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Application of Catastrophe Risk Modelling to Evacuation Public Policy

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The decision by civic authorities to evacuate an area threatened by a natural hazard is especially fraught when the population in harm's way is extremely large, and where there is considerable uncertainty in the spatial footprint, scale, and strike time of a hazard event. Traditionally viewed as a hazard forecasting issue, civil authorities turn to scientists for advice on a potentially imminent dangerous event. However, the level of scientific confidence varies enormously from one peril and crisis situation to another. With superior observational data, meteorological and hydrological hazards are generally better forecast than geological hazards. But even with Atlantic hurricanes, the track and intensity of a hurricane can change significantly within a few hours. This complicated and delayed the decision to call an evacuation of New Orleans when threatened by Hurricane Katrina, and would present a severe dilemma if a major hurricane were appearing to head for New York.

Evacuation needs to be perceived as a risk issue, requiring the expertise of catastrophe risk modellers as well as geoscientists. Faced with evidence of a great earthquake in the Indian Ocean in December 2004, seismologists were reluctant to give a tsunami warning without more direct sea observations. Yet, from a risk perspective, the risk to coastal populations would have warranted attempts at tsunami warning, even though there was significant uncertainty in the hazard forecast, and chance of a false alarm.

A systematic coherent risk-based framework for evacuation decision-making exists, which weighs the advantages of an evacuation call against the disadvantages. Implicitly and qualitatively, such a cost-benefit analysis is undertaken by civic authorities whenever an evacuation is considered. With the progress in catastrophe risk modelling, such an analysis can be made explicit and quantitative, providing a transparent audit trail for the decision process. A stochastic event set, the core of a catastrophe risk model, is required to explore the casualty implications of different possible hazard scenarios, to assess the proportion of an evacuated population who would owe their lives to an evacuation, and to estimate the economic loss associated with an unnecessary evacuation.

This paper will review the developing methodology for applying catastrophe risk modelling to support public policy in evacuation decision-making, and provide illustrations from across the range of natural hazards. Evacuation during volcanic crises is a prime example, recognizing the improving forecasting skill of volcanologists, now able to account probabilistically for precursory seismological, geodetic, and geochemical monitoring data. This methodology will be shown to help civic authorities make sounder risk-informed decisions on the timing and population segmentation of evacuation from both volcanoes and calderas, such as Vesuvius and Campi Flegrei, which are in densely populated urban regions.