EDITORIAL
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Editorial: Reimagining the History of Extreme Events

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Editorial on the Research Topic

Editorial: Reimagining the History of Extreme Events

The study of natural catastrophes is an observational rather than laboratory science. Major events cannot be replicated under controlled laboratory conditions; rather, they occur sporadically and haphazardly, and knowledge needs to be gained whenever and wherever they occur. For extreme rare events, every effort needs to be made to maximize this knowledge. This means looking beyond catalogs of historical events. There is more to learn from an event than what actually happened, which might have been the outcome of myriad random factors.

Any actual hazard event is just one specific realization of the underlying nonlinear chaotic geodynamics. Furthermore, the societal response to an event is also just one realization among numerous alternative pathways along which the consequences could have evolved amidst all the human interactions and response decisions. Much can be learned from exploring what else could have happened, both with regard to the hazard events themselves, and also the societal response.

Consider the VEI 6 Pinatubo eruption of 1991, which was the third largest in the 20th century. Around 400 people were killed in the eruption, but many thousands were saved by timely eruption forecasts and evacuations. Needless to say, this was only one of numerous possible loss outcomes from the Pinatubo eruption. It is rare for a detailed counterfactual analysis of any volcanic crisis to be undertaken, especially by one of the principal volcanologists. But this is what Chris Newhall has done in his paper: Newhall. One of his key observations is the practical impact of several major concurrent volcanic crises. He remarks that if the Taal volcano had erupted in 1991, as happened in early 2020, it would have diverted limited Philippine volcano monitoring resources away from Pinatubo, which would not have received the attention it deserved. The coupling between volcanic events is inherently human as well as geodynamic.

This kind of in-depth retrospective analysis of a volcanic crisis from a counterfactual perspective is a gem of the hazard warning literature, full of insights into the factors that might have derailed the evacuation process. Accordingly, this paper should be standard reading for any observatory volcanologist who may have responsibility for managing a future volcanic crisis. Indeed, this paper provides material for a practical training exercise, rather like a flight simulator, to test human decision making for alternative realizations of volcano history.

Another legendary American volcanologist is Frank Perret, who monitored the volcanic unrest on the Caribbean island of Montserrat in the 1930s. He astutely remarked on the devastation if several years of unrest energy were released in just a single week. This is a downward counterfactual: a thought about the past where things turned for the worse. A general exposition of this fundamental risk concept, applicable to any peril, has been presented in Gordon Woo's paper: Woo This provides an explicit algorithm for finding Black Swans. These are hitherto unrecognized disasters on the risk horizon, which take risk analysts by surprise. Nicholas Taleb, whose influential book on the Black Swan was published at the time of the great 2007 financial crash, was sceptical that such an algorithm could be found for Black Swans.

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The downward counterfactual terminology was developed originally by cognitive psychologists in the context of human perception, but should be essential vocabulary for catastrophe risk analysts and practitioners. The explicit downward counterfactual algorithm for finding Black Swans involves an iterative process of identifying ever worse alternative outcomes of historical events. Eliciting these downward counterfactuals can be done via real or virtual group meetings. An illustration of a specific elicitation process is given by Camilla Penney and Cambridge University colleagues in their paper: Penney et al. Using the great 365 CE Mediterranean earthquake as an initial seed event, three rounds of analysis were conducted to explore worse impacts.

Together with Willy Aspinall, Gordon Woo has contributed another paper on Aspinall and Woo. In June 1997, when Aspinall was the chief scientist at the Montserrat Volcano Observatory, there was an eruption on Montserrat. This event generated a dangerous pyroclastic flow, but might have been much larger; a downward counterfactual which this paper addresses. The estimated likelihood of a runaway volcanic explosion provides justification for the decision to evacuate observatory volcanologists.

A practical guide for downward counterfactual analysis was prepared by Yolanda Lin and colleagues from the Earth Observatory of Singapore (EOS): Lin et al. This guide developed from a highly interactive and productive counterfactual analysis workshop held at EOS in August 2019, supported by the National Research Foundation, Singapore, under the NRF-NRFF2018-06 award, and EOS.

One of the important practical applications of downward counterfactual analysis is to gauge the benefits of risk mitigation. Maricar Rabonza, Yolanda Lin and David Lallemant have undertaken such an analysis for seismic retrofitting of schools in Nepal. This work is described in their paper: Rabonza et al. Using a school building database for Kathmandu Valley, Nepal, they present two applications: 1) the quantification of lives saved during the 2015 Mw 7.8 Gorkha earthquake as a result of the retrofitting of schools in Kathmandu Valley since 1999, 2) quantification of the annual expected lives saved if the pilot retrofitting program was extended to all school buildings in Kathmandu Valley based on a probabilistic seismic hazard model. The shift in focus from realized outcome to counterfactual alternative enables the quantification of the benefits of risk reduction programs amidst disaster, or for a hazard that is yet to unfold.

Large hazard events such as the 2015 Gorkha earthquake are infrequent, and every effort should be made to learn as much as possible from them. This includes learning from reimagining the past. This collection of six papers provides an introduction to this new exploratory window onto the past, which holds the prospect of enhancing our vision of a safer future.

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