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Seismic observations of the 2021 Uttarakhand landslide/debris flow and flood events

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Debris flows and corresponding floods are a significant natural hazard for downstream communities in vulnerable regions, as yet unpredictable triggers and remote source locations might cause dynamics which are difficult to measure and quantify. Continuous observational coverage offered by seismic monitoring is one potential avenue for addressing this problem. Displacement of mass at Earth's surface generates elastic seismic waves, which carry information about the temporal and spatial variability of the source and which can be recorded by seismometers at high temporal resolution across large spatial scales. Here, we report on seismic observations of the destructive 2021 Uttarakhand (India) debris flow and flood events. By means of a dense regional seismic network, we track and quantify the spatial and temporal evolution of the flood. Using continuous time-stamped seismic observations, a coherent signal of the flood movement is observed in a limited frequency band which can be tracked down the valley during the flood duration. Our analysis highlights potential benefits of using a network-wide seismic monitoring systems.