Special Issue on the ARkStorm Scenario: California's Other Big One

Keith Porter

Univ. of Colorado, 428 UCB, Boulder, CO 80309-0428 (corresponding author). E-mail: keith.porter@colorado.edu

Dale Cox

U.S. Geological Survey, 3020 State University Dr. E, Modoc Hall, No. 4003, Sacramento, CA 95819.

Michael Dettinger

U.S. Geological Survey, Climate Research Division/Scripps Institution of Oceanography, La Jolla, CA 92093-0224.

F. Martin Ralph

Scripps Institution of Oceanography, UC San Diego, 9500 Gilman Dr. #0224, La Jolla, CA 92093-0224.

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Introduction

At the request of the U.S. Congress' House Appropriations Committee, the U.S. Geological Survey developed a comprehensive multidisciplinary coastal program, including a research agenda designed among other things to address the most critical issues of coastal and marine geology in the southwestern United States (USGS 2006). As shown by Ralph et al. (2006) and Ralph and Dettinger (2011, 2012), atmospheric rivers are among the principal drivers of several critical physical processes in the coastal systems of the southwestern United States. An atmospheric river is a low-altitude jet of warm moist air that originates over the midlatitude North Pacific Ocean and transports that moisture to California, where much of the moisture is released as rain and snow that falls on the state.

Beginning in fall 2010, the U.S. Geological Survey's Multihazards Demonstration Project (MHDP) studied the potential impacts of severe winter storms in the context of a disaster scenario: a depiction of a particular hypothetical but realistic storm, explored in sufficient detail that citizens and decision makers can understand its processes, and prepare for and mitigate its consequences. After creating this scenario, dubbed ARkStorm, MHDP's mission was subsequently expanded to include the western United States, and the project has been renamed Science Application for Risk Reduction (SAFRR).

This scenario and others like it provide insight into society's disaster vulnerability that structural analyses and catastrophe risk models do not. While scenarios tend to be blind to outcome probability distributions (they provide little information for risk-based decision making) and can involve the application of judgment, they can focus deeply on a single event and involve numerous experts who are familiar with different aspects of the relevant disciplines of science, engineering, and social science. That is, as a single (by design) exceptionally challenging event, a scenario can be explored in considerably more detail with a wider range of experts than can probabilistic depictions of risk. They capture interactions among systems and between systems and people, and depict how recovery unfolds over time. They can illuminate how human behavior affects damage and recovery. They measure societal interests in terms of dollars, deaths, and downtime. They inform decision making for planning, mitigation, response, and recovery. Scenarios invite collaboration among experts in different disciplines to recognize and analyze unchartered failure mechanisms, such as the flooding of high-voltage transformers with long-duration replacement requirements.

SAFRR is not new in creating planning scenarios. The National Oceanic and Atmospheric Administration (NOAA), the California Geological Survey, the U.S. Army Corps of Engineers, FEMA, and others have created planning scenarios or modeling tools for earthquakes, hurricanes, floods, and other disasters (e.g., Algermissen et al. 1972; Steinbrugge et al. 1987; FEMA 2004; Scawthorn et al. 2006). Three unusual features of SAFRR's scenarios, including ARkStorm, are that they employ innovative science, are created in large multidisciplinary collaborations with the stakeholders whose assets are at risk, and incorporate extensive multimedia and other outreach efforts. The present volume summarizes some of the findings and innovations of the ARkStorm project. The works presented here address aspects of the scenario that the full report (Porter et al. 2010) does not.

A multidisciplinary team of 118 researchers and practitioners from 56 agencies generated the ARkStorm scenario. They evaluated the potential for flooding, severe winds, coastal inundation, landslides, physical damage to buildings and lifelines, agricultural impacts, insurance losses, evacuation planning, traffic, business interruption, environmental and health issues, and public policy. Readers interested in the full, broad study are referred to the USGS Open File Report on the scenario (Porter et al. 2010). The present introductory paper provides brief summary of the scenario. It draws, to some extent, upon intellectual contributions from all of the authors and other contributors to Porter et al. (2010).

Articles in This Issue

This issue of Natural Hazards contains six articles (in addition to the present introduction) that explore some of the effects of an ARkStorm-level California winter storm. Wills and his co-authors offer a new method for estimating landslide losses from major winter storms in California and application to the ARkStorm scenario. They developed California's first statewide landslide susceptibility map, a work that included the development of models relating rainfall to the numbers and distribution of landslides and detailed records of the impact of landslides in past storms.

Wein and co-authors examine social characteristics that relate to evacuation resource planning, especially vehicle ownership, age, poverty, English language limitation, and shelter needs. These characteristics help planners examine the sufficiency of mutual aid agreements; address the needs of carless populations; and tailor multilingual communication strategies. In another work, Wein and co-authors quantify the potential for a severe winter storm to cause catastrophic damage California's agriculture. Notable among their contributions are new algorithms for translating the outputs of geospatial engineering models of disaster damage (in the present case, using the FEMA-developed software HAZUS-MH) into sequences of shocks to agricultural capital stocks and productivity.

Plumlee and co-authors show how a severe winter storm can cause environmental damages, release contamination from diverse natural and anthropogenic sources, affect ecosystem and human health, and cause economic impacts from environmental-remediation, liability, and health-care costs. A storm like ARkStorm could release complex mixtures of contaminants such as petroleum, mercury, asbestos, persistent organic pollutants, molds, and pathogens; impact riverine and coastal marine ecosystems; and increase incidences of some vector-borne diseases and Valley Fever. Finally, Nafday examines how a severe winter storm can affect operations at marine oil terminals. He finds that ARkStorm runoffs would overwhelm their drainage design and recommends site-specific flooding analyses and review of mooring for extreme currents.

References

Algermissen, S. T., et al. (1972). "A study of earthquake losses in the San Francisco Bay area." *Office of Emergency Preparedness*, National Oceanic and Atmospheric Administration, Washington, DC.

FEMA (Federal Emergency Management Agency). (2004). "Hurricane pam exercise concludes." ⟨http://www.fema.gov/news-release/2004/07/23/hurricane-pam-exercise-concludes⟩ (Aug. 27, 2013).

Porter, K., et al. (2010). "Overview of the ARkStorm scenario." *Open-File Rep. No. 2010-1312*, U.S. Geological Survey.

Ralph, F. M., et al. (2006). "Flooding on California's Russian River—Role of atmospheric rivers." *Geophys. Res. Lett.*, 33(13), 1–5.

Ralph, F. M., and Dettinger, M. D. (2011). "Storms, floods and the science of atmospheric rivers." *Eos*, 92(32), 265–266.

Ralph, F. M., and Dettinger, M. D. (2012). "Historical and national perspectives on extreme west-coast precipitation associated with atmospheric rivers during December 2010." *Bull. Am. Meteorol. Soc.*, 93(6), 783–790.

Scawthorn, C., et al. (2006). "HAZUS-MH flood loss estimation methodology. I: Overview and flood hazard characterization." *Nat. Hazards Rev.*, 10.1061/(ASCE)1527-6988(2006)7:2(60), 60–71.

Steinbrugge, K., Lagorio, H. J., Davis, J. F., Bennett, J. H., Borchardt, G., and Toppozada, T. R. (1987). "Earthquake planning scenario for a magnitude 7.5 earthquake on the Hayward Fault in the San Francisco Bay area." CDMG Special Publication, Sacramento, CA.

USGS (U.S. Geological Survey). (2006). "A plan for a comprehensive national coastal program." ⟨http://marine.usgs.gov/coastal-plan/index.html⟩ (Oct. 27, 2013).