Book Review

Climate Forcing of Geological Hazards by Bill McGuire and Mark Maslin, The Royal Society/Wiley-Blackwell, 2013; ISBN: 978-0-470-65865-9 (cloth), USD 159.95, CAN \$175.95, EU 93.00.

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Research into geological hazards, for example volcanic eruptions, earthquakes, or tsunamis, has long been disassociated from study of climate patterns and climate change, because the source of surface instability was sought deeper in the Earth's crust. Increasing interest in ongoing climate change and climatic perturbations, and in climate-change projections in particular, has, apparently, catalysed a search for a possible alternative, or additional, explanation of why natural catastrophes happen and whether they are solely endogenic. The very same volcanic eruptions and seismic events once analysed exclusively in terms of crustal processes are now increasingly studied in the context of large-scale climate change and related changes in ice and/or water loading and unloading of the crust. In contrast, geomorphologists studying such geomorphological hazards as mass movements and valley floor remodelling because of floods have been well acquainted with meteorological initiation of catastrophic events, and with longer-term patterns of geomorphic change modulated by climate variations. For example, the concept of paraglacial relaxation of once ice-butressed slopes is now more than 40 years old. Nevertheless, observed accelerated glacier retreat, permafrost decay, and coastal change, each of almost global dimensions, has made links between climate change and surface change an increasingly popular research topic of substantial practical importance.

"Climate Forcing of Geological Hazards" is best regarded as the state-of-the-art of this research topic, in which volcanologists and seismologists try to investigate possible causative links between climate change and violent geodynamic processes, while geomorphologists focus on slope instability and provide an overview of the relationships between climatic trends and events, and surface processes, using examples from different geographical contexts. The book is the outcome of a conference held at University College London in September 2009, and is a reprint, in book format, of a thematic issue of *Philosophical Transactions of the Royal Society*, published in 2010 (vol. 368). However, the order of papers is slightly rearranged, in some papers the content is updated, and two discussion voices contained in that volume are missing. The senior editor, Bill McGuire, Professor of Geophysical and Climate Hazards at University College London, has long been active in research on hazardous phenomena, especially volcanoes, and is a contributing author to the 2012 IPCC on climate change. Mark Maslin, based at the same institution, focuses on palaeoclimatology and climate change at global and regional scales.

The book contains twelve chapters, which can be broadly divided into five themes. Two opening chapters set the stage for the detailed studies to follow. McGuire provides a general overview of possible links between periods of rapid climate change and crustal and surface response, dividing the argument into sections on glaciated high latitudes, ocean margins, mountain terrains, and volcanic landscapes. Liggins et al., adopting the same framework, in turn examine climate change projections for the 21st century and their possible effect on crustal and surface processes.

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The next three chapters focus on volcanic systems. Tuffen discusses, using a global perspective, the possible effect of deglaciation of ice-covered volcanoes on the level of volcanic hazards. It is worth noting that the chapter includes (one example of updating of the original publication) brief consideration of the 2010 eruption of Eyjafjallajökull. Much more site-specific is the contribution of Deeming et al., who have attempted, by use of cosmogenic isotopes, to date a major prehistoric flank failure of Mt Etna, which left an amphitheatre 8×5 km across. They conclude that the event occurred approximately 7.5 ka BP and may have been causally linked to the complex interactions between wetter climatic conditions of the Early Holocene, magma emplacement, and the material strength of the volcanic edifice. The third paper in this section, by Sigmundsson et al., is more theoretical and focuses on modelling stress changes within active volcanoes caused by ice load changes. Katla volcano in Iceland is used as an example of this exercise. In the third part, consisting of two chapters, possible seismic responses to climatic forcing are examined. Hampel et al. use factual evidence from northern Scandinavia and the Basin and Range Province in the United States, and numerical models, to argue that faults can respond to changes in ice loading and cause catastrophic earthquakes. Many instances of high-magnitude seismic events have been detected in the palaeoseismological record for the latest Pleistocene and early Holocene and the authors wonder if similar events may occur in the future should decay of the Greenland and Antarctic ice caps accelerate. The paper by Guillas et al. is much more speculative and the authors use mainly statistical procedures to suggest that a link may exist between ENSO-driven sea-surface gradients and earthquake activity on the East Pacific Rise. An informal part four consists of three chapters focused on mass movements. In the first, Tappin provides a wide-range overview of large submarine mass failures, considering different geographical settings and discussing their potential to generate tsunamis. He indicates that glacial and/or interglacial cyclicality, with its changes in sea level, sedimentation style, and rate, is a major control on the occurrence of mass movement, even if initiators of specific events may be seismic. The

other two papers focus on mass movements in mountain terrains, examined in the context of longer-term trends of climate warming and permafrost decay (Huggel et al.) and anomalous weather events such as very warm or very wet summers recently experienced in the Alps (Knight et al.). Gas hydrates and their stability are the focus of the final section. First, Maslin et al. speculate on what may happen to onshore and offshore gas hydrate reservoirs if the warming trend continues. They suggest that an increase in frequency of submarine mass failures and, hence, tsunamis is likely. A different, geological perspective is offered by Dunkley Jones et al. who examine uncertainties related to gas hydrate behaviour at the Palaeocene–Eocene transition and its relevance to current concern about climate warming.

My overall opinion of the book is very positive, although—as usual in edited volumes—some chapters are better than others. In my judgement, papers presenting factual evidence about ice-covered volcanoes and deglaciation-induced earthquakes, and the whole set of chapters focused on submarine and terrestrial mass movements, are the strongest parts of the volume. I am less enthusiastic about modelling exercises, and claims of links between climate and sea level change and geohazards which do not seem fully justified. The introductory chapter by McGuire is a useful overview of the subject, but here my reservations concern the context adopted. The phrase “anthropogenic climate change” is used frequently, and catastrophic IPCC climate change projections well into the future are called for throughout the paper; this leads to the overall impression that we are on the brink of a global catastrophe, with volcanic eruptions and earthquakes following one another, and that this catastrophe would be entirely a consequence of human activity. This approach stands in contrast with more modest stance adopted by most of the authors of other chapters who, apparently, prefer to speak about climate change in general, without claiming they know the reasons, and draw attention to the variety of uncertainties in data interpretation, and, often, the paucity of data used to draw bold conclusions.

The book is well produced, in colour throughout, easy to navigate, with a comprehensive index.

Besides being a source of much information, I am sure it will serve to inspire further research of geohazards in a changing world, as the editors also hope.

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