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Contact: David Clarke, Society for Risk Analysis, 301-467-2752
davidpaulclarke@gmail.com
Dr. Thomas Cova, University of Utah, 801-581-7930
cova@geog.utah.edu
Paul Gabrielsen, University of Utah Communications, 801-585-6861
paul.gabrielsen@utah.edu

As Hazard Warnings Increase, Experts Urge Better Decisions on Who and When to Warn

Well designed and executed emergency warnings can save lives, so risk experts are urging steps to create the most effective warnings for hurricanes, wildfires, and other environmental hazards.

McLean, VA—A group of risk experts is proposing a new framework and research agenda that they believe will support the most effective public warnings when a hurricane, wildfire, toxic chemical spill or any other environmental hazard threatens safety. Effective warnings are a growing need as expanding global populations confront a wide range of hazards.

Right now, "the potential for errors is high" when officials decide when to issue emergency warnings, who to send them to, and what safety measures to urge the public to take, says Thomas Cova, a professor in the University of Utah geography department.

That's because "researchers tend to focus on one or two of those questions," Cova says. "But it's a challenge to think about all three," which is necessary to avoid such errors as deciding the right time and right action but wrong target group or the right group and right time but wrong protective action, he adds. Emergency managers must contend with uncertainty about how the three components interact, and have to consider how likely and how costly it might be to make "false positive" decisions to issue a warning when hazards don't occur or "false negative" decisions to continue normally when hazards do occur.

Cova and colleagues have published a paper called "Warning triggers in environmental hazards: Who should be warned to do what and when?" that proposes a way forward in improving emergency warning by thinking constructively and critically about all three issues. The paper, published in the online version of *Risk Analysis*, a publication of the Society for Risk Analysis, was co-authored by Cova with colleagues Philip E. Dennison, Dapeng Li, and Frank Drews, also of University of Utah, as well as Laura K. Siebeneck of University of North Texas and Michael K. Lindell of University of Washington.

Essential to improving emergency warning practices is research into the most effective methods for alerting the public. But, currently, public warning researchers are each carving out little hazard niches (hurricanes, wildfires, hazmat), as well as single dimensions of the warning problem (timing them, delimiting risk zones, selecting protective actions). "The end result is that

no one is taking on the big question of simultaneously asking: who should do what when?" Cova explains. The authors' goal is to sound a "wake up call" that they hope will lead to an improved understanding of how warnings are formulated and implemented across hazards, which in turn could lead to improved training methods, warning system innovations, and synergy between researchers and practicing emergency managers. "We're not proposing a new approach to warnings, we're proposing a new approach to public warning research," Cova says, but adds, "The results may have beneficial feedbacks into public warning improvements and innovations."

Today's guidance on emergency warnings is not optimal. In light of the many global environmental hazards, experts are developing new procedures to simplify the warning process, aiming to prevent casualties and increase transparency about the decision making process. Widely used "warning triggers" are a decision rule that links an environmental condition to "protective action recommendations" for a specified target group, helping answer the questions: "Who should take what action and when?" For example, fire occurrence is a common qualitative trigger condition, but a more specific indicator would be a flame front crossing a prominent ridgeline, river, or road toward a community. Rainfall rates and duration can serve to define a threshold value that, once exceeded, results in a warning for flooding or landslides. Triggers aid managers in deciding when to change from "wait and see" to "take immediate action," thereby helping them stay ahead of the emergency's advancing curve.

But, even though warning triggers are used often, little research has been done on how emergency managers set them or how effective they are when combined with integrated early warning systems, the authors write. In an overview of key warning trigger issues, the authors discuss the critical importance of an "unambiguous trigger condition" when deciding when to issue a warning, as well as methods for defining the condition, such as directly observed environmental cues or measurements from sensors. They also discuss issues pertaining to deciding which population to warn, including the use of "emergency planning zones" such as "everyone on Manhattan Island," a physical feature, or "south of Central Park," a built feature that includes apartment buildings and stores. And they review challenges of deciding on the most effective actions to recommend, such as evacuating or sheltering in place.

The problem of effective warnings "has dimensions that are geographic, temporal, cognitive, and perceptual, particularly in how the public might respond," says Cova. "So it's an ideal challenge for interdisciplinary research" that addresses all three of the key systems at work (natural, built, social) and their interactions across different types of hazards. Emergency managers simultaneously deal with who, what, and when issues every day, and therefore so should research to improve warnings, the authors suggest.

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