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Editorial: Extreme events in human evolution: From the Pliocene to the Anthropocene

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Editorial on the Research Topic
Extreme events in human evolution: From the pliocene to the anthropocene

Introduction

This volume of *Frontiers in Earth Science* brings together ten contributions on the topic of *Extreme Events in Human Evolution: From the Pliocene to the Anthropocene*. It features perspectives from archaeology, the earth sciences, and other related disciplines to explore a variety of extreme events and how they have impacted human societies at various points of the past. In studies of the contemporary world, extreme events–rapid climate change, drought, floods, tsunamis, landslides, volcanic eruptions, and earthquakes–are much discussed. Such events, many of which are exacerbated by anthropogenic climate change, are widely predicted to become more common, severe and costly in the future (IPCC, 2021). This is putting lives, livelihoods, and a trajectory towards sustainability in jeopardy (Reichstein et al., 2021; Thiery et al., 2021). Understanding extreme events in the deep past is not only of intrinsic interest and scientific importance, but also provides baseline data and perspectives which can help societies adjust to future challenges on our unstable planet.

From the Pliocene to the Anthropocene

Ranging from the deep past to the future, the contributions to this collection explore both the character and physical impacts of extreme events, and their impacts on societies.

This provides a way to understand past human societies and their responses, and also to bring long-term evidence to bare in discussions about future sustainability and risk reduction.

A useful entry point to the topic is Stewart et al's. systematic review of the diverse ways in which extreme events are understood and operationalized across different disciplines and periods of interest. They randomly selected 200 papers on the topic from the biological, societal, and earth science literature for evaluation. While this found a high level of variability, it also identified a number of commonalities in how researchers think about extreme events, which may be useful for more integrated and comparative research across spatial and temporal scales.

Patalano et al. take us deep into early hominin evolution. They explore the conundrum that while climate shifts are often inferred to have impacted hominins, the temporal and spatial scale of data to evaluate such claims is limited. There is, for instance, often an assumption of uniform regional changes in climate. In this article, they propose a microhabitat variability framework and link this to the evolution of the adaptability shown by the genus *Homo*. This ability to utilize microhabitats provides both a general adaptive mechanism but also a way of dealing with abrupt environmental changes.

Staying in the Pleistocene, Nicholson et al. focus on the relationship between human societies and the climatic/environmental fluctuations of the Saharo-Arabian deserts, a topic of considerable recent scientific interest. One of the challenges has been precisely dating periods of abrupt climatic change, particularly the periodic northwards incursions of the African and Indian Ocean monsoons into Arabia. In this paper the authors compare the most recent wet phase, the Holocene Humid Period, with the Last Interglacial (MIS 5e). This highlights the extreme character of MIS 5e, yet, as the authors argue, human adaptability and resilience complicate simplistic inferences from climate records.

Nyland et al. now take us into the Holocene, specifically to one of the climatic episodes argued to have been a systemic tipping point (Brovkin et al., 2021) and which has been used to subdivide the Holocene (Walker et al., 2019): the 8.2 ka event. In this context, they investigate how a broadly contemporaneous extreme environmental event–the major Storegga tsunami–may have affected societies already under pressure. They evaluate the possible impacts of this tsunami on Mesolithic societies, and emphasize the different ways in which the tsunami would have been experienced and human impacts would have been generated.

Groucutt et al. move on to yet another prominent climate event, and one coinciding with the transition from the middle to late Holocene: the 4.2 ka event. The collapse of the iconic Maltese 'Temple Period' and the 4.2 ka event seemingly occurred simultaneously, yet as this paper explores, we have to be cautious about superficial (e.g. wiggle-matched) correlations. The paper explores how while climatic deterioration may have been involved in the downfall of the Temple Period, so might a variety of other aspects such as a plague epidemic. The paper therefore presents itself as a case study on how to consider processes with different drivers, providing an exemplar of how quantitative analyses can help disentangle the influences of multiple drivers.

Riris and de Souza stay with quantitative analytical approaches. The notion of resilience is often highlighted in discussions of extreme events and their impacts, both here and elsewhere. The authors bring a quantitative perspective to resilience (the capacity of a system to absorb disturbances), in contrast to the rather subjective way the term is often used. They present resilience metrics, drawn from ecology, and highlight their utility for archaeological research through a series of case studies. In particular, they apply their resilience-resistance framework to prehistoric eastern Brazil, and argue that it is useful in evaluating aspects of demographic change in the region.

Working in a similarly quantitative manner and taking us into the Common Era, Carleton et al. take a precise look at a fascinating example of human-environment interactions: The second millennium CE in Europe is well known for being a period in which highly violent conflict and a variety of climatic extremes (such as the Little Ice Age) coexisted. Carleton and colleagues present a Bayesian regression model to explore whether conflict and climate extremes correlated. They found no evidence for correlation, and therefore argue that extreme climate conditions alone were seemingly not the drivers of conflict.

Lavigne et al. explore the reasons for periods of apparent crisis in the 15th century CE Tu'I Tonga kingdom in West Polynesia. By evaluating various sedimentary and archaeological aspects, they argue that the kingdom was severely impacted by a large tsunami, which inundated large areas. This contrasts with previous views which have tended to emphasise models like internal politics. Their study highlights the possibly significant role of single, large-scale natural disasters (rather than climate change) in altering socio-political trajectories.

Kavková et al. likewise focus on a punctuated event, namely the Tunguska explosion that occurred in Siberia in 1908. Through the analysis of sediments from two cores, the authors evaluate whether the Suzdalevo Lake was created by a meteorite impact and resulting explosion. They found that the lake existed before the explosion. Their multiproxy analysis of the sediments, however, indicates significant changes in the landscape that may relate to the explosion, with the catchment and lake system taking more than 50 years to return to its normal state.

Finally, Blong explores the character, likelihood, and risks of four major global catastrophic events–sea level rise, a large volcanic eruption, a global pandemic, and a geomagnetic

storm. While focusing on the Anthropocene future, the paper highlights the diverse characteristics of different extreme events, many of which would have also occurred in the past. Blong's paper also demonstrates the importance of studying extreme events through a societal filter. For instance, while a geomagnetic storm is unlikely to cause much harm to a society reliant on stone tool technology, it is a different story for one reliant on satellites and other vulnerable technology.

Closing comment

The suite of papers in this collection highlights the diverse ways in which extreme events can be understood and studied. The importance of quantitative analyses emerges as a key theme, but so does the importance of evaluating diverse forms of human vulnerability and resilience. Lamentably, a serious consideration of extreme events and their impacts on human societies is more timely than ever (Kemp et al., 2022). Studying the impacts of extreme events in the past brings both a time depth and a human element to evaluating future hazards and challenges.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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