SDSU Workshop: Social Media Analytics and Decision Support Systems: Applications to Public Health and Crisis Management

Improving situational awareness in wildfire evacuations with volunteered geographic information

Thomas J. Cova
Director, Center for Natural & Technological Hazards
Department of Geography
University of Utah
Salt Lake City, UT 84112-9155
Email: cova@geog.utah.edu

Introduction

Regional evacuation analysis and modeling began in the 1970s with assessing the time it might take to clear an area of its inhabitants around a nuclear power plant. From there researchers branched out into hurricanes, dam breaks, and other hazards, but the primary question remained the same: how long will it take to clear a delimited area? Evacuation (traffic) simulation models were developed and used to identify potential bottlenecks, critical links, and traffic management strategies. Modeling assumptions were initially very strong in terms of detection time (instantaneous), management decision making (instantaneous notification), and public response (idealized household behavior). Additional topics pursued include multi-modal evacuations, the role of refuge shelters, transient populations, diurnal population fluctuations, realistic response behavior, family gathering, optimal routing, and return-entry. Researchers branched out with new questions that were spatial (e.g. Where might evacuating residents be problematic?), temporal (When is the best time to warn the public?), and spatio-temporal (How can an evacuation zone be optimally subdivided and staged to minimize traffic congestion?).

This research area experienced a quantum leap in interest following Hurricane Katrina in 2005, but many other events from the 2007 SoCal Wildfires to the 2011 Tohoku Tsunami have broadened the range of hazards under consideration, breadth of questions and methods, and modeling sophistication. Many of the assumptions regarding warning decisions, best protective action, evacuation zone, and household behavior have been relaxed and turned into questions. A current challenge in protecting the public across all hazards is developing decision support systems (DSS) to answer the question: who should be warned to take what action and when? (Cova et al. 2017). While a full-fledged DSS to address this question in real-time is a ways off, new optimization and simulation models are being proposed. Contemporary approaches tend to couple dynamic models to represent the threat, management decision making, household response, and traffic flow, but in general a wide variety of regional evacuation analysis methods and models are being developed and applied.

Tracking wildfires with volunteered geographic information

Answering the question “Who should take what action and when?” is a multifaceted challenge that requires information drawn from a dynamic, coupled natural-built-social system. Using wildfire as an example, an emergency manager would need information on the wildfire including its current extent, rate-of-spread, direction, intensity, expected fire weather, and the surrounding topographic and fuel context. Inputs on the built environment are also essential including the distribution and types of threatened structures, the roadway context, proximal refuge shelters, and the available warning systems. Example elements from the social system would include the population distribution and demographics, vehicle availability, and preparedness level. To aid in meeting these information needs, one avenue of research is what insight social media analytics might provide and to what level of detail, timeliness, and quality.

In researching factors that wildfire incident commanders (ICs) value as important in making protective-action decisions, we found that more experienced ICs place a higher value on information regarding the fire (dynamics and predicted behavior) than community factors (housing type and fuels) (Drews et al. 2014). To explore the value of social media in wildfires, we mined Twitter data drawn from the 2012 Waldo Canyon Fire in Colorado Springs to assess whether geotagged tweets and images could provide up-to-date information on a wildfire’s progress in an area of high-relief (Klein 2014). This can be characterized as using citizens as fire scouts. As residents were scattered around the fire perimeter and actively tweeting, our goal was to assess post hoc whether their unique vantage points might have provided valuable information had social media been harvested and analyzed in real-time as the fire progressed.

The approach relied on analyzing geo-coded tweets with information related to viewing the fire’s location or movement. For each tweet, a viewshed was calculated for that observer, which were then overlain to create shared viewsheds that define a set of locations that might contain the fire. The viewshed, both individual and shared, were overlain with the actual fire boundary to see which users could see which aspects of the fire and when. While much of this fire was not visible to these observers in an area with such high relief, the findings show that important areas of fire advancement were visible to different observers throughout its progress (2:00 pm to 11:00 pm on June 26th, 2012). A second goal was to assess the value of each vantage point in its potential to offer information on the fire to other citizens who could not see the fire from their perspective. The most valuable of tweets in this category related to highlighting critical events in the fire’s progress toward populated areas (e.g. “Crested over the ridge” sent at 4:40 pm).

References

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