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The seismic footprint of the devastating July 2021 Ahr Valley flood, Germany

Michael Dietze[1], Rainer Bell[2], Thomas Hoffmann[2,3], and Lothar Schrott[2]
[1]GFZ German Research Centre for Geosciences, Geomorphology, Potsdam, Germany (mdietze@gfz-potsdam.de)
[2]Institute of Geography, University of Bonn, Bonn, Germany
[3]Department of Fluvial Morphology, Sediment Dynamics and Management, Bundesanstalt für Gewässerkunde, Koblenz, Germany

Valley confined floods are a major hazard. In contrast to large river floods with day long warning time, they can evolve within minutes to hours, exhibit higher flow velocities and drive large amounts of debris into populated places. While many Alpine communities have developed mitigation, early warning and rapid response schemes for this natural hazard type, these measures are virtually unknown in Central European upland regions. Beyond flood protection, lacking measurement infrastructure also prevents retrospective collection of event anatomy data, which would be key to understand the evolution of an event and, hence to improve our response to future hazards.

The 14–15 July 2021 flood that hit the Ahr valley in the Eifel mountains, west Germany, was a drastic example of the potential of such valley confined floods. A wall of water flushed through the deeply incised valley, flooding more than 15 towns and affecting 42,000 people, resulting in the highest number of casualties in Germany since 1962. All gauges along the main channel were destroyed while the flood hydrograph was still on the rising limb and grid power loss interrupted collection and transmission of data from other potential sensors.

Here, we use data from a single seismic station near the town of Ahrweiler, originally deployed for earthquake seismology. Despite grid power cutoff around 23:19 CEST, the station recorded the arrival of the fast rising limb of the flood. We show how even an incomplete record of a single station not set up for flood early warning can be used to infer crucial and timely information about the flood: propagation velocity, water level and debris transport rate. We argue that installing a network of a few distributed low cost seismic sensors could have improved flood early warning and near real time provision of kinetic flood data. More importantly, such a network would be the key for improved response actions for future floods, deemed more likely in Central Europe under the currently changing climate conditions.