

Attila's Huns were driven by drought

Hunnic peoples migrated westward across Eurasia, switched between farming and herding, and became violent raiders in response to severe drought in the Danube frontier provinces of the Roman empire



Objects from Kerch in Crimea showing stylistic influences from both the steppe areas and the Mediterranean.
Based on figure 4 in Hakenbeck and Büntgen

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(1) Drought encouraged Attila's Huns to attack the Roman empire, tree rings suggest 15 December 2022

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(2) The role of drought during the Hunnic incursions into central-east Europe in the 4th and 5th c. CE

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Drought encouraged Attila's Huns to attack the Roman empire, tree rings suggest

Date: December 15, 2022

Source: University of Cambridge

Summary: Hunnic peoples migrated westward across Eurasia, switched between farming and herding, and became violent raiders in response to severe drought in the Danube frontier provinces of the Roman empire, a new study argues.

FULL STORY

Hunnic peoples migrated westward across Eurasia, switched between farming and herding, and became violent raiders in response to severe drought in the Danube frontier provinces of the Roman empire, a new study argues.

Hungary has just experienced its driest summer since meteorological measurements began, devastating the country's usually productive farmland. Archaeologists now suggest that similar conditions in the 5th century may have encouraged animal herders to become raiders, with devastating consequences for the Roman empire.

The study, published today in the *Journal of Roman Archaeology*, argues that extreme drought spells from the 430s -- 450s CE disrupted ways of life in the Danube frontier provinces of the eastern Roman empire, forcing Hunnic peoples to adopt new strategies to 'buffer against severe economic challenges'.

The authors, Associate Professor Susanne Hakenbeck from Cambridge's Department of Archaeology and Professor Ulf Büntgen from the University's Department of Geography, came to their conclusions after assessing a new tree ring-based hydroclimate reconstruction, as well as archaeological and historical evidence.

The Hunnic incursions into eastern and central Europe in the 4th and 5th centuries CE have long been viewed as the initial crisis that triggered the so-called 'Great Migrations' of 'Barbarian Tribes', leading to the fall of the Roman empire. But where the Huns came from and what their impact on the late Roman provinces actually was unclear.

New climate data reconstructed from tree rings by Prof Büntgen and colleagues provides information about yearly changes in climate over the last 2000 years. It shows that Hungary experienced episodes of unusually dry summers in the 4th and 5th centuries. Hakenbeck and Büntgen point out that climatic fluctuations, in particular drought spells from 420 to 450 CE, would have reduced crop yields and pasture for animals beyond the floodplains of the Danube and Tisza.

Büntgen said: "Tree ring data gives us an amazing opportunity to link climatic conditions to human activity on a year-by-year basis. We found that periods of drought recorded in biochemical signals in tree-rings coincided with an intensification of raiding activity in the region."

Recent isotopic analysis of skeletons from the region, including by Dr Hakenbeck, suggests that Hunnic peoples responded to climate stress by migrating and by mixing agricultural and pastoral diets.

Hakenbeck said: "If resource scarcity became too extreme, settled populations may have been forced to move, diversify their subsistence practices and switch between farming and mobile animal herding. These could have been important insurance strategies during a climatic downturn."

But the study also argues that some Hunnic peoples dramatically changed their social and political organization to become violent raiders.

From herders to raiders

Hunnic attacks on the Roman frontier intensified after Attila came to power in the late 430s. The Huns increasingly demanded gold payments and eventually a strip of Roman territory along the Danube. In 451 CE, the Huns invaded Gaul and a year later they invaded northern Italy.

Traditionally, the Huns have been cast as violent barbarians driven by an "infinite thirst for gold." But, as this study points out, the historical sources documenting these events were primarily written by elite Romans who had little direct experience of the peoples and events they described.

"Historical sources tell us that Roman and Hun diplomacy was extremely complex," Dr Hakenbeck said. "Initially it involved mutually beneficial arrangements, resulting in Hun elites gaining access to vast amounts of gold. This system of collaboration broke down in the 440s, leading to regular raids of Roman lands and increasing demands for gold."

The study argues that if current dating of events is correct, the most devastating Hunnic incursions of 447, 451 and 452 CE coincided with extremely dry summers in the Carpathian Basin.

Hakenbeck said: "Climate-induced economic disruption may have required Attila and others of high rank to extract gold from the Roman provinces to keep war bands and

maintain inter-elite loyalties. Former horse-riding animal herders appear to have become raiders."

Historical sources describe the Huns at this time as a highly stratified group with a military organization that was difficult to counter, even for the Roman armies.

The study suggests that one reason why the Huns attacked the provinces of Thrace and Illyricum in 422, 442, and 447 CE was to acquire food and livestock, rather than gold, but accepts that concrete evidence is needed to confirm this. The authors also suggest that Attila demanded a strip of land 'five days' journey wide' along the Danube because this could have offered better grazing in a time of drought.

Hakenbeck said: "Climate alters what environments can provide and this can lead people to make decisions that affect their economy, and their social and political organization. Such decisions are not straightforwardly rational, nor are their consequences necessarily successful in the long term."

"This example from history shows that people respond to climate stress in complex and unpredictable ways, and that short-term solutions can have negative consequences in the long term."

By the 450s CE, just a few decades of their appearance in central Europe, the Huns had disappeared. Attila himself died in 453 CE.

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The role of drought during the Hunnic incursions into central-east Europe in the 4th and 5th c. CE

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Abstract: The Hunnic incursions into eastern and central Europe in the 4th and 5th c. CE have historically been considered one of the key factors in bringing the Roman Empire to an end. However, both the origins of the Huns and their impact on the late Roman provinces remain poorly understood. Here we provide a new, combined assessment of the archaeological, historical, and environmental evidence. Hunnic raids and warfare within the Roman provinces are most intensely attested for the first half of the 5th c. We propose that severe drought spells in the 430s to 450s CE disrupted the economic organization of the incomers and local provincial populations, requiring both to adopt strategies to buffer against economic challenges. We argue that the Huns' apparently inexplicable violence may have been one strategy for coping with climatic extremes within a wider context of the social and economic changes that occurred at the time.

Keywords: climate change, human migration, Huns, paleoclimate, Roman Empire, subsistence practices

The incursions of Huns into eastern and central Europe in the 4th and 5th c. CE have historically been thought to be the initial crisis that set in motion the so-called Great Migrations of “barbarian” tribes.¹ Scholarship on the Huns has frequently placed them in a dichotomy between civilization and barbarism, where the very fact that they were mobile and did not engage in agriculture contributed to their apparently barbarian nature. The narrative is of violence and sometimes conquest, and of raids into the Roman provinces, apparently motivated by an “infinite thirst for gold.”² However, the historical sources documenting these events are written from the perspectives of the settled populations, often by members of the elite with little direct experience of the peoples and events they described. The nature of Hunnic activities – their apparently sudden appearance, rapid military and political impact, and sudden disappearance – and their impact on populations in the Late Roman Danube frontier provinces are therefore still poorly understood.

Recent research has looked to natural proxy archives for an explanation, suggesting that climate was a “push factor” that initiated migrations of the Huns.³ However, such approaches often rely on simple models of causality, arguing that droughts caused migrations, without further explanation of why that might be. Drawing on multiple strands of evidence – historical, archaeological, and environmental – this article aims to advance an explanation that goes beyond simple causative models and takes account of the complex relationships between climate variation and human actions.

¹ Heather 1995.

² Amm. Marc. *Res gestae* 31.2.11 (transl. Rolfe 1939, 386–87).

³ Cook 2013; Harper 2017, 191–92; McCormick et al. 2012, 190.

Historical accounts of the Huns

According to written sources, the Huns came from east of the Sea of Azov (Fig. 1).⁴ They are thought to have crossed the Volga around 370 CE, causing the displacement of the Goths who resided there.⁵ In the following 50 years, the Huns likely first settled in Muntenia in Romania, on the lower Danube, before establishing themselves on the Great Hungarian Plain, east of the Danube. At times they were thought to have reached as far as the Rhine in the west and southern Scandinavia in the north, though the latter is more speculative. In the first decades of the 5th c., written sources indicate that Hunnic war bands were active within the eastern Roman Empire, sometimes allied with Roman forces, sometimes engaged in raiding, and capitalizing on local instabilities.⁶ From the 430s, and especially after Attila came to power in the late 430s, these attacks intensified. The Huns increasingly demanded payments of gold and then also the evacuation of a strip of Roman territory along the Danube.⁷ In 451 CE, the Huns invaded Gaul, resulting in the battle of the Catalaunian Plains, which proved to be a disaster for all sides. A year later they invaded northern Italy, where they sacked Aquileia and captured Milan.⁸ In 453 CE, Attila died suddenly, choked to death by blood from a nosebleed.⁹ This led to internecine fights for supremacy among Attila's sons, and in 454 CE, the Huns were finally defeated in battle at the river Nedao.¹⁰ By the 470s, the Huns were no longer a significant force.¹¹ Table 1 provides a timeline of these events. It is important to note that some of the dates are the result of scholarly interpretations of sources that might be imprecise.

Several historical sources tell us of the rapacious activities of the Huns, and of their greed, violence, and untrustworthiness. Negative descriptions begin with Ammianus Marcellinus, a 4th-c. military officer, who describes the Huns thus:

They all have compact, strong limbs and thick necks, and are so monstrously ugly and misshapen, that one might take them for two-legged beasts or for the stumps, rough-hewn into images, that are used in putting sides to bridges. But although they have the form of men, however ugly, they are so hardy in their mode of life that they have no need of fire nor of savoury food, but eat the roots of wild plants and the half-raw flesh of any kind of animal whatever, which they put between their thighs and the backs of their horses, and thus warm it a little.¹²

Later writers elaborated on this, with Jordanes describing Attila as “a man born into the world to shake the nations, the scourge of all lands, who in some way terrified all mankind

⁴ Amm. Marc. *Res gestae* 31.2.1 (transl. Rolfe 1956, 380–81); Jord. *Get.* 5 (transl. Mierow 1915, 60).

⁵ Maenchen-Helfen 1973, 18.

⁶ Croke 1977; Kelly 2014, 197; Meier 2019, 402–6. Sources: e.g., Prosper Tiro, *Chron.* 1326 (ed. and transl. by Becker and Kötter 2016, 110–11).

⁷ Kelly 2014, 201; Meier 2019, 418–20; attacks on the eastern provinces: Prosper Tiro, *Chron.* 1346 (ed. and transl. by Becker and Kötter 2016, 122–23); demands for gold and land: Priscus, *Fr.* 5, 1–8; 7.2 (Carolla) (transl. Given 2014, 37–38; 44).

⁸ Prosper Tiro, *Chron.* 1366–67 (ed. and transl. by Becker and Kötter 2016, 129–31); *Chron. Marcell.* sub annum 452 (transl. Croke 1995, 20).

⁹ *Chron. Marcell.* sub annum 454 (transl. Croke 1995, 21); Jord. *Get.* 49 (transl. Mierow 1915, 123).

¹⁰ Jord. *Get.* 50 (transl. Mierow 1915, 125).

¹¹ Kelly 2014, 202.

¹² Amm. Marc. *Res gestae* 31.2.2 (transl. Rolfe 1939, 380–81); Prosper Tiro, *Chron.* 1370 (ed. and transl. by Becker and Kötter 2016, 132–33).

The role of drought during the Hunnic incursions into central-east Europe



Fig. 1. Historically recorded locations of Hunnic activity. The arrows indicate the assumed routes of the main Hunnic raids. Sites sampled for isotope analysis in Hakenbeck et al. 2017: 1. Keszthely-Fenépuszta; 2. Hács-Béndekpuszta; 3. Győr-Széchenyi Square; 4. Mőzs; 5. Szolnok-Szanda. Shaded area: Roman Empire. Roman provinces map data adapted from the Ancient World Mapping Centre (Creative Commons Attribution-NonCommercial 3.0 Unported); coastline and river data from Natural Earth (<https://www.naturalearthdata.com>); elevation data from the GMTED2010 (Danielson and Gesch 2011). (Map created by David Redhouse.)

by the dreadful rumors noised abroad concerning him.”¹³ By their appearance and behavior, the Huns seemed in every way opposed to Roman civilization. This negative image was perpetuated in historical scholarship and has persisted in the popular imagination up to the present day.¹⁴

Yet these descriptions of the Huns were largely not based on eyewitness accounts. A critical analysis of the textual sources reveals that late Roman writers drew on established conventions when describing nomadic groups, reaching back to Herodotus.¹⁵ Greek and Roman writers had long fitted the peoples living beyond their frontiers into a universe that was Mediterranean-centric, both geographically and morally.¹⁶ Ammianus Marcellinus describes the Huns as less than human because they did not engage in agriculture or live in permanent settlements, but the pursuit of agriculture was central to Roman

¹³ Jord. *Get.* 35 (transl. Mierow 1915, 102).

¹⁴ Kelly 2009, 221–22; Pahl 2007.

¹⁵ Richter 1974; Schubert 2007.

¹⁶ Kulikowski 2018, 154.

Table 1.

Timeline of events, as outlined by Maenchen-Helfen 1973, 59–152; Meier 2019, 397–461. References to the original sources can be found there.

<i>Year (CE)</i>	<i>Event</i>
400	Uldin's Huns attack the Gothic leader Gainas who aimed to settle the Goths across the Danube
404/05	Uldin's Huns attack Thrace
405/06	Huns support Stilicho in Italy against Radagaisus
422	Huns attack Thrace under Ruga
425	Huns support Aetius's army in a civil war against forces of the eastern Empire
427	Rome takes back control of Pannonian provinces. Uncertain attestation. More likely a Roman victory over the Huns.
ca. 430	Huns under Oktar attack Burgundians living on the right bank of the Rhine. Conjectural.
433	Huns support Aetius in civil war in Italy
Second half of 430s	Death of Ruga; Attila and Bleda become kings
434	Treaty of Margus
441	Huns attack Margus
442	Huns cross Danube and attack Thrace and Illyricum
445?	Attila murders Bleda
445	Possible treaty with Rome, including demands for land along the Danube
447	Attila's army attacks Thrace (70 cities), reached Chersonesos (Gallipoli) and Thermopylae
447	Treaty with Rome: huge sums of gold, a strip of land by the banks of the Danube
450	Treaty: Attila cedes buffer zone along the Danube and returns prisoners
451	Hunnish campaign westwards towards Gaul concluding with the battle of the Catalaunian Plains
452	Huns cross the Alps to Italy and sack Aquileia and Milan
453	Death of Attila
454	Huns defeated in battle by Gepids at the unknown river Nedao

ordered existence. It was an economic necessity but also a sign of virtue.¹⁷ Ancient ethnographic writings served to “other” populations beyond the Roman Empire, and there could be no greater “other” than peoples constantly on the move and unwilling to farm the land.

Huns and Xiongnu: is there a link?

The apparently alien nature of the Huns in central Europe is often linked to their assumed origins in central Asia, adding a racial dimension to their “othering.” Ancient ethnographic sources were vague about the homeland of the Huns prior to their engagement with the Roman Empire, suggesting only a location east of the Sea of Azov, between the Volga and Don Rivers.¹⁸ However, since the 18th c., the Huns have often been equated with the central Asian Xiongnu, a nomadic group mentioned in Chinese sources as being active in the Mongolian steppes from the late 3rd c. BCE to the 1st c. CE.¹⁹ Since then, there

¹⁷ Kronenberg 2009, 94–95; Nelson 1998, 89.

¹⁸ Amm. Marc. *Res gestae* 31.2.1 (transl. Rolfe 1939, 380–81); Jord. *Get.* 5 (transl. Mierow 1915, 60).

¹⁹ De Guignes 1756, vi.



Fig. 2. An example of a “Hunnic” cauldron, found in Törtel in Hungary in 1869. (Photo by György Klösz, public domain.)

has been considerable debate about the plausibility of this link, based on written, phonological, and archaeological evidence.²⁰

Archaeological research in the culture-historical tradition aimed to identify ethnic and tribal groups by apparently characteristic items of material culture, usually from graves. The innumerable groups mentioned in written sources in Late Antiquity and the early medieval period were associated with particular jewelry styles or weapons, and the distribution of such artifacts was then used to attempt to track the groups’ movements.

While this approach has been criticized extensively, both because it makes use of ahistorical concepts of ethnicity and because of its simplistic interpretations of material culture,²¹ it has nevertheless been used to connect European Huns and the Xiongnu through archaeological evidence.²²

Yet, the Huns have defied even culture-historical attempts to pin them down. Early scholarship recognized the heterogeneity of material culture derived from central Asia or the steppes north of the Black Sea. More recent research has increased the evidence but also the great variability of the material.²³ The most characteristic items are bronze mirrors and cauldrons, as well as component parts of composite bows with very widely scattered find spots (Fig. 2).²⁴ Other items, such as narrow longswords, gold diadems, and particular jewelry types, have a more defined distribution north of the Sea of Azov and along the middle Volga.²⁵ It is clear that none of these form a clear link with the archaeological evidence associated with the Xiongnu, whose burial practices and grave goods are quite different.²⁶

Another feature that is often cited as evidence for Huns is artificial skull modification (Fig. 3). This practice is carried out in infancy, when the bones of the skull are still soft and unfused. This allows the skull to be manipulated with bindings to flatten the frontal

²⁰ E.g., Alföldi 1932; Atwood 2012; de la Vaissière 2015, 178–79; de Takács 1935; Hirth 1900; Kim 2013, 26–28; Maenchen-Helfen 1944; Maenchen-Helfen 1973, 451; Meier 2019, 159–62.

²¹ Brather 2002; Hakenbeck 2011; Von Rummel 2010.

²² Hayashi 2014; Jettmar 1952; Tomka 2008.

²³ Anke 1998; Bóna 1991; Werner 1956.

²⁴ Anke 1998, 17, 55; Masek 2017.

²⁵ Anke 1998, 31, 93.

²⁶ Brosseder 2018, 184.



Fig. 3. A modified skull of a child, unknown provenance. (Photo by Susanne Hakenbeck, Natural History Museum Budapest.)

and elongate the parietal bone. When the bones are fused, this shape remains a permanent feature of a person's appearance. The practice first arose west of the Tian Shan mountains in the 2nd c. BCE, spreading westwards to the northern Black Sea region at the turn of the millennium and reaching central Europe by the 5th c. CE. However, the practice is not typical for the burial complexes of Mongolia that have been associated with the Xiongnu. In central Asia, burial of individuals with modified skulls was very diverse, and it cannot be associated with any distinct

group. Furthermore, the chronological spread of skull modification does not match the much more rapid timeline of Hunnic appearance and disappearance.²⁷

In central Europe, skull modification became a local practice, with 10 to 20 percent of individuals in some cemeteries having modified skulls.²⁸ This is supported by a genomic study of eight individuals with modified skulls from Bavaria, which indicated that most had genetic ancestry in southeastern Europe, though one woman had around 20 percent East Asian ancestry. A control sample, also with modified skull, from the Roman city of Viminacium in Serbia had a similar ancestry profile.²⁹ This is another indicator of close connections between populations across Eurasia, but as a practice it cannot uniquely be associated with Huns.

While archaeological evidence does not support the idea of large-scale, rapid movements of people from central Asia into Europe in the early centuries of the 1st millennium CE, it nevertheless suggests extensive connections across Eurasia.³⁰ Belt sets, bronze mirrors, cauldrons, and occasionally silk, among other items, are evidence of enduring long-distance communication and trade between the Black Sea and Mongolia, and even as far as northern China.³¹ Skull modification was also a part of this.

Considering the above, there is therefore no evidence that Huns originated as the Xiongnu in Mongolia and from there spread rapidly and as a coherent group into Europe. Historical and archaeological evidence instead indicates that it is much more likely that the Huns mentioned by Ammianus Marcellinus were an aggregation of people from somewhere north of the Black Sea.

²⁷ Hakenbeck 2018.

²⁸ Hakenbeck 2018, 489.

²⁹ Veeramah et al. 2018, 3496.

³⁰ Brosseder 2015.

³¹ Brosseder 2011; Brosseder 2015; Érdy 1994; Simonenko 2001; Yao 2012; Zaseckaja and Bokovenko 1994.

Huns in the Carpathian Basin

In the Carpathian Basin, archaeological evidence for Huns is also difficult to grasp. Various strands of “Hun” material culture only rarely occur together to form a coherent picture. The rich assemblage from Pannonhalma has been interpreted as a Hun funerary sacrifice or cenotaph, since there is no evidence of a body, and has been linked to Hunnic elites.³² Similar depositional practices and material culture can be found in steppe areas north of the Black Sea, the lower Danube, and the mouth of the Dnepr, and there are few Roman or Mediterranean influences (Fig. 4).³³ However, elite burials of the period are often very “international” and share commonalities across vast distances.³⁴ We therefore cannot consider these funerary sacrifices as exclusively typical of Hunnic practices.

There is no distinct material culture that would allow us to identify ordinary, lower-ranking Huns. Cemeteries in the Pannonian provinces and beyond, to the north and east of the Danube, are characterized by heterogeneity and a hybridity of material culture and burial traditions.³⁵ There is evidence of extraordinary connections that linked the Black Sea, the Mediterranean, and western Europe, and Late Antique craftworking traditions are joined with innovations from beyond the Roman frontier. “Foreign” material culture and practices can therefore not simply be taken as evidence of migrations.

Equally, while there is evidence for destruction in fortifications and settlements in the eastern provinces of the Empire, for example, burning at the fort of Iatrus in Moesia,³⁶ it is difficult to link this unequivocally to Hunnic attacks. Even the destruction at Aquileia, where historical accounts clearly indicate an attack by Hunnic forces in 452 CE, has been re-evaluated.³⁷ It was recognized that every burnt layer was dated to the Hunnic attack, rather than through independent archaeological methods, thereby increasing the impression of complete destruction. This is likely the case at other sites too.

Archaeological evidence for Huns in Europe is ephemeral and difficult to interpret. There is no evidence for a large-scale migration, or even invasion, from the Black Sea regions or further east. To understand to what extent these people may have seen themselves as part of a group with a shared identity, we must shift our focus from artifacts as ethnic signifiers to other potential markers of group cohesion.

Economic practice and identity

Since the mid-1st millennium BCE, written sources have divided the pastoral nomads of central Asia and eastern Europe into a multitude of named tribal groupings, but it is questionable whether these named groups indicated rigid ethnic divisions. They may or may not have had a sense of a shared ethnic identity or common descent. More likely, these pastoral populations formed confederations based on a shared economy and lifestyle. Moving beyond approaches that focus exclusively on material culture, it may be more productive to consider peoples’ practices and habits when attempting to understand the causes of the

³² Tomka 1986.

³³ Tejral 2011, 332.

³⁴ Quast 2009; Schmauder 2002.

³⁵ Heinrich-Tamáška and Straub 2015; Vida 2011.

³⁶ Von Bülow 2007, 468.

³⁷ Marano 2011, 176.



Fig. 4. Late 5th- to early 6th-c. CE objects from Kerch in Crimea showing stylistic influences from both the steppe areas north of Crimea and the Mediterranean. (Berthier-Delagarde Collection, British Museum, under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International [CC BY-NC-SA 4.0] license.)

rapid appearance and impact of the Huns in the Pannonian Basin. In the absence of any written information about how Huns and other nomadic pastoralists understood their identity, it is therefore more productive to approach them through their subsistence economy.

Anthropological and archaeological studies of ethnicity have emphasized the importance of praxis in creating distinctions between people, and there are ethnographic examples of groups identifying primarily through their social or economic habitus.³⁸ More generally, Rogers Brubaker has drawn attention to the organizational, institutional, and behavioral frameworks that facilitate the creation of ethnicity.³⁹

³⁸ Barth 1969a; Bentley 1987; Jones 1997; “praxis” as defined by Bourdieu (1977). Ethnographic examples: Astuti 1995; Barth 1969b.

³⁹ “We need not frame our analyses in terms of ethnic groups and [...] it may be more productive to focus on practical categories, cultural idioms, cognitive schemas, commonsense knowledge, organizational routines and resources, discursive frames, institutionalized forms, political projects, contingent events and variable groupness” (Brubaker 2002, 185–86).

The role of drought during the Hunnic incursions into central-east Europe

Isotope analysis provides information about peoples' diets and the extent to which they were mobile, and, by extension, an insight into their subsistence practices. Archaeological evidence, in particular from burials, allows us to study habits that may engender group identity. Together, these strands of evidence enable us to reconstruct the circumstances of the lives of individuals in considerable detail and to situate them within the wider archaeological and historical context of frontier relationships in the 5th c.

Ethnographic and archaeological evidence from central Asia indicates that mobile animal herders consumed more meat and milk than farming populations, and they also preferred millet (*Panicum miliaceum*) over other grains. The subsistence strategies of nomadic pastoralists result in patterns of isotopic data that can be quite different from those of agricultural populations.⁴⁰ Pastoralists frequently had elevated $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values compared to those of farmers.

To test whether there was a shift in diet and mobility that may be linked to nomadic pastoralists during the Hunnic period along the middle Danube, skeletons from five cemeteries dating from the 5th c. were analyzed by Hakenbeck et al.⁴¹ The sites were chosen to provide comparison across the Roman frontier: four cemeteries were located within the province of Pannonia and one on the banks of the river Tisza, in the Great Hungarian Plain. At all five sites there were individuals with skull modification and there was some evidence for material culture pointing to the Black Sea region, suggesting a degree of cultural contacts.

A comparison with isotopic data from early medieval settled farmers from southern Germany and mobile pastoralists from the central Asian steppes showed that the populations in the Carpathian Basin consumed slightly more animal protein than the farmers, but less than central Asian pastoralists. Similarly, the $\delta^{13}\text{C}$ values suggested that the consumption of millet (or of other C4 plants) lay between that of Inner Asian pastoralists and that of agricultural populations from Germany. At all analyzed sites, there were some individuals who had been highly mobile, as revealed by the $^{87}\text{Sr}/^{86}\text{Sr}$ of their tooth enamel compared to local environmental values. A comparison of isotopic evidence from multiple teeth from the same individuals often showed more than one change in diet and/or residence.

The results of this study revealed that the people buried in these cemeteries, both in Pannonia and in the Great Hungarian Plain, had a diet that fell between the endpoints of an agricultural and a fully pastoral diet. There seems to have been a high level of mixing, with some individuals significantly changing their diets over their lifetimes. This showed that farming and pastoralism were not mutually exclusive strategies; rather, people buried in the same communities used them flexibly. Farming and animal herding could have been mutually beneficial strategies that were not limited to particular ethnic groups.

An encounter narrated by Priscus of Panium, the only written source that provides an eyewitness account of relations between Huns and Romans, aptly illustrates how identity can be mediated through social and economic conformity. While waiting for an audience at the court of Attila, Priscus meets a well-dressed Greek-speaker in Scythian (i.e., Hunnic)

⁴⁰ Isotopic evidence of nomadic-pastoralist diet in central Asia: Fenner et al. 2014; Motuzaitė Matuzevičiūtė et al. 2015; Murphy et al. 2013; Privat et al. 2005. Isotopic evidence of early medieval agricultural diets in Europe: Hakenbeck et al. 2010; Hull and O'Connell 2012; Knipper et al. 2013; Privat et al. 2002; Schutkowski et al. 1999.

⁴¹ Hakenbeck et al. 2017.

clothing.⁴² Surprised to find a man speaking perfect Greek among people where Greek was not a common language, Priscus asks him to tell his story.

He laughed and said that he was Greek by birth. He had come as a trader to Viminakion [Viminacium] [...], had spent a long time there and married a very wealthy woman. When the city came under the barbarians [...] he was selected for Onegesios [an advisor of Attila] himself in the distribution of war spoils [...]. After he had distinguished himself in later battles against the Romans and the Akateri, he gave the barbarian ruler, according to Scythian custom, the spoils he took and so obtained his freedom. He married a barbarian woman, and now had children. [...] He believed his present life to be better than his previous life.

The narrative then proceeds with a discussion between Priscus and the stranger about the respective merits of the political order among Romans and Huns. Persuaded in the end by Priscus, the man bursts into tears, agreeing with him that Roman laws and the Roman state were indeed superior to life among the barbarians.

While this exchange fits into an established narrative topos – a barbarian commenting critically on Roman society – and may even be entirely fictional,⁴³ it nevertheless reveals interesting possibilities about relations between ordinary people on either side of the frontier. Whether or not the trader existed as described, Priscus clearly thought it possible that a person from within the Roman world could set up among the Huns and even prefer their way of life, however wrong he considered this to be. Furthermore, as Maas has pointed out, the trader does not fit into neat categorizations, “being at once a Greek, a Roman and a Scythian, that is, both civilized and barbarian. He stands between cultural worlds in ways that Priscus considers confusing.”⁴⁴ His clothing marks him out as a Hun, but his language suggests otherwise. The differences between the Hunnic and the Roman way of life are here largely articulated as differences in the nature of government, rather than being fundamental ethnic or moral differences, as Ammianus Marcellinus had posited a century earlier. In this brief account, we see that categorizations of people in the Carpathian Basin of the 5th c. could be complex, defying simple dichotomies between Romans and barbarians.

This opens up the possibility that a person born into one particular way of life could join another. There is both ethnographic and archaeological evidence that such a fluid approach to apparently very different subsistence strategies is not unusual.⁴⁵ Most pastoralists rely on some form of agriculture, either by engaging in it themselves or through close interaction with agricultural populations, and nomadic groups can be mobile for part of a year or move between long-established locations.

Ammianus Marcellinus had described the Huns of the 4th c. as fully nomadic pastoralists.⁴⁶ But by the 5th c., their subsistence practices seem to have changed. Though he was an eyewitness, Priscus offers us no information about the herds of the Huns, but he

⁴² Priscus, *Fr.* 8.94–114 (Carolla) (transl. Given 2014, 62–65).

⁴³ Maas 1995, 152.

⁴⁴ Maas 1995, 153–54.

⁴⁵ E.g., Barth 1964, 105; Di Cosmo 1994; Khazanov 1994, 44; Murphy et al. 2013.

⁴⁶ “No one in their country ever plows a field or touches a plow-handle. They are all without fixed abode, without hearth, or law, or settled mode of life, and keep roaming from place to place, like fugitives, accompanied by the wagons in which they live” (Amm. Marc. *Res gestae* 31.2.6–12, transl. Rolfe 1939, 383–87).

does mention that members of his embassy were offered millet to eat and a drink made from barley.⁴⁷ Clearly agricultural produce was available and of some importance. This is consistent with the isotopic evidence. The Huns of the 5th c. likely relied to a great extent, but not exclusively, on mobile pastoralism. Interactions with local populations may have stimulated both parties to adapt their subsistence strategies. Yet, Huns were also documented as having a distinct political and military organization that has been likened to an empire.⁴⁸

The steppe environment and climate

How then can we understand the apparently sudden appearance of the Huns and the resulting destabilization in the Roman frontier areas of eastern and central Europe? For this we need to consider the wider backdrop of climatic, environmental, and economic affordances in the 4th and 5th c.

The Eurasian steppes are an expanse of grassland that stretches 8,000 km from modern-day Manchuria in the east to Ukraine in the west. Broadly, from north to south, the steppes change from boreal forests to forest-steppes and then to desert steppes and desert zones punctuated by oases. Towards the east, the climate is more continental and more arid, resulting in shorter growing seasons.⁴⁹ Over the course of the Holocene, the extent of these ecological bands fluctuated in accordance with more humid and more arid phases.⁵⁰

The Eurasian steppes have supported populations engaged in large-scale animal husbandry since the Chalcolithic, around the turn of the 5th to the 4th millennium BCE. Mounted pastoral nomadism emerged in the second half of the 3rd millennium BCE.⁵¹ Since then, the steppes have supported nomadic-pastoralist groups, right up to the present day. Food production depended on animal herding, requiring groups to be mobile all year round, though the boundary to semi-nomadic lifeways is fluid. Different populations relied to a greater or lesser extent on agriculture and sedentism.⁵² These groups had large herds of sheep, horses, and, in some areas, camels. Herd sizes could be variable and depended on the richness of the available pasture areas. The Eurasian steppes supported a fully nomadic and pastoral lifestyle, and pastoralists might often only encounter agriculturalists in – for them – marginal environments: the oases of central Asia.⁵³

The Great Hungarian Plain forms the westernmost part of this enormous steppe belt, but here the situation is quite different.⁵⁴ The environment in the Great Hungarian Plain is characterized by a mosaic of different types of steppe habitats that have also been subject to considerable changes over the course of the Holocene.⁵⁵ From the Neolithic onwards,

⁴⁷ Priscus, *Fr.* 8.64–65 (Carolla) (transl. Given 2014, 56–57).

⁴⁸ Bóna 1991, 47.

⁴⁹ Kohl 2007, 127.

⁵⁰ Kremenetski 2003.

⁵¹ Frachetti 2012, 6, 9; Kohl 2007, 53, 144.

⁵² Hermes et al. 2018; Khazanov 1994, 19.

⁵³ Khazanov 1994, 33.

⁵⁴ Taaffe 1990.

⁵⁵ Molnár et al. 2012.

land was increasingly used for agriculture, leading to extensive anthropogenic landscape changes.⁵⁶ Prior to the 18th c., land use typically switched between crop cultivation and grazing in multi-year cycles.⁵⁷ Areas of grassland were not very large, and land was widely used for agriculture. Exclusive nomadic pastoralism was not possible here.⁵⁸

Scholars have attempted to link a putative mass migration of Huns from central Asia to mega-droughts caused by the El Niño Southern Oscillation (ENSO) climate system of the Pacific Ocean.⁵⁹ Such mega-droughts have been recorded in the Dulan-Wulan juniper tree-ring record from north-central China and in a second, more recent, juniper tree-ring record from the northern Qinghai province.⁶⁰ These droughts lasted for several decades, the first, around 360 CE, being the worst in the past 2,000 years. A second major drought occurred in the mid-5th c.⁶¹ But on the basis of the archaeological evidence outlined above, we must discount these droughts as not being relevant to what might have happened in Europe at that time.

More relevant to the question of the Huns in Europe is the fact that this region also saw climatic fluctuations during the 4th and 5th c. Tree-ring sequences from across Europe provide the basis for a reconstruction of summer temperatures going back to the 2nd c. BCE.⁶² They suggest a series of negative temperature anomalies in the mid-4th c. and again in the early 5th c. While the downturns were not as extreme or sustained as the Late Antique Little Ice Age (LALIA) that began in the 6th c., this period nevertheless saw cycles of negative temperature anomalies and episodes of drought.⁶³

A recent study of summer hydroclimate in central Europe during the last two millennia allows us to infer how these climatic fluctuations would have affected the Carpathian Basin. This study used stable carbon and oxygen ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) isotope data from oak tree-rings to reconstruct summer hydroclimate at an annual resolution. The 27,080 annually resolved and absolutely dated measurements of tree-ring stable carbon and oxygen ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) isotopes from 21 living and 126 relict oaks (*Quercus* spp.) that grew in what is today called the Czech Republic and southeast Bavaria best represent central Europe between around 10° and 25°E and 45° and 55°N (Fig. 5).⁶⁴

There are clear indicators of extreme drought events around the time of the LALIA, the late 10th c., and 1490 to 1540 CE, as well as from the 1970s to the present (Fig. 6A).⁶⁵ A close-up perspective on the years 350 to 500 CE also shows increasingly dry summers after the 420s CE. The period from 430 CE up to Attila's death in 453 CE included several extremely dry summers. This was followed by a century of drier-than-average

⁵⁶ Magyari et al. 2010; Sümegei et al. 2015; Willis et al. 1998.

⁵⁷ Molnár et al. 2012, 230.

⁵⁸ Gyulai 2010, 165.

⁵⁹ Cook 2013; Harper 2017, 191–92; McCormick et al. 2012.

⁶⁰ Shao et al. 2010; Sheppard et al. 2004.

⁶¹ Cook 2013, 91.

⁶² Luterbacher et al. 2016.

⁶³ Büntgen et al. 2016; Luterbacher et al. 2016, 3.

⁶⁴ For a detailed view on the spatial distribution of the dendrochronological samples, see Büntgen et al. 2021, Extended Data Figure 1.

⁶⁵ Büntgen et al. 2021, 193.

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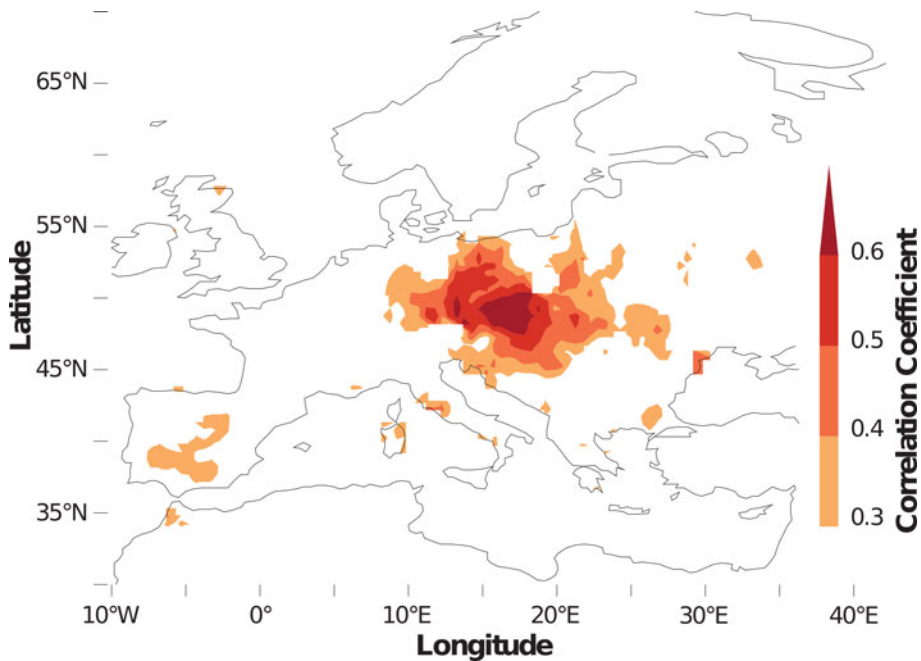


Fig. 5. Spatial agreement between reconstructed and measured European summer drought. High-resolution, 0.5° spatial correlation coefficients (color scale) between the tree-ring stable isotope (TRSI) proxy record and the gridded European-wide self-calibrated Palmer Drought Severity Index (scPDSI) target data calculated over the common period 1901–2018 CE. (Created by Ulf Büntgen.)

summers, before renewed drought episodes in the second half of the 6th c., the period of the LALIA (Fig. 6B).

It is difficult to evaluate what the implications of these increasingly dry summers might have been for the people living on either side of the Roman frontier. The floodplains of the Danube and the Tisza are extensive and, due to the enormous catchment of the Danube watershed, would have buffered, or indeed accelerated, the regional hydroclimate. Archaeobotanical evidence from the 3rd to 4th-c. settlement site of Kiskundorozsma-Nagyszék in Csongrád County suggests a highly diverse environment consisting of waterlogged meadows, pastures, and open woodland. Indeed, extensive areas of the floodplains of the river Tisza were permanently or periodically inundated.⁶⁶

Climatic changes affected such an environment in complex ways. A study of the impact of the onset of the Little Ice Age on settlement patterns in the Tisza valley suggests an increase in waterlogged and pasture land of about 50 percent, with a concomitant reduction in arable land. Such a growth in the extent of wetland floodplains likely increased albedo rates and changed local evaporation patterns, which may have had an impact also on the regional climate system.⁶⁷ Büntgen and Di Cosmo attempted to relate the withdrawal of the Mongols in 1242 CE to cold and wet conditions that year, following several warmer and drier years.⁶⁸ They suggested that this reduced the land available for

⁶⁶ Gyulai 2010, 167, 171.

⁶⁷ Pinke et al. 2017a, 110.

⁶⁸ Büntgen and Di Cosmo 2016.

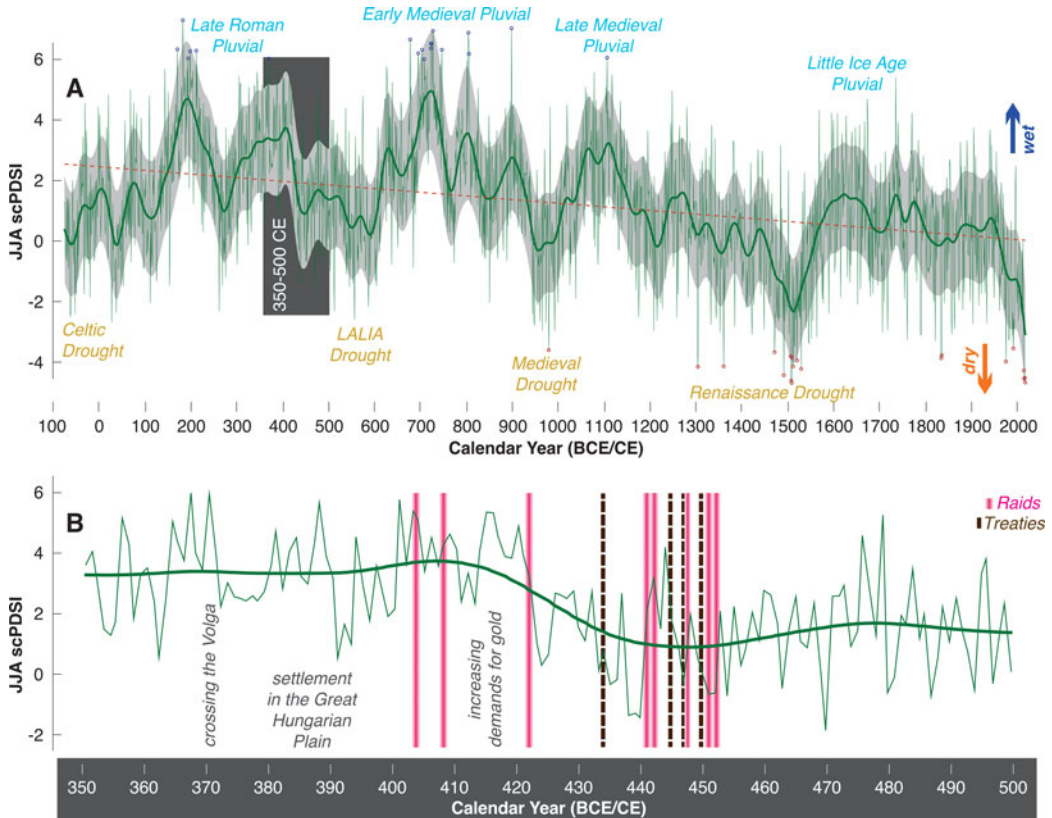


Fig. 6. (A) Reconstructed June–August (JJA) self-calibrated Palmer Drought Severity Index (scPDSI) from 75 BCE to 2018 CE (from Büntgen et al. 2021). The thick curve is a 50-year cubic smoothing spline of the annual values, and the circles show the 20 lowest and highest reconstructed values, respectively. The grey shading refers to the confidence limits after smoothing, and the dashed line represents the highly significant long-term drying trend. (B) A close-up of reconstructed JJA scPDSI from 350–500 CE, together with Hunnic raids and treaties with the Roman Empire, as documented in historical sources (see Table 1 for details). (Created by Ulf Büntgen.)

agriculture and access to pastureland for horses, had an impact on military effectiveness, and possibly caused a famine. Countering this, Pinke and colleagues have argued that prolonged precipitation in fact increased fodder yields, which would have provided improved conditions for the Mongol army.⁶⁹

In the 4th and 5th c., where historical and environmental data are much less highly resolved, it would therefore be problematic to link historic events to climatic conditions in a way that implies a simple cause-and-effect. Nevertheless, the climatic fluctuations of the period, in particular the dry summers from 420 to 450 CE, would likely have had an impact on both agricultural and pasture carrying capacities, at least in areas that were not directly in the moisture-rich floodplains.

Historical sources tell us that Roman and Hun diplomacy was extremely complex with, at least initially, mutually beneficial arrangements, resulting in Hun elites gaining access to vast amounts of gold. This system of collaboration broke down in the 440s, leading to

⁶⁹ Pinke et al. 2017b.

regular raids of Roman lands, increasing demands for gold, and, at one point, a demand for a strip of territory along the Danube “five days’ journey wide.”⁷⁰ This coincided with increasing aridity in the Carpathian Basin. If the dating of these events is reliable, then the most devastating Hunnic incursions, in 447, 451, and 452 CE, happened during extremely dry summers (see Fig. 6 B). This raises the question of whether altered environmental affordances provoked adaptations to subsistence, economy, and perhaps even social organization. How this may have played out is discussed further below.

Economic instability and violence

In their work on cultural responses to risk and uncertainty, Halstead and O’Shea identify four types of buffering mechanisms that societies employ to mitigate the risks of resource variability: mobility, diversification, exchange, and storage.⁷¹ In the Carpathian Basin of the 5th c., we have evidence of several of these buffering mechanisms being employed.

Mobility is an established strategy for nomadic pastoralists, encompassing both transhumance and migration to entirely new areas for pasturing or other economic activities. But settled populations may also be forced to move if resource scarcity is too extreme. Isotopic evidence from populations in Pannonia and beyond certainly indicates high levels of mobility.⁷²

Dry summers could have altered the productivity of the agricultural land and affected how much land was available for grazing. Given the general instability of the time – episodes of warfare on the frontier, as well as a decrease in long-distance trade – diversification in subsistence practices and the ability to make use of both farming and mobile animal herding, as observed from isotopic evidence, could have been important insurance strategies during a climatic downturn, helping people to mitigate unstable economic times. Those populations for which we have isotopic evidence engaged in a mixed agro-pastoral economy, with less reliance on large-scale herding than had probably been practiced by the original incomers from the steppes.

This must have had a significant impact on the established social organization. Former horse-based animal herders may have recast themselves as war bands led by a war lord or warrior king, on whom they relied for support. Demands for gold and tribute, and the wealth and prestige items to be had within the Roman Empire, became necessary for sustaining these groups of warriors and the lifestyle to which they had become accustomed.⁷³

This leads us to the role of exchange – even by violent means – as a mitigation strategy. Halstead and O’Shea describe this as “negative reciprocity.”⁷⁴ We know little about the main attacks by the Huns on the provinces of Thrace and Illyricum, in 422, 442, and again in 447 CE, other than that they were devastating for the provincial populations.⁷⁵ Contemporary studies of livestock raiding and violence among pastoralists in the Turkana District of Kenya have shown that livestock-related violence has occurred in

⁷⁰ Priscus, *Fr.* 5.1–3 and 7.2 (Carolla) (transl. Given 2014, 37, 44).

⁷¹ Halstead and O’Shea 1989.

⁷² Hakenbeck et al. 2017.

⁷³ Hardt 2003.

⁷⁴ Halstead and O’Shea 1989, 4.

⁷⁵ *Chron. Marcell.* sub annum 422; s.a. 441; s.a. 442; s.a. 447 (transl. Croke 1995, 13, 17, 19).

both dry and wet seasons. The authors suggest that people opportunistically raid livestock during wet months, since the animals are healthier and vegetation provides cover for the raiders. However, when the rains fail and resources become very scarce, they carry out raids to compensate for livestock losses or to gain control over pastures.⁷⁶ It is quite possible that one focus of the raids on the provinces of Thrace and Illyricum was to acquire food and livestock, though we have no concrete evidence for this. Even Attila's demand for an extensive strip of land along the Danube can perhaps be seen as a mitigation strategy, since land in the floodplain would have offered better grazing in a time of drought.

People living in the Carpathian Basin tried a range of strategies to buffer the effects of prolonged summer droughts. They flexibly changed their subsistence economy between herding and farming, and some – Hunnic war bands – also changed their social and political organization in favor of raiding and extraction of gold.

Conclusions

In recent years, climate has often been proposed as a key driver of human migrations, though without clear evidence for how and why such processes might have occurred. In this article, we have instead attempted to examine at a high resolution the complex range of direct and indirect human responses to climatic changes.

Historical, genomic, and material culture evidence suggests that there was indeed an influx of people from regions north of the Black Sea, or from areas further east, in the 4th and 5th c. CE. However, the nature and extent of this influx is difficult to quantify. Certainly, there is no indication of one large-scale migration from central Asia to Europe.

The first half of the 5th c. CE saw a series of very dry summers from the 420s to the 450s. Isotopic evidence from this period shows that populations in the Carpathian Basin, both within the province of Pannonia and in the more steppic areas of the Great Hungarian plain, exercised a high degree of flexibility in subsistence practices. Groups and individuals switched between farming and herding, often quite rapidly. It is possible that this was a mitigation strategy in response to climatic and environmental changes, as well as perhaps to warfare and instability. Agricultural diversification is certainly safer than reliance on monoculture in uncertain climatic and economic times.

Historical sources describe the Huns at this time as a highly stratified group with a military organization that was difficult to counter, even for the Roman armies. The increasingly dry summers from the 420s to 450s may have disrupted the earlier economic organization of the incomers from the steppes who, we can assume, formed the core of the Hunnic elites. This climate-induced economic disruption may also have changed Hunnic social organization, requiring Attila and others of high rank to extract a supply of gold from the Roman provinces that was probably used to keep war bands and to assure inter-elite loyalties. The violence of the Hunnic elites that was so dramatically recorded in late Roman written sources could thus have been a consequence of climatic fluctuations in the first half of the 5th c.

Climate alters environmental affordances, which in turn lead people to make decisions that affect their economy and their social and political organization. Crucially, such decisions are not straightforwardly adaptive, nor are their consequences necessarily successful

⁷⁶ Ember et al. 2012; Schilling et al. 2014, 250–51.

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in the long term – after all, by the 450s CE, just a few decades after their appearance in central Europe, the Huns had disappeared.

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