

## Impacts of Europe's changing climate

### Introduction

Global climate change is a reality. In Europe the most vulnerable regions are the Arctic, mountain areas, coastal zones and the Mediterranean. Key economic sectors, which will need to adapt include energy supply, health, water management, agriculture, forestry, tourism and transport.

Earlier this year the EEA published a report on climate-change impacts in Europe, which confirm the impacts from a changing climate;

- temperature is increasing;
- sea levels are rising;
- glaciers, ice sheets and sea ice are melting;
- precipitation is changing, and the intensity and frequency of weather extremes are increasing;
- changes have led to an increased risk of floods and droughts, losses of biodiversity, threats to human health, and damage to economic sectors such as energy, transport, forestry, agriculture, and tourism;
- there is an urgent need for global action to stabilise the climate below a 2 °C increase above pre-industrial levels (the proposed EU target), to avoid major irreversible impacts on society and ecosystems;
- both action on mitigation (reducing greenhouse gas emissions) and on adaptation is needed.

### Temperature and precipitation changes

Global mean temperature has increased by 0.8 °C compared with pre-industrial levels. Europe has warmed more than the global average, especially

in the Mediterranean, the north-east and mountain areas. Looking forward projections suggest further temperature increases in Europe between 1.0–5.5 °C by the end of the 21st century.

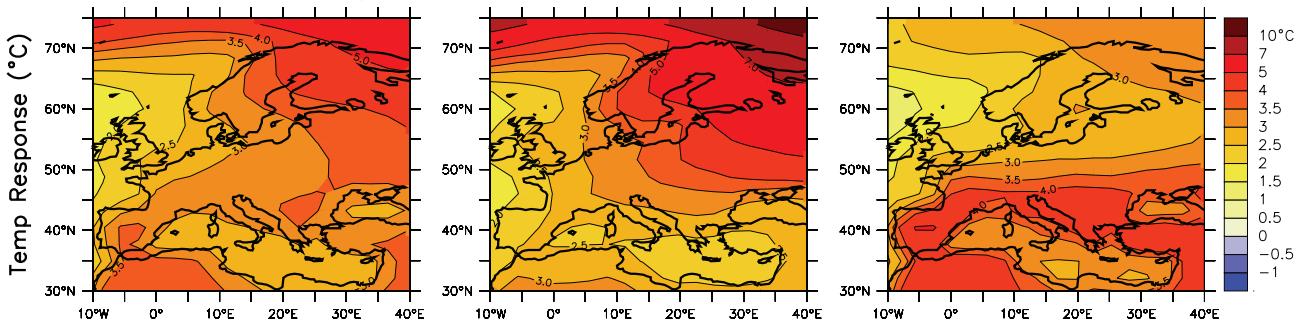
More frequent and more intense hot extremes and a decreasing number of cold extremes have occurred over the past 50 years and this trend is projected to continue. Much of Europe was affected

**Map 1 Key past and projected impacts and effects on sectors for the main biogeographic regions of Europe**



Source: IPCC, 2007; EEA.

**Map 2** Modelled change in mean temperature over Europe between 1980–1999 and 2080–2099



**Note:** Left: annual; middle: winter (DJF); right: summer (JJA) changes in °C for the IPCC-SRES A1B emission scenario averaged over 21 models (MMD-A1B simulations).

**Source:** Christensen *et al.*, 2007. Published with the permission of the Intergovernmental Panel on Climate Change.

by a heat wave during the summer of 2003, the hottest summer since at least 1500. Such hot summers may become much more frequent during the second part of the 21st century.

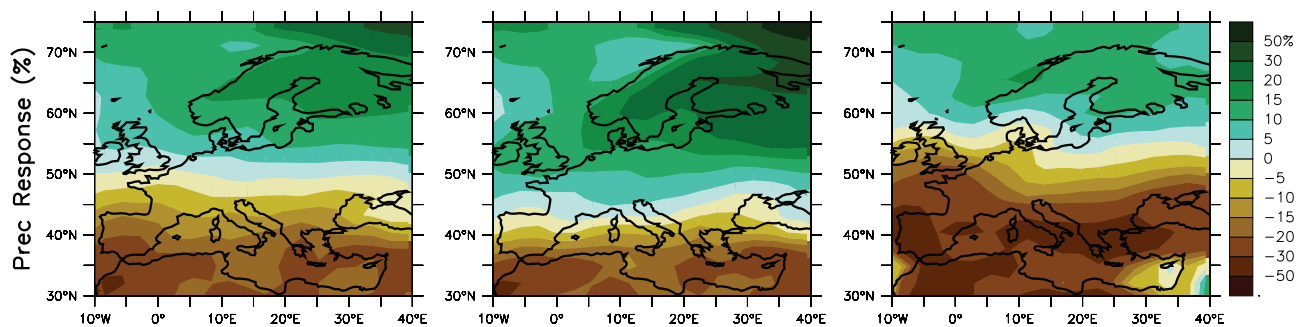
In Northern Europe annual precipitation increased 10 to 40 % during the 20th century

while in the south it decreased by up to 20 %. The intensity of heavy rain events has increased in the past 50 years, and these events are projected to become more frequent. In contrast dry periods are projected to increase in length and frequency, especially in the Mediterranean.

**Arctic**

The reduction in Arctic sea ice, especially in summer, has accelerated over the past fifty years, with a record low extent in September 2007. Arctic sea ice may even disappear at the height of the melting season in the near future, creating a feedback that will further increase climate

**Map 3** Modelled precipitation change between 1980–1999 and 2080–2099



**Note:** Left: annual; middle: winter (DJF); right: summer (JJA) changes % for the IPCC-SRES A1B emission scenario averaged over 21 models (MMD-A1B simulations).

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change as dark open water reflects less sunlight than white snow-covered surfaces.

Oil and gas exploration, shipping, tourism and fisheries may offer new economic opportunities, but also increase risks to the vulnerable Arctic environment and species specialised for life in the ice continue to be threatened.

### **Coastal areas and sea level rise**

Sea-level rise from thermal expansion of the oceans and increased inflow of melt-water from glaciers and ice-sheets can cause flooding, coastal erosion and the loss of flat and low-lying coastal regions. In addition, it will increase the likelihood of storm surges, enforces landward intrusion of salt water and endangers coastal ecosystems and wetlands, and increases the threat of loss of life and damage to infrastructure.

The rate of global mean sea-level rise has increased in the past 15 years and IPCC (2007) sea-level rise estimates may be too low because of the risk of more rapid changes than so far assessed in the Greenland ice sheet. The Greenland ice sheet has lost ice since the 1990s, and its contribution to global sea-level rise has increased in the past decades. Sea level rise is projected to continue the coming decades.

### **Mountain areas (Alps)**

European glaciers are melting rapidly: those in the Alps have lost two thirds of their volume since 1850, with loss

accelerating since the 1980s, and they are projected to continue their decline. These changes will cause natural hazards and damage to infrastructure and changes in river flows and seasonality, thus substantially affecting the hydrological cycle in river catchment areas.

### **Water quantity and quality, river floods and droughts**

Annual river flows have increased in the north and decreased in the Mediterranean, a difference projected to exacerbate due to climate change, while changes in land use and river management also have an influence. Lower flows in summer and higher flows in winter are projected and thus droughts and water stress will increase, particularly in the Mediterranean and in summer.

Europe has been affected by several major droughts, e.g. in summer 2003 in central Europe and the 2005 drought in the Iberian Peninsula. The Mediterranean is most prone to an increase in drought hazard, but minimum summer river flows will also decrease significantly in many other parts of Europe. Looking ahead floods are projected to occur more frequently in many regions, particularly in winter and spring.

Warming of surface water is leading to movement of freshwater species northwards and to higher altitudes, and earlier spring phytoplankton and zooplankton blooms. This may lead to increased harmful cyanobacteria and increased

threats to the ecological status of lakes and enhanced human health risks.

### **Terrestrial ecosystems and biodiversity**

Plant species and birds, insects, mammals and other animal groups are moving northward and uphill. By the late 21st century, plant species are projected to have shifted several hundred kilometers to the north, forests are likely to have contracted in the Mediterranean and expanded in the north, and 60 % of mountain plant species may face extinction. A combination of the rate of climate change, habitat fragmentation and other obstacles could lead to a decline in European biodiversity.

### **Agriculture and soil**

The length of the growing season of several agricultural crops has increased at northern latitudes, favouring the introduction of new species that were not previously suitable, but there has been a shortening of the growing season locally in the south. The variability of crop yields has increased as a consequence of extreme climatic events, such as the summer heat of 2003 and the spring drought of 2007. These changes are projected to continue.

In the Mediterranean increases in water demand for agriculture are projected enlarging competition for water between sectors and uses.

Climate change may also lead to a future decline in soil organic carbon stocks and thus a substantial future increase

in CO<sub>2</sub> emissions. Soils may also be more susceptible to erosion, especially in the Mediterranean. Soil degradation is already intense in parts of the Mediterranean and central-eastern Europe and contributing to an increased risk of desertification. Projected risks for future desertification are the highest in the same areas.

**Forest fires**

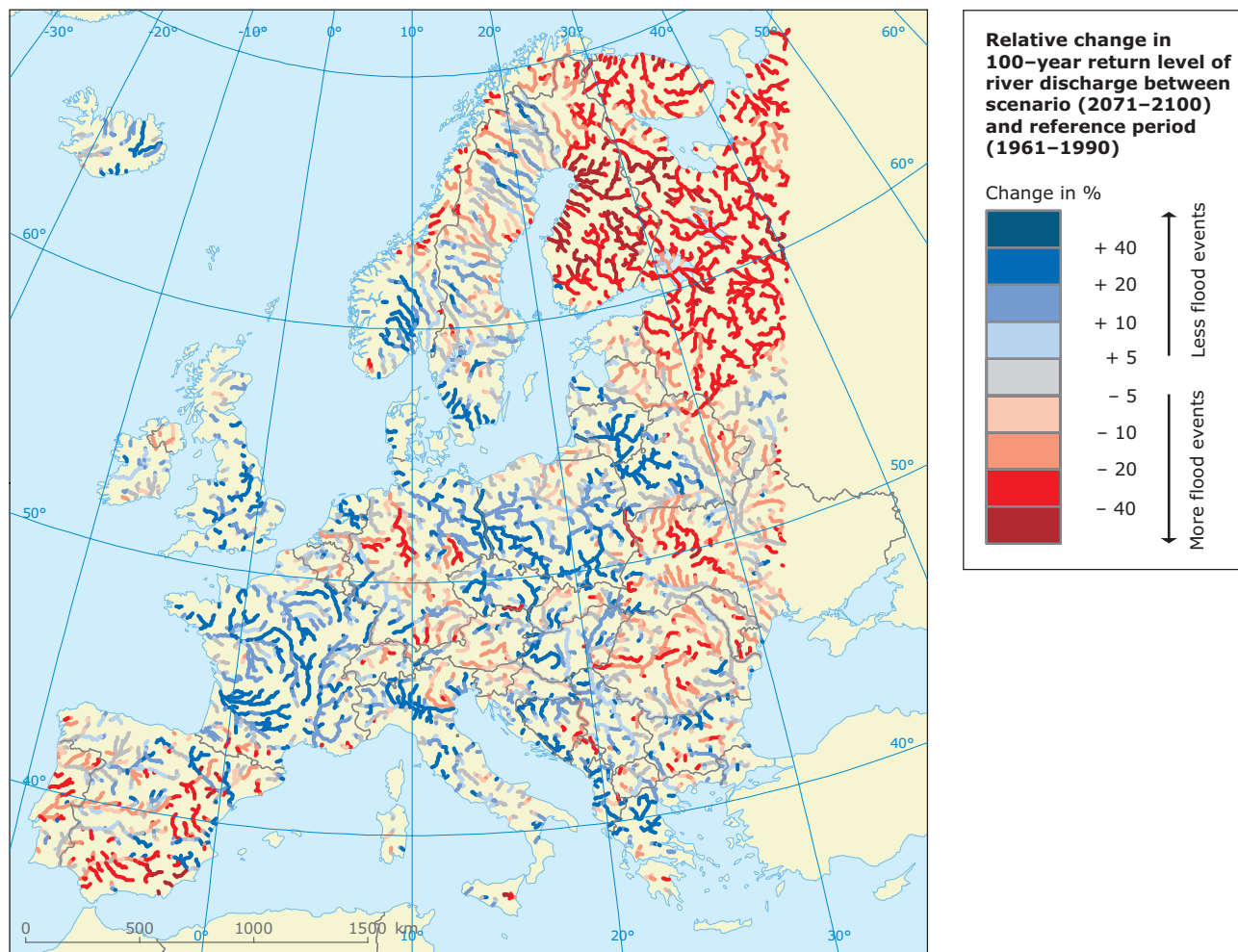
Wildfires are a serious threat to forests and ecosystems in Europe. The total burned area changes yearly mainly due to weather conditions. Projected temperature increases will increase the danger of forest fires and lead to more area being burned, more ignitions and longer fire seasons,

especially in southern and central Europe.

**Human health**

Heat waves are projected to become much more common in future and, depending on the location, will increase mortality risk. Winter mortality in Europe has decreased, but this is mainly due to improved

**Map 4** Projected change in 100-year return level of river discharge between 2071–2100 and the reference period 1961–1990



**Note:** Simulations with LISFLOOD driven by HIRHAM — HadAM3H/HadCM3 based on IPCC SRES scenario A2.

**Source:** Dankers and Feyen, 2008b.

housing and the prevention of winter infections.

Increasing numbers of older adults in the population will increase the proportion of the population at risk. A number of vector-borne diseases are expected to increase in the near future. The tiger mosquito, a transmitter of a number of viruses, has extended its range in Europe substantially and is projected to extend even further. Ticks and the associated Lyme disease and tick-borne encephalitis are moving into higher altitudes and latitudes.

### Adaptation to climate change

Adaptation involves decision-making from municipalities to international organizations. It is a cross-sectoral and transboundary issue and integration of adaptation into sectoral policies at European and national levels is important.

The European Commission adopted a Green Paper on adaptation (2007) and is planning a White Paper in early 2009, framing a European adaptation strategy and options for adaptation. National adaptation strategies

have been adopted in various EEA member countries (e.g. Denmark, Finland, France, Hungary, the Netherlands, Spain, United Kingdom).

Examples of adaptation measures include: health/heat action plans, vaccination, health system planning, flood risk planning and early warning systems, drought and water scarcity risk management, water demand management, coastal and flood defences, natural hazard monitoring, reinforcing the built environment, land-use management, and greening of cities.

Europe has to adapt itself but should also assist developing countries as they are most vulnerable in terms of communities, economic sectors and ecosystems.

### Key future challenges

Better monitoring and reporting of observations of climate change and high-resolution climate change scenarios are needed as appropriate adaptation measures are best taken at regional and local level. A better understanding of costs and benefits across all

sectors is also needed. Good practices should be developed in synergy with mitigation actions. It is also important to better understand how to avoid mal-adaptation.

A European Clearing House on climate change impacts, vulnerability and adaptation could make information widely available to users across Europe. It could be underpinned by the EU Shared Environmental Information System (SEIS), the services to be generated by the EU GMES programme on global monitoring for environment and security and the WHO Climate, Environment and Health Information System (CEHAIS).

### References

EEA/JRC/WHO, 2008. *Impacts of Europe's changing climate – 2008 indicator-based assessment*, EEA Report No 4/2008. [http://reports.eea.europa.eu/eea\\_report\\_2008\\_4/en](http://reports.eea.europa.eu/eea_report_2008_4/en).

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