

THE Language OF Extreme Events

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Extreme Events: Definitions and history

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Would the (non-avian) dinosaurs have gone extinct if a large asteroid had not struck the earth 65 million years ago? Was there a sudden 'cognitive revolution' when archaic hominins became humans? Was the 2010 Eyjafjallajökull volcanic eruption an extreme event? We can ask many such questions, which often involve analogous debates on how we distinguish processes and events, and how we distinguish the 'normal' from the 'extreme'. Extreme events are much discussed in the contemporary world, largely in terms of climate change but also extending to other factors such as earthquakes and tsunamis. Here I will explore the meaning, study, and implications of extreme events at various scales, and across diverse spatial and temporal settings. The study of extreme events is necessarily highly interdisciplinary, which makes it an exciting subject, but one which can be challenging in terms of the methodology and language involved.

Discoursing extreme events: Concepts of their time and place

Greg Bankoff (Department of History, University of Hull)

From the vantage point of the third decade of the twenty-first century, it is an opportune moment to review the terms and concepts that have been employed regularly over the past 50 years to assess risk and to measure people's exposure to extreme events in the light of the wider geopolitical context. In particular, it is useful to examine 'vulnerability', 'resilience', and 'adaptation', the principal theoretical concepts that, from an historical perspective, have dominated disaster studies since the end of the Second World War and to inquire as to the extent to which such discourses were ideological products of their time and place

How extreme events shaped the human past: impacts in the archaeological and linguistic records, across the world's ecologies and in microcosm in the Andes

Paul Heggarty (Dpto de Humanidades, Pontificia Universidad Católica del Perú) and David Beresford-Jones (McDonald Institute of Archaeological Research, University of Cambridge)

Perturbations in climate and ecology have long been invoked as drivers of fundamental changes in the human trajectory. Their impacts may be visible in archaeology, genetics, and even in radical changes and disparities in the worldwide panorama of our language lineages.

First we summarise conceptual principles in how human cultures and languages may be shaped by climate change, and indeed record its impacts. Many correlations are only indirect, articulated especially through subsistence strategies (e.g. 'farming/language dispersals'). Humans also respond: adapting their subsistence strategies to changing climate, even reshaping their own landscapes to mitigate the impact of extreme events in particular.

We briefly survey illustrative cases worldwide, including occasional linguistic reflexes of extreme volcanic or tectonic events. But we focus on one uniquely instructive test-case, where geography and topography conspire to make the Central Andes a uniquely diverse microcosm of the world's ecologies, compressed through rapid changes both in elevation and from desert west to rainforest east.

These are contexts of great abundance, but also fragility. Archaeological orthodoxy sees the trajectory of Andean civilisation as one of punctuated equilibrium, driven by extreme climatic perturbations, most famously by the 'El Niño' Southern Oscillation (ENSO) phenomenon, first recognised and named in Peru. Individual extreme events, and 'longue durée' shifts in ENSO and other climate patterns, are typically invoked to explain apparent discontinuities in the archaeological record, oscillating between expansive highland 'horizons' of pan-regional unity that then collapsed into 'intermediate periods' of fragmentation. We discuss how far such extreme climate events – and human responses to them – can safely be taken to have shaped the rises, falls, demography and societal structures of Andean civilisation, and even the ebb and flow of Andean languages, from Moche and Nazca, through Wari and Tiwanaku, to the Incas.

European colonialism and responses to extreme events in the tropics

Patrick Roberts (isoTROPIC Research Group and Department of Archaeology, MPI-GEA)

European colonialism had major, lasting impacts on the tropics, including major shifts in demography, the marginalization of Indigenous land use, impacts on settlement structures and urban planning, and the introduction of profit-driven approaches to agriculture and herding. This talk will explore the ways in which European colonialism in the tropics intersects with discourses on extreme events. Given their lasting environmental and social legacies for today, colonial invasions of the tropics can arguably be seen as extreme events in their own right in the sense that they represent a 'transition between stable states'. Similarly, as European colonialism underlies the emergence of regional and global economic and political inequalities, with much extracted wealth flowing into the hands of local elites or imperial regimes seated beyond the tropics, it can certainly be seen as something which enriched the 'margins of a distribution' of socioeconomic agents and processes. Beyond these more theoretical considerations, however, this talk will highlight how colonial land use, violence against local people, social organization, and economic structures imposed new pressures on local communities around the tropics that challenged, or even inhibited, well-honed responses to extreme events (e.g., flooding, drought). This has not only come to characterize local experiences of colonial regimes in many cases, but has also intensified with the expansion of global market pressures, shaping tropical experiences of the Anthropocene in the 21st century.

From Resilience to Ruin: The Complex Role of Extreme Climatic Events in the History and Demise of Angkor

W. Christopher Carleton (Extreme Events Research Group, MPI-GEA)

Angkor is the largest pre-industrial urban complex ever recorded. Epigraphic and historical sources indicate that it served as the seat of power for the Khmer Empire during the eponymous Angkorian period from the 9th to the 15th century CE. Historical tradition suggests that in the 15th century the political seat of power was shifted southward to Phnom Penh following an attack by Ayutthaya forces (originating from modern-day Thailand), leading to a gradual decline and eventual abandonment of the Angkor complex. Palaeoenvironmental reconstructions, on the other hand, suggest that extreme droughts played an important role in the abandonment of the city and destruction of key hydrological infrastructure. Recent simulation research suggests that the infrastructure was built up in a way that

led to fragility, precipitating systemic collapse as a result of extreme flooding and subsequent abandonment of the city. New Bayesian modelling of urban developmental trajectory, however, indicates that none of these narratives fully capture the complex interrelationships between sociopolitical developments, extreme climatic events, and the fall of Angkor. This talk will reset the stage for new debates about the impact of extreme events on the trajectory of urban development at this massive city and highlight the importance of managing uncertainties when modelling past urban-environment dynamics.

Extreme ice melt events and implications for sea level

Ricarda Winkelmann (MPI-GEA)

Prehistoric climate changes and their effects on the development of Unangam Tunuu

Anna Berge (University of Alaska Fairbanks), Ben Potter (University of Alaska Fairbanks) and Jason Roger (Lake Clark National Park)

Prehistoric climate change, population movements, and language contact in the Bering Sea and northern Pacific Coast region of Alaska are intimately connected. Paleoenvironmental and archaeological records show cooler climatic periods are associated with more abundant marine resources and population expansions while warmer periods correlate with marine instability, region-wide population stress, migration and evidence of conflict. We integrate linguistic patterns in Unangam Tunuu (Aleut) prehistory with regional climatic, archaeological and genetic data. The onset of the Neoglacial, massive volcanic eruptions, and Medieval Climatic Optimum are associated with migrations, genetic isolation, expansion and contraction of south-central Alaskan cultures from Aleut areas, and admixture with inland Dene peoples.

Extreme Events and the spread of Uralic languages – a critical review

Sampsa Holopainen (University of Helsinki) and Terhi Honkola (University of Helsinki)

Recently, it has been suggested that the 4.2 ka event (a climate anomaly which led to societal collapses in low latitudes) at least partly triggered the spread of Uralic languages (Grünthal et al. 2022). In our presentation we critically evaluate this view by carefully observing the existing climatic data. Our emphasis is on the physical proximity of the palaeoenvironmental proxies and the hypothesized speaker areas of Uralic populations. In addition to the early spread of Uralic, we also discuss whether extreme climatic events have had any notable impact on the formation of speaker areas of Finnic and Saami, as this issue is currently debated.

We found that currently there is not enough evidence about the effect of the 4.2 ka event in Northern Eurasia where Uralic languages are spoken to support the claim about the connection of 4.2 ka event with the early Uralic spread (Renssen 2022). Instead, Seima-Turbino transcultural phenomenon – an

extreme cultural event – is a more likely candidate influencing the early spread of the Uralic languages (Kallio 2006; Grünthal et al. 2022). In western Uralic languages the effect of extreme climatic events, such as the Late Antique Little Ice Age (ca. 540-660 AD) has depended on the population in question. Those with a broad range of livelihoods survived better (Oinonen et al. 2020) while those more dependent on farming experienced more dramatic effects (Tvauri 2014). In both cases, however, disruption of trade networks and formation of new ones can be connected to this period and we will discuss how this possibly affected the spread of Finnic and Saami.

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The Little Ice Age: Comparing History and Historical Linguistics

Mark Hudson, Martijn Knapen, Bingcong Deng, Alexander Gorelik and Rasmus Bjørn (Language and the Anthropocene Research Group, MPI-GEA)

The Little Ice Age—and chronologically related crises not all necessarily directly caused by climate—forms one of the major ‘extreme events’ of the past few centuries, although it can be debated as to whether it was ‘event’ rather than a ‘process’. In this presentation we attempt to compare views of the Little Ice Age and its impacts in history and in historical linguistics. For historians, the impacts were huge, even if variable across space. Within historical linguistics, by contrast, the period has received less attention. The colonial spread of European languages over the same period is seen as the more significant process.

Understanding how historical linguistics might approach the Little Ice Age forces us to confront the problem of large-scale language change. Dixon’s (1997) punctuated equilibrium model has been influential in this respect. For Dixon, languages are basically stable unless impacted by punctuations, which might be considered as a type of ‘extreme event’ that moves speakers away from the norm of stability. Hudson (2019) used resilience theory to propose an alternative model, which considered punctuations and equilibrium as elements of a broader adaptive cycle.

From this background, our presentation will explore a range of examples of social, ecological and linguistic change across the Little Ice Age period in an attempt to find parallels and correlations between the different lines of evidence. Examples discussed will include Norse Greenland, language contact between Mandarin speakers and their Altaic (especially Manchu) neighbours during the Ming-Qing transition, the eastward Russian expansion and the fur trade in Siberia, and Ewenic expansion in relation to reindeer herding contrasted with the comparatively stable distribution of its Tungusic relatives in the Amur Basin.

Climate change and the spread of the Transeurasian languages

Martine Robbeets (Language and the Anthropocene Research Group, MPI-GEA) and *Christian Leipe* (MPI-GEA)

The linguistic panel of our conference considers unusual climate periods that had a high impact on the ecosystem, such as the Holocene climate optimum (c.7500-3500 BC), the Meghalayan drought (c.2 200 -2 000 BC) and the Medieval Climate Optimum (c.950–1250 AD) as extreme events. Starting from this concept, our presentation will examine whether and how these periods of climate change impacted the spread of the Transeurasian languages in North and East Asia.

The term “Transeurasian” refers to a large group of geographically adjacent languages, stretching across Europe and northern Asia and including five well established linguistic families: Japonic, Koreanic, Tungusic, Mongolic, and Turkic. In spite of the controversy with regard to the genealogical relatedness of these languages, we accept that there is a small core of reliable evidence in support of their common origin.

Modeling the break-up and dispersal of the Transeurasian languages, we will examine whether long-term climatic and archaeobotanical trends in Northeast Asia in the Holocene can be aligned with the linguistic evidence in time and space. To this end, we will review palaeoclimate proxy records from Northeast Asia, showing moisture and temperature trends during the Holocene.

By way of conclusion, we will extend our findings to an outlook on how global climatic events may yield local linguistic responses, more or less simultaneously in different language families across the world. We will argue that the connection between climate change and language mobility is an indirect link, that in many cases surfaces through subsistence strategies.

Paleoclimate, flood and Sino-Tibetan phylogeny

David Bradley (La Trobe University, Australia) and *Elisabeth Bradley* (University of Colorado, USA)

The internal phylogeny of Proto-Sino-Tibetan is well-established on the basis of comparative linguistic data (regular phonological correspondences in cognate lexicon, regular correspondences in morphosyntax), also supported by recent Bayesian studies of lexicon. The chronology of this phylogeny can be related to archaeological and historical information including paleobotany, paleozoology, metal technology, pottery and other types of data. This nonlinguistic data, in conjunction with the etyma for relevant crops, animals and metals in Proto-Sino-Tibetan and its descendants, also shows that the homeland of Proto-Sino-Tibetan was in the upper Yellow River valley in central China.

This presentation will discuss how this established phylogeny and chronology correlate with climate change over the same period. Relevant data include speleothem and other data which are proxies for rainfall; also polar ice core and other data which are proxies for temperature. Other relevant proxies include lake core studies and sea level changes.

Another important factor is climate-related disasters, such as sea level changes and floods due to the collapse of ice-melt lakes. One known flood was circa 3950 BP in the Yellow River valley, at that time the homeland of most of the early successors of Proto-Sino-Tibetan: Sinitic and most of Tibeto-Burman. Memories of this flood persist in the oral and historical traditions of many modern Sino-Tibetan languages.

Proto-Sino-Tibetan was probably spoken in the Upper Yellow River Yangshao Culture (7000-5000 BP)

area during most of the Holocene climate maximum. It appears that each of the substantial shifts in climate since the late Holocene and the major flood may be linked to particular phylogenetic events in the diversification of the Sino-Tibetan languages. The separation of the Majiayao Culture (5300-4000 BP) or Proto-Tibeto-Burman, moving up along the Yellow River circa 5300 BP away from the Yangshao Culture, and the spread of Proto-Sinitic downriver in the Longshan Culture from circa 5000 BP may be connected with Late Holocene cooling. The major bifurcation between Karenic and the rest of Proto-Tibeto-Burman may reflect the long-term cooling and rainfall decrease at the end of the Holocene circa 5000 BP with subsequent warming and rainfall increase circa 4700 BP, motivating and then facilitating movement southward of Karenic. The major cooling and rainfall decrease circa 4200 BP and the Yellow River flood circa 3950 BP may correlate with the split of Central Tibeto-Burman from residual Tibeto-Burman. The warming and rainfall increase circa 3600 BP may be related to the split of Western and Eastern Tibeto-Burman, allowing the spread of Western Tibeto-Burman into Tibet and beyond. Later splits can also be correlated with historical events and climate changes, such as warming circa 1400 BP and cooling circa 750 BP.

Uracanes, Baguios, Temblores and Erupciones: The changing media of calamity in the Philippines, 1645-1754

David Max Findley (Pantropocene Research Group, MPI-GEA)

The Philippine Archipelago today is called “the most hazardous place on Earth”, a moniker reflecting its position along the Western Pacific Rim and Typhoon Belt as well as its susceptibility to droughts and floods. Naturally sourced extreme events, or “natural hazards”, are a feature of the Philippine environment, one every society based there must negotiate. This included colonial societies like the Spanish Philippines (1565-1898), which until the 19th century was a geographically ill-defined collection of villages under Spanish suzerainty and administered from key ports and cities, most prominently Manila. Although separated by the Pacific Ocean, the Philippines was part of the Viceroyalty of Nueva España (capital: Mexico City) and was fiscally dependent upon trade between the Spanish-controlled Americas and China via the annual voyages made by the Manila Galleons, rendering it uniquely vulnerable to disruptions by natural hazards. In that context, this paper studies changing representations of natural hazards in various written documents produced between 1645 and 1754 CE, years chosen to coincide with two especially impactful hazard events. Through close attention to documents’ changing language and formats, the paper demonstrates how Spanish colonial narratives began emphasizing the importance of physical causes rather than human sin in creating extreme events. Simultaneously, it uses colonial era language dictionaries and contemporaneous histories to explore how effectively colonial conceptions of hazards were diffused among Philippine villages, where alternative perspectives on and rationalizations of natural extremes persisted.

Detection of extreme events in geological time-series: Case studies from southern Arabia

Samuel L. Nicholson (Climate Geochemistry, Max Planck Institute for Chemistry, Mainz)

The varying climatic conditions of the Saharo-Arabian belt are frequently discussed in palaeoclimatological and palaeoanthropological research. Fluctuations between “green” phases characterised by increased summer monsoonal rainfall and the expansion of grassland environments to drier conditions with desert expansion followed orbitally-paced cycles over the last 1.1 million years. Periods of enhanced precipitation are frequently related to the formation of biogeographical corridors through Arabia, connecting the Afrotropical, Palaeartic and Indomalayan realms and serving as a motor for hominin dispersals. One particular example is the recurrent Southern Arabian Humid Periods (SAHPs), a regional extension of “green” periods across the Saharo-Arabian Desert belt. In the last 130,000 years, at least four wetter periods occurred and are related to Marine Isotope Stages (MIS) 5e (128–121 ka BP), 5c (104–97 ka BP), 5a (81–74 ka BP) and 1 (10.5–6.2 ka BP). Here, global and regional geological records are combined to provide an overview of the climates and environments of Southern Arabia during these extreme periods, and their potential effect on human populations (dispersal and adaptation). Statistical techniques to distinguish variability and trends are employed to compare and contrast these periods, showing how “extreme” does not have a linear binary response. Other topographic factors (such as sea-level height) can be incorporated to answer questions about processes of human mobility across continents during these phases. Overall, this presentation will provide examples of climate and environmental change from Arabia at one extreme end of its climate range.

The Nile Valley as a socio-linguistic crucible: the role of climate-induced stress in the development of Ancient Egyptian

Marwan Kilani (University of Basel) and *Joanne Clark* (University of East Anglia, Norwich)

Our paper aims to explore how climatic phenomena in the areas surrounding the Nile Valley in the 4th millennium BCE might have played a role in shaping the Ancient Egyptian language in its early phases.

The first part of our presentation will delve into the linguistic aspects of Egyptian language development. We will begin with a brief overview of Egyptian language and its historical evolution. Then, we will highlight several unique and typologically unusual linguistic features of Egyptian, as well as features that have their best parallels in geographically and linguistically distinct realities. These observations lead us to propose that Egyptian might have emerged as a contact language or undergone significant reshaping through intensive language interactions. These linguistic phenomena, evident as early as the third millennium BCE, likely coincide with the formative stages of the Egyptian state in the late fourth to early third millennium BCE, or possibly even earlier.

Building upon this linguistic groundwork, we then move to the question why linguistically diverse communities converged in the Nile valley during that period. Drawing from climatological data and historical records, we argue that the late 4th millennium BCE marked the final phase of progressive desertification in regions surrounding the Nile Valley, notably the Sahara. This climatic stress likely prompted various communities to migrate towards the Nile valley. These population movements and resulting sociolinguistic interactions laid the groundwork for the unique linguistic features observed in the Egyptian language.

We will conclude by discussing some sociocultural dimensions of this phenomenon and how the emergence of the Egyptian state might correlate with these dynamics.

Climate change, population collapse and early settlement of Bantu speakers south of the Congo Forest

Koen Bostoen (UGent), Peter Coutros (UGent), Jessamy Doman (UGent), Cesar Fortes-Lima (Johns Hopkins University), Sara Pacchiarotti (UGent) and Carina Schlebusch (Uppsala University)

Coutros *et al.* (2024) report the earliest archaeological evidence for iron production south of the Congo Forest from Idiofa (DRC). It dates to the 2nd century BCE and was found in combination with pottery and lithics. Palaeoenvironmental data indicate that its producers did not settle in open grasslands but in a forest ecology that had started to undergo climate-induced degradation prior to their immigration. The Early Iron Age (EIA) continues until the 3rd century CE and is followed by a long hiatus that is not driven by climate change and lasts until the start of the Late Iron Age (LIA) in the 15th century CE. EIA ceramics (146 BCE-226 CE) most resemble slightly younger Kay Ladio pottery (30-475 CE) from the Lower Congo region further west, which is also associated with the first metallurgy there. LIA pottery (1487-1648 CE), on the contrary, is diagnostic of a regional exchange network in the 15th-17th centuries CE between the Kamtsha-Kasai Rivers. These shifting dynamics in pottery production correspond to major evolutions in the region's linguistic stratigraphy. In this paper, we assess how (mis)matching evidence from archaeology, palaeoecology, genetics, and linguistics contributes to the interdisciplinary reconstruction of the population history of Bantu speakers south of the Congo Forest. We examine more specifically whether the occupation hiatus observed around Idiofa also occurs elsewhere in the Lower Kasai area, whether its chronology corresponds to that of the widespread population collapse in the Congo Forest from 400CE (Seidensticker *et al.* 2021) and what could be its origins.

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Fire through the ages: Contextualizing modern megafires in a palaeoecological perspective.

S. Yoshi Maezumi (Department of Archaeology, MPI-GEA)

Megafires, marked by their unprecedented scale and intensity, have become increasingly prevalent, posing substantial challenges to ecosystems and communities globally. This research employs a palaeoecological approach to contextualize these recent megafires by integrating historical ecological data, sedimentary records, and analyses of past vegetation and fire dynamics. By extending the temporal scope to encompass millennia, this research aims to discern patterns and drivers that contribute to the contemporary surge in megafires. The study includes an examination of ecosystem responses, evaluating the impact of recent megafires on vegetation, biodiversity, and post-fire recovery.

Additionally, this research explores long-term human-environment interactions to understand the role of anthropogenic factors in recent megafires, including land-use practices and fire management strategies. Furthermore, this research undertakes a critical assessment of the influence of recent climatic conditions on the occurrence and severity of megafires. By contributing insights into the compounding effects of climate change, the study aims to provide a nuanced understanding of the environmental dynamics shaping the current era of megafires. Consequently, this research not only contributes to the characterization of recent megafires as extreme events but also offers a comprehensive palaeoecological perspective that is vital for informing adaptive strategies, policy decisions, and sustainable fire management practices. The insights garnered from this study hold significant implications for addressing the escalating risks posed by megafires in the context of a changing climate and human-induced environmental transformations.

Explosions and extinctions - Metaphors in animal evolution

Andresa Hejnal (Institute for Zoology and Evolutionary Research, FSU Jena)

The Cambrian Explosion stands as a pivotal moment in the history of animal evolution. This metaphorical "explosion" signifies the remarkably swift emergence of diverse animal body plans, marking a period of significant evolutionary innovation. However, the specifics of what emerged during this epoch often remain vaguely defined. It also fuelled a misunderstanding of the evolutionary process, so that misconceptions entered the literature and even led to research projects that were based on non-testable hypotheses. Similarly, animal evolution has been profoundly influenced by major extinction events, frequently triggered by significant environmental shifts. Here, the negative impact on evolutionary thinking is less severe, but still remains open questions. I will discuss the current scientific context of the Cambrian Explosion, critically examining the prevailing views on evolutionary radiations and extinction events. I will explore their implications for our (mis)understanding of animal evolution and its broader impact on the history of life on Earth.