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A flood of disaster response challenges

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On 14 July, 60 to 180 mm of rain fell in just 22 hours in western Germany (1), causing heavy flooding. The storm was unexpectedly destructive because fast runoff and quickly rising streams interacted with mobilized sediment and debris, giving rise to a combination of effects not commonly observed in this central European landscape. As climate change produces more severe and frequent weather, such interactions will likely continue to cause unexpected results. Rather than just planning more of the same preparations, scientists must work to anticipate these challenges.

Hydrological models usually predict flood damage factors such as discharge and inundation (2) but ignore the role of organic and inorganic debris (3). The 14 July events were characterized by effects that are not commonly taken into account: Through saturation runoff and linear erosion, hill slopes routed water 10 to 100 times faster than expected (4). The rushing waters mobilized and carried large volumes of coarse woody debris, clogging bridges and extending the flooded area. Floodwaters running over sedimentary slopes cut back terraces outside the river-bed by hundreds of meters, undermining areas that were previously thought to be safe. Water overtopping a reservoir crown during the same event severely damaged a dam holding a volume of 1.2 million m³. If the dam had collapsed, the ensuing flood would have added a further unforeseen complication to this hydrological disaster.

Progressive climate and environmental change in this region will destabilize forests, reduce the landscape's capacity to hold back water, and make extreme precipitation more frequent (5). As a result, rainfall similar to the 14 July event will lead to more intense floods, and the floodwaters will move more quickly, mobilize more debris, and cause more erosion than those caused by equivalent rainfall in years past. The unexpected features visible in the 14 July event may become the norm. To better anticipate the effects of future hydrometeorological extremes, robust approaches must include the ability to account for dynamically changing surface conditions during events. Models will have to explicitly describe the interactions between floodwater discharge and mobilized sediment as well as the transport and deposition of large woody debris. Detailed observations from newly affected flood areas will help to incorporate these factors into predictive models. These forensic observations must include high-resolution surface information (by airborne laser scanning) and detailed mapping of upper catchment and channel heads beyond the severely affected regions.

References and notes

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