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Climate and Causation in the Swedish Iron Age: Learning from the Present to Understand the Past

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Abstract

The paper reassesses the role of climate as a factor shaping changes in settlement and landscape in the Swedish Iron Age (500 BC to AD 1050). Two reasons motivate this re-evaluation. First, high-resolution data based on climate proxies from the natural sciences are now increasingly available. Second, the climate-related social sciences have yielded conceptual and theoretical developments regarding vulnerability and adaptability in the present and recent past, creating new ways to analyse the effects of climatic versus societal factors on societies in the more distant past. Recent research in this field is evaluated and the explicitly climate deterministic standpoint of many recent natural science texts is criticized. Learning from recent approaches to climate change in the social sciences is crucial for understanding society–climate relationships in the past. The paper concludes that we are not yet in a position to fully evaluate the role of the new evidence of abrupt climate change in 850 BC, at the beginning of the Iron Age. Regarding the crisis in the mid first millennium AD, however, new climate data indicate that a dust veil in AD 536–537 might have aggravated the economic and societal crisis known from previous research.

Key words

Climate, Sweden, Iron Age, vulnerability, AD 536, fimbul winter

The problem

Climate has long been debated by historians and archaeologists as one possible causative factor shaping the emergence and decline of civilizations as well as societal development more generally. Positions have varied from extreme climate determinism to the opposite, i.e. that the collapse of complex societies can be explained by endogenous social dynamics apart from changing climate. In research into the Scandinavian Iron Age (500 BC to AD 1050), climate change has been invoked as a possible causative factor for changes in settlement, landscape, and society in two distinct periods. The beginning of the Iron Age is thought to have been closely connected to the shift from the Subboreal to Subatlantic climate periods. Furthermore, the settlement decline in the mid first millennium AD has been connected to the cooling after the Roman climatic optimum. This paper re-evaluates the role that climate might have played in these two periods. This is done against the background of recent advances both in climate reconstruction and in our understanding of how social systems react to climate change.

Why is climate determinism so strong?

The massive increase in climate research in recent decades has put us in a much better position to understand the effects of climate on prehistoric societies. This is due both to advances in natural-science-based climate reconstructions and to climate-related research in the social sciences. Based on an improved understanding of how to interpret information from natural climate archives in various parts of the world and on new methods of handling qualitative climate data, we now have access to much higher-resolution climate records of the past. This paves the way for more precise discussion of the role of climate in social change. Social science research that focuses on current adaptation and vulnerability problems is also an important source of inspiration for historical studies. Conceptual and theoretical developments in social science climate research have called into question many of the climate determinist assumptions that have largely dominated research into global change.

Climate change versus extreme weather events

Previous research into the role of climate in societal change has not always clearly distinguished between long-term gradual change in climate and series of extreme weather events, such as droughts and flooding. The increased focus on recent climate change and its possible relationship with more frequent extreme weather events has led to a greater conceptual clarity that historians and archaeologists must take into account. Are we talking about *climate change*, *abrupt climate change*, an *extreme weather event*, or possibly a series of extreme weather events (see IPCC definitions in Solomon, 2007: 941ff.)? Much of the paleoclimatology literature, which claims a causal relationship between climate and social collapse, uses the *climate event* concept – though without precisely defining it. When social scientists write about the influence of climate on societies, these distinctions are often lacking or imprecise.

Natural scientists explaining social change

One sign of the recent growth in academic and public interest in climate change has been the increased visibility of articles taking an overt climate deterministic standpoint. These are written by natural scientists, published in prestigious journals, and often claim to explain societal change and collapse based on high-resolution data from climate proxies. For example, Cullen et al. (2000), writing in *Geology*, claimed to explain the fall of the Akkadian state in Mesopotamia 4200 BP. They wrote:

Archeological evidence and regional paleoclimate data collectively implicate abrupt climate change as having been a key factor that contributed to the demise of this sophisticated culture which had imperialized Mesopotamia. (p. 382)

Similarly Haug et al. (2003), writing in *Science*, found support for the hypothesis “that regional drought played an important role in the collapse of the Classic Maya civilization” (p. 1734). Büntgen et al. (2011) concluded their recent study of reconstructed summer precipitation and temperature variability in Europe over the past 2500 years with the following statement:

Our data provide independent evidence that agrarian wealth and overall economic growth might be related to climate change on high- to mid-frequency (interannual to decadal) time scales. Preindustrial societies were sensitive to famine, disease, and war, which were often driven by drought, flood, frost or fire events, as independently described by documentary archives. (p. 582)

It will be an interesting task for future historians of science to investigate why so many science journals in the early twenty-first century accepted such one-sided explanations of societal change, written by natural scientists lacking any demonstrated knowledge of social dynamics. One explanation is of course the heated political atmosphere surrounding global warming. In this context, the study of history sometimes seems mainly valued not for helping

us understand the past, but for finding arguments for present action. This tendency is expressed in much popular science literature on collapse, in which climatic determinism and the overexploitation of natural resources are often cited as explanations and as explicit or implicit warnings to politicians and the general public. Büntgen et al. (2011), although writing in a scientific journal, argue along much the same lines when they openly declare in their abstract that “Such historical data may provide a basis for counteracting the recent political and fiscal reluctance to mitigate projected climate change”.

Towards a new research agenda

A common denominator of the above articles on the Akkadian and Maya collapses and on the connections between climate and societal change in Europe is that they are based on extremely good, detailed, and sometimes also very local climate reconstructions. The argument for moving from such detailed records of climate to an explanation of general societal change seems to be that the main obstacle to understanding causal relationships between climate change and society lies in the lack of detailed climate data. This is what Büntgen et al. (2011) explicitly argue:

Discrimination between environmental and anthropogenic impacts on past civilizations, however, remains difficult because of the paucity of high-resolution paleoclimatic evidence. (p. 578)

Büntgen et al. are of course right in arguing that high-resolution climatic data series are necessary for any conclusion regarding these relationships. While previous climate reconstructions mainly captured long-term climate change, the more recent, detailed data allow precise conclusions as to the time scale, and events of abrupt climate change can now be dated. However, a basic problem of causation is involved: The fact that two events happened at the same time usually does not, in other contexts, permit drawing a conclusion regarding causation. We need to know much more about the mechanisms involved.

Let us return to the problem of the Akkadian collapse in Mesopotamia 4200 BP. It is indeed true that the increased number of detailed climate reconstructions allows a new discussion of causal relationships. However, as the number of climate reconstructions increases, so does the number of possible interpretations. Finné et al. (2011) review the evidence of some 80 paleoclimate reconstructions of the eastern Mediterranean and conclude, in contrast to Cullen et al. (2000), the following about the Akkadian collapse:

A period of widespread and pronounced aridity is evident around 4200 yrs BP. However, there is no unambiguous evidence for a widespread and distinct event at 4200 yrs BP; rather the evidence to date appears to suggest that it is masked or mediated by the overall climatic changes recorded for the period which commenced at approximately 4600 yrs BP. Although tempting, it is still too early to draw far-reaching conclusions of a possible rapid climatic event behind the fall of e.g. the Akkadian state. More precisely-dated and interpreted high-resolution paleoclimate data are needed to further test the extent and character, and possible effects of this so-called 4.2-event. (p. 3169)

Increased climate research might well complicate the picture, as it allows more nuanced discussion of causation. Parallel to this is another current, namely, an improved understanding of the complex relationships between the societal and climatic causes of, for example, historical collapse. I will return to this matter, but to conclude the discussion of the Akkadian collapse, I refer to Karl Butzer’s (2012) recent insightful evaluation of both the climatic and archaeological information from that area. Butzer concludes that the evidence “does not support the hypothesis of a catastrophic megadrought as a prime mover for collapse of either the Akkadian empire or a synergistic group of Near Eastern civilizations”. He instead points to “imperial unrest” and the “relentless expansion of Akkad” (Butzer, 2012, Supporting Information).

Vulnerability: social science and climate change

The main problem with such simplistic and overstated conclusions regarding climate change as the cause of societal collapse is that they implicitly invoke arguments regarding the character, not only of the specific climate change (which these scientists *have* investigated), but also of the relevant society and its vulnerability to climate change (which they usually *have not* investigated). Exactly what social dynamics climate change, either gradual or abrupt, can set in motion can never be determined using natural science methods. To put it another way, statements about how a specific social formation reacted to climate change are also statements about how that society functioned. The character and dynamics of social change in these societies must first be understood before conclusions can be drawn about societal collapse. O'Brien et al. (2007), who argue for a better understanding of the present double exposure to globalization and climate change faced by the poor worldwide, remind us that "climate hazards and long-term changes represent only part of the profound transformations affecting societies" (p. 84). This is true for present as well as past societies.

Vulnerability has become a key concept in the recent social science literature on climate change. This concept was invoked to understand the relationship between hazards and disasters in the book *At Risk: Natural Hazards, People's Vulnerability, and Disasters*, in which Blaikie et al. (1994) developed a chain of explanation identifying the factors that make some natural hazards into human disasters. Factors creating vulnerability include the construction of settlements on slopes, in deltas, etc., as well as the existence of, for example, marginal economies, social stratification, and social groups without safety nets. Since then, the vulnerability concept has been considerably developed, both conceptually and empirically, in studies of the social effects of climate change (see e.g. O'Brien et al., 2007; O'Brien & Leichenko, 2000).

Returning to societies of the past that we want to understand, we can preliminarily list several factors that influence vulnerability to abrupt climate change, such as crop–livestock relationships, crop diversity, social organization, social stratification, grain storage, redistribution, and risk-minimizing strategies. The role of social stratification is crucial in this respect. Even if it can be established that, for example, grain production decreased significantly due to a series of extreme weather events, estimations of the effect on society need to take into account the crucial distinction between *food availability decline* and *food entitlement decline* (Sen, 1981).

Social dynamics underlying collapse

Another factor, which most climate determinist writing tends to ignore, has been identified by anthropological research highlighting the possibility of dramatic dynamics in past social systems, regardless of climate change. Internal dynamics and the external political and economic relationships of past complex societies have been demonstrated to set in motion dynamics similar to those seen in climate reconstructions, i.e. clear expansions and declines (Tainter, 1987). In his book *How Chiefs Come to Power*, Tim Earle (1997) analysed chiefdoms from a comparative perspective, citing examples from Hawaii, the Andes, and prehistoric Denmark. In comparing these three cases, he demonstrated how such political structures are dynamic and can create fast growth as well as fast decline in populations:

Rather than experiencing long and sustained growth, the populations at these three locations expanded and declined in erratic cycles that were not evidently related to resource conditions. Certainly populations grew initially because new habitat niches were made available by colonization and the introduction of agricultural technologies. But then growth stalled for reasons not clearly related to resource availability. (Earle, 1997: 65)

Such an understanding is slowly being integrated into recent studies of collapse and climate change. One example is the recent collection of papers by archaeologists and historians looking into the resilience of various past societies and their vulnerability to sudden

environmental change (Cooper et al., 2012), and another is a special issue of *PNAS* in which Karl Butzer and others conduct broad interdisciplinary analyses of the causes of historical collapse. They apply a critical perspective to previous authors who have emphasized either climate or environmental overexploitation as the main drivers of collapse, and analyse, in a series of cases, the roles of political development, climate change, and possible environmental degradation (Butzer, 2012; Butzer & Endfield, 2012, and references there).

Interdisciplinary research into African climate and societies

At Stockholm University, People Land and Time in Africa (PLATINA) – a research group straddling the departments of physical and human geography – has worked for the past decade to promote interdisciplinary research into African landscapes and environments.

Understanding the interplay between climatic and social drivers of landscape change has been a central concern of this group, and in a series of seminars and meetings, climatic determinist and social determinist perspectives have confronted each other (Holmgren et al., 2008). This effort has involved a broad range of researchers, from physical geographers working on climate reconstruction to human geographers and anthropologists. While human geographers initially applied a social determinist perspective, physical geographers put a greater emphasis on the role of climate as a driver of change. The gradual integration of these two perspectives is reflected in the group's publications.

From at first having a more determinist viewpoint, climate historians have moved to a much more dialectical understanding. While Tyson et al. (2002) emphasized the influence of changing climate on the development of the settlement patterns and livelihoods of Iron Age agriculturalists in southern Africa, Holmgren and Öberg (2006) scrutinized these interrelationships in more detail. Their study was based on the detailed climate records reconstructed by Holmgren from stalagmites in South Africa and a literature review on the rise and fall of several social formations in southern Africa over the last millennium, i.e. the Mapungubwe settlement system in northern South Africa, and the Great Zimbabwe and later Sotho-Tswana polities. Holmgren and Öberg (2006) were able to demonstrate that the Mapungubwe settlement survived and continued to expand during the dry conditions around 1000 AD and the long period of drier climate in the twelfth century, collapsing in the late thirteenth century in connection with a much shorter and less pronounced period of drought. From this study, they drew the following conclusions regarding the role of climate in societal change, conclusions clearly valid beyond southern Africa:

- Societal changes often coincide with climatic changes;
- Climatic changes do not always result in societal changes – a stable society can sustain severe climate conditions;
- Climatic change is a common external trigger when internal instability already is established. When times of climate change coincide with times of socioeconomic and political instability, it can lead to societal catastrophes, but also to new developments;
- Climatic conditions that are favourable have been an important factor in the past in the rise of new centers for the accumulation of power;
- Adaptational strategies, as traced from history, seem to be
 - flexibility in short- and long-term mobility and in the reorganization of centres;
 - flexibility in changes in agricultural practices and in types of staple crops
 - possibility of controlling external trade (Holmgren & Öberg, 2006: 193)

The understanding of such a dialectical interplay between climate, on the one hand, and social, political, and economic factors, on the other, has been further developed in the same research group by an interdisciplinary team representing physical geography, human geography, archaeology, and anthropology led by physical geographer Lars-Ove Westerberg

(Westerberg et al., 2010). This team traced the establishment, development, and subsequent decline of the ancient irrigation system at Engaruka in Tanzania from the 1400s to early 1800s. The history of this irrigation system can be explained by a complex interplay between climate, trade, and agriculturalist–pastoralist interactions. The irrigation system was established in the context of a drier climate and, parallel to that, the growth of caravan trade, which increased the demand for grain along the trade routes. The ensuing history of the irrigation community, however, cannot so easily be explained by either climate or trade alone. The irrigation system survived and intensified during a period of much drier climate between 1550 and 1670 and during the decline in caravan trade between 1550 and 1750. By then it must have had its own internal growth dynamic, based on successful farming and on interaction with local pastoralists. The final abandonment was probably caused by a combination of climate deterioration, pastoralist Maasai expansion, and a resulting change in livelihood strategies. This abandonment would not have occurred under duress but can be described as the result of the “successful accumulation of wealth in the form of cattle, by which Engaruka farmers secured a shift, or possibly a return, to pastoralism” (Westerberg et al., 2010: 10). Such an explanation of the rise and fall of an irrigation system says a great deal about human ingenuity and the complexities of social and climatic factors in a difficult environment.

Climate and the beginning of the Iron Age

In previous publications on Swedish Iron Age settlement and landscapes, Ellen Anne Pedersen and I have taken a clear social determinist viewpoint and criticized previous views emphasizing climate as the driver of societal change (Widgren, 1983; Pedersen & Widgren, 1998, 2011). I have also briefly discussed and started to reassess the role of climate in this period (Widgren, 2005). I will next address two periods of change based on more recent climate reconstructions and inspired by close collaboration with climate historians from the PLATINA network. Is a social determinist viewpoint defensible today when detailed climate data are increasingly being published for this period and region as well?

In much writing on the development of settlement and agriculture over the last millennium BC in Scandinavia, the role of climatic deterioration, described as the shift from the Subboreal to the Subatlantic climate period, has been regarded as significant. In the Swedish-language version of the history of Swedish agriculture, we spent several pages refuting what many writers before us had taken for granted, namely, that this climate deterioration had radically transformed conditions for agriculture, leading to increased sedentary settlement and the introduction of indoor cattle stalling. In contrast, we made a clear case that the changes in agriculture in the first millennium BC could *not* be explained on the basis of climate (Pedersen & Widgren, 1998: 253).

Two considerations had made the cooling of the last millennium BC into such an important element of previous discussions. On one hand, the discovery early in the twentieth century of layers of pine stumps in Scandinavian peat bogs marked an early and important step in the development of a Holocene climate chronology. The shift to a wetter and cooler climate indicated by this growth of sphagnum peat in formerly drier areas of pine woodland was the basis for the periodization of the Subboreal and the Subatlantic climate periods. The fact that researchers early on gave this period a name from the Edda poems, i.e. the *fimbul* winter (from the Icelandic *fimbulvetr*, “great winter”), also gave this explanation extra rhetorical power (Bergeron et al., 1956). Furthermore, the climatic explanation helped explain what archaeologists had taken to be a “findless period” at the beginning of the Iron Age.

The fact that, starting in this period, the winter stalling of cattle became common also seemed to emphasize the fundamental impact of the climatic cooling on the nature of the farming system. Winter stalling was closely connected to the development of the characteristic Scandinavian landscape with hay meadows where winter fodder had to be

collected. However, the connection to an episode of climate cooling is not as obvious as it would seem at first glance. The basis for such an argument is weak. Cattle can withstand cold weather and snow up to a certain depth, and can browse bushes and trees. Indoor stalling is not a necessity in the present Nordic climate, but represents the intensification of livestock keeping and of the milk economy. The choice farmers had to make in the past, in Northern Europe as in other parts of the world, between out-wintering and stalling did not simply reflect climatic conditions or other environmental factors.

It could instead be argued that stalling was part of an innovation that spread from central Europe to Scandinavia in the Bronze Age and early Iron Age. It was established in parts of Europe well before the climate deterioration and continued to spread to the Atlantic islands long after that. Stalling, through promoting a closer connection between humans and animals, permits more intensive milk production, including a more productive use of fodder-producing areas. Furthermore, the connection between stalling and the use of cattle manure on intensively cultivated infields is one aspect of a more general intensification of agriculture. As has been demonstrated for many other parts of the world, the increased role of private property and herd security can also be seen as factors contributing to the spread of cattle byres in this period. Indoor stalling was thus not primarily an adaptation to a cooler climate, but part of an intensification of agriculture that also included several other elements (Pedersen & Widgren, 1998: 239–266, 2011: 46–51).

One reason not to treat the climate as a cause of this development is that the cooling of the climate was part of a long-term gradual change. The whole period of agriculture in Scandinavia occurred at a time of declining mean temperatures and, at the time of writing, there was no convincing high-resolution climate curve covering the last millennium in sufficient detail to permit an informed discussion of the role of climate for agriculture. The data needed to compare the cooling over the last millennium BC with, for example, the better-known Little Ice Age in the seventeenth century simply did not exist (Pedersen & Widgren, 1998: 250). In a private communication some years later, Bas van Geel kindly brought to our attention his findings of a period of abrupt climate change some 850 calendar years BC. He and his colleagues had also proven that this climate change had a definite impact on agriculture and society, as archaeological evidence clearly attests to its effects. From 850 to 760 BC, the groundwater level rose and the final outcome was the abandonment of coastal settlements in the marshlands of the northern Netherlands (van Geel et al., 1996, 1998).

The question we must therefore ask is whether it is still possible, in light of van Geel et al.'s results, to defend the view that climate did *not* have a crucial effect on Scandinavian agriculture in the last millennium BC. The first thing to note is that this climate change was not part of a gradual cooling, but was instead connected to a comparatively short period of extreme weather events including inundations (van Geel et al., 1996: 457). In northern Netherlands these events had a decisive effect on settlement and society. The problem then becomes whether, and, if so, how this abrupt climate change affected Northern Europe more generally. Björn Berglund (2003) assessed the relationship between this climatic event and possible changed human impact in north-west Europe and was unable to demonstrate any clear correlation. This climatic event may be correlated with the retreat of settlement and human influence in some peripheral areas in southern Sweden, but the evidence is definitely not conclusive (de Jong & Lagerås, 2011: 24). If a major short-term cooling event occurred in Scandinavia during this period, its impact cannot yet be assessed, due both to the lack of detailed climate reconstructions and to the nature of the archaeological data for the period. When it comes to assessing the vulnerability of societies of that time, we are also on fairly shaky ground. For example, we have no clear evidence in Sweden of settlements in such marginal and vulnerable regions as the marshlands of the North Sea coast of the Netherlands. Furthermore, the combination of livestock farming and cereal cultivation, and the fact that

crop diversity was greater before the dominance of hulled barley since the beginning of the Iron Age (500 BC), might have been factors that kept vulnerability comparatively low (Engelmark, 1992; Pedersen & Widgren, 2011: 51). We are not yet in a position to assess the social effects of the abrupt climate change that Bas van Geel has highlighted.

The fifth and sixth-century crisis

In the mid first millennium AD, settlement and landscape underwent radical changes. The previous expansion during the Roman Iron Age (AD to AD 400) came to a halt, and settlement and lands were abandoned in many parts of Sweden and in Scandinavia more broadly. This is most visible in the regions where both house foundations and enclosures were built in stone (i.e. on the Baltic islands of Gotland and Öland) or where at least enclosures were built in stone (e.g. in the provinces of Östergötland and Uppland in Sweden). In addition, in the Swedish province of Hälsingland, this settlement desertion is evidenced by the many terraced house platforms, which indicate a total of several thousand abandoned farms dating from this period. Moreover, pollen diagrams bear witness to a distinct but often short-lived reforestation of grazing lands, especially on the Baltic islands and in the eastern mainland zone of Sweden from Blekinge in the south to Hälsingland and Medelpad in the north (Pedersen & Widgren, 2011: 60–62).

Explaining the crisis: political and economic factors

This decline in human influence on the landscape has been given varying explanations over time. War, pandemics, the fall of the Roman Empire, and climate deterioration have all been cited as possible causes. In our syntheses we argued that, to understand the crisis, we must also understand the nature of the previous expansion and the character of society and the landscape before the crisis. The rapid settlement growth on Öland, Gotland, in eastern central Sweden, and along the southern part of the Norrland coast (Hälsingland and Medelpad especially) must be understood as the intensive exploitation of the central areas of various petty kingdoms. The settlement pattern and especially the enclosures bear witness to an intensively exploited landscape. These areas, on the outer fringes of Roman influence, were probably drawn into international exchange and may have produced a small, but significant, surplus of wool and hides. According to such a view, the development of the agrarian landscape in Sweden cannot be seen in isolation from broader political and economic changes in Europe (Pedersen & Widgren, 1998: 312–314; 2011: 61). This argument is consistent with our understanding of the role of the Roman Empire in the exchange system beyond Roman lines, as broadly described by Hedeager (1987).

Our emphasis on links to the Roman Empire does not mean that we see the crisis and decline purely as the direct effects of decreased contacts with Rome, but as more broadly connected to the political turbulence that affected petty kingdoms and the exchange of prestige objects in the broader region of Northern Europe (see also Näsman, 2012). One reason to see this development as not simply a response to one external factor, be it climate or the fall of the Roman Empire, is the fact that different regions in Sweden responded differently to the crisis, the variation being regional as well as chronological. In western Sweden, the decline of settlements and the decrease in grazing pressure is less pronounced. Similarly, in the eastern zone there are, parallel to the decline, indications of an expansion of human influence in two regions: central Uppland, which then started to develop as a new and important political centre, and in the northern province of Ångermanland.

The AD 536 dust veil

In the past decade, evidence of a specific climatic event, a dust veil emanating from a volcanic eruption in the sixth century AD, has become increasingly clear. The dust veil event was contemporaneous with the studied crisis, so the evidence seriously challenges the

interpretation outlined above. We now know that this dust veil influenced the climate in large parts of Europe at least in the two consecutive years 536 and 537. The significance of this dust veil for understanding the archaeological record was highlighted in the volume *The Years Without Summer: Tracing 536 and its Aftermath* (Gunn, 2000). More recently, Larsen et al. (2008) have been able to date the sulphate deposits in ice cores from Greenland and the Antarctic and proven that the dust veil must have emanated from “a large explosive, near equatorial volcanic eruption”.

In a pioneering study, archaeologist Bo Gräslund (2007) not only summarized the international research into this phenomenon, but also explored its relationship with Nordic oral traditions and with settlement development in Scandinavia. Gräslund convincingly argues that it must have been this climatic event that formed the background for the *fimbul* winter described in the Edda poems, rather than the period of cooling in the last millennium BC. The association of this earlier period of cooling with the term *fimbul* winter has been well established, though not much discussed, among archaeologists and climate historians alike. Gräslund (2007; in English, see Gräslund & Price, 2012) further demonstrates that this event may also be the background to other oral traditions, such as the Finnish Kalevala, and may also figure in Iranian myths. The dust veil is also well documented in written sources from late antiquity.

When the written evidence is judged together with the paleoclimatic data, it seems clear that this must have been a dust veil that indeed caused a period of two very cold summers – three winters without intervening summers, as is said in the Edda poems. It has been estimated that mean summer temperatures may have been 3–4 degrees Celsius below average during these years, and that the effects may have extended beyond the two coolest summers. This means that the effects of this dust veil must have been much more severe than those of the historically documented dust veils from the volcanic eruptions of Tambora in 1815, Krakatau in 1883, and Pinatubo in 1991, which only obscured the sunlight temporarily and locally.

All evidence so far indicates far-reaching consequences for farming and grazing. Two years of possibly total crop failure must have put the farming societies of Scandinavia under considerable stress. Furthermore, in contrast to many other extreme weather events, this event probably hit all areas in Scandinavia more or less equally.

Towards a synthesis

The evidence of the AD 536 dust veil provides a clear example of how better climate data from the past indeed permit more detailed examination of the relationship between climate and society. In view of this new evidence, it is difficult to defend a position that the crisis in the mid first millennium AD was driven only by political and economic changes in the wake of the fall of the Roman Empire. The question now is whether the dust veil data finally explain the root causes of the mid-first-millennium crisis. Was the crisis primarily a climate crisis or a social crisis? Can we, as some recent archaeological researchers have, call this a “climate crisis” and consider this as having triggered a series of social and ideological responses (Löwenborg, 2010; Zachrisson, 2011), or should we – in line with Blaikie et al. (1994) – see the root causes in the vulnerability of farming systems, economic systems, and various social groups? As has been stressed in previous analyses of this crisis, it was not a sudden event but a prolonged process having its origin in the third and fourth centuries AD (Näsman, 1988, in press; Herschend, 2009: 403).

The regional dimension emphasizes our understanding of a social rather than a climate crisis and of differentiated vulnerability. Several signs indicate that the various regions of Scandinavia were affected differently by the dust veil. The regional differences in the landscape changes occurring in Sweden were treated above; the Baltic Islands and east coast of Sweden, probably more drawn into continental networks, were more affected than were the

western parts. Furthermore, as Gräslund points out, the archaeological data also indicate that northern Norway, with its rich marine resources and less reliance on agriculture, came out of the crisis fairly well (Gräslund, 2007: 112). At a wider geographical level, it can be inferred from the pollen data that the regions in Northern Europe along and immediately beyond the Roman *limes* were the most affected by agricultural decline and reforestation, while in some areas that were more peripheral to the Roman Empire (on the British Isles and along the North Sea coast), the human influence on the landscape actually increased between AD 200 and AD 600. This indicates that areas that were more directly drawn into the Roman sphere were also the most affected by the crisis (Frenzel et al., 1992).

Moreover, it seems as though some social strata not only survived, but emerged strengthened from the crisis. In central Uppland, around the emerging power centre of Old Uppsala and elsewhere, there was continuity and in some places even agricultural expansion during the general period of crisis (Hammar & Damell, 1999; Karlsson 1999, Karlsson et al., 2008: 167). In the period following the crisis, there is clear evidence of increased social stratification and the concentration of land in fewer hands (Gräslund, 2007: 114; Löwenborg, 2010). In sum, the crisis had clear social implications. Vulnerability to the severe climate was unevenly distributed geographically and socially. Scandinavia at that time did not consist of equal subsistence farmers, but was a highly stratified society. Internal power relationships and the various types of exchange relationships with the continent arguably may have had an indirect, but decisive impact on the outcome of the crisis.

Climate crises, societal crises

I argue that much of the recent literature on the effects of climate on past societies suffers from severe environmental determinism and a lack of understanding of the social aspects of how societies react to abrupt climate change. In the heated situation of present-day climate change, *learning from history* has rightly been advanced as a method for understanding the relationships between climate change and its societal impact. However, many of the scientific articles claiming such a position suffer from a lack of understanding of the social aspects involved. The recent literature on present-day relationships between climate change and society has formulated an advanced understanding of these relationships, starting from concepts such as vulnerability and adaptability. Such an understanding, which emphasizes the roles of social organization and stratification in seeking to understand vulnerability to rapid climate change, offers an important challenge to any historian, archaeologist, or climatologist trying to understand climate effects on past societies. I would therefore argue that the process of learning from history must start with learning from the present, i.e. from the advanced understanding of social reactions to environmental change that researchers studying present-day vulnerability have started to develop.

I have investigated more closely two cases of possible causal relationships between climate change and society in the Swedish Iron Age. The two cases give partly diverging results. The period of abrupt cooling starting about 850 BC is well documented in the Netherlands and has been demonstrated to have had a decisive influence on settlement and society there, especially for coastal settlements. Evidence that this cooling had any clear effect on society and settlement in Sweden, however, is lacking: neither the detailed climate reconstructions nor possible effects on society have yet been clarified for Sweden. On the other hand, new evidence of a distinct and comparatively short period of colder climate, caused by a dust veil of volcanic origin in AD 536 and the following year(s), directly ties in with a well-documented period of crisis, decline, and settlement abandonment. This new evidence challenges many of the established explanations of this crisis, which have emphasized political and economic factors, but not climate change. However, I would argue that the two explanations are not mutually exclusive. Our new knowledge of the volcanic dust veil, and of two summers with distinctly lower temperatures, could explain the rapid and

unmistakable decline in settlements and open lands evidenced in the archaeological and paleoecological record of some areas. On the other hand, the regional and social variation in the effects cannot be explained by the climate alone. The stagnation had started before the sixth century, and the dust veil aggravated the crisis considerably. However, vulnerability was not evenly distributed, either geographically or socially, so the new evidence does not contradict the political, economic, and social factors that were proposed in earlier interpretations of the stagnation process.

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