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Flood of July 13-15 2021: a new type of floods in Western Europe?

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Introduction

The flood event of July 13-15 2021 in Western Europe did not just surprise the inhabitants and the local authorities of the affected regions, also scientists were stunned to see such a catastrophic flood event occur, especially during summer (Cornwall, 2021). With economic losses running into billions of euros and over 200 fatalities (United Nations, 2022), the flood event exposes a vulnerable weakness in current flood risk management: flood risk associated with the smaller streams that form the tributaries of major rivers such as the Meuse and the Rhine. In the Mediterranean region and the Alps, similar sudden floods, known as flash floods, are common and specific warning systems have been developed (Marchi et al., 2010). Does the 2021 flood event force us to take a similar approach and include flash floods in our flood risk management plans or was the flood event not as unique as we perceive it to be?

Method

In order to understand the uniqueness of the flood event, context must be provided, both historically and spatially. A data analysis of the precipitation and discharge measurements combined with a detailed site description is a simple method for this purpose. An explorative approach for determining relevant parameters prevents a possible tunnel vision towards specific findings. Furthermore, it gives the research both a wide and deep layer of understanding. We select the most critical catchments, based on a heatmap from the flooding locations, of Germany, Belgium and the Netherlands as case studies. These are respectively the Ahr, Vesdre and Geul catchments. It must be noted that measurements of the event were rare due to several dysfunctional (and sometimes destructed) gauges. The consequential data gaps, combined with the often less accurate measurements of gauges during extreme events, introduce uncertainty in the analysis. Therefore, this abstract focuses on qualitative findings rather than precise numbers.

Results

of A common method to provide historical context of an event is to determine return periods. The frequency analysis of both precipitation and discharge measurements undeniably shows the rarity of the event, with the exception of several precipitation gauges. Return periods of a 100 years form the norm, but outliers over a 1000 years were found as well. As many values of precipitation and discharge had never been measured before, the significance of these results is reduced by the relatively short time period of these measurements, ranging from ten to ninety years (a problem already acknowledged by Rodier et al. (1984)). For the Ahr catchment, Roggenkamp et al. (2014) reconstructed historical peak discharges which show a similar event in 1910 and an even more extreme case in 1804. This centenary occurrence contrasts with the return period of over 10.000 years for the peak discharge in July 2021, as obtained from the available discharge measurements (Schäfer et al., 2021). Both the 1804 and 1910 floods occurred during summer. Seel (1983) provides the timing of more historical floods, which shows that just below 50% of all registered floods occurred during summer. These findings imply that the flood event in the Ahr of July 13-15 2021 may not have been as rare in size and timing as anticipated. Extending this conclusion to the catchments of the Vesdre and Geul is not possible due to a lack of data.

Historical context is only one insight in the uniqueness of the flood event, flood typology provides another. Merz et al. (2003) introduces five types of regional floods of which the potential summer flood types are: flash floods, short-rain floods and long-rain floods. The large extent of the precipitation area and its stationarity, due to the large cold core low over Western Europe, is a characteristic of a long-rain flood.

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In contrast, the hydrographs indicate a lag time (defined as the time between the centroid of the precipitation event and the moment of the peak discharge) of less than 24 hours. This fits the characterization of a flash flood (Merz et al., 2003). These mixed characteristics of the July 2021 flood event prevent an identification of the flood type, which highlights the uniqueness of the flood event. This may complicate flood risk management, as a new flood type weakens the common approach of flood risk analysis.

Besides historical context, spatial context helps to understand the local conditions in which these flood events occurred. Although the catchments are similar in terms of size, shape and mean annual discharge, considerable differences can be found in their slope (both regarding the overall landscape and the river channel bed), the mean annual precipitation, the geology and human interference in the river course. The importance of catchment characteristics is highlighted by the different runoff ratios. The total volume of precipitation of the Ahr catchment is only slightly higher than for the Geul catchment while the total volume of precipitation is twice as large for the Vesdre catchment. The peak discharges show a different pattern, with the Ahr's peak discharge of around 800 m^3/s, followed by the Vesdre with 600 m^3/s (Zeimetz et al., 2021) and lastly, the Geul with 100 m^3/s (Task Force Fact Finding Hoogwater 2021, 2021). This order of flood severity in the catchments, indicated by the peak discharges, aligns with the varying degree of financial damage and number of fatalities between the three catchments. The varying runoff response and thus potential flood behaviour may be caused by the different catchment characteristics described above, and illustrates the importance of spatial context in flood typology.

Conclusion and further research

There is no denying that the 2021 flood event was a rare and surprising event, as shown by the damage and number of fatalities. And indeed, the forcing of the flood event from the high precipitation resulting from the extensive cold core low, is a unique circumstance. However, the size and timing of the flood event is not entirely new. Floods of similar magnitude have occurred before the measurement record, and should be accounted for in flood risk analysis. Similar analysis is required for the Geul and the Vesdre catchments and possibly a generalization to Western Europe. Furthermore, the hydrological and hydrodynamic behaviour must be understood before possible measures can be considered. The high peak flows of this event complicate the implementation of structural measures. It may lead to a mentality shift away from the current philosophy that flooding must be prevented at all costs. Finally, the role of both urbanisation and climate change must be investigated to assess their impact on the return periods of similar events in the future.

References

Cornwall, W. 2021. Europe's deadly floods leave scientists stunned. Science. https://www-science-org.tudelft.idm.oclc.org/content/article/europe-s-deadly-floods-leave-scientists-stunned.

Roggenkamp, T. Herget, J. 2014. Reconstructing peak discharges of historical floods of the river Ahr, Germany. Erdkunde. 68, 49–59.

Schäfer, A. Mühr, B. Daniell, J. Uwe 2021. Hochwasser Mitteleuropa, Juli 2021 (Deutschland). CEDIM. https://www.cedim.kit.edu/download/FDA_HochwasserJuli2021_Bericht1.pdf.

Seel, K.A. 1983. The Ahr and its floods in old springs.

Merz, R. Blöschl, G. 2003. A procces typology of regional floods. AGU Water Resources Research. 39, 12.

Task Force Fact Finding Hoogwater 2021 2021. Hoogwater 2021 Feiten en Duiding. https://klimaatadaptatienederland.nl/publish/pages/192998/hoogwater-2021-feiten-en-duiding.pdf.

Zeimetz, F. Launay, M. Bourqui, P. Calixte, E. Fallon, C. Teller, J. 2021. Analyse indépendante sur la gestion des voies hydrauliques lors des intempéries de la semaine du 12 juillet 2021. Lot 1 - factualisation. Stucky. https://www.wallonie.be/sites/default/files/2021-10/rapport_synthese_analyse_inondations_-_stucky_-_volet_1_-_11-10-21_.pdf.

Gumbel, E.J. 1941 The return period of flood flows The annals of mathematical statistics. 12, 12, 163–190.

Marchi, L. Borga, M. Preciso, E. Gaume, E. 2010. Characterisation of selected extreme flash floods in Europe and implications for flood risk management. Journal of Hydrology. 394, 1-2, 118–133.

Rodier, J.A. Roche, M.A. 1984. World catalogue of maximum observed floods= Repertoire mondial des crues maximales observees. IAHS. http://hydrologie.org/redbooks/a143/iahs_143_0000.pdf.

United Nations 2022. 2021 floods: UN researchers aim to better prepare for climate risks. https://unric.org/en/2021-floods-un-researchers-aim-to-better-prepare-for-climate-risks/.