

Education can improve response to flash floods

As climate change intensifies and torrential rainfall and extreme floods increase (1), flash floods, one of the deadliest hazards because of their sudden onset (2), are becoming more frequent and widespread. Accurate flash flood early warning systems can mitigate casualties, but even the best warnings cannot protect people who disregard them. Public awareness is a crucial aspect of flash flood safety.

Scientific advances have led to extensive use of flash flood monitoring systems and accurate early warnings (3), and efforts to mitigate harm continue to focus on hydrometeorological monitoring, flood forecasting, risk analysis, and countermeasures. The contribution of human factors such as perception and behavior to reducing harm has received less attention (4).

Social behavior has undermined the success of flash flood early warning systems across the world. In 2021, flash flood warnings were widely broadcasted hours in advance of hazardous conditions in China, central Europe, and the United States (5–7). Yet the predicted floods led to more than 300 casualties in Zhengzhou, China and 200 in central Europe, mostly local residents. In New York, despite warnings, people were caught by floods in unexpected locations, such as subway stations. On 13 August, flood warnings were issued 1 hour in advance of a flash flood in Longcao Stream, Sichuan Province, China (8), where people had come from cities to escape a heat wave. About 100 people refused to leave and 7 tourists died (9). This failure of social response and organization should be addressed through education and clearer dissemination of information.

Social education, based on social science data about the most effective way to convey information, is essential to enhancing the public's perception of and response to natural hazards (10). Such education is well established in regions vulnerable to traditionally abrupt natural hazards, such as earthquakes and tsunamis. In hazard-prone countries like Japan and New Zealand, drills are conducted regularly and local inhabitants are familiar with the hazards and evacuation routes (11, 12). Unfortunately, awareness campaigns for flash floods are less common (5).

Everyone—including those in traditionally high-risk areas, those in places where flash floods have been rare until recently, and those who live in low-risk regions but might travel to locations where flooding is possi-

ble—needs easy access to details about disaster identification, emergency response, and self-rescue. Local governments in disaster-prone countries or regions should regularly disseminate disaster response information through school education, social media, and social networks. Regular drills, similar to those in Japan and New Zealand, should also be conducted, not only in people's daily living and working environments but also in places that are usually ignored, such as tourist attractions. Education must include clear instructions, targeting people who do not understand what action to take as well as those who might be tempted to dismiss directives to vacate the area. To maximize the effect of early warnings, we must increase the likelihood that all people will heed them.

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