Human-induced climate change is driven mostly by greenhouse gas (GHG) emissions from fossil fuel use for energy, with deforestation and unsustainable agricultural practices also playing a role. Climate change drives environmental change more broadly, as it affects the direction and magnitude of other trends and megatrends. Aspects covered here include impacts on crop production, water availability, biodiversity and ocean acidification.

The concentration of atmospheric CO_2 has increased from about 280 parts per million (ppm) in preindustrial times to more than 387 ppm in 2008 (Richardson et al., 2009). As a consequence, the average global air temperature by 2009 had risen by 0.7–0.8 °C above the preindustrial level. Current projections suggest that global mean temperatures could rise by as much as 1.8–4.0 °C over the course of this century if global action to limit GHG emissions is unsuccessful (IPCC, 2007a).

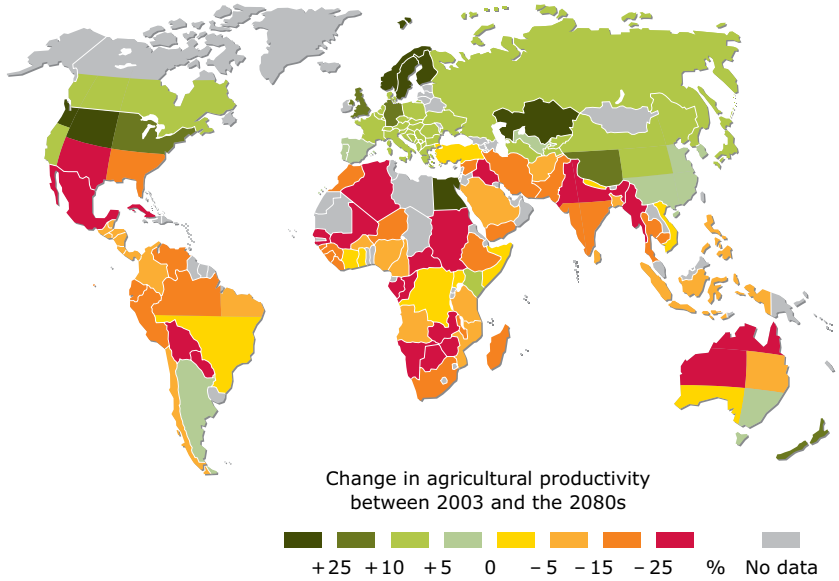
Although global crop production may increase initially (before 2030), global warming is projected to have negative effects in the long run. While production at high latitudes will generally benefit from climate change, in many African countries and Latin America it is projected to be severely compromised (Map 9.1).

Water availability in different parts of the world may be severely affected by climate change (Map 9.2). Many drylands are projected to become even drier and water demand for agriculture will increase in all regions because of greater evapotranspiration caused by higher temperatures. Furthermore, climate change may cause extreme

weather (including droughts), with greater frequency and intensity, increasing risks and uncertainty in food production.

Climate change also affects biodiversity. Boreal forest is projected to increase due to longer and warmer growing seasons. Vegetation change in low- to mid-latitudes is uncertain because transitions between tropical desert and woody vegetation types are difficult to forecast. A general increase of deciduous at the expense of evergreen vegetation is predicted at all latitudes (Map 9.3).

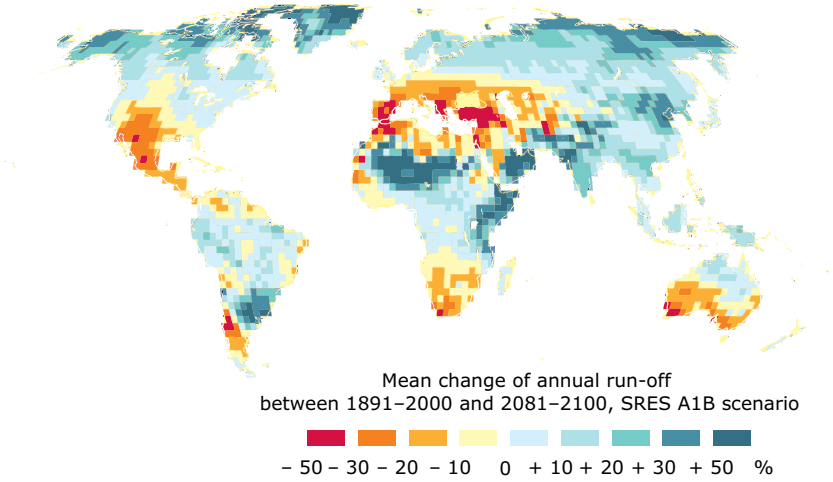
Map 9.1 Project impacts of climate change on agricultural yields



Note: The map represents the case of a business as usual scenario, and takes assumed benefits of carbon fertilisation into account. Calculations are based on the average output of six available climate general circulation models (GCM).

Source: Cline, 2007.

Map 9.2 Projected impacts of climate change on freshwater flows

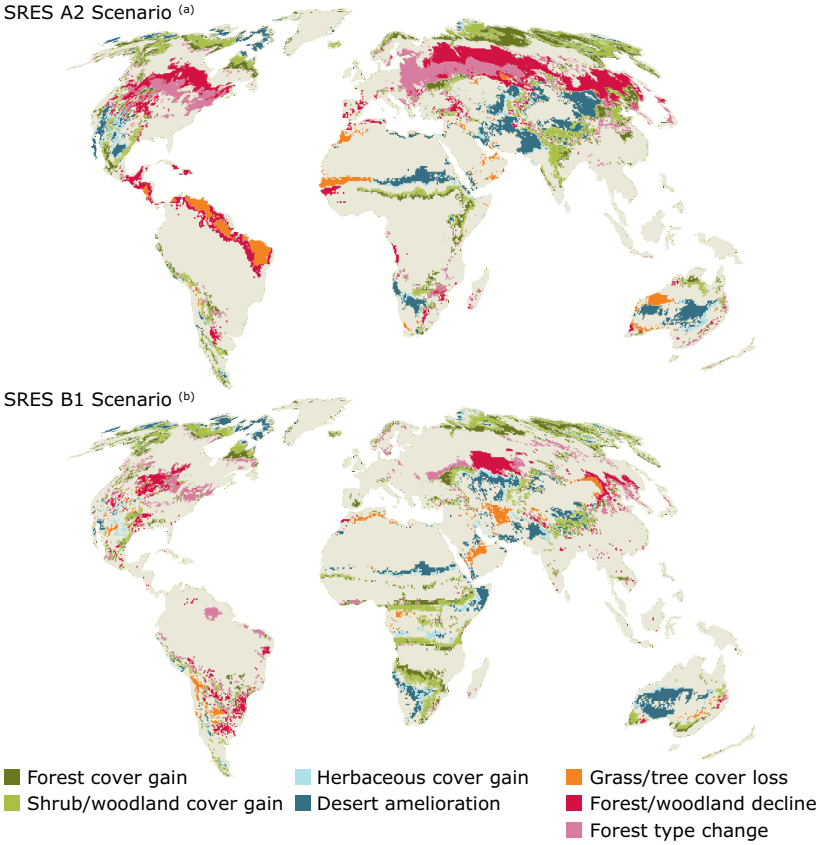


Source: IPCC, 2007b.

The increasing accumulation of CO_2 in the atmosphere is also important for marine ecosystems as its absorption in the ocean increases acidity (IPCC, 2007c) (Map 9.4). Organisms with shells and skeletons of calcium carbonate are expected to be especially vulnerable. Within 10 years, 10 % of the Arctic Ocean may become corrosive to aragonite, potentially damaging the skeletal structures of pteropods (free-swimming pelagic snails) and bottom-dwelling shellfish, which are crucial to the Arctic food web (Steinacher et al., 2009; Feely et al., 2004; Orr et al., 2005; Fabry et al., 2008; Comeau et al., 2009). Coral species are also heavily threatened and may disappear regionally by the end of this century (WGBU, 2006; Guinotte et al., 2006).

Map 9.3 Project impacts of climate change on terrestrial ecosystems

The projections only take changing climate constraints into account. Actual vegetation changes will also depend heavily on human land use.



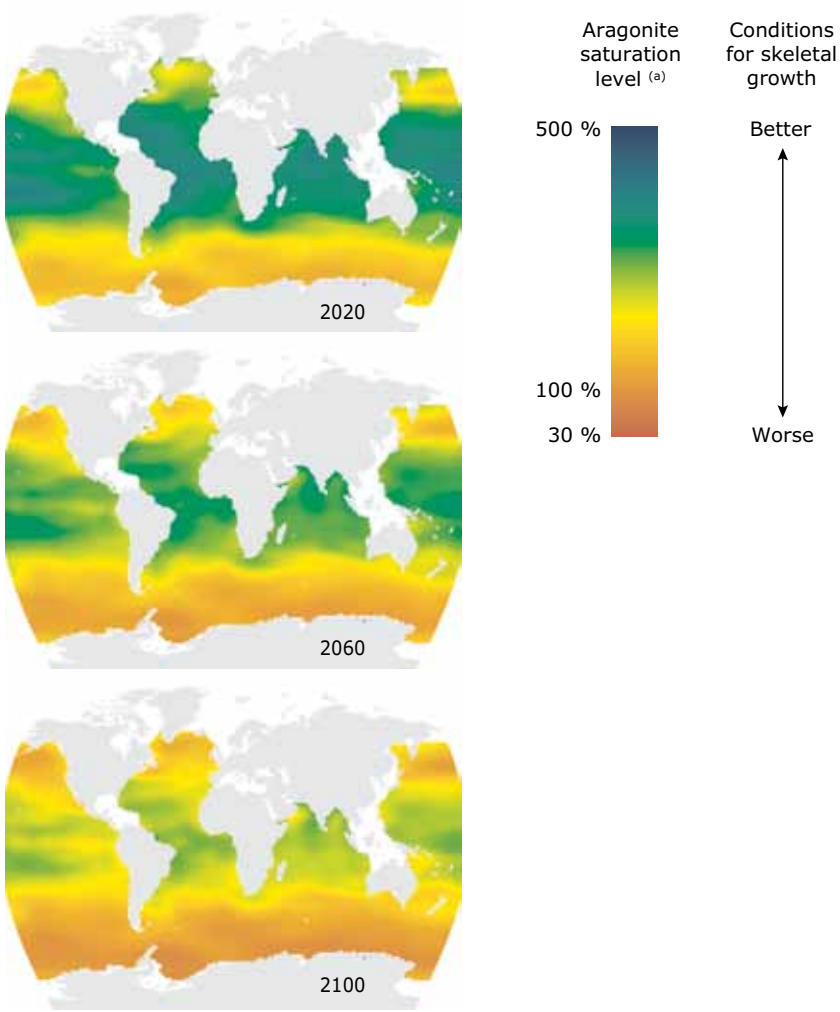
Note: IPCC Special Report on Emissions Scenarios (SRES):

(a) The A2 Scenario depicts a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies.

(b) The B1 Scenario depicts a world in which the emphasis is on local solutions to economic, social, and environmental sustainability, with continuously increasing population (lower than A2) and intermediate economic development.

Source: IPCC, 2007b.

Map 9.4 Projected ocean acidification by 2100



Note: (a) Aragonite is a form of calcium carbonate used by organisms such as corals, molluscs and some plankton species to build up skeletal structures and shells. Aragonite saturation levels go down as the ocean water acidifies. A value below 100 % indicates undersaturation, meaning that aragonite structures would dissolve. Lowering values imply that it becomes increasingly difficult for the mentioned organisms to survive and grow.

Source: IPCC, 2007c.

Box 9.1 Why is the growing severity of climate change impacts important for Europe?

Climate change influences the Earth's surface temperature, the sea level and the amount, timing and intensity of precipitation. On land, these changes affect freshwater availability and quality, surface-water run-off and groundwater recharge, and the spread of water-borne disease vectors. Extreme weather conditions have an increasingly large impact on vulnerable human communities, particularly the world's poor. Climate change can severely affect human health, food production, security and resource availability.

The major impacts of climate change may only become visible several decades from now but it is expected to become more important relative to the other megatrends towards the latter part of the 21st century. Projected climate change will have far-reaching impacts in Europe. It will affect the vulnerability of European society to an array of threats to human health, almost all economic sectors, ecosystem goods and services, and biodiversity. Pronounced consequences are expected in the Mediterranean basin, north-western Europe and the Arctic. Many coastal zones, mountains and areas prone to river floods are particularly vulnerable, as are urban areas. New opportunities may arise in some sectors and regions. However, with increases in both temperatures and the frequency and intensity of extreme weather events, adverse effects are likely to dominate in the medium to long term.

Key drivers and uncertainties

Increases in GHG emissions are largely due to the use of fossil fuels, although deforestation, land-use change and agriculture also provide significant but smaller contributions. Major drivers are therefore global population growth, increases in demand for food, water and energy, and agricultural practices. Policy responses, both mitigation and adaptation, are crucial.

The uncertainties regarding GHG emissions and ecosystem responses (including tipping points) are considerable. Major uncertainties also remain about impacts on human society, including long-term health effects, regional conflicts, migration and political instability.