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Europe: climate change and large-scale flood risks

Flood risk in Europe has changed over the last 50 years. Climate change and urbanisation make the flood risk landscape dynamic. Risk assessment has to actively trace trends to reflect present-day climate and socio-economic changes, including climate change adaptation policies. Despite the long absence of major events, windstorms remain an ever-present hazard in Europe.

Two sides of the coin: floods and drought

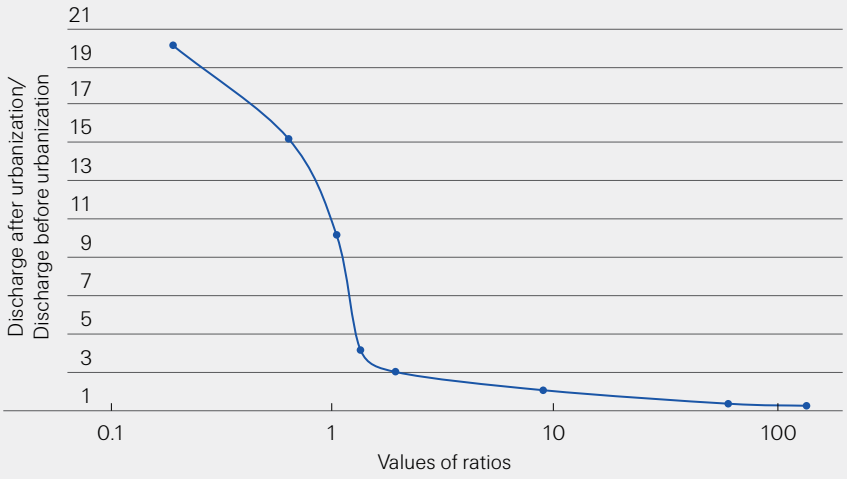
Flood is a peak risk in Europe. The central European floods of 2002 and 2013 serve as important reminders of the loss potential of this secondary peril. Natural variability is an important aspect, but studies also confirm that a changing climate has had significant impact on seasonality and on the severity and frequency of flood events in Europe, with clear regional patterns. A 2019 systematic analysis of a comprehensive dataset of flood observations has detected both increasing and decreasing trends over the last five decades.[1] According to this study, large parts of central and north western Europe experienced an increase of up to 11% per decade in annual river-flood discharge, while the Mediterranean area and eastern Europe showed significant decreases. Flood severity depends not only on precipitation levels and the extent of surface sealing, but also on soil moisture, snowmelt, and the occurrence of persistent weather patterns, all of which are influenced by warming temperatures.

Variations in annual peak flood discharges do not give a direct indication of changes in tail risk. Nevertheless, they are correlated to extreme flood events. The same study highlights how the recurrence intervals of typical 100-year events in the 1960s have changed from then to the present day.[2] What was considered a 100-year flood 60 years ago can now occur every few decades, or even more frequently in many regions in central and north western Europe. At the same time, return periods have increased significantly in south and eastern Europe.

Socio-economic factors also impact flood risk. Changing land use for forest management, agriculture and water drainage have significant effects. Likewise population growth and urbanisation, which impact the hydrological cycle, especially during heavy rainfalls, with surface-water runoff and river flooding more severe. The removal of natural absorption zones amplifies the impact of smaller flood events in particular. Already in 1975, a study (Figure 1) showed that urbanisation could lead to a tenfold increase of frequent small floods, and a doubling in size of a typical 100-year event.[3]

1 G. Blöschl et al., "Changing Climate Both Increases and Decreases European River Floods", *Nature*, vol 573, 2019.
2 Ibid.
3 G.E. Hollis, "The effect of urbanization on floods of different recurrence interval", *Water Resources Research*, vol. 11, no. 3, 1975.

Figure 1
Effect on flood magnitude of paving 20% of a basin



Source: G.E. Hollis, "The effect of urbanization on floods of different recurrence interval", *Water Resources Research*, vol 11, no 3, 1975.

The same study from Blöschl et al. also shows decreasing rainfall and increasing evaporation for southern and eastern regions pointing to, conversely, rising drought risk. And with it comes the risk of drought-induced soil movements (subsidence). Long and intense dry spells can lower the ground so much that fissures in the earth appear, damaging the foundation of houses, bridges, industrial sites and other structures. Sinkholes start to appear, causing the collapse of entire buildings, all areas of potential protection gap in property insurance. Besides meteorological factors such as precipitation and soil moisture content, urbanisation and land use exacerbate the risk.

Losses from drought-induced subsidence have been rising. A study from Swiss Re and the Swiss Federal Institute of Technology in close collaboration with the National Centre of Competence in Research on climate shows that in France alone, economic losses from soil subsidence rose by more than 50% between 1990 and 2010.[4] Both frequency and severity of incidents of soil subsidence are likely to increase with climate change, calling for risk views reflecting full understanding of current conditions and integration of risk into a broader adaptation policy.

[4] T. Corti et al. "Simulating past droughts and associated building damages in France", *Hydrology and Earth System Science*, 2009.

Climate change adaptation: lessons from the Dutch masters

No country in the world is more aware of the dangers of rising sea levels and overflowing rivers than the Netherlands, also a giant delta. Over the course of history, it has learnt to successfully mitigate the hazard of both coastal flooding from storm surge and river water discharge. With its expertise in building dykes, dunes, dams and barriers, the Netherlands has been able to increase agricultural land and become the second-largest agricultural exporter by dollar value in the world.

Today, the country faces combined threats of climate change and ever-increasing subsidence. Sea levels are rising; extreme rainfall events today occur twice as often as 50 years ago;[5] and a third of the Netherlands lies below sea level and vast swathes are gradually sinking (subsiding) under the weight of the centuries-old practice of saltwater drainage and land reclamation to make the lowlands suitable for agriculture and other land use.

Faced with the prospect of rising sea and precipitation levels, the Dutch government has reformulated its policies on flood protection and water management, from one focused only on reducing the hazard to a more comprehensive risk-based and adaptive approach. A wide range of adaptation measures based on both water management and sustainable spatial planning have been devised. In addition, climate risk is continuously assessed, and the policy is redefined as new scientific information about an evolving physical risk landscape and the impact on flood risk is made available by the scientific community.

Already in 2007, in a reversal of the centuries-old practice of land reclamation, the government launched the "Room for the River"' programme to reduce water levels during times of high river discharges, by creating extra storage facilities (lakes, parks and even parking garages) along the rivers and increasing the retention capacity of urban areas. Instead of keeping the water between ever-higher dykes and discharging it into the sea as fast as possible,[6] the idea is to "accommodate the river water." During intense rainfall these extra storage spaces will retain water, and at other times serve as playing fields and communal areas.[7] Among the most recent measures are the creation of additional flood channels (bypasses or "green rivers"'), increasing the depth of flood channels and removing obstacles from the floodplain,[8] but also floating roads, buildings and structures that adapt to changing water levels. The challenge is balancing between water levels that allow optimum land use while minimizing subsidence. In 2010, the government further strengthened its action on the water domain within the national framework of the Delta Programme. The aim is to make flood risk management, freshwater supply and spatial planning climate-proof and water-resilient by 2050, ready to deal with both extreme flooding and drought.[9]

Pan-European rainfall deficits in the summer of 2018 caused a national water shortage with severe consequence for agriculture (economic losses of EUR 1.4 billion). Due to the role that Rotterdam plays in the shipping sector, the low level of the rivers Waal, Ijssel and Lower Rhine triggered transportation disruption and further losses of EUR 354 million.[10] The drought came as a shock in the land of

5 *Preparing for natural disasters and extreme weather events in BeNeLux – Webinar,* Swiss Re Institute, 29 May 2019.

6 H.P. Ritzema and J.M. Van Loon-Steensma, "Coping with Climate Change in a Densely Populated Delta: A Paradigm Shift in Flood and Water Management in The Netherlands", Irrigation and Drainage, vol 67, 2018.

7 J. Rijke et al., "Room for the River: Delivering integrated river basin management in the Netherlands", *International Journal of River Basin Management*, vol 10, no 4, 2012.

8 Ibid.

9 *Delta Programme 2019: Continuing the work on the delta: adapting the Netherlands to climate change in time*, Ministries of Infrastructure and Water Management, Agriculture; Nature and Food Quality; and Interior and Kingdom Relations, 2018.

10 "Economische shade door droogte in 2018", *Ministry of Infrastructure and Water Management*, February 2019.

aquatic plenty and reinforced the urgency to press ahead with the freshwater supply measures within the Delta Programme. The experience also reinforced that fighting climate change requires a fully integrated holistic approach, where response is adaptive to new developments (from multiple hazards and the risk side). Or else, when building any mitigation measures with a non-adaptive static view, they run the risk of being outdated by the time they are completed.

Windstorms are another peak weather-related natural catastrophe risk in Europe. There has been a lull in large-scale storm disasters in recent years, but the 1999 storm series of Lothar and Martin, and the North Sea storm surge in 1953, remain significant tail risk events.[11] The risk is dominated by strong natural variability: the history of European windstorms shows a strong multi-decadal pattern.[12]

[11] *Christmas 20 years ago: Storms Lothar and Martin wreak havoc across Europe*, Swiss Re, December 2019.

[12] O. Krueger. F. Feser and R. Weisse, "Northeast Atlantic Storm Activity and Its Uncertainty from the Late Nineteenth to the Twenty-First Century", *Journal of Climate*, vol 36, no 6, 2019.