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Climate change and river flooding in Europe

Extreme floods are the most common type of natural disaster in Europe. Climate change, including the increasing intensity of heavy rainfall, is projected to make extreme river floods even more frequent in some areas, especially in central, northern and northeastern Europe.

In particular, the number of sudden, localised but severe floods — flash floods — is expected to rise, which is also likely to increase the risk of casualties.

Action to prevent flooding and to reduce its impact is needed. Some countries are already taking initiatives. Recognising the often transboundary nature of floods and flood prevention, the European Commission has recently proposed concerted action on flood risk management.

Floods and their consequences

Floods can kill people and animals and make people ill and homeless. They can also damage the environment, infrastructure and property. However, they can also have important beneficial effects for river ecosystems, groundwater recharge and soil fertility. A distinction can therefore be made between normal (annual) flooding events, usually causing very little or no damage and sometimes having beneficial effects, and exceptional events that can have severe negative impacts.

The adverse impacts of exceptional flooding events on human health are complex and far-reaching. The risk of death is higher during flash floods, because these happen with little or no prior warning. The death rate is relatively low in the case of river floods or storm surges, as these can be forecast.

Other health effects include those caused by a lack of medical aid, increases in diseases such as gastrointestinal diseases and dermatitis, and psychological health problems.

In addition, human health can be affected through damage caused to the environment. The environmental impact of floods occurring in large rivers includes the clogging up of water treatment plants (potentially leading to the release of large quantities of contaminants), damage to vegetation and the mobilisation of contaminants present in the soil.

The rupture of underground pipelines, dislocation of storage tanks, overflow of toxic waste sites or the release of chemicals stored at ground level can pollute rivers and aquifers.

Flash floods can also cause intense destruction and environmental damage such as soil erosion, especially when associated with other natural processes such as landslides, although usually across relatively small areas.

European Environment Agency

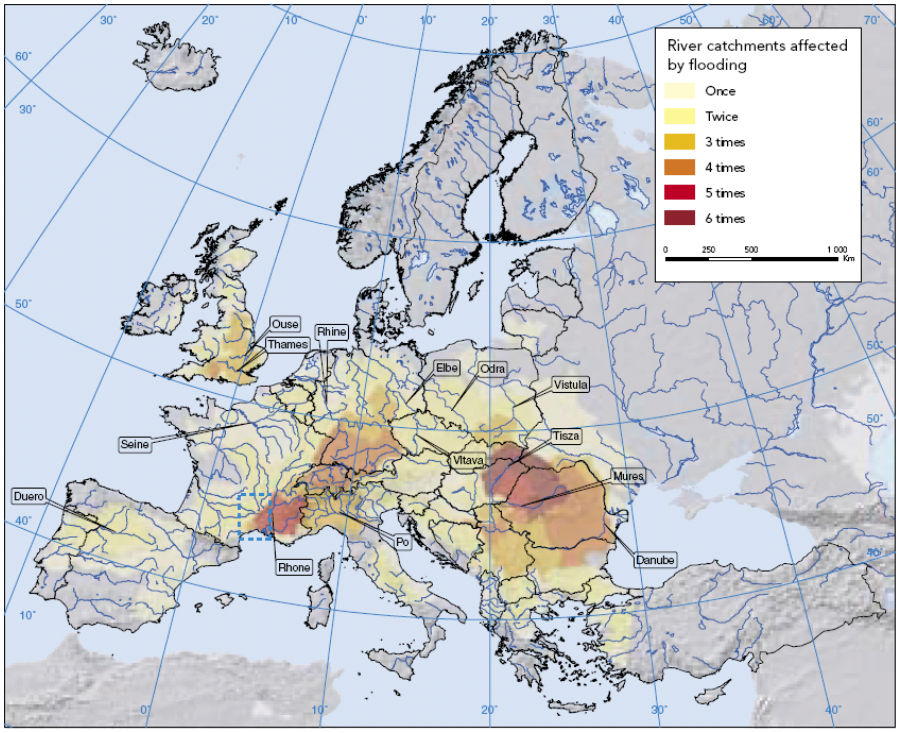
Floods in Europe

Floods are the most common type of natural disaster in Europe. According to the EM-DAT international disaster database, floods comprised 43 % of all disaster events in the period 1998–2002. During this period, Europe suffered about 100 damaging floods causing some 700 fatalities, the displacement of about half a million people and at least 25 billion EUR in insured economic losses. The floods covered an estimated one million square kilometres (areas with repeated flooding in the period being counted more than once). Around 1.5 % of the European population was affected.

From January to December 2002, 15 major floods occurred in Europe in countries such as Austria, the Czech Republic, Germany, Hungary and the Russian Federation. These floods killed approximately 250 people and adversely affected a further one million.

Mapping the damaging floods that occurred in Europe over the 1998–2002 period indicates which regions were prone to flooding. As Map 1 shows, eastern Hungary, Romania, southeastern France, southern Germany and Switzerland were hit most times by flooding.

Map 1 Recurrence of flood events in Europe 1998–2002



Source: ETC/TE, 2003 (based on NASAsupported Dartmouth Flood Observatory/Digital Elevation Model (GISCO)/Rivers (GISCO)/ Watersheds 1M (JRC-IES) / Administrative boundaries (GISCO)).

Trends in floods in Europe

Floods vary in frequency, location and intensity as a result of seasonal and regional variations in precipitation and other weather conditions, and more long-term changes in the climate. Human activity also plays a role. Deforestation in mountainous regions accelerates runoff, thereby increasing the likelihood of flooding. Urban development on former flood plains is likely to increase the magnitude of negative impacts of flooding events in the area itself, and to increase the likelihood of floods downstream due to 'canalisation' of rivers.

Looking at the 238 flood events recorded between 1975 and 2001 in EM-DAT, the number of flood events per year increased over the period. However, the number of deaths per flood event decreased somewhat, probably due to improved warning and rescue systems.

Climate change and floods

Trends in the frequency and intensity of flood events in the future will be closely related to changes in the patterns of precipitation and river discharge, and thereby also to other long-term changes in the climate.

Though uncertainties are high in many of the projections, scientific confidence in the ability of the climate models to estimate future conditions is increasing. The following summarises the state of

knowledge and understanding at the present time.

Temperature

Europe has experienced considerable temperature increases in the last 100 years, especially in recent decades (Figure 1). The warmest year in Europe in this period was 2000, and the next seven warmest years occurred in the last 14 years. A heatwave across much of Europe during August 2003, considered the warmest August on record in the northern hemisphere, claimed possibly as many as 35 000 lives.

Warming has been greatest in northwest Russia and the Iberian Peninsula. Temperatures are increasing in the winter period more than in summer, resulting in milder winters and a reduced seasonal variation.

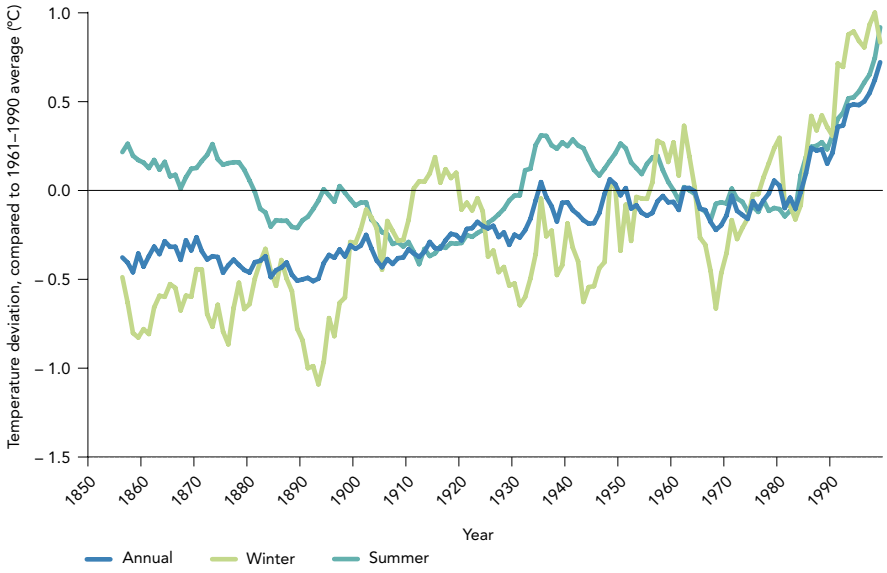
All these trends are expected to continue, with the exception of the reduced seasonal variation, which is not expected to be the case in southern Europe.

Precipitation

Annual precipitation increased over northern Europe by 10–40 % in the period 1900–2000, while parts of southern Europe experienced a 20 % decrease. Seasonal patterns show even more pronounced trends. During the winter season especially, southern and eastern Europe became drier while many parts of northwestern Europe became wetter.

Projections indicate increasing annual precipitation in northern Europe and wetter summers across most of Europe.

Figure 1 Annual, winter and summer temperature deviations in Europe 1850–2000



Source: CRU, 2003; Jones and Moberg, 2003.

Precipitation extremes

In many regions, the trend in precipitation extremes is more pronounced than the average trend. Since 1976, an increase has been observed in the number of very wet days in central and northern Europe, while decreases have been observed in parts of southern Europe.

Episodes of intense precipitation are projected to grow in frequency, thus increasing the risk of flooding across the river basin. In addition, winter precipitation will fall more often as rain, as a result of higher temperatures. This will lead to immediate runoff and a greater risk of flooding.

River discharge

Over the twentieth century, river discharge decreased considerably in many southern European basins, while large increases occurred in eastern Europe. It is very likely that the changes were largely due to precipitation changes, although discharge is also affected by various other factors such as land-use change or the straightening of rivers.

The combined effects of projected changes in temperature and precipitation will in most cases amplify the changes in annual river discharge. By 2070, river discharge is estimated to decrease by up to 50 % in southern and southeastern Europe, and to increase by up

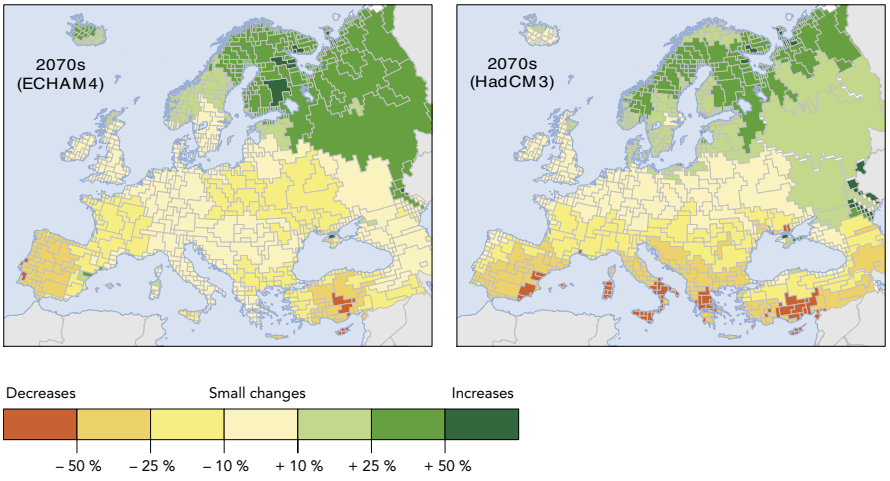
to 50 % or more in many parts of northern or northeastern Europe (Map 2).

Policy responses

It seems reasonable to expect that the frequency and intensity of extreme flooding events will increase in many parts of Europe in the future, especially in parts of central, northern and northeastern Europe, unless countries take serious steps to prevent floods and to reduce their impacts. Some countries, such as Germany, are already taking initiatives. Recognising the often transboundary nature of floods and flood prevention, the European Commission has recently proposed a concerted action on flood risk management focusing on the development and implementation of coordinated flood risk management plans and flood risk maps.

The European Environment Agency is currently analysing the various ways in which EU Member States are developing their flood risk maps.

Map 2 **Projected change in annual average river discharges for European river basins in the 2070s compared to 2000**



Note: Two different climate models are used.
Source: Lehner *et al.*, 2001.

References

This briefing builds on material from two EEA reports, in which references to the many original sources, also for the figures and maps, can be found:

Mapping the impacts of recent natural disasters and technological accidents in Europe, Environmental issue report No 35, EEA, Copenhagen

Impacts of Europe's changing climate, EEA Report No 2/2004, EEA, Copenhagen

COM(2004)472 final: Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: Flood risk management — flood prevention, protection and mitigation.

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