LETTERS

Edited by **Jennifer Sills**

Integrated data could augment resilience

The massive November 2018 Camp Fire set the record for the deadliest and most destructive wildfire in California's history (*1*). By the time the blaze was contained, it had scorched 153,336 acres, destroyed 18,804 structures, displaced approximately 52,000 people, and killed 85 people (*1*, *2*). Insured losses are estimated to be between $7.5 and $10 billion (*3*). The damages and losses will likely increase, as there is a risk of potential cascading hazards, such as toxic ash, poor air quality, and mudslides and debris flow (*4*). California has experienced an increase in wildfire activity over the past few years (*5*), and the trend is projected to continue (*6*). Going forward, scientists must help decision-makers and first responders prevent extreme hazards like the Camp Fire from turning into massive human disasters.

Lack of an integrated framework for circulating information among decision-makers and passing it to residents exacerbated the devastating impact of the wildfire. Reports unanimously point to shortcomings in disseminating critical information to residents before and during the wildfire (*7*). The data crisis further increased in areas where cellular and telecommunication infrastructure was damaged, limiting internet access (*8*).

Investment in an integrated data system for identifying, harnessing, synthesizing, and communicating pertinent data will enable decision-makers and communities to better anticipate, prepare for, respond to, and recover from extreme events such as the Camp Fire. We must identify relevant stakeholders, examine the required data, collect public and relevant private data efficiently, and develop platforms for processing datasets such as weather data, cell phone GPS data as proxy for people, social media feeds, and traffic cameras and sensors. We then need strategies to convert datasets into usable information by using artificial intelligence technologies for decision-support systems. To communicate the resulting information effectively, we need a reliable data infrastructure for real-time analysis that could alert residents by email, phone messages, text warning, television, radio, and "reverse 911" (*9*).

California's wildfires are just one example of emerging compound natural hazards. By augmenting existing resiliency platforms, we can mitigate the destruction caused by future natural disasters. These augmented platforms will require regionalized resiliency indices that can be tested, verified, and updated after each extreme event. Successfully integrating and communicating data cannot be achieved without close collaboration with data stakeholders, community-level stakeholders, and state-level institutions.

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Wildfires: Opportunity for restoration?

Wildfires are increasingly making global headlines due to their destructive effects. In many parts of the world, climate change (*1*), accelerating land-use alterations (*2*), and other factors are making large wildfires more frequent and their ecological effects more severe (*3*). Most organisms in the world's fire-prone ecosystems have evolutionary adaptations to cope with natural fire cycles (*2*). However, ongoing changes in fire regimes, coupled with drier climate and other associated natural and anthropogenic disturbances (*4*–*6*), can surpass the capacity of organisms to cope with disturbance (*7*) and ultimately trigger ecosystem collapse (*5*). As a result, wildfires are one of the major drivers of change in forest cover worldwide (*8*). Yet, under some circumstances, wildfires can also provide an opportunity for ecosystem restoration.

About 2 billion hectares of the world's terrestrial ecosystems are considered degraded and in need of ecological restoration (*9*), and most ecosystems are under the threat of changing climatic conditions. Wildfires can provide a window of opportunity in which scientists and forest managers can