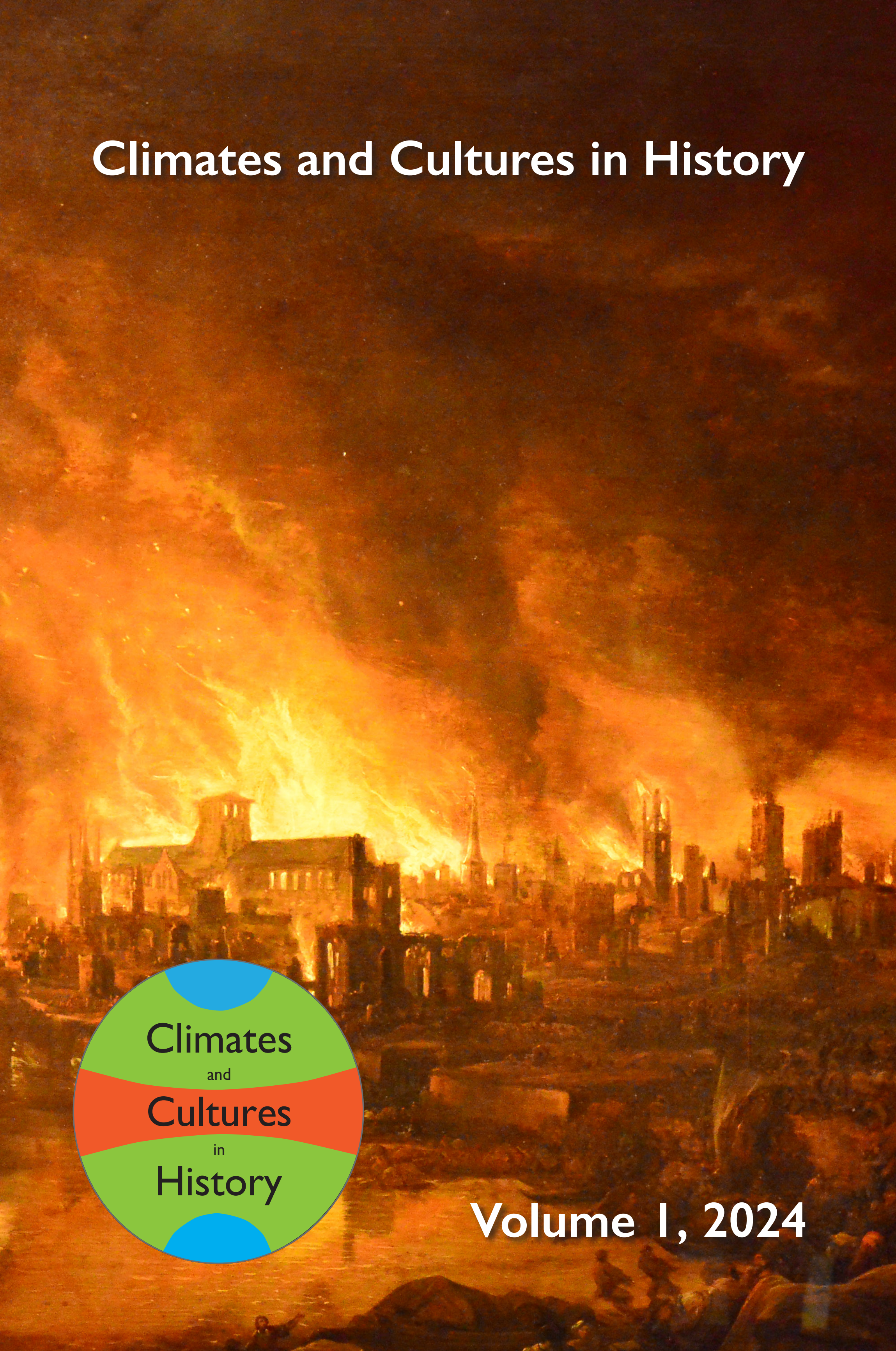
Climates and Cultures in History



Climates and Cultures in History

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Volume 1 (2024)

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Climates and Cultures in History

Climates and Cultures in History addresses the social, cultural, political and economic dimensions of climatic variability in human history around the world.

It publishes articles – original research, reviews, perspectives, and teaching pieces – on all periods of human history. The journal aims to bring into conversation what disciplinary separation has fragmented – the expertise of all the historical sciences: archaeology and ancient, medieval, early-modern and modern history. We hope, by this integrative approach, to create a thesaurus of knowledge about cultural interactions with the climate system, from the paleolithic era to the present. This new Open Access journal seeks to bring broader attention to historical climate research in general and to emphasise its relevance in the ongoing discourse about anthropogenic climate change today. It is a forum for collaboration to flourish between archaeologists; human, historical and physical geographers; historians; and climatologists. In this collaborative spirit, we place particular emphasis on including the perspective of researchers from countries of the Global South, which still tends to be underrepresented in (historical) climate research. The journal's scope is global, which means it welcomes studies on any part of the world, not only at the global scale, but also at regional and local levels.

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EDITORIAL

We are delighted to introduce the inaugural volume of *Climates and Cultures in History* (CCH), a new peer-reviewed open-access journal published by The White Horse Press. The journal emerges from the growing recognition of the need to explore the complex and multifaceted relationships between climate and human societies throughout history. By providing a dedicated forum for this vital field, we aim to advance understanding, foster dialogue and create a space where scholars from diverse disciplines and perspectives can come together.

CCH invites contributions spanning all historical periods and geographies, from the archaeology of ancient civilisations to the modern era's political and cultural responses to climatic change. It seeks to bridge the gaps left by disciplinary silos and to offer new insights into the ways societies have shaped, and been shaped by, their climatic environments. This approach includes not only studies addressing large-scale patterns of climate variability and their social consequences but also localised and cultural perspectives that illuminate the nuanced, lived experiences of climate and its transformations.

The field of historical climate research is characterised by remarkable breadth, drawing on methodologies from archaeology, climatology, historical geography and cultural studies, among others. Yet, despite its interdisciplinary potential, the field often struggles with fragmentation. Key insights from one discipline may not reach others, and regional or thematic studies frequently remain isolated. The absence of a dedicated platform has meant that historical climate research is often subsumed under broader environmental or historical journals, where its contributions risk being overlooked.

This is where CCH intends to make its mark. By offering a specialised platform, we hope to integrate the diverse strands of historical climate research, fostering a sense of shared purpose and mutual enrichment. A journal such as CCH can serve as a hub for a growing community of researchers, allowing for cross-pollination of ideas and providing opportunities for collaboration across disciplinary and geographical boundaries.

The journal also seeks to address historical blind spots. While research on premodern periods has been robust, the nineteenth and twentieth centuries – crucial for understanding the roots of anthropogenic climate change – are often underrepresented. These periods not only mark the acceleration of industrial impacts on the climate but also provide critical lessons on adaptation, resilience and governance. By encouraging contributions on these recent epochs, we hope to enrich contemporary discussions on climate policy and action.

Diversity and inclusivity are at the heart of CCH's mission. We recognise the pressing need to amplify voices from the Global South, where climate

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histories often diverge from the narratives prevalent in Western scholarship. By inviting contributions from underrepresented regions, we aim to broaden the scope of historical climate research and highlight the global nature of climate-society interactions. We are committed to building a community that is as inclusive as it is interdisciplinary, bringing together historians, archaeologists, human and physical geographers, and climatologists from all corners of the world.

Our ambition is also practical: to facilitate engagement with the ongoing challenges of climate change. By studying the historical entanglements of climate and society, CCH aims to provide insights that are relevant for understanding and addressing the crises of our time. This requires not only rigorous historical analysis but also critical engagement with the present, and we encourage submissions that address the intersections of past and present in innovative ways.

We are deeply grateful to our contributors, readers, editorial board and The White Horse Press for their support in launching this endeavour. The challenges of our era demand a profound understanding of the past, and we believe that *Climates and Cultures in History* can play a vital role in advancing this understanding. Through this journal, we invite you to join us in building a collaborative and inclusive community that not only studies the past but also shapes the future.

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LARGE FIRES AND CLIMATIC VARIABILITY IN URBAN EUROPE, 1500–1800

David Garrioch

ABSTRACT: Several hundred large urban fires occurred in Europe during the early modern period, but they did not take place randomly. This article charts their incidence and reveals a peak in the seventeenth century, coinciding with some of the coolest periods of the Little Ice Age. This apparent paradox can best be explained by climatic variability, since overall cooling was accompanied by numerous warm, dry anomalies. While the cause of fires was usually human activity, and small fires happened frequently, this paper shows that many of the largest conflagrations of the early modern period took place in years of such hot and/or dry climatic anomalies, and closer analysis of individual fires confirms that these meteorological conditions facilitated their spread. This strongly suggests that climatic variability associated with the Little Ice Age was a major determinant of the timing of large fires in Europe. Over the same broad period, climatic disasters linked to cooler and damper conditions contributed to social and political instability, and there is evidence that this in turn undermined fire prevention and control and thus further increased the likelihood of small fires becoming large ones.

KEYWORDS: History of fire; Little Ice Age; early modern Europe; urban history; climatic variability

The history of large fires in early modern European towns offers a striking paradox. Charting their incidence across a long period reveals that the greatest number, and many of the most disastrous ones, occurred during the coldest periods of the Little Ice Age. Five of the eight largest fires to strike European towns in peacetime, during the entire early modern period (1500–1800), took place in the thirty years between 1656 and 1686, and the seventeenth century as a whole witnessed a disproportionate number of major conflagrations. These included the Great Fire of London of 1666, the most devastating urban fire in Europe since Ancient times, and the second-largest early modern urban fire, the 1656 conflagration in Aachen that destroyed around 4,600 houses. This article argues that climatic factors provide much of the explanation for this apparent paradox, and that they do so in two ways. Firstly, a great number of large fires, right across the early modern period but particularly in the seventeenth century, coincided with anomalous hot, dry seasons. Secondly, the climatic disasters of the Little Ice Age contributed to political, economic and social instability that undermined the capacity of urban governments and populations to prevent and manage large fires.

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Until recently, neither urban historians nor environmental historians have paid much attention to climatic factors in accounting for disastrous fires.[1] Although large parts of individual European towns and cities burned at intervals, destructive fires have largely been taken as a given, accidents waiting to happen. Since flame was used for many day-to-day purposes, there was an ever-present risk of wildfire in towns built primarily of wood, with narrow streets and densely-packed housing. Only across the nineteenth century did urban fires that burned hundreds or even thousands of houses disappear from Europe, a change generally attributed to the introduction of less flammable building materials and to suburbanisation.[2] Environmental history has not shown great interest in early modern urban fire, despite Stephen Pyne's observation that, as long as towns were predominantly built of materials taken from the lands that surrounded them, primarily wood and thatch, urban fires behaved in the same ways as wildfires elsewhere. He too sees the nineteenth century as the major turning point in urban fire regimes, as industrialisation brought new forms of building and new ways of controlling and using fire (Pyne 2001: 101–18).

Only in the last few years have historians begun to recognise that accidental urban fires did not occur randomly in the preindustrial period. In 2012, the editors of an important collective volume, covering many parts of the world, argued that fire regimes have shifted significantly, particularly since the expansion of global trade in the seventeenth century, which drove the creation of new forms of wealth and social control. They suggested that in cities dominated by imperial and mercantile interests, by autocratic rulers, or by colonial elites, new political regimes combined with local environmental conditions to change the way fires took place and were managed (Bankoff et al. 2012: Introduction; Garrioch 2019a).

The influence of climatic factors, however, has only begun to be explored. The most important work to date is Cornel Zwierlein's monumental study of fires in German-speaking Central European towns during the past millennium (2021). It identifies 1666, unusually warm and dry, as one of the worst peacetime fire years in the continent's history, second only to 1540, which climate historians have shown to be one of the hottest and driest of the last 500 years. Zwierlein also points out that the two decades of the 1650s and 1660s not only witnessed a wave of fires in parts of Europe, but also huge blazes in Edo (Tokyo) and Constantinople (Istanbul). He concludes that anomalies linked

1. Exceptions are Mauelshagen 2010 and Zwierlein 2021: 90–99.
2. The key study is Frost and Jones 1989. There has been debate about the chronology proposed by Frost and Jones, and Shane Ewen has argued that the concept of the 'fire gap' is methodologically flawed. See particularly Pearson 2004: 33–38; Zwierlein 2021: 69; Ewen 2006.

to the long period of cooling were major factors in the conflagrations both of 1540 and 1666 (Zwierlein 2021: 90–99).[3] Drawing on this work, Geoffrey Parker (2013: 62–63) also connects drought with exceptionally large fires in the mid-seventeenth century, pointing to several examples from around the world, and suggests that climate was the ‘true culprit’ in the fires of 1666. The present article builds on these insights, examining the record of large urban fires across most of Europe from 1500 to 1800, and drawing on the work of climate historians to examine the role of meteorological conditions and broader climatic factors in the outbreak and spread of such fires.

The sources for early modern fires are incomplete and often imprecise, and this must particularly be borne in mind in any comparative study. Early chronicles, compiled in religious houses or by local scholars, were often more concerned to demonstrate God’s purpose than to construct an accurate chronology. They frequently tell us only that a large fire took place, rarely give the precise date, and are sometimes vague even about the year. We know, for example, that Venice experienced two bad fires in 1505/6, and that one burned ‘the entire district of Casselaria’, while the second destroyed ‘the whole island of Rialto’ (Gallicciolli 1795: Vol. 2, 237). Many descriptions of fires, even at later dates, were based on hearsay, rather than eyewitness information, and where first-hand accounts exist, they are often impressionistic, referring to a ‘great’, ‘dreadful’ or ‘impetuous’ fire. Many accounts, in pamphlets or local histories, simply assert that half, a third, or even the whole of a town burned. Even where more detail is given, the information needs to be treated with caution, as different sources often offer conflicting accounts. Estimates of the destruction in the French town of Issoudun in 1651, for example, range from 600 to 1200 houses destroyed (Pérémé 1847: 205). Many accounts of damage, as in this example, offer suspiciously rounded figures. Wherever possible, we must compare different sources. Municipal records sometimes mention payments to firefighters and court rulings awarding compensation to victims, or plans drawn up for reconstruction, often indicate that earlier reports of the scale of a fire were greatly exaggerated. Archaeological or architectural records sometimes help to evaluate the accuracy of the original accounts. Where the sources offer different estimates, the minimum estimate of damage has been adopted here.

We rarely possess much information on fire behaviour, unfortunately, since that might also indicate the role of meteorological conditions. Only occasionally, as in the London fire of 1666, did witnesses record spotting, changes of fire direction and sudden increases in intensity, or details such as shifts in wind direction, strength and gusting. This is very useful information. But there was no agreement on terminology, and neither the scientific knowledge nor the

3. For corroborating evidence on the 1666 anomaly, see Mauelshagen 2010: 128.

instruments of the time allowed the collection of information on the intensity of flames, or even accurate observations of wind speed and direction.

The most common statistical indication of fire damage is the number of houses destroyed, which is commonly used by historians of urban fire for comparative purposes. Figures are very frequently provided in diaries, municipal requests for assistance and newspaper reports, and these estimates offer some sense of scale. Admittedly, this method of evaluating the size of a fire has its drawbacks. Public rumour and claims for compensation often inflated the losses. Contemporary accounts do not always distinguish between dwellings, warehouses and other buildings. In some places, local measures were used, as in Scandinavia, where fire damage was often expressed as the number of *gårdar* that burned: literally 'yards', the buildings around a central courtyard. And even where estimates seem fairly accurate, the dimensions of a 'house' varied considerably from one place to another. Small towns typically contained single- or two-storey houses, whereas the larger cities had many multi-storey buildings. The most extreme example is eighteenth-century Edinburgh, which was built on a confined site and where some residential buildings reached ten or even fifteen storeys. In London or Vienna, most of the buildings were no more than four storeys but, as in most European towns of any size, there was a significant difference between the centre and the suburbs. Even within individual neighbourhoods the size of houses might vary greatly, with large houses inhabited by noble families sitting alongside far humbler dwellings. There were also major changes over time. Even the largest sixteenth-century towns had a very low skyline, with few residential buildings more than two storeys tall, but by 1800 they contained many apartment buildings that were not only higher but had a much greater surface area.

Nevertheless, the number of houses destroyed is the best measure we have, and this study uses the threshold of 100 houses, for what I will simply call 'large' fires. This is much higher than the benchmark adopted by Eric Jones and his collaborators, who took the loss of ten houses as the minimum threshold for a 'major' fire, one that Cornel Zwierlein also broadly adopted in his survey of fires in German-speaking Central European towns (Jones et al. 1984; Zwierlein 2021: 74). My reason for using a higher figure is pragmatic. The nature and quality of the sources vary considerably from place to place. The primary ones used by Zwierlein, the extraordinary *Städtebücher*, were originally a product of the Nazi regime's desire to document the history of the German Volk, and do not exist for other parts of Europe (Zwierlein 2021: 65–69). Elsewhere, gathering equivalent data would require visits to the surviving archives in hundreds of towns, and would even then be seriously incomplete. Even the admirable *Gazetteer* compiled by Jones, Porter and Turner, which attempted to cover only England, where newspapers and local histories are abundant, has been shown to have omitted a great many fires (Pearson 2004: 33). Blazes that destroyed over 100 houses, on the other hand, are far more likely to be traceable in the historical record, to be reported in the international press as well as in local sources, and to be recalled in local histories. It is important to note, however, that this threshold is arbitrary and has no absolute value. It serves simply to identify the greatest conflagrations, which exceeded all hope of control with the resources available to early modern urban populations, destroyed significant parts of a city or town, and caused serious social and economic dislocation.

I have followed Jan de Vries's study of *European Urbanization* in excluding the eastern parts of Europe (Russia, the Baltic states, the eastern half of Poland, Hungary, Slovakia, Ukraine and the Balkans), areas which in any case had fewer towns than many other parts of Europe. This enables a comparison with his estimates of population growth during the early modern period (de Vries 1984). I have, however, adopted a minimal definition of 'urban' that includes places with a population of at least 2,000, although in the absence of reliable censuses it is often difficult to be sure. The database also excludes fires that we know were deliberately lit as weapons of war, since their chronology, as Zwierlein has shown, primarily reflects shifts in military strategies. In the seventeenth century, armies routinely burned towns, either as a siege tactic or to punish the inhabitants, but in the eighteenth century this practice was largely abandoned (Zwierlein 2021: 87–88).

Between 1500 and 1800, in the regions covered by this survey, I have used a wide range of primary and secondary sources, including many archival ones, to identify 574 peacetime fires that burned 100 or more houses.[4] They took place in 417 towns in different parts of Europe. Their approximate size is given in Table 1.

The largest, by far, was the Great Fire of London of 1666, which destroyed some 13,200 houses and 87 churches. Next in size was the 1656 Aachen fire, which devastated seven-eighths of the town's buildings: some 4,425 houses and twenty churches (Porter 1998; Kraus 2007: 35, 48). A blaze of 1684 burned over 1,700 houses in Hamburg, then a city of 60,000 people. Stockholm too experienced many large fires, including one that burned around 1,800 buildings, mostly small, single-storey dwellings. A fire of similar size burned nearly a third of Copenhagen in 1728. Devastating fires also completed the almost total destruction of Lisbon, a city of around 180,000 people, in the aftermath of the earthquake of 1755 (Zwierlein 2021: 200; Stockholm City Archives [henceforth SSA], John Swensk Collection, BI–4; Gamrath 1999; Molesky 2012).

4. This includes, for German-speaking Central Europe, considerable relevant material generously provided by Cornel Zwierlein. Comprehensive data on Poland are now available in Karpińsky 2021.

Table 1. Number of fires, 1500–1800, by scale of destruction.

Number of houses destroyed	Number of fires
>1000	12
500–999	24
300–499	82
100–299	456
Total	574

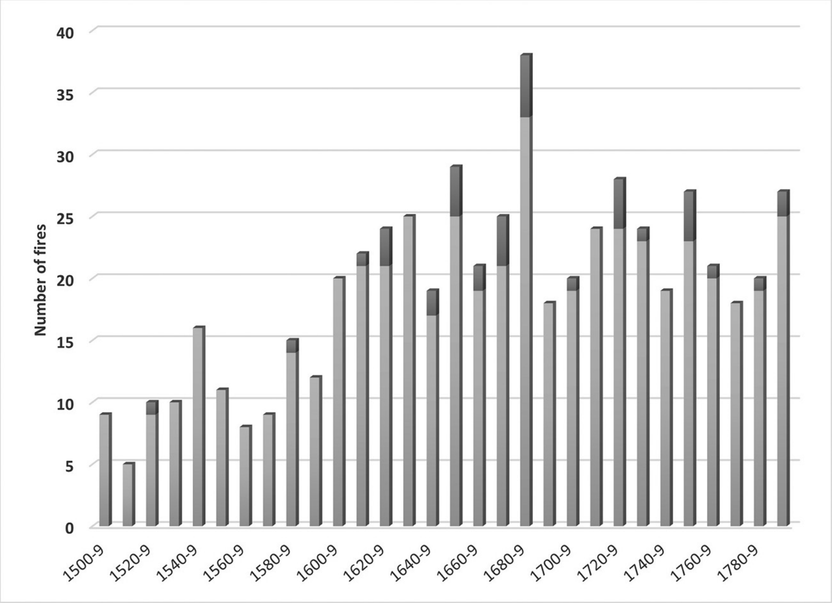

Figure 1. Peacetime fires that burned 100–499 houses (light) and >500 houses (dark), 1500–1800.

The chronology of reported large fires, by decade, is given in Figure 1. Their incidence fluctuated across the sixteenth century, with peaks in the 1540s and the 1580s. The beginning of the seventeenth century then saw a sudden jump in their frequency, rising to peaks in the 1650s and especially the 1680s. Not only were the overall numbers of these fires higher in those years, but there were many more very large conflagrations (over 500 houses burned). After a relative lull in the 1690s, the number of large fires recorded then rose steadily to another peak in the 1720s. For the rest of the eighteenth century, it remained at levels broadly similar to, but often below, those of the 1600s. Very large fires continued to occur, with the 1720s and the 1750s worse than most decades of the preceding century. The nineteenth century is not included in this study, but blazes of the kind discussed here continued to occur until the 1840s, although the general trend was for major fires to be confined to large single buildings and industrial complexes rather than destroying wide residential areas (Ewen 2010). In terms of the simple numbers of dwellings burned, what we might call the early modern era of great urban fires lasted from the early seventeenth century to the early nineteenth.

Yet, within this period, the seventeenth century stands out. In the years 1600–1699 we know of 241 large peacetime fires, compared with 105 for the sixteenth century, an increase of just under 230 per cent. Even allowing for a possible under-recording of large fires in the earlier period, this was a dramatic change. There were also slightly more large fires recorded for the seventeenth century than for the eighteenth, when 228 are identifiable. That was despite the growth in the numbers and size of towns and cities in the 1700s, which meant there were many more buildings that could have burned.

The exceptional character of the 1600s is also apparent if we consider the incidence of very large fires (those that burned >500 houses – see Figure 1). Only two (if we accept a suspiciously rounded figure of 500 houses lost in Łowicz in 1529) occurred between 1500 and 1599, but 21 were recorded between 1600 and 1699. In 1700 to 1799, despite there being more large cities, fourteen such fires took place. As already noted, the second half of the seventeenth century also witnessed the most devastating fires: the Great Fire of London of 1666 and that of Aachen in 1656. Only the 1842 fire in Hamburg, which burned 4,200 houses, came close to these in size.

Within the seventeenth century, the decade of the 1680s was the worst. It was unusual in witnessing one or more large fires recorded every year, and these included some very extensive ones: around 700 houses burned in Turku in 1681, more than 1,000 buildings in the London suburb of Wapping in 1682, over 1,700 houses in Hamburg in 1684, some 1,300 in Stockholm in 1686, and 568 in Mühlhausen in 1689. Further fires in Passau, Dresden, Bergen, Gera, Elberfeld and Sagan destroyed over 300 houses each.

The graphs reveal, therefore, that both the numbers of large fires, and their scale, were greatest during some of the coldest periods of the Little Ice Age, which is generally dated from around 1300 to roughly 1850 (White et al. 2018: 338–44). It was one of the coolest eras of the last two millennia, although the decline in average temperatures was not constant: in Europe, Alpine glaciers advanced rapidly in the fourteenth century, again from the 1580s to around 1660, and in the nineteenth century. The first half of the sixteenth century was mild, but it was followed by markedly colder, wetter conditions that persisted until the early seventeenth century. There was then a brief respite before cooling resumed. The middle decades of the century, from the 1640s to the 1670s, punctuated by some very large volcanic eruptions, brought many exceptionally cold, wet years across much of the northern hemisphere. European winter temperatures were again low during what is termed the late Maunder Minimum (1684–1715), associated with reduced solar activity, and the 1690s were very cold and wet, leading to famines in some parts of Europe. Warmer conditions gradually returned in the first half of the eighteenth century but, after 1740, average winter temperatures were again cooler in much of the continent, other seasons more favourable (Pfister et al. 2018; Parker 2013: 3–8, 15).

This broad pattern is now well known, but finding out what was happening in a particular year, in a specific region, is more difficult. No meteorological measurements were taken before the mid-seventeenth century, and thereafter only in a few places. Even after they began, the instruments used were often not accurate and the recording was not always systematic. Before the eighteenth century, too, the records kept by different observers rarely cover the same periods, making us reliant on often idiosyncratic methods of measurement. Fortunately, many early modern chroniclers and diarists commented on extreme weather events, albeit in very subjective terms, and this has enabled the reconstruction of certain weather and climate patterns. In addition, paleoclimatologists have come up with a wide range of proxy measures, such as tree ring data, the dates of harvests, evidence of advances and retreats of glaciers, river and lake depths and archaeological material.[5] Most attention, understandably, has been devoted to the overall cooling trend and to its consequences for European society, and only recently have droughts begun to attract attention (Garnier 2019; Pribyl 2020; Przybylak et al. 2020; Leijonhufvud and Retsö 2021). Unfortunately, the nature and quality of the sources varies considerably from place to place, and more research has been done in some regions than in others. There was much variation in local conditions across the continent, and these are often very difficult to establish when looking at fires in individual towns. Such gaps make it impossible to establish statistically valid correlations between meteorological conditions and large fires.

It is nevertheless clear that the largest conflagrations occurred overwhelmingly in hot, dry and windy weather, particularly during summer and autumn. The summer of 1666 was unusually warm, and there was no rain in London in the six weeks before the Great Fire began on 2 September (Clark 1891–1900: vol. 2, 82; Evelyn 1955: vol. 3, 451; Macadam 2012: 237; Manley 1974: 393). This 'great Drought', wrote John Strype in 1720, 'had so dryed the Timber, that it was never more apt to take Fire'. He added that 'an Easterly Wind,

5. For a survey of the sources, the methods used to analyse them, and the reconstructions they make possible, see White, Pfister and Mauelshagen 2018: 27–148.

(which is the dryest of all others) had blown for several Days together before; and at that Time very strongly' (Strype 1720: vol. 1, 227). Eyewitness reports tell of the wind carrying embers several hundred metres ahead of the fire front, allowing the flames to jump firebreaks. This may indicate the formation of convection currents, also suggested by the observation of ash falling many kilometres away from the city and the smell of smoke 100 miles distant (Bell 1920: 68, 98–9).

Similar weather conditions prevailed at the time of other great fires. The one in Aachen in May 1656 followed a long period of warm, dry weather and, on the day of the fire, a strong westerly wind blew embers across the town from the suburb where the fire started, producing secondary fires (Kraus 2007: 42-7). The year 1728 also had an unseasonably warm summer, and in October that year some 1,670 houses burned in Copenhagen. Such weather dried out the buildings and sometimes reduced the availability of water with which to fight fires: both in Copenhagen in 1728 and in London in 1666, there were some difficulties getting enough water, especially in the crucial early stages of the fire (Gamrath 1999: 297–98).

The years when the greatest numbers of large fires were recorded were also, in the majority of cases, exceptionally hot and dry. During the three centuries covered by this study, the worst individual years were 1684, 1723 and 1794, each of which saw seven large fires. The summer of 1684 was hot and dry, and there were fires in towns across northern Germany and Estonia, including one in Hamburg that burned 1,714 houses (Zwierlein 2021: 200; Glaser 2001: 168). In 1723, the spring was unusually warm across much of Europe, and in May, a big fire on the south shore of Stockholm burned some 400 houses. Driven by strong winds, it even leapt the harbour, a distance of nearly a kilometre (Pfister et al. 2018: 280. SSA, John Swensk Collection, BI–4). In June, one of the largest urban fires in France during the early modern period took place in Châteaudun on a hot and dry Sunday, burning around 1,000 houses. It too was hastened by strong and changeable winds, and only stopped when it reached the barrier of the town walls (Robreau 2009: vol. 2, 180). In 1794, the spring was unusually warm and the summer was hot. Four of the five fires whose dates are known took place in those months (Pfister et al. 2018: 281; Glaser 2001: 176).

Table 2. worst years for large fires recorded 1500–1800, and known weather conditions in the areas affected.

Year	No. fires	Season where known (no. of fires)	Conditions
1540	6	Summer (5)	'Megadrought', very hot in most of Europe all year
1590	5	Spring (1), summer (2)	Drought year
1616	6	Summer (1), autumn (1)	Very hot summer across Europe
1624	6	Autumn/winter (2)	Unexceptional in most regions
1628	5	Spring (1)	Cold and wet in regions where fires occurred
1634	5	Autumn (1)	Drought in some regions
1652	5	Spring (1), summer (2), autumn (1)	Very hot summer, drought across Europe
1664	5	Spring (2), summer (1)	Unexceptional year
1682	5	Summer (1), autumn (1)	Unexceptional year
1684	7	Summer (4)	Hot, dry summer
1686	5	Spring (2), summer (1), autumn (1)	Very dry spring/summer in much of Central Europe
1719	6	Spring (1), summer (4), autumn (1)	Warm summer, extreme drought and heat in France
1723	7	Late winter (1), spring (4), summer (1)	Unusually warm, dry spring. Strong winds
1725	5	Spring (3), summer (1)	Mostly wet year
1731	6	Spring (1), summer (4)	Dry in some regions affected
1794	7	Winter (1), spring (1), summer (3)	Warm spring, very hot dry summer
1795	5	Late spring (2), summer (3)	Unexceptional year

As Table 2 shows, there were a further five years when six large fires occurred: 1540, 1616, 1624, 1719 and 1731. While we do not know the precise dates of all of these blazes, in four of the five years there appears to be a clear link to climatic conditions: only in 1624 is there no evidence of particularly hot or dry conditions. The summer of 1540, the hottest and driest of the entire early modern period, has already been mentioned. That of 1616 was very hot, and two of the fires were very significant: 440 houses burned in Oschatz in July, 375 in Paderborn in September.[6] 1719 had one of the few warm summers in the entire eighteenth century, and in France and central Germany was a year of extreme drought and heat, 1.8 to 2ºC higher than the average for 1900–1960 (see Figure 2a) (Garnier 2019: 58–59; Pfister et al. 2018: 280–81). In August,

6. Gai, Mahytka and Otte 2019: 213; F.L. Siegel, 'Historische und statistische Notizen über die Wichtigsten der abgebrannten Gebäuden ... und einer Schilderung des grossen Brandes derselben im Jahr 1616': http://www.oschatz-damals.de/siegel_07.html (accessed 27 Jan. 2023).

some 365 houses were destroyed in the north-eastern French town of Sainte Menehould, where the fire jumped wide streets, as well as the river that ran through the town. The dry conditions extended to Switzerland and to the western parts of Germany, where 400 houses burned in Frankfurt-am-Main in June, and there was insufficient water to fight the flames. The same year, two large fires took place in Stockholm, in July and September, burning some 200 and 300 houses respectively (Grasset 1988; Pfister 1988: 129; Herden 2005: 69; SSA, John Swensk Collection, BI–4; Forsbom 1950: 9). In 1731, once again, the summer and autumn were unusually dry and quite warm, both in England and in the Paris region. Early in June, a big fire in Blandford, in the west of England, burned 337 houses, and a day later one in Tiverton, not far away, destroyed 298. Both fires were driven by strong winds.[7]

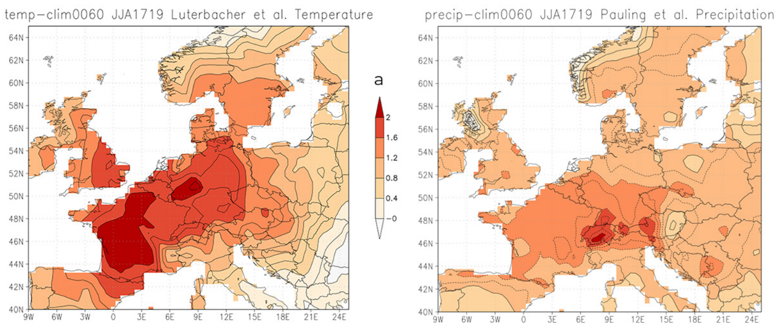

Figure 2. the summer of 1719 (JJA), compared to the average over the reference period of 1900–1960. Map 2a shows the anomalies of mean temperature in ºC. Map 2b shows the anomalies of precipitation, in millimetres. Sources: created using the KNMI Climate Explorer (https://climexp.knmi.nl), historical reconstructions. Temperature data from Luterbacher et al. 2004 and Xoplaki et al. 2005; precipitation data from Pauling et al. 2006.

Some of the years when there were five large fires were also unusually warm and/or dry. In 1590, large fires occurred in Wolverhampton and in Poznan, as severe drought affected England and Western Poland (Brázdil et al. 2016: 108; Pribyl 2020: 1031; Przybylak et al. 2020: 648) Most of Europe again had an exceptionally hot, dry summer in 1652, which in Sweden was called ‘the Great Drought Year’. It saw five large fires that we know of, including some exceptional ones: 500 houses burned in Glasgow in July, at least 600 in two separate fires in Stockholm in March and September, and 433 in the German town of

7. Snell 1892: 72; https://www.dorsetlife.co.uk/2009/03/when-blandford-burnt/ (accessed 5 Aug. 2023); Garnier 2019: 59.

Luckau (Pribyl 2020: 1034; Pfister 1988: 140; Rácz 2013: 131; Leijonhufvud and Retsö 2021: 2018; SSA, John Swensk Collection, BI–4; Cleland 1820: 4).

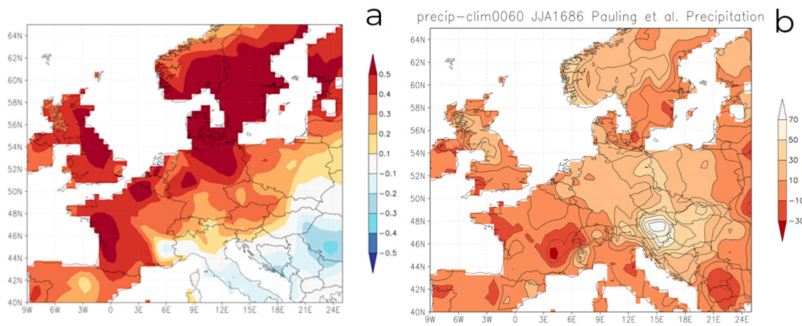

Figure 3. The summer of 1686 (JJA), compared to the average over the reference period 1900–1960. Map 3a shows the anomalies of mean temperature in ºC. Map 3b shows the anomalies of precipitation, in millimetres. In greyscale image, the darker the colour, the higher the temperature. Sources: as for Figure 2.

The spring of 1686 was the driest in 500 years and, in late March, a large fire destroyed 358 houses in the substantial German town of Gera. The summer was also hot and dry across much of Europe (see Figure 3). In June, a huge blaze burned 1,300 houses in Stockholm while, in September, another large fire took place in Bergen, in Norway, reportedly burning 231 blocks (Pauling et al. 2006: 393. Glaser 2001: 169; Hahn 1855: vol. 1, 659; SSA, John Swensk Collection, BI–3; Nielsen 1877: 372). 1634 was also very dry in England, Finland, and some of the Czech lands, although it is not singled out in climate histories of the German-speaking areas where large fires took place (Pribyl 2020: 1031; Garnier 2019: 51; Vesajoki and Tornberg 1994: 52; Brázdil et al. 2016: 108).

Although climate data are missing for some years and for some regions, therefore, it is clear that a great many large fires, including a majority of the most disastrous ones, occurred in hot and dry seasons that conspicuously departed from the general climatic trend. Climate historians have established that the Little Ice Age, like the Anthropocene, was characterised by considerable seasonal variability and by extreme weather events. While most years were cool and damp, by comparison with earlier periods and with the later nineteenth and twentieth centuries, some winters were very cold and a few summers exceptionally hot. The summer of 1540 rivalled the heat wave of 2003 in Europe, and at intervals across the early modern era there were periods of drought that sometimes lasted for several years (Pfister 2018; Garnier 2019; Pribyl 2020). Studies of the late Maunder Minimum and of the eighteenth and nineteenth centuries suggest that these anomalous seasons were related to atmospheric circulation in the Atlantic, which determined wind direction over much of Europe, and influenced both temperature and precipitation. These anomalies also appear to be linked to abnormal wind strength, as well as direction, which are both crucial factors in the incidence of large fires (Frich and Frydendahl 1994; Mellado-Cano et al. 2018; Mellado-Cano et al. 2020; Pfister 1994: 311). They continued into the eighteenth century but became less frequent after about 1750, although with variations across the continent (Pfister et al. 2018: 273–83; Frenzel, Pfister and Gläser (eds) 1994). It seems clear that they played a significant role in the incidence of large urban fires.

Yet we must also note the exceptions to this general pattern. There were a few unusually warm and dry summers, such as that of 1747, when very few large fires seem to have occurred (Pfister et al. 2018: 280. Le Roy Ladurie 2004–06: vol. 2, p. 24). Nor were heat and drought a necessary precondition for large fires. In 1628, for example, five such conflagrations took place in different Central European towns, making it one of the dozen worst years between 1500 and 1800. Yet across most of that region the year was cold and wet (Pfister et al. 2018: 280). In 1651, too, Issoudun lost over 600 houses to fire, but conditions do not seem to have been either hot or dry. Similarly, a huge fire in the London docks – admittedly driven by a very strong wind – destroyed over a thousand buildings in 1682, even though the year was very wet (Pérémé 1847: 205; Blackstone 1957: 56). A great many towns, constructed of wood and subject to the same weather conditions, never experienced a large fire, even at times when others in the same region burned. But of course we do not expect all forests to burn simultaneously, even when the fire risk is high. Hot, dry weather and high winds greatly increased the likelihood that a small fire would spread and become unstoppable, but did not make huge conflagrations inevitable. In any case, aside from lightning strikes, meteorological conditions were not in themselves a cause of urban fires, which were overwhelmingly produced by human activity. It is worth asking, therefore, in what circumstances climatic variability was important in the incidence of large urban fires.

One obvious factor was the nature of the buildings in any given location, since they provided the primary fuel for urban wildfires. In Mediterranean Western Europe, where early deforestation made timber scarce and expensive and where stone was often plentiful and suitable for construction, there were very few large fires. By the sixteenth century, most Italian, Spanish and southern French towns were built of stone and had tiled roofs. In the Low Countries, too, brick became the usual building material quite early and, there too, few large fires occurred. Elsewhere in Europe, the replacement of wood and straw with brick, stone, tiles or slates was often required by building regulations, but these were very unevenly observed. The construction of firewalls, in stone or brick, was obligatory in some places, and appears to have been effective, particularly where they projected above the roofline. In Paris and some other places, the widespread use of plaster – an effective fire retardant – was an important factor in preventing small fires from spreading (Keene 1999: 196–98; Garrioch 2019b). Historians have documented a trend towards the use of less flammable materials, especially in the eighteenth century (Frost and Jones 1989; Borsay 1989: 18).

Many historians have suggested that rapid population increases – at least as a proxy for urban growth – were a major factor in the occurrence of major fires. However, the data do not bear this out. Across the areas included in this study, Jan de Vries has estimated that the number of town dwellers grew by roughly 51 per cent between 1500 and 1599, by just over 24 per cent from 1600 to 1699, and by a little more than 44 per cent from 1700 to 1799. It was to accelerate dramatically after 1800. Yet, as we have seen (Figure 1), the number of large fires actually fell in the second half of the sixteenth century, rose strongly during the seventeenth-century period of slower urban growth, then levelled off in the eighteenth century, even though the urban population was then increasing more rapidly. Overall, the statistical correlation between population increase and the number of large fires was relatively low.[8]

In individual places, too, population growth did not necessarily accompany frequent large fires. Paris grew far more rapidly than most European cities between 1600 and 1700, but experienced only one fire that burned around 100 houses. Amsterdam also grew very fast in the first half of that century but appears to have had no fires of this size. By contrast, some of the most disastrous early modern fires took place in towns that had very low, even negative, rates of growth. Aachen, where the second-largest European fire of the period occurred in 1656, had a lower population in 1650 than in 1500. In Rennes, the population had stagnated for thirty years before the fire of 1720. Eighteenth-century Stockholm, whose economy and population grew slowly, if at all, nevertheless continued to experience large fires, notably in 1719, 1723 and 1759.[9]

This does not mean that population growth was irrelevant. It resulted in high demand for housing, which in turn encouraged poor-quality timber construction, if there were no well-enforced building regulations. That was certainly true for early modern London, especially in the port districts that housed a large labouring population, and probably contributed to the gravity

8. de Vries 1984: 50. Linear regression analysis, using de Vries's figures, indicates only a moderate association ($R^2 = 0.64$). I am grateful to Kathleen Neal for this calculation.
9. de Vries 1984: 272; Aubert 2010: 96; Ericson 2001: 100. Zwierlein 2021 (102) makes similar points for Hamburg.

of the numerous large fires in those areas (Power 1972). The same was almost certainly true in seventeenth-century Stockholm, where very large fires in 1625, 1640, 1652 and 1686 all coincided with a rapid increase in population and the extension of suburbs that contained mainly timber buildings, sometimes with thatched roofs (Ericson 2001: 98–100). Population pressure could also deplete groundwater supplies, making the task of firefighters even harder. There is evidence that the London water table fell in the early modern period, due to overuse (van Lieshout 2016: 790).

It is often forgotten, however, that buildings were not the only source of fuel for urban fires. London is, again, a conspicuous example. The frequency of very large fires there resulted partly from its functions as a port and a manufacturing centre. The Great Fire of 1666, according to witness reports, only became disastrous after it reached old wooden warehouses along the river, because they contained 'the most combustible matter of Tarr, Pitch, Hemp, Rosen, and Flax which was all layd up thereabouts so that in six houres it became a huge stream of fire at least a mile long and could not possibly be approach'd or quencht' (Nicolson and Hutton (eds) 1992: 276). The 1682 Wapping fire engulfed not only houses but also many warehouses and shipyards along the river, which contained similarly flammable substances (*Sad and Lamentable News from Wapping*). Between 1666 and 1800, of sixteen fires in London that burned more than 100 houses, all but three took place in port areas. This reflects the wider growth of world trade, and particularly that of the Atlantic. Hamburg had a similar port economy and experienced a very large fire in 1684. There too, many smaller but still dangerous fires destroyed factories and warehouses containing sugar, rum, and other flammable products linked to European and Atlantic trade (Garrioch 2016; Zwierlein 2021: 99–108). Yet, once again, preventative measures helped determine whether the presence of such potential fuels contributed to large fires. From the late seventeenth century, the authorities in Paris and Vienna regulated dangerous industries reasonably effectively, removing them from densely-packed residential areas to the urban outskirts (Le Roux 2011: 46–68; Weigl 2001–2006: vol. 2, 157). Wide avenues were created in many cities, especially in the late seventeenth and eighteenth centuries. Even when the motive was to demonstrate the power of the ruler or to improve traffic flow, the open spaces prevented fires from spreading.

Once a fire did break out, the efficacy of firefighting was crucial in determining whether it was extinguished or developed into a large conflagration. Controlling a dangerous fire depended particularly on early detection and rapid action. In many places, the introduction of night watch services, or of fire-spotters installed on church towers, enabled fires to be caught before they spread. Such arrangements assisted Vienna to avoid large fires after a terrible conflagration in 1627 (Pils 1999: 183). They were not failsafe, though, since similar measures did not prevent huge fires in Stockholm, for example – although it is possible that without them there might have been even more blazes.

Most accidental fires were put out quickly, even though very few towns engaged paid firefighters before 1800. The inhabitants were well aware of the danger, and some groups – notably building workers and sometimes other occupational categories – developed a lot of expertise in fighting fires. The tools were quite simple: buckets, fire-axes, hooks, ladders and, by the late seventeenth century, hand-operated fire pumps. Thus equipped, people doused the flames and dampened nearby sources of fuel. They watched for flying embers and quickly extinguished them. Knowing that fires usually spread from roof to roof, they removed or dampened wooden slats and shingles. If a fire continued to grow, they demolished buildings to create firebreaks. Such measures often enabled even multi-house blazes to be controlled and put out. One in the French town of Rennes in 1661, for example, destroyed around fifteen houses in a densely built block, but was prevented from spreading further. Another in Paris, in 1718, destroyed about twenty houses before being brought under control (Fillaut 1999: 32; Bibliothèque nationale, Paris, France. Collection Joly de Fleury, MS 1324, fol. 127).

Many disastrous fires, by contrast, began late at night, when there were few people in the streets. This happened in Aachen in 1656, in London in 1666, in the London borough of Southwark in 1676, in Rennes in 1720, and in Copenhagen in 1728. Fires that broke out on holidays, when many volunteer firefighters were absent, were also more likely to spread. The great fire in Rennes in 1720 started on a Sunday night just before Christmas and, when the alarm was given, few people arrived to fight the flames before they took hold (Aubert and Provost (eds) 2020: 28–29).

Even so, such accidents were less likely where preventative measures were enforced, and where firefighting services were well organised and funded. In Amsterdam, the fire service seems to have been particularly effective. Many potentially serious fires broke out there, and a few consumed multiple buildings, but well-trained firefighters generally arrived promptly, armed with the best equipment available, before the flames could spread further. This was also true of Venice, where squads from the city Arsenal were employed as firefighters, becoming experienced in reaching fires and extinguishing them quickly (van der Heyden 1996; Svalduz 2006: 62). In these two cities, of course, the widespread use of brick for building made their task easier, and canals provided ready access to abundant water. Elsewhere, firefighters depended on public fountains and conduits, which were reliable only if the city government built and maintained them. That was done in Vienna and Paris, but in London firefighters sometimes had difficulty obtaining water (Pearson 2004: 83–84). Effective prevention and firefighting required considerable foresight on the part of town authorities, both in providing equipment and training and in ensuring adequate supplies of water. In most towns, where there were no permanent firefighters, the experience and capacity of local officials was also crucial. Amid the confusion and smoke of large fires, they directed operations and decided when and where to create firebreaks.

Drought, heat and unfavourable meteorological conditions were therefore far from being the only factors that helped determine when and where small fires grew into large ones. Yet some of these other variables, notably the preparedness of city governments in the face of the fire risk, were indirectly influenced by the unfavourable climatic conditions of the Little Ice Age. These had a hugely disruptive impact on European society. Harvest failures produced by untimely cold, excessive rain, or even drought, led to population decline and economic crisis. High prices for basic necessities were disastrous at a time when much of the European population lived permanently on the edge of poverty. One result was very high mortality: it has been estimated that between 1691 and 1701 a million people died in France of climate-related famine and disease, in an overall population of around 20 million. Some 600,000 more were to die because of the harsh winter of 1709 (Parker 2013: 589). Undernourishment made them more vulnerable to diseases that flourished in very cold and wet conditions. But drought was also a killer. In early modern Britain, many very dry years were accompanied by outbreaks of plague, fevers and smallpox, and the great drought of 1719 in France saw high mortality from dysentery, spread by polluted water (Pribyl 2020:1035; Garnier 2019: 59).

Food shortages, death and disease in turn produced serious social disruption and political instability. The seventeenth century was marked by huge numbers of local revolts. These have been closely studied in France, where the very harsh winter of 1662 was followed by near famine in many towns, producing a record number of riots. This pattern recurred at the end of the century, from 1692 to 1710, when harvests failed repeatedly. The same years witnessed a huge spike in revolts against tax collectors (Nicolas 2008: 87, 346–67). It is arguable, too, that the number and extreme brutality of the civil conflicts and wars of the seventeenth century were also in part a product of harsh economic conditions linked to climatic variability.

Certainly, the economic consequences of these crises made it more difficult for urban authorities to invest in fire prevention and control. Even though firefighting was mostly done by volunteers, they required buckets, fire pumps and other tools. These were expensive, but tax revenues fell as populations and production declined, and municipalities had difficulty finding funds. In Rennes, when the great fire of 1720 began, there were no buckets or other firefighting equipment in the municipal store (Aubert and Provost (eds) 2020: 82). This was not a direct result of climatic factors, but these contributed to the pressures on local government. In many other towns, parishes and trade guilds were responsible for providing firefighting equipment, and these same institutions were generally the primary providers of poor relief. Demands on their resources grew at precisely the moment when they had less to spare.

Social and political crises may also have undermined the local leadership and social cohesion that were crucial in the event of a large fire. In London in 1666, the failure of the mayor to take decisive action has often been identified as a major factor in preventing the fire from being controlled in its early stages, and some of the local aldermen also appear to have opposed the destruction of houses to create firebreaks (Bell 1920: 29–30, 346). This might have been partly a product of inexperience. The political disruption of the years before the Great Fire – Civil War, followed by republican government until 1660, then the return of the monarchy – had left the city in the hands of less experienced administrators. The situation was exacerbated by a major plague epidemic, in 1665, that killed many people and drove others from the city. The mayor himself was relatively young, had come into office largely thanks to royal patronage, and had far less experience than most previous occupants of the position (Harding 2019; Porter 1998: 58). The case of London was exceptional, but economic and social dislocation and political instability were particularly widespread in the second half of the seventeenth century. This did not automatically lead to poor fire preparedness or management, but the failure of local officials to provide equipment, and to act effectively when fire disasters took place, is well documented.

This article has offered evidence of a causal link between large peacetime fires in early modern European towns and climatic variability linked to the Little Ice Age. The seventeenth century emerges as the worst period for such fires, both in the number that occurred and in their extent. It includes many of the most devastating ones, notably those of 1656 in Aachen and 1666 in London. This is at first surprising, given that climatic conditions were in general colder and wetter than in the Middle Ages or in the nineteenth and twentieth centuries. Yet the individual years and seasons when large fires were most numerous were, with a few exceptions, hot and dry, and analysis of individual large and very large fires reveals that drought, heat, and high winds contributed directly to their gravity. These weather conditions were anomalies, which appear to be a feature of periods of climatic variability. While not directly causing the fires, such anomalies greatly contributed to their spread and intensity.

They were not the only relevant variable. The impact of climatic conditions on wildfire, as we know from recent experience, is not independent of human activity. Just as increased housing on the fringes of cities has contributed to losses in recent years, so in early modern times the forms of building, zoning, and other preventative measures – or their absence – significantly influenced the scale of urban fires. Towns where extensive use was made of non-flammable building materials, and where dangerous activities were removed from residential areas, were far less affected by large fires. Those where firefighting was well funded and well organised were also often able to avoid large fires, even when meteorological conditions were unfavourable. These were crucial factors in reducing the overall number of large fires during the eighteenth century, despite quite rapid urban growth.

For precisely this reason, the social and economic disruptions brought by climatic conditions during the Little Ice Age, and the political dislocation that accompanied them, had an impact on the ability of some urban communities to deal with wildfire. Even towns where, in normal times, fires were usually controlled quickly now had fewer resources available to invest in less flammable building materials, in prevention, and in training and equipping firefighters. There is circumstantial evidence that in some places these disruptions to local government contributed to reduced enforcement of preventive measures and to poor handling of dangerous fires.

The early modern European experience offers a sobering warning of the potential impact of climatic variability on urban wildfire. Today's global warming is producing forest fires of unprecedented intensity, which in Australia, the United States and parts of southern Europe have converged on urban peripheries. But the risk is greater in areas of overcrowded housing where building materials are more vulnerable to fire. For example, the *favelas* around São Paolo, in Brazil, experienced massive fires in 2009, 2012, 2014 and 2016. Similarly huge blazes destroyed slums and shantytowns in New Delhi and in Freetown, Sierra Leone, in 2018 and, in 2021, a similar one hit Dhaka, in Bangladesh. Equally vulnerable urban zones exist in many large cities, notably in tropical and subtropical areas. The reporting of these blazes has focused on the ramshackle nature of the buildings, the absence of fire safety measures, and often on the likelihood that arson was involved, but climatic factors have received less attention. In addition to the direct effects of heat and drought, the early modern example of social and political disruption that was directly or indirectly produced by climatic factors is worth considering in the twenty-first century context. Urban planning, building regulation, fire prevention and firefighting are, in most parts of the world, publicly funded and run, and risk dislocation if budgets are cut and enforcement disregarded. Some of this was already clear in the Grenfell Tower fire of 2017 in London. It seems, alas, that the age of great urban fires is far from over.

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THE SOCIOPOLITICAL IMPACT OF A NATURAL DISASTER: THE SNOW DISASTER OF THE EARTH-RAT YEAR (1828) IN NORTHWESTERN TIBET

Palden Gyal

ABSTRACT: Drawing on primary historical sources and secondary paleoclimatic data, this paper examines the significant 'snow disaster' (*gangs skyon*) that occurred in the Nagchu region of Northwestern Tibet in 1828. It places this event within the context of the 'Little Ice Age', a globally cold period. By analysing reports of natural disasters exchanged between the Ganden Podrang Government and local administrators, the paper argues that the snow disaster led to an 'unprecedented' ecological and economic crisis. This crisis resulted in the deaths of tens of thousands of livestock and triggered various social and economic catastrophes. It also highlights that the Tibetan government responded by providing relief measures, including the suspension of yearly taxes. Notably, the Qing court extended substantial aid, facilitating the acquisition and replacement of livestock. This study underscores how a single climatic event can contribute to triggering various socio-political challenges in societies that are more exposed to vulnerabilities.

KEYWORDS: Tibetan plateau, heavy snowfall; banditry, migration

Introduction

This paper endeavours to contextualise the significant 'snow disaster' (*gangs skyon*) that occurred in the greater Nagchu region of Tibet in 1828 within the framework of the 'Little Ice Age' global climatic conditions of the early modern period. In doing so, leveraging palaeoclimatological research, this paper delves into the climate regimes and weather patterns shaping the Tibetan Plateau's (TP) climate, particularly focusing on central and western regions, aiming to construct a broader understanding of climatic conditions on the plateau during the early nineteenth century. Subsequently, it scrutinises natural disaster reports and correspondence detailing the 1828 event exchanged between the Ganden Podrang Government in Lhasa and regional leaders of Nagchu. It posits that this snow disaster, characterised by heavy snowfall, precipitated an 'unprecedented' crisis resulting in the deaths of tens of thousands of livestock and hundreds of people. Through analysis of these reports, the paper illustrates how a singular climatic event had far-reaching socio-political ramifications, including increased banditry, famine and mass migration. Notably, immediate relief aid was dispatched by the Tibetan government in Lhasa, coupled with the

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suspension of annual taxes for affected communities. Additionally, the Qing court, operating via the Amban office in Lhasa, provided substantial relief aid aimed at purchasing and replacing livestock. The paper contends that the disaster relief programmes not only highlight the Tibetan State's effective response capabilities but also that of the Qing court, thereby revealing the intricate political geography of the region. It notes that Qing imperial intervention during this state of emergency brings to the fore a unique legacy of Qing imperial expansion and frontier strategy under the Yongzheng Emperor (1678–1735), shedding light on the complex political landscape it engendered in the greater Nagchu region.

Several climate and environmental historians and scholars have explored the societal impacts of the Little Ice Age (LIA) and how different societies responded to its global cooling, examining imperial regimes like the Ottoman or Ming (Brook 2013; White 2011; Parker 2013; Di Cosmo 2014; Degroot 2018), while others have focused on specific climatic events such as the coldest years following large tropical eruptions like the Tambora eruption of 1815 (Brönnimann et al. 2019; Oppenheimer 2003). This article employs an interdisciplinary approach, bridging research findings from both natural and human archives to examine a particular climatic event on the Tibetan Plateau. Beginning with a discussion of general climatic conditions on the plateau, with a focus on the western and central regions, it contextualises the 'Earth-Rat-Year Snow Disaster' of 1828 that occurred in the greater Nagchu region of northern central Tibet. Positioning this event within the broader context of the Little Ice Age (early fourteenth to mid-nineteenth century), it draws upon secondary palaeoclimatological studies of temperature and precipitation reconstructions, primarily from sites such as Namtso lake and the Nyenchen Tanglha mountains. The article then provides a brief historical background of greater Nagchu and its relationship with the Tibetan government and the Qing court, aiding in understanding the socio-political conflicts and chaos that followed the disaster. Finally, drawing upon unexplored archival materials pertaining to natural disaster reports, the paper examines and discusses the ecological and socioeconomic repercussions of the snow disaster in detail. It sheds light on its significant contribution to famine, migration, and the surge in banditry in Nagchu and the surrounding regions, offering insight into the profound and multifaceted impacts of such calamities on vulnerable and largely pastoralist communities.

The Little Ice Age on the Tibetan Plateau

Utilising climatic reconstructions derived from pollen records across diverse locations has emerged as a crucial approach for comprehending paleoclimatic conditions on the Tibetan Plateau. These reconstructions have illuminated the previously unexplored realm of regional variability across the plateau. While most of these studies have focused on the margins of the Tibetan Plateau, there are a few studies of fossil pollen from Namtso (Ch. *na mu cuo*), Serling Tso (Ch. *se lin cuo*) and Tsige Dartso (Ch. *zi ge tang cuo*) in Central TP (Li et al. 2011; Sun et al., 1993; Herzschuh et al. 2006). The analyses of vegetation history based on the pollen records indicate a gradual reduction in typical steppe vegetation dominated by *Artemisia* and an increase in *Cyperaceae* and *Saussurea*-type vegetation in the late Holocene. Climatologists infer this transition from a temperate steppe to an alpine steppe to have been caused by a gradual shift from a warm and wet climate during the early and mid-Holocene to a cold and dry climate in the late Holocene. It illustrates the hypothesis of the Southwest Monsoon's southeastward retreat (in line with modern precipitation gradient) during the late Holocene. This transition in monsoon precipitation and moisture condition occurred at around 6.5–6.2 kyr BP in western TP, 6–4.4 kyr BP in the central and southern plateau (Li et al. 2011). Studies of pollen records from the lake Tsige Dartso in Nagchu also bear witness to this transition from a temperate steppe to an alpine steppe during the second half of the Holocene (Herzschuh et al. 2006). This agrees with other paleoclimatic data from the TP, and with the vegetation history of the central TP based on pollen records from Serling Lake. The hypothesis of the retreat of the Southwest Monsoon from western and central TP is also supported by the correlation of late-Holocene climate between the central and western TP and the North Atlantic, which implies that influences from climatic events in high northern latitudes also reached the Tibetan Plateau via the westerlies after the weakening of Southwest Monsoon (Li et al. 2011: 948). As a recent study of the lacustrine core sediments from Namtso suggests, the climate of central TP was influenced not just by the south Asian monsoon but also by the westerlies, while southern Tibet was solely controlled by the southwest monsoon (Zhu et al. 2008).

Most importantly, although it was not a universally cold event all over the northern hemisphere, as indicated by the growth reduction and changes in the isotopic composition of juniper trees, the period from 1430 until the late nineteenth century saw a series of cold intervals in Tibet (Bao et al. 2003). According to a multi-proxy reconstruction of LIA fluctuations on the Tibetan Plateau, the period between AD 1400 and 1850 reflects the 'Little Ice Age' while the period between AD 800 and 1100 indicates a relatively warm period

(Bao et al. 2003). Three cold episodes during the Little Ice Age, lasting about fifty years each, occurred in AD 1500, 1700, and 1800. The balance between several circulation patterns or weather systems like the westerlies and southwest and southeast summer monsoon might have been responsible for regional temperature differences. For instance, we can see regional variability within the Tibetan Plateau when different regions are compared with one another. We can infer from this study that western and northeastern TP experienced a period of low temperature in the early nineteenth century which did not occur in southern TP (Bao et al. 2003: 2339, Fig. 5). As we shall see below, this period of low temperature in the early nineteenth century coincides with the climactic event with which this article is concerned.

A high-resolution study of Himalayan ice cores from Dasuopo (Nyalam county, Shigatse) reveals that low precipitation due to monsoon failures brought devastating droughts in India and the central Himalayas, especially in the late eighteenth century. It also suggests an intensification of summer monsoon throughout the nineteenth century. This change in precipitation is illustrated in a decadal average snow accumulation variation since the mid-fifteenth century. It shows that the early nineteenth century saw a huge increase in snowfall in the central Himalayas which also contributed to glacier expansion (Thompson et al. 2000: 1919, Figure 5). The correlation of glacier fluctuations with proxy climate records suggests that not only temperature but also South Asian Summer Monsoon (SASM) is a controlling factor in glacier fluctuations in the Himalayas. For instance, the nineteenth century witnessed significant glacier expansion, aligning with an intensified phase of the summer monsoon (Bao et al. 2008). This period coincided with the third fifty-year cold episode of the LIA in the first half of the century. Additionally, ice core records from Dasuopo cap (28°N, 85°E) also showed that the nineteenth century was a period of maximum snow accumulation of the last 600 years in the Himalayas (Thompson et al. 2000, Duan et al. 2004). Interestingly, as discussed below, we could also infer from historical records and archival materials that the nineteenth century was a century of numerous snow-related natural disasters. Although the snow disaster of 1828 was the most prominent and presumably the most disastrous one as demonstrated by the fourteen reports concerning the single event, there were snow disasters of varying magnitudes in western and central Tibet in the years 1824, 1827, 1830, 1848, and a few undated reports of similar cases in the second half of the nineteenth century. These events of extreme climate variability are connected to a combination of heavy snowfall and low temperature.

Thus, the Tibetan Plateau experienced a phase of frigid climatic conditions during the early nineteenth century, a conclusion substantiated by a range of paleoclimatic reconstructions rooted in analyses of tree rings, pollen records, and glacial histories. More specifically, the last cold episode of the Little Ice Age on the Tibetan Plateau in the early nineteenth century coincided with a period of extensive snow accumulation in the central Himalayas. Each of these reconstructions provides us with the climatic backdrop and weather conditions during which the 1828 snow disaster of Nagchu took place. The archival materials pertaining to this event offer a rich historical case study, enabling an in-depth examination of the social and economic ramifications of climate variability.

A Brief Historical Background

Nagchu (*nag chu*; Ch. *naqu*) is in what is called the Central Tibetan Plateau alpine steppe. It lies between the Dangla Mountains in the north and the Nyenchen Tanglha Mountains in the south. Much of Nagchu is over 5,000 metres in altitude and therefore the region is cold and dry with only twenty per cent steppe and meadow vegetation. It has relatively warm, humid summers and long, dry and cold winters. Nagchu has been a predominantly pastoralist region for many centuries. Tibetan historical literature refers to the people of Nagchu as 'the northerners' (*byang rigs*) or 'northern nomads' (*byang gi 'brog pa*). Qing official documents from the eighteenth century typically retain either the transliteration or the translation of the Mongolian name for the region 'Hala Wusu' or 'Heihe', both of which mean 'Black River' in Mongolian and Chinese.

The region came under the control of a certain descendant of Mongol royalty from the Kokonor region (*mtsho sngon*) during the Sakya-Yuan period (1271–1368). Consequently, it was ruled by a line of Mongol rulers for thirteen successive reigns. They came to be called the 'thirty-nine Mongol communities' or Hor Sogu. According to local historical narratives, some of these Hor communities like Driru ('bri ru) were conquered by Gushri Khan (1582–1654) in the early seventeenth century and offered to the Fifth Dalai Lama (Nag chu'i lo rgyus rig gnas dpyad gzhi'i rgyu cha bdams bsgrigs (hereafter NLRGD): 210). During Lhazang Khan's rule of Tibet, Pholhané Sonam Tobgyal (1689–1747), the future king of Tibet, was sent to resolve conflicts and restore the loyalty of Nagchu leaders to Ganden Podrang in fear of defection to the Khans of Kokonor. The ruler of Hor Sogu, Uching Taiji (u cing thu ji), surrendered to Pholhané who raided and looted dozens of horses (NLRGD: 210). It is not very clear but parts of Hor Sogu came under the administration of a newly established (circa 1723) Qing garrison in Tengchen (Chamdo) that was under the High Commissioner of Xining in 1725. Citing Dungkar Lobzang Trinle, Shakya states that it was only in 1851 that the administration of the Hor Sogu was transferred to the Amban in Lhasa (Shakya 2015: 364). Notwithstanding, a local historical and cultural source compiled in 2010 presents new information regarding its transition. It claims that following the arrival of Sengge (1727–1733), the first Qing imperial commissioner (Man. Amban) in Lhasa in 1728, Hor Sogu came under the control of the Qing court. This shift is also reflected in the change of the name from Hor Sogu to Gyadé Sogu, meaning 'thirty-nine Chinese communities'.

Then, in 1731, in the ninth year of the reign of Emperor Yongzheng (1678–1735), a major reconfiguration of administrative geographies for the loosely held confederation of nomads in the Nagchu region was carried out. It was part of a broader Qing imperial strategy for governing its Inner Asian frontiers, implemented through the combined efforts of Qing imperial commissioners based in Lhasa, Xining and Chengdu (NLRGD: 211). While Petech's comprehensive study of Sino-Tibetan relations in the eighteenth century does not specifically mention this administrative reform, he does highlight Qing's reinforcement of its garrison in Dam (*'dam*) in response to threats from Dzungars in 1730 (Petech 1950: 144). Evidently, it was not an expansionist agenda but rather a pragmatic defensive strategy aimed at maintaining stability in this geopolitically significant region through the establishment of this new administrative system. In any event, from the early eighteenth century until the fall of the Qing Empire in the early twentieth century, all Hor communities of Nagchu and some of the surrounding regions were nominally under one king (*rgyal po*) whose palace was located at Akar monastery, a Bon monastery. There was a total of 79 Hor communities (*tsho ba*) including Hor Sogu, and Qing's reterritorialisation of the region placed forty communities under the administration of the Qing imperial commissioner of Xining. On the ground, the communities were administered by two 'Thousand Households Leaders' (*stong dpon*; Ch. *qianhu*), thirteen 'Hundred Households Leaders' (*brgya dpon*; Ch. *baihu*), and forty 'Leaders of Less than Hundred Households' (*be cang*; Ch. *bai chang*) (NLRGD: 214). Although Mongol nobles retained their status as local leaders under this new administrative structure, they effectively became subjects of the Qing empire, which meant that they had to pay their annual tax either to Qing officials in Xining or the Amban office in Lhasa (NLRGD: 211–13). This marked the end of the 'Mongol Period' and the beginning of the 'Chinese Period', or more appropriately the 'Qing Period', in Nagchu local history. Therefore, a large part of the region affected by the 1828 snow disaster was not under the direct control of the Tibetan Government in Lhasa but rather under the authority of the Qing imperial commissioners based in Xining and Lhasa. Thus, 'Gyadé Sogu' began to pay their annual tax to the Amban office in Lhasa who in return awarded pieces of turquoise to all the subjects. This was called 'turquoise salary' (*phogs g.yu*) (NLRGD: 212). As related in the following, this explains the level of Qing intervention in the disaster relief effort for the Nagchu nomads in 1828. The areas that were under the Tibetan government include western areas of Nagchu such as Namtso and parts of Amdo in the north. This is reflected in the natural disaster reports.

The Earth-Rat Year Snow Disaster of Nagchu

In the early winter of 1828, the earth-rat year of the Tibetan calendar, there was a massive 'snow disaster' (*gangs skyon*) due to heavy snowfall in the central Tibetan plateau that severely affected the nomads of Nagchu and neighbouring communities including Namtso and Namru.

Figure 1. A rough estimate of the affected area. Original map source: Keithonearth, Wikimedia Commons.

The reports from local leaders appealing to the Tibetan government for emergency relief refer to the climatic crisis as 'unprecedented' (*snga na ma grags pa*), indicating the enormity of the event at least on the scale of a human lifetime. Relying heavily on livestock and lacking substantial reserves, highland pastoralists found themselves profoundly vulnerable to the impacts of this natural disaster. As they struggled against famine, they also grappled with heightened social disruptions, including escalating banditry and large-scale migration, underscoring the immense challenges posed by such unforeseen calamities.

The Cabinet (Kashag) of the Tibetan Government in Lhasa received a letter from the leader of Nagchu (mi dpon spyi lcags pa can) on 9 September of the earth-rat year (1828) requesting relief aid as the people of Nagchu were facing the danger of famine (*mu ge*). It urged the government for the immediate supply of tsampa (roasted barley) and suggested routes and means of transportation to different pastoral communities of the affected region (Rang byung gnod 'tshe gangs skyon skor (hereafter RNGK): 12–23). The regent, Tsemonling Ngawang Jampel Tsultrim Gyatso (1792–1862/1864), issued a travel permit in two days for the transportation of relief aid that promised 915 loads of barley grain with specific instructions for distribution (RNGK: 14). Kashag issued another statement concerning the complete decimation of livestock of Otok monastery, and as one of few Geluk monasteries in the north, it was granted 400 loads of grain from the government treasury and another 400 loads from the personal treasury of the Dalai Lama (RNGK: 15–16). Interestingly, Otok monastery seems to have been the only religious institution that received this special attention and assistance. It is noteworthy that Nagchu is historically dominated by Bon and the Kagyud tradition and, in such a religious landscape, clearly, the survival of Otok monastery was very important to the Ganden Podrang State. As Tsering Shakya notes, Nagchu never had strong penetration by the Geluk tradition (Shakya 2015: 364).

Sometime in early 1830, over a year after the disaster, the Kashag wrote to the local leaders of Nagchu informing them that, in consultation with the Amban office, a report about the 'unprecedented' snow disaster in Nagchu had been sent to Emperor Daoguang (r. 1820–1850) requesting relief assistance. The Tibetan Cabinet petitioned the Qing court for relief aid to Nagchu and the pastoralists of Saga and Naktsang (RNGK: 17–18). Later in the same year, during the transitional period between the Ambans Huixian and Xingke, the Ambans wrote to regent Tsemonling asking the Kashag to provide relief to the communities of Dam ('dam) and 39 Gyadé (rgya sde so gu; Gyadé Sogu) communities. The letter relayed emperor Daoguang's decree which ordered the Kashag to not only provide aid but also investigate the current livelihood situation of the affected communities. It noted that 500 silver taels for Dam and 3,000 silver taels for Gyadé Sogu were granted from the imperial treasury (RNGK: 19–21). It seems to suggest that the Tibetan Government did not provide relief aid to all affected communities except those under its direct administration. As indicated above in the brief history of Nagchu, this special treatment from the Qing imperial court toward Gyadé Sogu is not surprising for they were direct subjects of the empire. However, after receiving relief aid from the Qing court, Tsemonling appoints a 'hundred-households leader' (*rgya* *shog spyi khyab*; Ch. *baihu*) named Ta Tsering Paljor as the person in charge of buying and replacing the livestock of Naktsang and Gyadé Sogu. With the 3,000-silver tales from the imperial treasury, Ta Tsering Paljor and other local leaders were ordered to buy 2,000 sheep and 3,700 goats. This uneven distribution of relief aid reflects the murky political geography of Nagchu and the surrounding areas.

Regarding the ecological impact of the snow disaster, according to the reports, many pastoralist communities were ‘entirely annihilated’ (*rtsa stong*) while others had over fifty per cent of their livestock destroyed due to hunger and hypothermia. A letter sent to the regent Tsemonling on 5 February 1832, stated:

> The snow disaster of the earth-rat year wiped out five of the eight Tashok communities; three of the seven Amdo communities; one of the five Lower Amdo communities; five of the thirteen Gerchoe communities … [and] one of the seven Samshok communities. As a result, out of 370 ‘dmag rkang’ families (land unit tax in soldiers), only 50 are left and 350 of them had people and/or livestock annihilated. Additionally, before the disaster, a big community (shog kha) had about 200 households, a medium community about 100 households, and a small community around forty households. And each household owned decent numbers of livestock including yak and sheep. Following the snow disaster, a big community has about thirty households, a medium community fifteen households, and a small community one household (RNGK: 30–31).

The letter continued to detail the decimation of livestock the snow disaster caused and explained why the communities have difficulty paying their annual ‘dmag rkang’ or land tax in military service. This was a form of tax to the Tibetan government. Each land unit had to send annually two soldiers who mostly provided transportation services including supply of ammunition, food or clothing. The above excerpt provides a sense of the severity of the event as it decimated whole communities along with their livestock. However, the letter also noted an incident of people migrating to Gyazhung (*rgya gzhung*) and Satré (*sa bkras*) due to the disaster and requested the government to investigate and order them return to Nagchu (RNGK: 32). Thus, it is hard to determine whether to what extent the number of households drastically reduced or the communities ‘wiped out’ could be attributed to mass migration. The reports lack a clear timeline of migration, leaving the chronological sequence of migration events unclear. We shall discuss the social disruptions that followed the snow disaster in the next section.

Furthermore, in 1829 and 1830, several general surveys were conducted to assess the impact of the snow disaster. While some reports provided detailed information about livestock mortality in specific areas and communities, including numbers and percentages, others merely offered rough estimates of livestock loss or simply indicated that livestock had been ‘entirely wiped out’. For instance, the survey reports on Northern Namru and Southern Namru claimed 56 per cent and 53 per cent livestock mortality respectively:

Table 1. Survey results of livestock loss due to the snow disaster of 1828.

Location	Livestock*	Total before	Total after	Percentage
N Namru	5614	9932	5614	56.52%
S Namru	2044	3824	2044	53.45%

It is noteworthy that, unlike pastoral regions in other parts of Tibet, Tibetan pastoralists in western and central Tibetan Plateau primarily raised sheep and goats, as these animals are better adapted to the alpine steppe ecology and the high altitude of the region. The numbers provided above do not capture this level of detail, but the reports utilise a standardised scale that highlights the diversity of pastoral animals and the varying susceptibility of different species to natural disasters. The scale used in the table is as follows: *one yak is equivalent to ten sheep, one yak is equivalent to thirteen goats, and one horse is equivalent to four yaks. This scale appears to be based on the prevailing exchange rates of these animals in the region. A similar study on the exchange values of animals in Changthang, located to the northwest of Nagchu, suggested that the exchange rate between a horse and sheep was one to forty or fifty, while the exchange rate between horses and yaks was one to five (Goldstein and Beall 1990: 72). Goldstein and Beall contend that more goats and sheep were raised by Tibetan pastoralists in this region because they have higher haemoglobin, more red cells, and can breathe four times faster than their low-altitude relatives (Goldstein and Beall 1990: 83). This scale and exchange rate clearly suggest that goats and sheep were more abundant than yaks and horses in this region. Consequently, it is reasonable to assume that a significantly larger number of animals were devastated by this disaster than indicated by the survey figures for Namru and Southern Namru.

As indicated, the political geography of Nagchu region in the early nineteenth century is complicated and fuzzy, as it is difficult to determine the political boundaries between different communities or the jurisdictions of the Tibetan government and the Qing court. Part of the confusion seems to stem from the double meaning and usage of the term ‘Nagchu’ as a smaller area to the northeast of the lake Namtso and as a reference to the greater region including Namtso, Naktsang, Amdo and even Tengchen in modern-day Chamdo (although sometimes specified as ‘Nagchu Khul’ or ‘the greater Nagchu region’). Some of these reports and correspondence about the snow disaster of 1828 reveal this complex state of administrative jurisdictions and boundaries as the disaster and social disruptions forced people to migrate and resettle in neighbouring areas.

Climate change or variability, and especially extreme climatic events like the snow disaster of 1828 in Nagchu often serve as catalysts that intensify or exacerbate existing vulnerabilities in society. Such extreme events, including heavy snowfall, droughts or cyclones, have the potential to trigger various societal disruptions due to abrupt changes in biomass production, such as food and fuelwood, directly impacting the economic, demographic and ecological wellbeing of vulnerable communities like the highland pastoralists of Nagchu on the Tibetan plateau. Examining this fundamental framework of the climate-society relationship provides insight into why numerous reports concerning the snow disaster of Nagchu in 1828 document and lament instances of mass migration, theft and banditry. Sometime in the middle of 1831, two years after the disastrous snowfall, the leader of Nagchu wrote to the Tibetan Cabinet: 'In addition to the poverty brought about by the snow disaster of the earth-rat year, the people of this region have since been afflicted by the violence of bandits' (RNGK: 22). He continued the letter by lamenting that 'of people who fled [Nagchu], communities such as Gacha, Gonga, Phun, and Sigyashok still live in Naktsang and they refuse to return' (RNGK: 23). Another letter from the same leader again complained that despite his appeal to the religious leader (*bla dbon*) to persuade the 140 households of Amdo Gonga and Sigyashok who had migrated to Naktsang to return, not a single person had come back. Instead, 293 households from Middle Hor, Lower Amdo, and Zungsog had migrated to Phentsateng in 1829 due to the imminent danger of famine and banditry. Even those who chose to stay in Nagchu remained impoverished, devoid of any livestock (RNGK: 24). The letter concluded with two requests: a) exemption from taxation, which required labour contributions for the construction of a stupa in Nepal; and b) an appeal to the Gyadé communities to repatriate all those who had fled to Nagchu (RNGK: 25). These letters addressing the challenge of mass migration prompted by famine and banditry underscore the intricate and intertwined political dynamics between the Tibetan state and the Qing court. They reveal that pastoral communities in the greater Nagchu region maintained varying degrees of allegiance to either the Qing or the Tibetan government.

Furthermore, additional evidence from other archival documents corroborates that the social disruptions in Nagchu indeed transpired after the massive snow disaster. Several Qing memorials address the issue of banditry and livestock raids in Nagchu during the years 1829 and 1830.

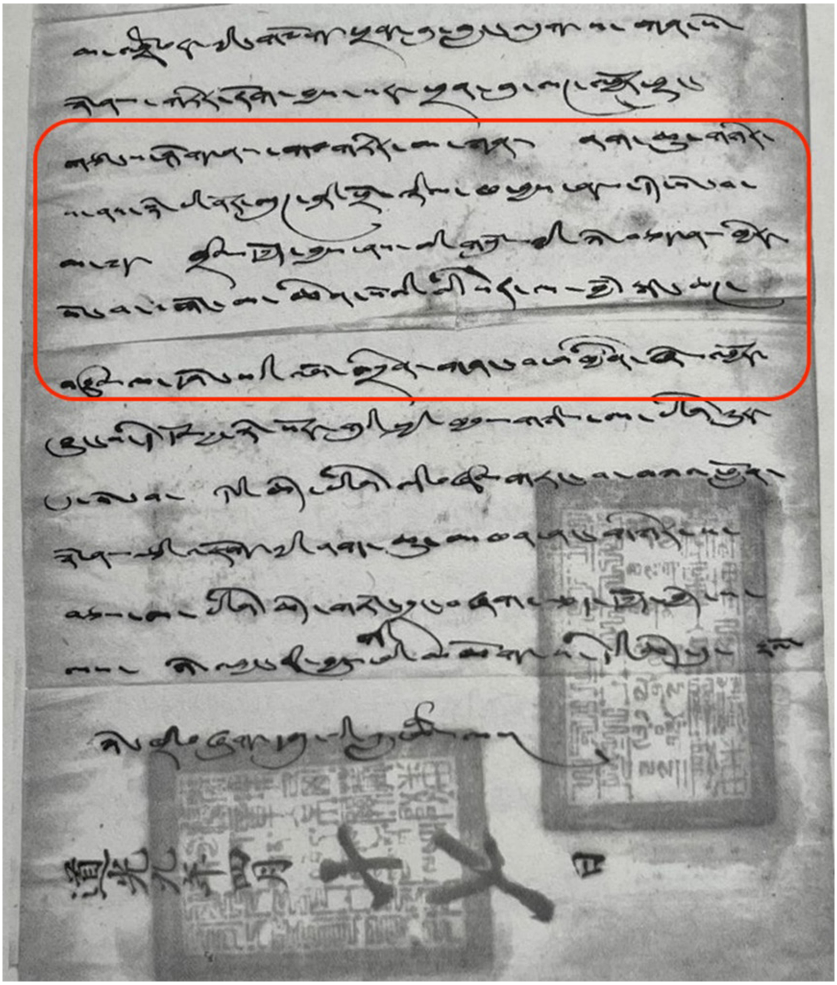

Figure 2. Author photo of document 32, Qing memorial from 1829. Source: Qing dai Xizang di fang dang an wen xian xuan bian, 2017, Vol. 4, Document 32: 279–80.

For instance, a memorial dispatched from the Qing court in 1829 orders the Ambans to investigate the problems of violence and banditry in Nagchu (Qing dai Xizang di fang dang an wen xian xuan bian, 2017, Vol. 4, Document 32: 279–80). The memorial pertains to a petition submitted to the Qing court, detailing an egregious incident involving a steward from Nagchu. According to the petition, this steward not only plundered a significant number of livestock from an unnamed neighbouring community, but also committed the heinous act of killing three individuals, decapitating them and taking away their severed heads. The petition implored the Qing court for the protection of the Great Emperor's subjects (*gong ma chen po'i mi ser*). Since the letter directs the Kalons (ministers) and the two leaders of Gyadé Sogu to investigate and address the issue, it can be inferred that the affected communities were part of Gyadé Sogu, the direct subjects of the Qing Empire. As we saw earlier in one of the reports, the leader of Nagchu appealed to the Tibetan government concerning the problem of migration of people under its jurisdiction to Naktsang and Gyadé Sogu areas. From the above Qing memorial, we could see a glimpse of the same incident from the perspective of the Qing court and Gyadé Sogu. Although extracting precise details about the livestock raids and bandit activities solely from a limited number of reports and memorials presents challenges, these incidents illuminate the intricate interplays between migration, violence, and climate change.

In another Qing palace memorial, submitted by Huixian during the second month of the ninth year of the reign of Daoguang (3 April 1829), it was reported that heavy snowfall transpired in early September. This snowfall endured for a period of ten days, accumulating over ten feet of snow (Neige bu yuan dang an, No. 001037). Huixian was the resident imperial official (Man. Amban) based in Lhasa from 1827 to 1830. Contrary to the narrative of the Qing's decline and perceived state incapacity beginning in Jiaqing's reign (1796–1820), the active involvement of the Qing court in relief efforts and the handling of social conflicts in Nagchu offers a counterpoint. It underscores the significant degree of Qing imperial power and presence in Inner Asia in the early 19th century. The snow disaster of Nagchu in 1828 not only allowed the Qing court and Emperor Daoguang to showcase imperial benevolence to their distant frontier subjects, but also served to reassert Qing authority and influence in Inner Asia, ultimately earning lasting loyalty from many Tibetan communities in Nagchu until the empire's eventual collapse, highlighting the strategic significance of such displays of imperial power and grace. This came to the fore in the early twentieth century when the Tibetan government declared independence and expelled Qing military and Chinese civilians from Lhasa, Nagchu became a temporary haven for Qing officials, military and Chinese people fleeing the onslaught by Tibetan troops. Some communities of Nagchu fought against the Tibetan army on the side of Qing imperial soldiers and officials (Shakya 2015: 366). It took nearly five years for the Tibetan government to gain complete control over Nagchu. The Gyadé Sogu came under the Tibetan Government in 1916 with the establishment of Hor General (*hor sbyi*) as the governor-general of the greater Nagchu region.

In conclusion, it is imperative to emphasise that this article refrains from assigning blame for all social disruptions to a single climatic event. Such an oversimplified narrative would fail to capture the multifaceted and nuanced ecological and sociopolitical forces at work. To truly grasp the vulnerability of highland pastoralists in this region, a holistic approach is necessary, considering a myriad of interconnected factors. Among these factors, climatic conditions, particularly extreme weather events, hold undeniable significance as they directly impact the availability of pastureland and vital water resources essential for the survival of livestock.

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'WONDERFUL PRODUCTIONS OF THE FRIGID ZONE': POLAR ICE AND CLIMATE CHANGE IN EARLY NINETEENTH-CENTURY BRITISH DISCOURSE

Björn Billing

ABSTRACT: In 1818 the British Admiralty launched an Arctic expedition. The immediate stimulus was recent reports from whalers of a significant decrease in polar ice, a condition interpreted by some natural philosophers as an indication of impending climate change. Such a warming would affect not only the Arctic but also the European climate, with profound consequences, possibly beneficial for British agriculture and commerce. These ideas were widespread but not uncontested. Polar ice appeared as a natural wonder that called for scientific attention, just as it appealed to the Romantic artists. This article investigates this British discourse at the threshold of modern climatology during the final phase of the Little Ice Age. It puts our current climate debates about the cryosphere, deep time and geoengineering into historical perspective.

KEYWORDS: polar ice, climate change, the Arctic, William Scoresby Jr, Little Ice Age, cold

Pleydell Wilton was a Church of England chaplain in Gloucestershire. He also wrote poetry and collected some of his works in *Geology and Other Poems*, published in 1818. The timing was no coincidence: one of the longest poems in the volume is 'The Polar Ice: Written at the time of the sailing of the northern expedition'. The expedition in question consisted of two parallel voyages of exploration. *Alexander* and *Isabella*, under Lieutenant Edward Parry and Commander John Ross, respectively, set sail in search of the Northwest Passage, whereas Captain David Buchan commanded *Dorothea* together with *Trent*, piloted by John Franklin, with the prospect of reaching the North Pole.

Wilton's poem is supplied with extensive footnotes, including quotations from recent articles in scientific journals about the Arctic and the awe-inspiring polar ice. It evokes imagery of an almost otherworldly, truly sublime landscape. Wilton also communicated a theory of climate change. The sources he cited reported the considerable reduction in ice masses in the previous year, 1817, a condition that baffled whalers and scientists. These themes in Wilton's poem mirror a contemporary British discourse about the Arctic, polar ice, cold, climate and geohistory. The following analysis investigates this discourse as a study in the history of ideas. How did explorers and natural philosophers conceptualise the Arctic environment and, more specifically, what ideas about climate were inferred from the observations on polar ice? Although the extreme

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North was geographically far away, the Arctic concerned British intellectuals of various kinds and on many levels. The melting of the polar ice, Wilton and others speculated, might make the European climate milder and perhaps enable the vineyards of England to flourish once again, as in Roman times (Wilton 1818: 84; Porden 1818: 13; Some remarks 1818: 281; c.f. Leslie 1818: 22–23). Such beneficial agricultural conditions would mean economic profits that in turn could strengthen Great Britain's 'superiority among nations' – Wilton's poem is indeed a piece of nationalistic propaganda (Wilton 1818: 84).

Wilton was not the only person whose fancy was spurred by the twin expeditions of 1818. Anne Eleanor Porden wrote *The Arctic Expeditions: A Poem* in the same vein, containing additional references to the reports of the polar ice. Icebergs of gigantic proportions, Porden wrote, had allegedly broken off and drifted southward. The cooling effect this had on Portugal and northern Africa was but temporary: in the long run, the reduction in polar ice would probably even out the Earth's temperatures to some extent, so that the Arctic regions might become habitable and the European climate warmer (Porden 1818: 11–12). With reference to an article by Sir John Barrow – Second Secretary of the Admiralty and an energetic proponent of the 1818 expeditions – Porden communicated the idea of a turning point in the climatic history of Europe that would end four centuries of extreme cold, manifested in the impenetrable ice-masses of the Arctic, with frigorific effects on the subpolar continents (Porden 1818: 5–6 and passim; on Barrow, see Wheatley 2009).

With their poems – passionate in tone, sensationalist in scope, serious in intent – Wilton and Porden intervened in a number of contexts. One was geopolitical, expressed in the overtly nationalistic and imperialistic themes in both poems. Another context was cultural. The year 1818 marked the threshold of a new era in British polar exploration, not only at sea but also in the sphere of narratives and images. Just as the North Pole exerted its influence on the needle, the Arctic functioned as a magnet to public interest. Travelogues from the polar regions were tremendously popular. The icy landscape with its sublime characteristics, and the cold, desolate North as a place where human physical and mental abilities were tested to their very limits, were themes that attracted artists of all kinds (Carroll 2013; Cavell 2017; David 2000; Lewis-Jones 2017; Loomis 1977; Potter 2007). A third context concerned the natural world itself, or rather conceptions of the Arctic landscape. In Britain by that time, in 1818, there was a lively discourse about the polar regions, and several thinkers argued that understanding this frozen environment was central to knowledge of nature, in terms of both general meteorology and physics, and more specifically regarding the peculiarities of these icy landscapes. With the surprising reports of decreased polar ice, ideas of climate change became a recurring feature – and a topic of disparate opinions – in the literature treating the Arctic.

Historical research on British polar exploration is extensive. In most cases, it takes the 1818 expedition as a starting point for investigations of the nineteenth century, with particular interest in the cultural and political impacts of the lost Franklin expedition of 1845. This vast body of research has primarily aimed at showing how narratives of the Arctic served ideological functions pertaining to, first, British nationalism and imperialism and, second, masculine heroism, which in turn supported the former (e.g. Hill 2008; Lewis-Jones 2017). More specifically, scholars in this stream have convincingly shown how the aesthetic concept of the sublime was employed for these ideological purposes. This interest long dominated the research to such an extent that, in 2016, Benjamin Morgan urged historians to move beyond such interpretations and read the historical records less allegorically and more literally as information about nature itself: the polar landscape, its flora and fauna, the Arctic climate and so forth (Morgan 2016). The following investigation of polar ice and climate change essentially follows Morgan's suggested line of ecocritical enquiry beyond politics and gender. Moreover, the present article is distinguished chronologically from previous research in that it focuses on the early nineteenth century and traces discursive threads back to the previous century rather than forward to the Victorian era.

The analysis aims to advance our historical understanding of the Arctic and climate change. While some important studies pay attention to this interrelationship in this particular time and place (Carroll 2013; Johns-Putra 2015; Zilberstein 2017), this article will both highlight previously neglected or marginalised sources and explore the discourse in greater depth. Among these published sources are journal articles, encyclopaedia entries, books and, not least, the narrated observations of whaler William Scoresby Jr, a key figure who deserves more attention in polar historiography. In our present time, the cryosphere has come to the fore in the context of global warming and the climate crisis (Radin and Kowal 2017). Icebergs and polar glaciers have become potent symbols of the perilous situation (Carey 2007). This study will put this current awareness and symbolism into historical perspective, albeit implicitly. It connects both with the well-established study of climate history (for a thematic overview see White, Pfister and Mauelshagen 2018), and with the emergent interdisciplinary field called 'Ice Humanities' (Dodds and Sörlin 2022). The British discourse mapped and discussed here reflects an early realisation of the importance of understanding the intricate connections between polar ice and global climate. In different ways and to various extents, it also anticipated current ideas of planetary thinking, deep time conceptualisation and geoengineering.

Relentless cold

By 1818 the incentives for polar travel had gravitated towards scientific research alongside whaling – a business that had in fact been in decline for more than a century – and the prospect of establishing new trade routes. Apart from surveying Arctic flora and fauna and advancing geography and cartography, there was progress to be made in a number of areas, ranging from meteorology and astronomy to understanding terrestrial magnetism and the Earth's curvature at the poles. After centuries of exploration, the Arctic was still full of blank spaces on the maps, literally as well as figuratively. Pivotal to this new scientific endeavour was the 1773 expedition commanded by Constantine Phipps, who stated the importance of 'the promotion of natural knowledge' in his published journal (Phipps 1774: 20; see also Fjågesund 2008). Almost half a century later, major questions remained unanswered. William Scoresby Jr, the most experienced whaler and Arctic scientist of his generation, included numerous tables, statistics, measurements and descriptions of natural phenomena in his much acclaimed *An Account of the Arctic Regions with a History and Description of the Whale Fishery* (1820) in order to meet this 'great deficiency of observation in the polar regions' (Scoresby 1820: 396). Polar ice in all its forms, shapes and physical aspects appeared as a particularly elusive phenomenon. Scoresby's detailed reports on this were unparalleled at the time and therefore a recurring reference in the scientific literature. Another topic of interest concerned climate and, by extension, how the masses of polar ice might causally relate to climate.

The physicist and secretary of the Royal Society, David Brewster, presented a paper on 7 February 1820, later published as 'Observations on the mean temperature of the globe'. He called for more empirical studies of the subject and referred approvingly to Scoresby's reports; indeed, Brewster claimed that scientific records of temperature and other climatological parameters constituted a crucial motive for further polar exploration (Brewster 1820: 207, 213–214). A similar argument was made by Bernhard O'Reilly, physician onboard an Arctic whaling ship in 1817. He wrote a 350-page travelogue in response to 'the absolute want of scientific information on the subject of northern climates' (O'Reilly 1818: iii). Even though Brewster did not explicitly discuss the masses of ice and snow in the North, possible connections between climate and the Arctic were addressed again and again in natural philosophy in the decades around 1800. Theories differed and speculations abounded, but the common denominator was cold itself. Early modern natural philosophers viewed cold as one of nature's most taxing qualities to grasp. Difficult but also essential, because, as Francis Bacon had declared in the 1620s, heat and cold constituted nature's two main energies or forces. Robert Boyle took on the challenge, and his pioneering *New Experiments and Observations touching Cold, or an Experimental History of Cold* (1665) was still an indispensable source in the early nineteenth century, one that Scoresby and others relied on (Rosengren 2023).

Boyle had conducted his experiments during a peak of what would later be termed the Little Ice Age, a period of intense cold and erratic weather events mirrored in the fairs on the frozen Thames and in cultural depictions of winter in landscape painting, poetry and plays (Fagan 2000). During the eighteenth century, British newspapers frequently reported on extreme cold. For example, in June 1795 the temperature in London plummeted to such low levels that the birds became numb and could not fly, ‘being oppressed with the uncommon cold and density of the atmosphere’, according to the *Morning Post*. ‘In Covent-garden market’, the article continues, ‘the dealers in vegetables sat wrapped up in cloaks and great coats, as if they had mistaken a Midsummer’s day in England for the regions of Spitzbergen!’ (News 1795). The wording further shows that the Arctic – here, Spitsbergen – was by then part of the vernacular as a kind of proxy for all things related to severe winter conditions. When polar travellers told of the loss of ice in 1817, this news was received with the harsh ‘year without summer’, 1816, fresh in the memory (Behringer 2019; for local reports in the 1810s, see Veale and Endfield 2016). The situation was thus favourable for the kind of enthusiastic ideas of climate change – i.e. a turning point with the potential of warmer days ahead – expressed by Wilton and Porden.

Against this background, with its intellectual as well as practical dimensions, cold became a compelling object of scientific enquiry. In *Encyclopaedia; or, A Dictionary of Arts, Sciences, and Miscellaneous Literature* (1798), various strange effects are listed under the entry ‘Cold’: extreme cold can splinter trees, it can even make rocks crack. Frozen metal can cause blisters on the skin. Really cold air burns the lungs, and it kills cattle and pets. The article also connects the subject matter with climate. Ice absorbs heat, it is explained. Consequently, the large icebergs in the polar regions have the capacity to cool their surroundings. ‘Indeed, where great quantities of ice are collected, it would seem to have a power like fire, both augmenting its own cold and that of the adjacent bodies’ (Cold 1798: 137). This has been the case in Iceland, the article claims, where colossal icebergs from the Arctic have remained for years before melting away completely, producing this effect with dire consequences for human societies.

In sum, ideas about polar ice and climate in the British discourse at the time of the 1818 expeditions connects with both the history of science and the Little Ice Age in general, including its aesthetic manifestations, such as the poems by Wilton and Porden. It is now time to take a closer look at the conceptions of polar ice, mediated mainly through Scoresby's reports, before turning to the debate about climate change in greater detail.

The enigmatic polar ice

Figure 1. John Ross – *A Remarkable Iceberg July 1818.*
https://www.flickr.com/photos/britishlibrary/11004309725

With Romanticism, the Arctic was established as the quintessential locus of sublime nature (Rix 2023a). This land of abundant snow, ice in the most astonishing shapes and overwhelming dimensions, intense cold, strange wildlife, the aurora borealis and other optical phenomena appeared as a land of wonder. Even the most sober, scientific travel reports included passages in which the authors expressed their emotional experience by means of aesthetic vocabulary and fanciful metaphors. In the early nineteenth century, this double-edged rhetoric had become a standard trait of polar travelogues. A review of the account of Ross and Parry from 1819 notes that, in this genre, 'dry details of hydrography were enlivened by discussions and schemes almost bordering upon romance; and … they were assailed by poetic theories of climate' (Account 1819: 151). More than anything else, it was the ice that struck the aesthetic sensibility and triggered scientific interest. Under the entry 'Cold' in *Encyclopaedia Britannica* 1818, the many shapes of polar ice are described as 'the grand productions of nature' (Cold 1818: 259). This phenomenon constitutes 'one of the greatest curiosities in nature', according to *A Concise System of Geography* (Vint 1800: 53).

Not surprisingly, then, William Scoresby Jr devoted more than a hundred pages to the polar ice in his *An Account of the Arctic Regions*, a monumental work in two volumes. The publication of *An Account* in 1820 confirmed Scoresby's authority on the subject. It is 'by far the most accurate and satisfactory account that has ever been given to the public, of the varied peculiarities of the Arctic regions', wrote the reviewer for the *Edinburgh Monthly Review* (An Account 1820: 628). Scoresby made his first trip to the Arctic when he was only ten years old, onboard a whaler of which his father was captain. From the age of thirteen, Scoresby Jr went on polar journeys almost every summer for two consecutive decades. During the winters, he studied chemistry and natural philosophy at the University of Edinburgh. He thus made a transition from whaler to scientist, which was highly unusual at the time (Bravo 2006). Scoresby's vast experience as a polar explorer opened doors to the learned community. He was in contact with Joseph Banks and Humphrey Davy and, after the publication of his magnum opus, he visited Paris where he met George Cuvier, Alexander von Humboldt, Joseph Louis Gay-Lassac and others of the scientific elite (McConnell 1986: 258; Stamp and Stamp 1976: 102–03).

It was with a work on polar ice that Scoresby made his scientific debut. This extensive paper was read on four occasions at the Wernerian Society in Edinburgh between December 1814 and March 1815 (Jackson 2008: xx). The text was later published in its entirety or in parts in several journals, and it was also translated into French and German. In footnotes to his poem, Wilton cited long passages from one of these articles, which appeared in *Journal of Science and the Arts* in 1818 – an indication of the reach of Scoresby's observations and of the dissemination of the polar imaginary in contemporary culture. In meticulous and systematic fashion, using improved instruments, Scoresby developed his observations of Arctic nature and presented several papers. The topics ranged from the peculiar colour of the sea water to the crystalline shapes of snow and the gravity of ice. In more-or-less revised form, these studies were then incorporated in *An Account* (for a list of Scoresby's published articles, see McConnell 1986).

Scoresby opened his 1814–1815 paper by describing to the British readership the almost unimaginable environment of the polar region: 'a country where every object is strikingly singular, or highly magnificent. The atmosphere, the land, and the ocean, each exhibit remarkable or sublime appearances' (Scoresby 1815/1818: 261). What fascinated him the most in this landscape was the ice. Since it appears in such 'great abundance and variety', Scoresby named, described and classified these forms in a quasi-Linnean fashion, distinguishing among eighteen types including field, floe, drift-ice, brash-ice, sludge, pack, patch, tongue, land-ice, etc (Scoresby 1820: 225). Most of these terms, Scoresby explained, had long been used by whalers. An almost identical list was presented by Ross in his travelogue from the 1818 expedition onboard *Isabella* and *Alexander* (Ross 1819: xxxv–xxxvi). A lexicon of polar terms was thus being communicated to a large British readership that had no first-hand experience of the Arctic in all its otherness.

The polar ice displayed visually striking shapes that often appeared as if they were works of art or architecture (e.g. Scoresby 1820: 98). The ice also generated peculiar visual effects in combination with the Arctic light, such as the iceblink, a bright light appearing near the horizon resulting from the reflection of light off an icefield below (383–95). In Scoresby's description, it is one of several examples illustrating the diverse colours the ice can render in this environment: a palate ranging from emerald and azure to pure white and yellowish, greyish and opaque shades. Beneath the water surface the ice could look almost black. The colour depended partly on whether the water was saline or fresh, a fundamental difference to which Scoresby devoted particular attention in his studies (230–33 and passim). Saltwater ice was lighter and somewhat elastic, he explained, whereas freshwater ice was hard and brittle, like glass or crystal. The latter could in fact be used as a convex lens to produce fire. Scoresby and his crew found it fascinating that the sun beams refracted through such an ice lens could be burning hot while the ice remained cold and did not melt (232).

One manifestation of ice unique to the polar landscape was the iceberg, a kind of subclass of varied shapes, sizes and colours (Scoresby 1820: 250–62 and passim). Icebergs could be smooth and compact or perforated with holes and caves; they could be solid or include rivulets and small lakes. Scoresby and others used the term iceberg for the large glaciers between mountains that terminated in a perpendicular front straight into the sea. The floating icebergs, also called ice-islands or floating-mountains, were understood to be huge blocks of ice that had detached from a glacier at this front, either through sheer gravitational pull or because water running inside the glacier had created cracks. When this water froze it would expand with great energy. No travel report from the Arctic omitted detailed and vivid descriptions of the icebergs, with their display of immense natural forces in action. Scoresby, who usually refrained from poetic language and hyperbole, was no exception. Even for him, the birth of an iceberg as it detached from a glacier and plunged into the water, the rotation of an iceberg or the collision of two icebergs were simply overwhelming scenes to behold:

> The majestic unvaried movement of the ice, – the singular noise with which it was accompanied, – the tremendous power exerted, – and the wonderful effects produced, were calculated to excite sensations of novelty and grandeur, in the mind of even the most careless spectator! (Scoresby 1820: 250)

A long time after such an event, when the iceberg seemed to have settled in the water, movements and sounds continued inside the ice: 'a noise resembling that of complicated machinery, or distant thunder' (Scoresby 1820: 249).

It was Scoresby's contention that the icebergs on land were growing in size, in spite of the relative summer warmth. The growth by precipitation and meltwater that froze once the temperature dropped exceeded the effects of melting. From this, Scoresby concluded that the increase over time was perpetual (Scoresby 1820: 108). The land ice not only grew vertically but horizontally as well, so that tongues or plates of ice extended into the sea, eventually breaking off from the main body and floating away. This resulted in another form of iceberg: fields (nowadays called shelf ice) that may be so large as to produce conditions similar to the glaciers in the fjords (225–26, c.f. Scoresby 1815/1818: 263–64). Under certain circumstances, primarily shelter from winds and strong sea currents, polar ice could then become a self-generating phenomenon. For Scoresby, this opened up a deep time perspective. 'For if we can conceive', he asked rhetorically,

> from the fore-mentioned process of the enlargement of fields by the addition of the annually deposited humidity, that a few years may be sufficient for the production of considerable fields of ice, what might be the effect of fifty or sixty centuries, affording an annual increase? (Scoresby 1820: 261)

One idea that Scoresby inferred from this was that 'a continent of ice mountains may exist in regions near the Pole, yet unexplored, the nucleus of which may be *as ancient as the earth itself*, and its increase derived from the sea and atmosphere combined' (Scoresby 1820: 319, my emphasis). This is also one of several instances where Scoresby intervened in the widely debated question of whether the North Pole was surrounded by open sea or not, and consequently whether it could be reached by sail or land travel (Martin 1988). Scoresby was not the only one for whom the Arctic evoked deep time speculations. John Laing was a surgeon onboard a whaler under Scoresby Sr in 1806 and 1807. In his travelogue, published in 1815, he wrote of Spitsbergen:

> The entire face of the country exhibits a wild, dreary landscape, of amazingly high sharp-pointed mountains, some of which rear their summits above the clouds, and are capt with strata of snow, probably coeval with the creation of the world. (Laing 1815: 74)

Laing also pondered over the immense polar glaciers, 'the most astonishing of all the natural phenomena of this country', which in 'size and magnificence' by far superseded the glaciers of the Alps (Laing 1815: 75). With his scientific habitus, Scoresby also discussed the different manifestations of polar ice in relation to one another, claiming that 'icebergs are probably formed of more solid ice than glaciers; but in every other respect they are very similar' (Scoresby 1820: 107). This difference was not insignificant, though, since the fixed icebergs 'are as permanent as the rocks on which they rest' (108). As with several other of Scoresby's theories of the polar glaciers, this latter conjecture was contested in *The Edinburgh Philosophical Journal* by Thomas A. Latta, who served as physician on Scoresby's expedition in 1818. Based on his own excursions on the glaciers of Spitsbergen, Latta also raised questions regarding Scoresby's ideas about the crevasses and the shape of icebergs. Scoresby replied with a short and rather dismissive text, to which Latta in turn responded with another extensive article on the subject of ice and climate on Spitsbergen (Latta 1820; 1827; Scoresby 1827).

The controversy between the two men illustrates the many uncertainties that scientists faced in the early nineteenth century before the establishment of modern glaciology by Louis Agassiz, Jean de Charpentier and others. While these new theories, developed in tandem with geology, did advance Arctic science, it was not self-evident how to extrapolate observations from the Alps to the extreme conditions of the polar regions. When Frederick William Beechey published his account of the 1818 expedition – he travelled onboard *Trent* under Franklin – as late as 1843, he was able to include such theories. Beechey contended that, even though the same laws of physics applied, the results nevertheless differed, 'for in the arctic regions all ordinary sources of fresh water are locked up by the iron hand of perpetual frost' (Beechey 1843: 150). The crevasses on the polar glaciers may indicate the kind of movement that Agassiz had proposed, Beechey considered. However, he added, 'it is hardly possible to imagine a power capable of moving so large a body, firmly united at its base, as it must be, by perpetual frost to the ground' (153). The extreme manifestations of the Arctic nature appeared as a veritable barrier to scientific understanding.

Climate change or coincidence?

Scoresby devoted several paragraphs to questions relating to climate. A large piece of ice functions like a cooling unit, and the extensive ice cover in the polar region also has the effect of equalising the temperature. This means that it is not necessarily colder the farther north one travels. Consequently, it might be as cold on Spitsbergen as at the North Pole, or even colder, depending on the quantity of ice. This, Scoresby asserted, was why every proposed model for calculating how the Earth's temperature is distributed across latitudes had failed (Scoresby 1820: 353–54). The polar ice seemed to create a complicating factor. To assist the natural philosophers in this matter, Scoresby measured and collated notes in elaborate tables: his forty-page Appendix 1 to *An Account of the Arctic Regions* consists of 656 measurements made on 242 days over nine years. Furthermore, in the polar regions, the temperature can drop faster than anywhere else on Earth. When the cold settles rapidly, the body cannot acclimatise: the skin becomes dry, the lips crack, breathing causes a burning sensation in the chest and it becomes difficult to speak. The breath freezes and creates a layer of frost in the cabins. These 'morbid effects of a low temperature' are one reason why conducting research in the polar regions is such a daunting task (338). It is also another aspect of the Arctic environment that distinguishes it from familiar lands: even though there had been severe winters back home, the Arctic cold was 'so different from any thing experienced in Britain', Scoresby informed his readers (338).

Scoresby was aware that the science of climate, including atmosphereology and meteorology, was 'in a state of rapid improvement' but was still 'in its infancy' (Scoresby 1820: 345). He mentioned Humboldt, Franklin and Hutton as important figures in this field of study, and he referred to the entry on 'Climate' in *Encyclopaedia Britannica* 1818 as 'an admirable article' (72). Scoresby's own contributions were not insignificant, even though he left the theoretical conclusions based on his empirical observations to others, which he explicitly admitted (395). Many whalers had reported the diminished ice fields in 1817, but it was the words of Scoresby that had the most noticeable impact. His estimation of a 2,000-square-league reduction circulated in the scientific journals and was forwarded in a formal letter from Joseph Banks to the First Lord of the Admiralty in promoting an expedition. The letter stated:

> a considerable change of climate, inexplicable at present to us, must have taken place in the circumpolar regions by which the severity of the cold, that has for centuries past enclosed the seas in the high northern latitudes in an impenetrable barrier of ice, has been, during the last two years, greatly abated. (quoted by Jackson 2009: xxix)

As this letter shows, the ice conditions in the Arctic were linked to climate on a macro level, representing an idea of such cultural magnitude as to find its way into the poems of Wilton and Porden. The conception of a major climate change that had taken place some four centuries earlier, resulting in both immense quantities of polar ice and low temperatures on the European continent, was widespread in British discourse. For the natural philosophers, such a climate change was an enticing problem, and even more enigmatic, against this background, was the recent sudden loss of ice – 'inexplicable at the present', as Banks put it. A basis for the ideas about climate in this context was a semantic shift that had taken place during the eighteenth century. 'Climate' used to denote a geographic unit and was also imbued with ideas about human character and passions (Mauelshagen 2018). Elements of this early denotation still informed the British encyclopaedias at the turn of the century, but climate was now mainly employed as a concept relating to temperature, weather patterns, air humidity, etc.

Consequently, 'climate change' took on a new meaning. An 1812 example comes from *Omniana, or Horae otiosiores*, a journal produced by the poets Robert Southey and Samuel Taylor Coleridge. Under the heading 'Change of Climate', they claimed that the British climate had become colder in recent years. Two indications of this were a reduced swallow population and a delay by a month of the herring fishery off the east coast. The article touched on the possibility that natural disasters such as earthquakes and volcanic eruptions might cause climate change. Another suggested explanation was the import of foreign plants, which exerted a transformative effect on British ecosystems (a word not used in the article), but the authors argued against this theory (Southey and Coleridge 1812). Regarding volcanoes as a possible driver of climate change, there was no consensus in the scientific community and it was only marginally addressed. John Leslie, Scottish physicist and mathematician known for his research into heat and ice, argued decidedly against such a theory (Leslie 1818: 8). Striking to the modern reader is that the 1815 eruption of Tambora in Indonesia was virtually ignored in speculations about polar ice in the late 1810s.

Regardless of the causes, centuries of low temperatures posed concrete problems to manage. Banks engaged in horticulture and in a lecture 1805 he addressed the need to adapt plants in Britain to the 'ungenial springs, the chilly summer, and the rigorous winters' that had occurred for some time (Banks 1820: 21). The idea of an emerging pattern due to the British climate getting colder was firmly established in the early nineteenth century. One of the articles that Wilton relied on was 'Some remarks on the deterioration of the climate of Britain, with an attempt to point out its cause'. It was published in *Journal of Science and the Arts* in the same volume as Scoresby's paper on polar ice. This editorial makes the double claim of both long-term change and a more recent temperature drop. The latter was backed up by 'the most irresistible evidence': the springs were delayed, the summers had become shorter and these seasons were colder and more humid (Some remarks 1818: 281). There used to be a time when vineyards flourished in Britain, but growing grapes was no longer possible and, in the future, the production of cider might face the same destiny – a 'really melancholy' scenario to imagine (282).

The mean temperature was dropping throughout the Northern Hemisphere, the article argued, supported by information from travellers. The glaciers in the Alps were expanding: indeed, 'the accumulation of ice and snow is very sensibly increasing' (Some remarks 282). The vicinity of Mont Blanc might even become inaccessible to travellers. The climate change that had begun 400 years previously had possibly trapped a colony of settlers in Greenland behind a barrier of ice, and since these masses of polar ice were the root cause of the cold climate at home, the future looked dire, because 'if the same causes continue to act, [it] is equally threatening to our at present more fortunate neighbours upon the continent of Europe' (286; on the Greenland colony, see Rix 2023b). With reference to the reports from the Arctic in 1817, the author was nevertheless optimistic. The 'year without summer' in 1816 might actually signal a change for the better. The article speculated that this year's cold was the result of large icebergs that currents and winds had transported southwards, with a frigorific effect on subpolar countries. A much larger quantity of ice than usual had broken off, so the cause of the recent cold in Europe was actually the beginning of a warming of the Arctic. In other words, the state of the polar ice could be interpreted as both cause and effect: a warmer Arctic caused lower temperature farther south, a transient condition that would pass with the melting of the floating icebergs. This was the theory that ignited the visions of Wilton and Porden of warmer days ahead.

Not everyone subscribed to these ideas of climate change. One divergent voice was that of John Leslie. In 1818, *Edinburgh Review* published an over fifty-page article by him on the subject.[1] It was framed as a review of five books about the Arctic printed the same year, but the text unfolded to present a broader critical examination. Leslie was writing against the grain when it came to the information about the polar ice in recent years. He maintained that reports of the diminished ice sheet were 'greatly exaggerated' and lamented that they 'have given occasion to much loose reasoning, to wild and random conjectures, and visionary declamation' (Leslie 1818: 5). Accurately assessing such information would require a climate science taking both historical records and a planetary perspective into account. Only when we fully understand the laws governing 1) heat coming from the sun, 2) heat radiating from within the Earth and 3) the transmission of heat in the atmosphere, and how these three forces intercorrelate, could we truly understand global climate. Leslie was convinced that 'the economy of Nature' held these three factors in balance (9). The recent melting of polar ice, Leslie argued, was not nearly enough to influence the climate much farther south. With reference to a mathematical model proposed by Pierre-Simon Laplace, it would take 220 years to lower the earth's temperature one single degree (21). 'As long as ice remains to thaw, or water to freeze', Leslie concluded,

1. The article was published anonymously but the authorship has been established by historian Janice Cavell (2008: 64, 257 n.52).

> the temperature of the atmosphere can never vary beyond certain limits. Such is the harmony of the system; and all experience and observation forbid us to believe it to be subject to any radical change. Some years may chance to form more ice than others, or to melt more away; but it were idle to expect any thing like a general or permanent disruption of the glacial crust which binds the regions of the North. (Leslie 1818: 19)

This did not mean that change could not occur at all. Leslie presented a long list of deviations in temperature plus extreme weather events from the fifth century onwards. From this historical perspective, the recent anomalies diminished in importance: 'On glancing over these slight notices, it is obvious that no material change has taken place for the last thousand years in the climate of Europe' (Leslie 1818: 30). True climate change would appear in 'vast cycles', and to understand these we would need further advancement in science, meteorology in particular (30). But when it came to the Arctic, Leslie was adamant in his conviction that 'we certainly can perceive no decided symptoms of any general or progressive tendency towards a dissolution of the Polar ice' (34). Leslie was not the only sceptic in this discourse, albeit arguably the most thorough and energetic. An editorial in *Journal of Science and the Arts*, published only a few days before the four ships set sail in 1818, downplayed the reports from the previous year and noted that the reduction in polar ice could very well be coincidental and not an indication of advancing climate change (Expedition 1818). As was the case with the polar ice, climate and climate change were contested areas in early nineteenth-century British discourse.

Hopes in vain

Arctic science and theories of climate did not begin with the expedition of 1818 and the reports of polar ice that preceded it, but these events gave the discourse mapped here considerable momentum and fuelled the dissemination of the polar imaginary in the broader culture in Britain, illustrated here by the poems of Wilton and Porden. There were several forerunners. One is the book from 1806 by John Williams entitled *The Climate of Great Britain; or Remarks on the Change it has undergone, particularly within the last Fifty Years*. Although Williams's focus was on domestic agriculture, he stressed the wider importance – 'the health of Mankind' – of an improved understanding of the elusive climate (Williams 1806: v). No less ambitious but with greater authority, Erasmus Darwin treated the subject in *The Botanic Garden* (1791). With reference to articles in *Philosophical Transactions* and to Boyle's experiments, Darwin subscribed to the idea that the alpine glaciers as well as the masses of ice in the Arctic were growing. Darwin unequivocally stressed the correlation with the British climate: ‘we cannot doubt but that the northern ice is the principal source of the coldness of our winters, and that it is brought hither by the regions of air blowing from the north’ (Darwin 1791: 51). Furthermore, Darwin proposed that these forces ought to be mastered for the benefit of civilisation. If a method were developed, he speculated, to transport icebergs from the Arctic to southern regions, the advantages would be twofold: ‘the tropic countries would be much cooled by their solution, and our winters in this latitude would be rendered much milder for perhaps a century or two, till the masses of ice became again enormous’ (51). Such ideas about geoengineering *avant la lettre*, as it were, also featured in the discourse some decades later. The aforementioned article in *Omniana* from 1812 explicitly referred to Darwin’s proposal, and added another method, namely, to erect electric mills all over the country to supply electricity to the atmosphere and thus affect the weather. Similar thoughts about electricity as a key factor in weather – and, by extension, climate control – were expressed at length by Williams (1806: 343–58).

Williams and Darwin may illustrate that the far-reaching discourse about polar ice and climate around 1818 was a culmination, not a starting point. Various theories of climate change had been suggested throughout the early modern period. With the unfolding of the scientific revolution from the seventeenth century onwards, these theories gradually downplayed theological explanations in favour of natural or anthropogenic causes (Fagan 2000; Gilson 2015; Parker 2017: 7–15). New ideas paved the way for an emerging subfield of natural philosophy later to be labelled climatology. Input ranged from regional observations to grand theories of the Earth. The most influential thinker with a planetary perspective was arguably Georges-Louis Leclerc Buffon. In *Epochs of Nature* (1778) Buffon presented a theory of continuous global cooling. It took 60,000 years for the Earth to reach a temperature in which humans could thrive, Buffon argued, but we are probably at the end phase of this climatic optimum. Indicators of this was, first, the growth of the Alpine glaciers and, second, the polar ice at Spitsbergen and Greenland, which was larger than a century ago (Buffon 2018: 168–175). Although Buffon briefly referred to Phipps and other explorers his planetary conception was founded on experimental science and theoretical physics.

In the early nineteenth century, climate theories could draw from new observations of the polar ice – ‘these wonderful productions of the Frigid Zone’, in the words of Scoresby (1820: 252). As this article has shown, extrapolations from these observations were tentative and contested, and at the same time infused with radical claims. Not only was global climate considered a notoriously complex issue, it was ‘commonly treated in a very loose manner’, stated *Encyclopaedia Britannica* in 1818 (Climate 1818: 177). This encyclopaedia entry refers briefly to the theories of Alexander von Humboldt, whose newly presented concept of isotherms was also highlighted by Brewster in 'Observations on the Mean Temperature of the Globe' (Brewster 1818–1823). The theories of Humboldt established the basis of modern climatology (Mauelshagen 2018), and not long thereafter groundbreaking progress was made in the understanding of glaciers by Louis Agassiz, Ignaz Venetz and others. Venetz gave new input to conceptions of the Earth's large expanses of ice and thus to the Arctic environment, which the travelogue of Beechey exemplifies. Consequently, the premises for scientific discussions of climate and polar ice changed a few decades into the nineteenth century.

The animated discussions mapped here, ignited by reports of reduced ice in 1817, petered out rather quickly. However, some of the ideas lived on – for example, the idea of a lost colony trapped behind a barrier of Arctic ice (Rix 2023b). The high expectations of Wilton, Porden and others came to an anticlimactic end when the twin expeditions of 1818 returned to England. No Northwest Passage had been found. The North Pole had not been reached. And perhaps more importantly, the ice had not continued to melt away but was back to normal. In hindsight, the conditions of 1817 appeared as an inexplicable anomaly, just as Leslie – and Scoresby (1820: 264) – had suspected. In the Far North as well as at home, the cold remained during the last decades of the Little Ice Age.

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RURAL INFERNO: ENVIRONMENTAL AND SOCIO-ECONOMIC CONSEQUENCES OF WILDFIRES IN SEVENTEENTH-CENTURY WESTERN FINLAND

Jakob Starlander

ABSTRACT: This article addresses the impact of wildfires on rural peasant communities during the pre-modern period. It demonstrates how and when wildfires started, what was done to limit their occurrence, what economic and environmental consequences followed, and what social safety-nets existed. By using the case of Lower Satakunta (Western Finland) during the seventeenth century, the article reveals that the occurrence of wildfires was strongly correlated with agricultural methods, climate variability, and weather conditions. The environmental consequences often led to substantial loss of forest and agricultural lands and the economic consequences were often such that, without aid from the local community, the future existence of peasant households was impossible. Nevertheless, through the renewed medieval laws on fire support (Sw. *brandstod*), peasant communities were able to create socio-economic safety nets that helped them withstand and recover from fire disasters.

KEYWORDS: Wildfire, forest, agriculture, climate, environmental hazards

Introduction

Fire is a prerequisite for life. Without it, civilisation would not have emerged. Historically, it has provided humankind with warmth that made it possible to survive nature's elements and heat with which food was prepared, and it has been a cornerstone of industrialisation. But it is also a terrible force. From just one spark, it can spread with breathtaking speed, laying waste to buildings, cities, forests and life. Within historical research, scholars have mainly focused on urban environments, with fire labelled as the greatest threat to cities and towns during the early modern period (Allemeyer 2007: 146). In early modern Europe, perhaps the most notorious example is the Great Fire of London, which began in the oven of a bakery on Pudding Lane on 1 September 1666. When the smoke had settled, roughly 13,200 houses had been destroyed and 100,000 people had been rendered homeless (Garrioch 2016: 319). In a Swedish context, the royal castle *Tre Kronor* (En. Three Crowns) in Stockholm almost completely burnt down, consuming most of Sweden's old national archives and its royal library on 7 May 1697, presumably due to a poorly maintained chimney (Söderlund 2001: 153–67).

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Historically, there have been many reasons why fires broke out, although they did not happen at random. The frequency and intensity of fires (fire regime) has shifted over the centuries, which can be explained by changing economic, commercial, industrial, social and environmental conditions (Bankoff et al. 2012). However, the impact of climatic conditions on the occurrence of urban fires has only recently been the subject of more detailed investigation, which has shown how episodes of drought and particularly dry and hot years coincided with major urban fires during the Little Ice Age (Zwierlein 2021; Garrioch 2024). Whilst the study of urban fires makes it possible to better understand how the use of fire has affected and changed past societies, the use of fire and consequent disasters also occurred in the countryside. As such, this article takes a different approach in arguing that sustainable use and (mis)management of fire has played a much more crucial role in rural environments than current historiography has shown. The aim of the article is thus to quantitatively and qualitatively examine fire disasters in the Finnish countryside during the seventeenth century. The hitherto virtually unaddressed issues of how and when rural fires started, how they spread and what was done to prevent them, their environmental and economic consequences, and what socio-economic safety nets existed for rural communities will be examined, as well as how climatological variations can be used to explain this development.

Lower Satakunta

The region under investigation in this article is Satakunta, today located in Western Finland, which was a part of the Swedish Kingdom until 1809. Administratively, it was a part of the Province of Turku and Pori (Sw. *Åbo och Björneborgs län*) and was divided into two parts, Lower and Upper Satakunta, of which this article focuses on the former. The region had two towns, Pori (Sw. *Björneborg*) and Rauma (Sw. *Raumo*), but it was an economic-geographic area characterised by agriculture and cattle breeding (Huhtamies 2004: 25). Peasant farmers constituted the majority of the rural population (with a small portion of landless people), which grew from around 30,000 at the beginning of the seventeenth century to over 50,000 in the mid-1690s (Koskinen 2017: 90). Many villages were located along the rivers stretching from the coast and throughout the landscape, and most people belonged to, and worked within, a peasant household of between seven and nine inhabitants. As such, the peasant population shared certain circumstances in terms of living conditions, although other circumstances separated them distinctly. Whilst field cultivation was practised throughout the region, this was complemented by a higher degree of cattle breeding in the southern parishes, whereas grain cultivation was more important for the peasant economy in the north. Furthermore, the northern and southern parishes differed in the matter of land ownership. The proportion of peasants cultivating homesteads owned by the nobility (Sw. *frälsehemman*) was larger in the north than in the south where freeholding peasants and Crown holdings (Sw. *kronohemman*) were more common (Huhtamies 2004: 25 & 48–49). However, much land that had been given to noble families by the Swedish Crown during earlier centuries was recalled with the Great Reduction (Sw. *den stora reduktionen*) in 1680, which changed the composition of land ownership (Prytz 2013: 224–25; Koskinen 2017).

Another circumstance that created further divisions among the peasant population was brought on by the wars of the seventeenth century, especially the Swedish Kingdom's involvement in the Thirty Years' war (1618–1648). The parishes of the region became successively characterised by a noticeable wealth inequality due to the socio-economic advances taken by some peasant homesteads in becoming *rusthåll* (Huhtamies 2004: 50–51). This was a maintenance and recruitment solution where each peasant was responsible for providing the army with a cavalryman and horse as well as for paying for the equipment and the rider's salary (Thisner 2014: 20–21). Furthermore, as explained by Mikko Huhtamies (2004: 159–63), peasant households that kept more livestock could more easily overcome the socio-economic challenges associated with recurrent conscriptions. Earlier research has shown that the level of vulnerability, or social vulnerability, can differ considerably between different groups depending on economic, social and political factors (Van Onacker 2019). Considering the differing circumstances in terms of living conditions in Lower Satakunta, the hypothesis has been that those living under less favourable economic conditions were worse off and more vulnerable as fire disasters occurred.

The relevance of the region in terms of studying rural fires can be established based on the different ways in which fire was used in everyday life. In the Swedish Kingdom, and especially in Finland, slash-and-burn agriculture was practised throughout the Middle Ages and continued until the early twentieth century (Myllyntaus et al. 2002). It is an extensive form of cultivation that has been, and still is, used by rural populations all over the world (Kleinman et al. 1995; Scherjon et al. 2015; Tedim et al. 2015; Tomson et al. 2015). It includes cutting and burning forested or bush-covered areas, the ash from which boosts soil fertility, which allows productive cultivation for one or several years. In Finland, it was also common to dry grain in grain barns (Fi. *riihi*; Sw. *ria*) where it was laid on thinly spaced bars under which a fire was lit. Both practices naturally entailed an elevated risk of fires breaking out and demanded meticulous supervision. Furthermore, the wealth of source materials from this region makes it possible to use a bottom-up perspective.

These materials consist of local district court protocols containing first-hand accounts of the course of fire events and tax records that reveal the subsequent economic impact on peasant households.

Consequently, since the peasant population shared certain living conditions whilst other circumstances separated them, the article will discuss the degree to which they, as a larger community, dealt with disaster events that, in one way or another, concerned and affected them all. As such, it will be possible to determine whether certain parts of the population were made more vulnerable than others after fire disasters occurred.

Sources

For clarity, a definition of the word ‘wildfire’ is needed. In the *Oxford English Dictionary*, it is defined as a ‘Furious or destructive fire’[1] that spreads ‘with immense rapidity and effect; very swiftly and forcibly: usually with run, spread, etc.’[2] In this article, the terms *forest fire* and *settlement fire* are used, which indicate the fires’ place of origin. Nevertheless, the word *wildfire* is sometimes used as an umbrella term when fires are discussed in general.

Three categories of sources are analysed in this article, the first and main one being local court records (Fi. *Renevoidut tuomiokirjat*). The seventeenth-century local court was a place where people went to make their complaints heard, to make collective decisions and come to terms with each other over a plethora of different issues. It was a place where both formal and informal rules and agreements were discussed and, as such, it was an important conflict-solving arena for the rural population (Korpiola 2014; Larsson 2016: 1101–102; Starlander 2023: 70–76). It was also here that people went after a fire had struck in order to determine who had started it, what the damage was and what level of compensation should be given to the suffering parties. These sources make it possible to get a detailed grass-root perspective of the chain of events leading up to fires occurring, but also to reveal the after-effects. However, whilst the court records contain valuable descriptive information on the nature of how fire events occurred, it is difficult to establish exact statistics of their occurrence. The reason is because not all fire events were reported to the courts, which is similar to urban fires (Garrioch 2018: 203). This becomes evident from a court case that took place in Loimaa parish in 1691. As the homestead of chaplain Mathias Rungius was to be appraised, it was reported how the

1. *Oxford English Dictionary*, s.v. ‘wildfire (n.), sense 1’, https://doi.org/10.1093/OED/7031123310 (accessed 10 April 2024).

2. *Oxford English Dictionary*, s.v. ‘“like wildfire” in wildfire (n.), sense 5.c’, https://doi.org/10.1093/OED/1913611847 (accessed 10 April 2024).

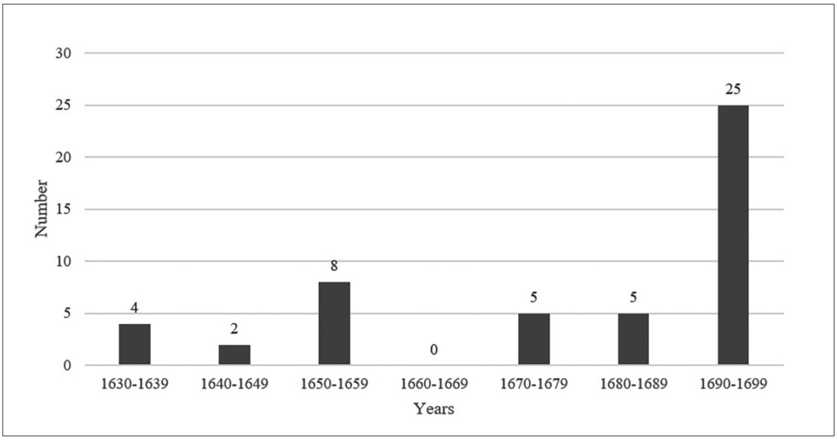

Figure 1. Recorded forest fires in Lower Satakunta in ten-year increments, 1634–1699. Data source: NAF, Court Records.

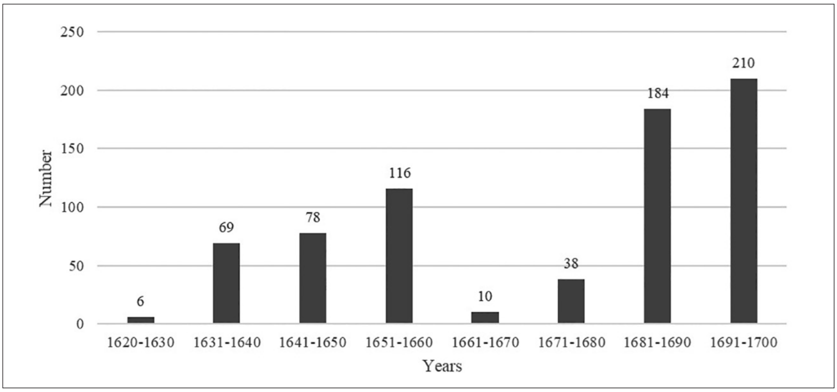

Figure 2. Applications for fire support in Lower Satakunta, 1620–1700. Data source: NAF, Court Records.

'concerned homestead and its stakeholders' forest and outlying lands during fifteen years had burnt down five times', yet no mentions of the preceding fires are found in the court records.[3] Furthermore, when it comes to forest fires, each case does not always represent one fire event. This is because particularly severe fires could be recurrently discussed at the local courts several years after

3. Vinterting, Loimaa parish, 7, 9 and 10 March 1691, NAF, Court Records, II KO a:6, 1691–1691, act 65. Original text: 'ber:de hemmans och dess Intressenters tilhörige skogh och uthmarck uthi fembton åhrs tidh femb gånger afbrunnit'.

they had happened. However, qualitative investigation has made it possible to determine that a total of 49 individual forest fires are referenced in the court records between 1634 and 1699 (Figure 1). In addition to these, 711 cases concerning applications for economic relief following a fire event have been found (Figure 2).

To evaluate the efficiency of the economic relief system, the second source category is seventeenth-century tax records. These provide information revealing whether peasant households were able to resume the cultivation of their homesteads after having been exposed to a fire. Lastly, Swedish legislation has been used to establish what impact this had on the peasants' ability to resume and rebuild their lives.

Forest fire legislation and climate

As mentioned earlier, where there is human life there is also fire. This means that the nature of how fires start, and thus what consequences they have for the natural environment and society, is shaped by human activity since its induction is often anthropogenic, caused by human industry or mismanagement (Kala 2023). However, climatic conditions and the biophysical environment in which people live and work are circumstances that similarly contribute to how and when fires break out (Mhawej et al. 2015).

During the seventeenth century, the Swedish Crown experienced growing fear of a wood shortage in the kingdom. This resulted in new forest legislation being decreed that put greater responsibility on the rural population in terms of how they managed their forests (Warde 2018: 78–79; Starlander 2023: 42). In the Swedish part of the realm, slash-and-burn agriculture was heavily restricted in the new legislation since authorities viewed it as wasteful and because of the risk of wildfires, although it remained commonplace in the Finnish part of the realm (Kuisma 1984; Sundin 1992: 372). However, the escalating trend of forest fires eventually led legislators to pass the Royal Forest Fire Ordinance in early 1690, which decreed that 'during the times and the year that a great drought occurs, no swidden should be lit, or burned that year, but be postponed to another year and a more convenient time'.[4]

The success of the new legislation is difficult to determine. However, it is noteworthy that 24 of the 25 reported fires in the 1690s occurred between 1690 and 1693 (Figure 3).

4. *Kongl. May.tz Förordning, Angående Skogz-Eldar, sampt deras förekommande och släckiande. Gifwen Stockholm den 10 Novembr. Åhr 1690* (1690). Stockholm, Printed Kongl. Booktryckerijet, Sal. Wankijfs Effterlefwerska. Original text: 'De tijder och det Åhr/ som stoor Tårcka infaller/ skall icke någon Swedja antändas/ eller det Åhret brännas/ uthan där med upskiutas till annat Åhr och beqwemligare tijd'.

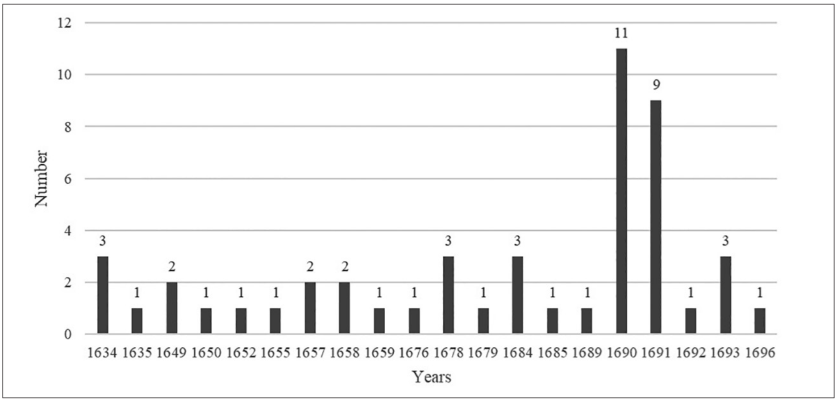

Figure 3. Recorded yearly occurrence of forest fires in Lower Satakunta, 1634–1699. Data source: NAF, Court Records.

There are several possible reasons for the absence of fires during the post-1693 period. Although it took three years, it is possible that the fire-repressive instructions contained in the Royal Forest Fire Ordinance gradually gained influence among the rural population, which made fire prevention measures more effective. Another possible explanation can be drawn from the fact that the region saw a significant cultivation and population growth during the later decades of the century up until the great famine of 1695–1697 when as much as 28 per cent of the population perished (Koskinen 2017: 57, 90). The number of fires could well have been a result of this development, given the exploitation and cultivation practices used in the region, and it may explain the absence of fire events during the latter part of the decade. However, it can also be explained by climatic conditions. As can be seen in Figure 4, the mean temperatures during the summer months (June, July, August) were notably higher during the period 1689–1694 than during the succeeding years, as a drastic shift can be noted in 1695, which persisted throughout the century. Furthermore, the summer months of 1689–1694 were the warmest consecutive summers during the whole study period (Figure 5), which could have strongly affected the occurrence of wildfires. This is further substantiated by written accounts as the records of both Kokemäki and Eura parish contain descriptions of the 'very dry summer' of 1691 and that 'drought' persisted.[5]

5. Ting, Kokemäki parish, 8 and 9 Oct. 1691, NAF, Court Records, II KO a:6, 1691–1691, act 250–251. Original text: 'muckit tårr sommar.' Sommarting, Eura parish, 3 and 4 June 1692, NAF, Court Records, II KO a:7, 1692–1692, act 63. Original text: 'torka'.

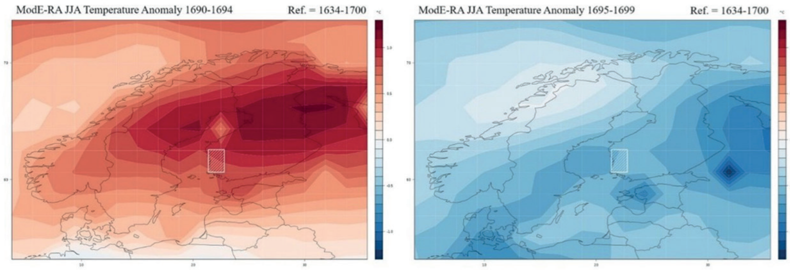

Figure 4. Mean temperature during JJA (June, July, August) during 1689–1694 to the left and mean temperature during JJA during 1695–1699 to the right. Data source: Warren et al. (preprint).

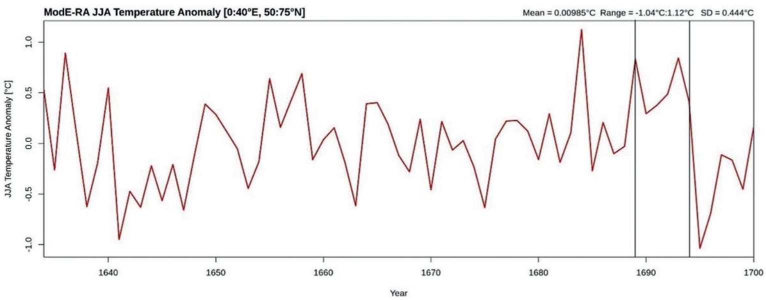

Figure 5. Temperature anomalies during JJA (June, July, August) between 1643–1700, showing the warmest consecutive summers between 1689–1694. Data source: Warren et al. (preprint).

How and when fires started

There were many ways in which a forest fire could start. In 1649, for example, the peasant Erich Jönsson was accused of causing a forest fire by failing to sufficiently supervise his cooking fire, which quickly spread and caused great damage to the forest.[6] In June 1659, a young girl called Lisa got lost in the forest and a group of women and men went in search of her; however, they were unable to locate her before darkness fell. They were forced to make camp

6. Höstting, Huittinen parish, 2 and 3 Nov. 1649, NAF, Court Records, I KO a:6, 1644–1649, act 604–605.

for the night and made a fire in an old pine stump, which they forgot to put out ‘and thus the forest was destroyed’.[7] However, fires were more commonly caused through forestry and agricultural work.

Slash-and-burn agriculture was a common agricultural practice in the Baltic region during the early modern period (Myllyntaus et al. 2002). This included Finland, but also places like Estonia, where it has been shown that this fire cultivation played a significant role in the formation of present-day forest landscapes as such cultivation sites are now covered by mature trees (Tomson et al. 2015), and it has been proven that an intermediate level of forest disturbance boosts forest diversity (Kleinman et al. 1994; Downey et al. 2023).

The cutting was often done during the spring and the trees and branches were laid to dry until the following year when they were ignited during spring or early summer (Lindman 2005: 10–11). The risk of fires spreading from such a combustion-rich environment was always present. The Lower Satakunta court records reveal that this exploitation type was the most common factor in triggering forest fires. For example, in the parish of Eura in 1652, the peasant Henrich Thomasson explained how fire had spread from a swidden belonging to two peasants from a neighbouring village and that ‘the fire thereby caused great damage to their forest’.[8] In late June 1690, in the same parish, Mårthen Henrichsson accused Jacob Matsson and the soldier Anders Simonsson of having let the fire from their swidden spread, which had burnt ‘the entire outlying land and caused incurable and priceless damage’. Whilst Jacob was present at the court meeting and denied all accusations, the soldier Anders was not. However, his wife Karin Henrichsdotter was, and she told the court how Jacob ‘had asked her to go with him to light the swidden, which she also did, and when Jacob had set fire to his swidden, he gave her fire, which she carried and put in her swidden, which was close by Jacob’s’. The layman Anders Otila further informed the court that ‘the fire lingered for five weeks close to the burned land, and simmered, until it widened and broke loose, where it could well have been extinguished and prevented, but no one saw to take care of it’.[9]

7. Sommarting, Ulvila parish, 8 and 9 Aug. 1659, NAF, Court Records, I KO a:3, 1658–1659, act 292–293. Original text: ‘och således Skogen förderfwadt’.

8. Höstting, Eura parish, 25, 26 and 27 Oct. 1652, NAF, Court Records, I KO a:7, 1650–1652, act 475. Original text: ‘der igenom Elden stoor skadha opå deras skogh giordt’.

9. Höstting, Eura parish, 17, 18 and 19 Sept. 1691, NAF, Court Records, II KO a:6, 1691–1691, act 197–198. Original text: ‘heele uthmarcken förbräntt och obotelig sampt owärderlig skada giort’; ‘bedit henne gå medh sigh att itända sweden, dett hon och giort, och enär Jacob hade satt eldh i sin swedh, gaf han henne eldh, som hon baar och satte i sin swedh, hwilcken när inn widh Jacobs war’; ‘elden drögdts femb weckors tidh, när inn widh bemt: swedieland, och Kyttiat, förr än der sigh wigdade och lööskom, hwarest den wähl kunnat släckias och i tijdh förekommas, men ingen sigh der om wårdat’.

Settlement fires were many times more common than forest fires, which is not altogether surprising. Even though slash-and-burn agriculture and fire clearing of unploughed meadows (Sw. *ängsröjning*) or forest lands was hazardous, these were relatively infrequent events seen over the course of a whole year, whereas fire was a constant feature of life at the homestead. Out of the 711 cases concerning settlement fires, 161 cases (22.6 per cent) were treated by the local court in Huittinen parish alone. These cases have been studied in detail and provide valuable information on the seasonality of settlement fires. Not only do they contain information on how the fires started and what consequences followed, but also often the month (sometimes the exact date) when they occurred. In the case of Huittinen, this is specified in 95 of the applications. More than half the fires (51.5 per cent) took place during the autumn months (September, October, November), whereas less than a fifth (17.8 per cent) occurred during the hottest months of the year (June, July, August).[10]

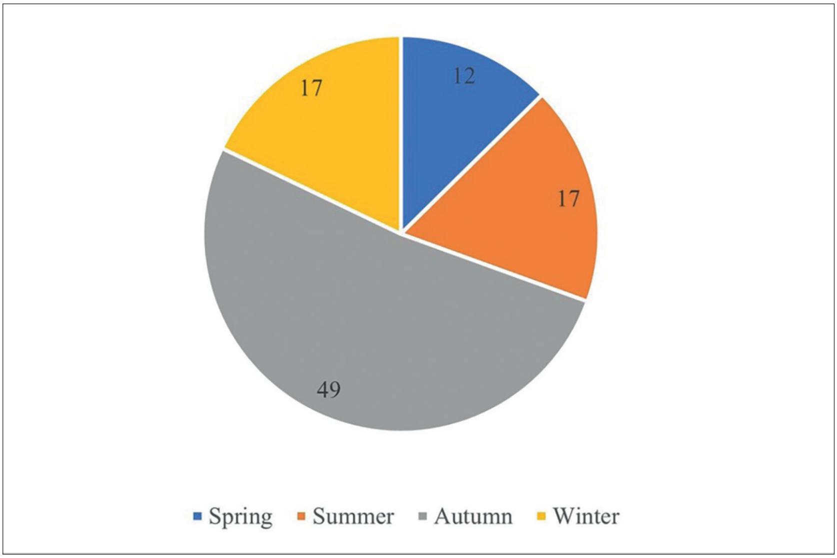

Figure 6. Seasonality of settlement fires in Huittinen parish. Data source: NAF, Court Records.

Fluctuations in the occurrence of fires during certain historical periods have much to do with climate. It has been argued, for example, that the risk of fires during the climatic regime of the Little Ice Age was generally low. However,

10. The percentage for the winter months (December, January, February) is 17.8 per cent and for the spring months (March, April, May) 12.6 per cent (see Fig. 6).

since the colder climate required people to heat their homes for longer periods of the year, it has been theorised that it could have led to an increase in urban fires (Garrioch 2018: 206–07). This may be one reason why settlement fires were more frequent in the autumn than in summer. However, a more compelling factor has to do with the time of harvest. The harvest season typically occurred in August and September. As mentioned earlier, it was common to dry the harvested grain in grain barns (Fi. *riihi*; Sw. *ria*) using fire. However, it was not uncommon that the heat ignited the grain and ultimately the barn itself. If it had been a dry summer and the wind was strong, the distance between the buildings did little to prevent the fire from spreading. For example, in October 1691, the peasant Mårten Henrichsson from the village of Jalanoja told the local court that a recent fire had consumed several buildings and barns containing much of that year's harvest worth 100 copper thalers. When asked how the fire had started, Mårten's neighbours explained that the fire had started in the drying barn and that 'the fire at the wall of the oven was burning, of which no one knew until it in the grain had the upper hand, which later could not be extinguished'.[11]

In establishing how and when forest and settlement fires started, it can be determined that there was a strong correlation between forest fires and the practice of slash-and-burn agriculture – in other words, that they were caused by anthropogenic factors, including exploitation type and proximity to forests and agricultural lands. Settlement fires were common throughout the century, with most occurring during the harvest times due to the practices of grain drying. However, even though the different kinds of fire events contrasted in terms of how and when they occurred, they were both equally affected by factors related to the nature of how fire spreads.

How fires spread and were prevented

The location at which a fire started determined the devastation it left behind (Garrioch 2018). Fires that started in buildings were often confined to a peasant farm or village, and rarely spread further into the forest and outlying lands. However, cultivated lands and infields were vulnerable due to their proximity to buildings, which sometimes resulted in the annual growth of one or several homesteads being completely burnt. Nevertheless, the infields functioned as a kind of buffer zone since measures to halt or redirect the fire were more easily carried out here than in the forest. This was done, for example, by clearing areas

11. Höstting, Huittinen parish, 1, 2 and 3 Oct. 1691, NAF, Court Records, II KO a:6, 1691–1691, act 241. Original text: 'elden sigh widh ugnen wäggen itändt, hwar af ingen wetat, för än den uthi der insatte säden hafft öfwerhanden, som sedermera eij stodh att släckia'.

and digging ditches to separate as-yet unaffected biomass from the spreading fire, something that a few peasants in Huittinen parish successfully did in 1693 when a fire was spreading in the area where they lived.[12]

The severity of a fire is dependent on several factors, such as weather conditions, including drought, low relative humidity, unstable air and strong surface wind (Werth et al. 2011: 25; Lecina-Diaz et al. 2014). In the latter case, earlier research has established different spread schemes and factors where wind plays a determinative role in the severity and spread of wildfires. There are convection or plume-dominated, wind-driven and topographic fires. The main difference between them is their behaviour and the intensity with which they burn, with convection or plume-dominated fires being the most extreme and topographic fires being less severe and more influenced by local winds shaped by topographic factors (Sande Silva et al. 2010: 126; Lecina-Diaz et al. 2014). Historically, information about the danger and propelling effects of wind can be found, for example, in reports produced after the devastating fire in the Swedish town of Sundsvall on 25 June 1888. Not only had the days preceding the fire been particularly hot and dry, but strong winds contributed greatly to its spread, ultimately making around 9,000 of the city's 10,000 inhabitants homeless (Rohland 2011: 157, 161).

Similar accounts can be found in seventeenth-century Lower Satakunta as well – for example, in the parish of Ulvila in 1693. The peasant Johan Andersson told the local court that several of his outbuildings had burnt down in late September that year, to which his neighbours Olof Henriksson and Gertrud Simonsdotter further added that the fire had started in a nearby field from which it quickly spread due to the 'persistent storm'.[13] Another example is from the neighbouring parish of Kokemäki as the circumstances related to a particularly severe wildfire caused by mismanaged slash-and-burn agriculture were discussed. Three individuals stood to answer the court on the matter of who had instigated the fire that had 'caused irreparable damage, that cannot be assessed' to the outlying lands and forests of several villages in the parish, including all the outlying lands of the village of Harjavalta during the summer of 1691. As one of the accused, the peasant Henrich Eriksson, called upon one of his witnesses, it was explained how the fire had spread from the village of Hiirijärvi located approximately five kilometres away 'and ultimately in the great storm over the public road threw itself'. At an earlier stage, the members of the court had similarly explained how the fire had been 'so fierce that it spread from the trees over the great Kokemäki river and began to burn' and that

12. Sommarting, Huittinen parish, 21 and 22 July 1693, NAF, Court Records, KO a:13, 1693–1693, act 359.

13. Höstting, Ulvila parish, 18, 19 and 20 Oct. 1693, NAF, Court Records, II KO a:1, 1693–1693, act 197. Original text: 'påliggande stårmen'.

'especially timber and bark forest as well as some meadows were destroyed by fire'. It was also described how the rapid spread was enhanced by the 'very dry summer' of that year.[14]

The effect strong winds had on the development and spread of a fire was something that both the rural population and Swedish legislators knew. In the case of the latter, the Royal Forest Fire Ordinance of 1690 specified how swidden 'must not be lit during stormy weather'.[15] Another example can be drawn from the precautionary measures taken in castles and fortifications during the eighteenth century as an increased number of guards were put on fire watch during such weather conditions (Sundin 1992: 404). Nevertheless, the accused in Kokemäki said that they had all made sure that their swidden had been put out several weeks before the great fire had started. However, the laymen of the court explained that they had seen how 'smoke had risen all summer since the fire had been simmering in the earth … even though it had been raining', which meant that it 'finally in one day extended over half a mile'.[16] The only thing that could be done under conditions like those of the summer of 1691 was to warn everyone of the rapidly spreading wildfire, which Henrich's wife Agnes Thomasdotter had done as she 'sat up on a horse and rode to the nearest villages with terrified shouts to come and help her'.[17]

Judging by the surviving accounts, the Kokemäki fire of 1691 can be categorised as a convection/plume-dominated or wind-driven fire, considering its reportedly violent behaviour, the propelling effects of the persistent wind and the availability of combustible biomass (Lecina-Diaz 2014: 2). Wildfires as severe as the one in 1691 are unprecedented in the records of Lower Satakunta during the seventeenth century. However, fires of a lesser magnitude could still cause irreparable damage and devastation for individual households

14. Ting, Kokemäki parish, 8 and 9 Oct. 1691, NAF, Court Records, II KO a:6, 1691–1691, act 250–251. Original text: 'giort een obotelig skada, som intet skall kunna verderas', 'så häfftigh att den ifrån trään slagit öfwer stoora Cumo Elfwen och begyntt brinna', 'besynneligast timber och näfwerskogene sampt några ängiar wara af eldh fördärfwade'; 'muckit tårr sommar.' Ting, Kokemäki parish, 4, 5 and 6 Oct. 1692, NAF, Court Records, II KO a:7, 1692–1692, act 216–217. Original text: 'och omsijder i stora stårmen öf.r allmänne wägen sig kastat'.

15. *Kongl. May.tz Förordning, Angående Skogz-Eldar, sampt deras förekommande och släckiande. Gifwen Stockholm den 10 Novembr. Åhr 1690* (1690). Stockholm, Printed Kongl. Booktryckerijet, Sal. Wankijfs Effterlefwerska. Original text: 'Måste icke påtändas när Stormwäder är'.

16. Höstting, Kumo parish, 8 and 9 Oct. 1691, NAF, Court Records, KO a:6, 1691, act 250–251. Original text: 'röök slåtts på den kantten upgå heela Sommaren hwarest elden i jorden legat och Pyttiat … fast om dett regnat', 'omsider på een dag fahrit öfwer half mijhl wägh'.

17. Kokemäki parish, 4, 5 and 6 Oct. 1692, NAF, Court Records, II KO a:7, 1692–1692, act 216–217. Original text: 'satt sig på hästen och näste byarne tillrijdit medh farligit anskrij komma at hielpa henne'.

and villages. Nevertheless, the spread of fires that were more sensitive to topographic variations could be repressed by measures that are recounted in the court records, such as digging ditches as mentioned above. However, another strategy was to counter the spreading fire with a new one.

In Sweden, prescribed burning (or controlled burning) has been practised since the 1890s (Cogos et al. 2020). It is a method by which one intentionally starts a fire, thereby clearing an area of hazardous fuels that can intensify the severity of a wildfire and thus decreasing the risk of wildfires occurring altogether. A much older and similar agricultural tradition is slash-and-burn agriculture, which was, as mentioned earlier, widely practised in Finland for many centuries (Kardell et al. 1980: 10–11; Myrdal and Söderberg 1991: 356; Lindman 2005). Controlling intentionally ignited fires was therefore something the rural population knew a lot about, and the benefit these could serve as a fire hazard reduction method is evident in the court records. For example, in 1693, the peasant Jacob Matsson stood accused of having unleashed a fire that had spread throughout the forest common of his and a few other villages. However, Jacob explained that the fire was started by a soldier named Sigfred Matsson and that he himself had witnessed the fire approaching his homestead and therefore 'started another fire, in order thereby to avert a greater danger, which would run against the soldier's fire'. The fences surrounding Jacob's meadow were nonetheless burnt, although his homestead survived.[18] It is evident, therefore, that whilst mismanagement of fire and accidents was in some sense inevitable, the rural peasant population possessed knowledge of how to effectively quench fire with fire.

In the wake of fire – environmental consequences

When properly controlled, slash-and-burn agriculture yielded nutritive soils favourable for cultivation. However, recent studies have highlighted the fact that the burning of organic matter (either controlled or uncontrolled) has consequences for soil resilience as it affects the chemical properties of the soil, leading to either an increase or decrease of available nutrients. This is determined by the fire's intensity, extent and recurrence, as well as by the amount of available biomass that is burnt and the characteristics of the soil (Datta 2021: 2; Agbeshie et al. 2022: 1420; Chicco et al. 2023: 1–2). However, even though the regeneration capacity of soils and organic matter is often high, particularly severe fires can result in long-lasting degradation and aridity,

18. Sommarting, Huittinen parish, 21 and 22 July 1693, NAF, Court Records, KO a:13, 1693–1693, act 357–359. Original text: 'han optendt en annan eldh i mening att der medh afwäria en större fara, som skulle löpa emot Såldatens eldh'.

sometimes for tens of years (Zavala et al. 2014: 311). This is substantiated by the Lower Satakunta court records, as two cases were discussed in 1681 in the parish of Loimaa. The first concerned a fire that the peasant Jacob Jöransson had caused many years previously. At that time, the fire had spread and burnt the chaplain's lands, consuming three loads of winter hay. However, the more pressing point was that the soil had burnt so fiercely 'that it in 10 years did not come to its previous growth'.[19] The second case concerned a forest fire that broke out in 1678 that had spread into the fields of a certain homestead, which 'had become severely emaciated' since the fire had 'burned so deep in the earth, that it is impossible to determine when any grass will grow again'.[20]

The environmental devastation of wildfires often leads to a severe reduction of available resources that are essential for rural households, but it can also drastically reduce their ability to import and export resources and products that they produce (Kala 2023: 291). The most important export commodities from Lower Satakunta were livestock, livestock products and to a certain degree tar (Huhtamies 2004: 48). Given that the animals grazed in the forests during summer, livestock production was negatively affected when a wildfire eliminated this possibility, but spreading fires could also claim the lives of the animals themselves. In 1693, a fire was quickly spreading in the parish of Ulvila at the same time as a servant girl named Lisa Enutsdotter was grazing a herd of cows in the forest. As the fire was approaching, she moved the animals away from the fire, although one cow 'had hidden in a dense forest, obscured in the smoke because of horseflies and flies, so that Lisa did not notice it, until she came upon the cow a little later lying under a tree'.[21]

Whenever forest areas had burnt, estimations were not made of how large the area was worth in monetary terms. However, descriptions of the aftermath can be found. For example, in 1690 in Loimaa parish, a forest common belonging to a few villages had been 'completely burned so that not one fresh twig remained there'.[22] In the same parish, an adjacent forest that had survived the fire of the year before had burned due to a mismanaged swidden, meaning 'some suitable house timber, some bark and spruce twigs are available apart

19. Vinterting, Loimaa parish, 22, 23 and 24 March 1681, NAF, Court Records, I KO a:5, 1679–1680, act 663. Original text: 'att dhet uthi 10 åhr intet kom koma till sin förra wäxt'.

20. Vinterting, Loimaa parish, 22, 23 and 24 March 1681, NAF, Court Records, I KO a:5, 1679–1680, act 676. Original text: 'illa uthmerglat blifwit'; 'att man intet kan pröfwa när såsom dhe åter kunna kommat till någon grääswäxt igen'.

21. Vinterting, Ulvia parish, 12 and 13 March 1694, NAF, Court Records, II KO a:3, 1694–1694, act 34. Original text: 'undandålt sig i een trång skog, trängiandes sig till röken för brombser och flugor, att Lijsa den intet warsse blifwit, förr än hon koon lijtet der efter liggandes under träd påkommit'.

22. Vinterting, Loimaa parish, 7, 9 and 10[t]March 1691, NAF, Court Records, II KO a:6, 1691–1691, act 71. Original text: 'aldeles brunnit, att icke een färsk qwist der å mera qwarblifwit'.

from the logs that have already fallen, and those that are still standing are so burnt by the fire that they cannot be used'.[23]

Fire support and compensation

Swedish laws concerning the management of wildfires exist from the mid-fourteenth century. In the Country Law of King Magnus Eriksson from the 1350s, instructions are given on how to punish those who cause a fire and how different causes of such events merit different punishments. During the seventeenth century, one specific paragraph increased in importance, namely the one concerning fire support (Sw. *brandstod*), which was an early form of a 'half-public mutual fire and property insurance organisation at the countryside' (Hägg 1998: 110). It stipulated that '[i]n whatever hundred such damage has occurred, as has now been said, the hundred owes him fire support, according to how the damage is estimated', and furthermore how '[a]ll will take and give fire support, who are residents, clerics, and laymen, and likewise the members of their household. No one should be free from this.'[24]

As the frequency of rural fires increased during the seventeenth century, new legislative efforts were made as the medieval laws were updated to better aid those who suffered from fire disasters. This was done in 1642 with the renewed Beggar Regulation and in King Karl XI's House Inspection Ordinance of 1681. The motivation behind the revived legislation was the central government's desire to ensure a stable and continued flow of tax revenues. As such, the state emphasised the importance of fire support for the restoration of peasant homesteads, and in doing so, often allowed peasants three years of tax exemption (Sw. *frihetsår*) if it was deemed necessary.[25] To receive fire support from the parish community, a detailed investigation into why the fire had occurred and the extent of damage had to precede the application to the local court. In most of the applications, the content makes it possible to establish how severe the fires were, what was lost and what level of compensation was

23. Höstting, Loimaa parish, 24, 25 and 26 Sept. 1691, NAF, Court Records, II KO a:6, 1691–1691, act 208–209. Original text: 'något dugeligit huustimber, mindre näfwer och granris, finnes, föruthan dhe ståckar som dehls ellaredan äro needfallne, dehls och af dhe som ännu oprätt ståå, af elden så förbrände, att de inte kunna nyttias'.

24. *Magnus Erikssons landslag, i nusvensk tolkning av Åke Holmbäck och Elias Wessén* (Stockholm: Nord. bokh. (distr.), 1962), p. 120. Original text: 'I vilket härad en sådan skada än har kommit till, som nu är sagt, så är häradet skyldigt honom brandstod, allt efter som skadan blir uppmätt'; 'Alla skola taga och giva brandstod, som äro bofasta, klerker och lekmän, och likaså deras husfolk. Det skall ingen vara fri från.'

25. For more information on tax exemption (Sw. *frihetsår*), see Huhtamaa et al. (2022: 2087) and Starlander (2023: 73).

given to the applicant, but also on what grounds applications were rejected. Out of the 161 applications in Huittinen parish, the estimated worth of property lost can be established in 106 of the applications between the years 1635 and 1700, which varied between 25 and as much as 1,699 copper thalers for a single applicant. Nevertheless, the average loss was 257.5 copper thalers per case with a median of 120, where the average was within the range of three and the median one and a half annual wages of a shipbuilder during the latter part of the century.[26] Once the damage had been established, the level of compensation was set at a certain amount of money that every household in the parish was obliged to pay. By multiplying this amount by the number of taxpaying households, it is possible to determine how much the applicant ultimately received. The number of households can be found in contemporary tax records, which reveal that, on average, approximately a third of the value lost was reinstated by the parish community. However, larger compensations could sometimes be given if the fire was particularly severe.

In early modern Europe, it has been argued that laws and systems of relief can be seen as a form of control mechanism aimed at adjusting the behaviour of the applicant to what was deemed desirable (Hindle 2004; Spierenburg 2004). Building on questions put forth by Hindle (2004), Healey (2024: 21–22) has focused on reasons why relief was denied or withdrawn from an applicant in early modern England and found that the most common reason was the lack of necessity. In terms of having been exposed to a fire disaster, especially if the damage was minor rather than extensive, the necessity of being given financial aid could, from a contemporary perspective, be called into question. Nevertheless, the only issue that had to be established to receive fire support was whether the fire had been caused by accident or out of carelessness, where the latter led to immediate rejection. For example, in May 1690, the peasant Johan Johansson Ailu from the village of Nanhia explained to the court how he 'last summer by means of a harmful fire lost all his property, including both the house and barn, so that not a single corner of a house was left of the homestead after the fire'. The fire had started in the chimney of a smaller log cabin (Fi. *Pirtti*; Sw. *pörte*) that ignited the roof from which sparks quickly spread throughout the whole farm, consuming everything from buildings and hop yard to fences and fields. Since it could be established that it had not been caused by carelessness, Johan was granted one copper thaler by each homestead in Loimijoki, which amounted to 318.5 copper thalers. However, since the estimated value of the farm was 600 copper thalers, the court argued that 'since this fire support is small compared to the damage taken, Johan is urged

26. According to Koskinen (2017: 134), estimations of the total worth of peasant homesteads in this region were between 200 and 300 copper thalers.

to make a humble application to his Grace High Wellborn Baron and County Governor', so that he may 'enjoy a few years of freedom'.[27]

Even when carelessness could be established as the cause of a fire breaking out, the parish community could nonetheless choose to help the applicant without the court's ruling. Similar expressions of solidarity can also be seen in the Dutch Republic during the eighteenth century, where members of villages that had burnt down received help in the form of foodstuffs and money, both from within the community and from without (Teeuwen 2012; Duiveman 2021: 317–20). Furthermore, it was possible to submit applications in more than one parish if it was deemed reasonable. This can be exemplified by a case from mid-October 1682. Four peasants from the village of Mullila named Johan Davidsson, Pål Eskilsson, Henrich Clementsson and Jöran Henriksson explained to the court in Eurajoki that on 29 August they had lost all their houses and most of their personal property, at an estimated value of 1,934 copper thalers, in a fire. However, the court regretfully informed them that no legal fire support could be given since the fire had been caused by carelessness. Nevertheless, because of the considerable damage, the parish members promised 'to benevolently give them 1 copper thaler from each homestead here in the parish', which amounted to 144 copper thalers. However, given that this was not even a tenth of the value of what had been lost, they were urged to 'humbly seek their gracious lordship for some pardon on the taxes', which they eventually did.[28]

A petition was written and sent to County Governor Carl Gustav Soop who, on 14 November 1682, wrote a reply stating that, considering the great damage they had sustained, and since they 'loudly lamented not being able to build up and inhabit their homesteads and farms again, they should with a few years of freedom be provided and helped, thus and because their homesteads must not completely fall into desolation and become unused, but again be occupied and inhabited'.[29] However, even though they were spared from paying

27. Häradsting, Huittinen parish, 30 Sept. 1690, NAF, Court Records, II KO a:5, 1690–1690, act 199. Original text: 'förl.n Sommar förmedelst een skadelig wådheldh bårtmist all sin ägendohm, så och både Man: och fägården, att icke een Knuut opå dess hemman efter branden qwarblifwit', 'men som denne Brandstudh fast ringa emot tagne skadan förstår, underwisses Johan i ödhmiukheet hos hans nåde högwälborne H.r Baron och Landshöfdingen, ansöchning giöra'; 'några åhrs friheets uthniuta'.

28. Sommarting, Eurajoki parish, 12, 13 and 14 Oct. 1682, NAF, Court Records, II KO a:1, 1682–1686, act 195. Original text: 'opå Sochnens wegnar godwilleligen at gifwa dhem tillhopa 1 d km:t af hwart hemman här i Sochnen', 'ödmiukel. at sökia sit Nådiga Herskap om någon förskoningh på Uthlagorne'; Turun ja Porin läänin tilejä, Asiakirjat, 7355 Maakirja, 1682–1682, act 908.

29. Turun ja Porin läänin tilejä, Asiakirjat, 7358 Tositekirja, 1682–1682, act 1132. Original text: 'beklagandes sigh högeligen icke kunna sine Hemman och Gårdar igen upbygga och beboo, med mindre dhe icke medh några åhrs frijheet blifwa försedda och hulpne, Altså och på der

the king's taxes, it was not enough. Two years later, in early March 1684, the four peasants went to the neighbouring parish of Huittinen and explained their regrettable situation, requesting that they 'like in other parishes here in the hundred where fire support is granted, that in return for the damage they had suffered, that this parish also should give something for their rectification'. The laymen of the court and peasantry replied that they 'out of good will' would give them 8 *öre* copper per homestead, which amounted to about 75 copper thalers, that is, approximately four per cent of the estimated damage.[30] The investigation has not been able to reveal how many parishes the four peasants applied to for fire support, and thus how much economic relief they received. Nevertheless, by examining the tax records, it becomes clear that all of them were paying their taxes seven years after the disastrous event in August 1682, which means that the freedom years granted by the county governor, and the economic support given to them by the peasantry of the hundred, were enough for them to resume cultivation of their homesteads.[31]

Even though any compensation and help received was important for the survival of peasant households that had burnt down, it does not necessarily mean that the assistance strategies were successful. To establish the degree to which fire support was enough or not, the tax records are again useful. In the Swedish Kingdom, taxes levied on the peasant population increased throughout the seventeenth century and, together with conscriptions, were one of the most burdening responsibilities peasant families had to fulfil to be considered faithful subjects (Villstrand 1992: 65). Whenever a household was unable to pay the king's taxes for three years in a row, it became 'deserted' (Sw. *öde*) and was marked as such in the tax records. This did not always mean that it was deserted in a literal sense – the peasant family could sometimes remain at the farm as a tenant of the Crown – but it does indicate an inability to resume a sufficiently productive cultivation of the homestead and can therefore serve, as pointed out by Huhtamaa et al. (2022: 2080), as a proxy for a decline in subsistence. Since the court records contain the name of the applicant, in what village he or she lived and when the fire disaster had occurred, a detailed investigation of the tax records makes it possible to find out whether or not the homestead of an applicant became deserted after a fire. However, the tax and court records differ on a few key points, which makes it difficult to find fire support

Hemman ocke aldeles må komma uthi Ödesmåhl och Obrukade blifwa, Uthan igen uptagne och bebodde'.

30. Vinterting, Huittinen parish, 6, 7, 8 and 10 March 1684, NAF, Court Records, II KO a:1, 1682–1686, act 543. Original text: 'såsom andre Sochnar här i Häradet dhem brandhstudh ähr bewilliat, som emoth deras tagne skadha ringa skall förslå att och denna Sochnen till deras uprättelse något förskjuta wille', 'af een godh willia'.

31. Turun ja Porin läänin tilejä, Asiakirjat, 7384 Maakirja, 1690–1690, act 781.

applicants in the tax records. The person who went to the local court and filed the application and the one who turned up for the yearly tax registration of the peasant homestead was not always the same person. Therefore, only 56 of the 161 applications in Huittinen (34.7 per cent) can be confirmed and traced in the tax records. The results show that only four homesteads (seven per cent) were marked as deserted up to seven years after the fire events occurred. This is a remarkably small number, which proves the utility of the institution of fire support and the resilience of the peasant communities.

As mentioned earlier, the parishes of Lower Satakunta became gradually characterised by wealth inequality (Huhtamies 2004: 50–51). Under such conditions, previous research has determined how social networks and wealth inequality were important factors that affected the ability of peasant households to endure subsistence crises during the early modern period (van Bavel et al. 2018; Huhtamaa et al. 2022). Furthermore, it has been shown how the relative strength of intra-village exchange networks coulds have great implications for the ability of peasant communities to withstand great collective challenges (Vanhaute and Lambrecht 2011). When it comes to fire disasters, the Lower Satakunta case shows that it made no difference whether an applicant was a freeholding peasant or a tenant of the Crown or nobility. All applicants were treated the same by the local courts and were given equal opportunity and support to resume the cultivation of their homesteads after they had been devastated by a fire, which was very much facilitated by the solidarity shown and support given by the peasant communities of the region.

Conclusions

The aim of this article has been to describe and explain a historical development that has been surprisingly neglected in previous research. While fires in the urban space have been much researched by historians, questions about how this affected rural environments and societies still lack sufficiently clear answers. As such, the article has asked: (1) how and when wildfires started; (2) how they spread and were prevented; (3) what the economic and environmental consequences were; and (4) what socio-economic safety nets existed for the rural population. The area of investigation has been Lower Satakunta in Finland during the seventeenth century, a region that was characterised by field cultivation, slash-and-burn agriculture and cattle breeding, as well as growing income inequality during the period.

(1) The results have shown that the most common triggering factor of forest fires was the peasantry's practice of slash-and-burn agriculture. Even though Swedish legislation existed that was meant to prevent peasants from practising

this agricultural method, it remained common in Finland for several centuries after the seventeenth century ended since it generated better yields than arable cultivation. Therefore, and bearing in mind the cultivation and population growth during the latter decades of the century, the number of forest fires reported in the court records increased during the period. Correspondingly, the number of settlement fires also increased. The occurrence of fires had a strong connection with the rhythm of the yearly working seasons. Since the lighting of swidden was carried out during spring and early summer, most forest fires occurred during this period, whereas settlement fires were more common during the autumn months. This was because of the harvesting methods practised, whereby grain was dried in grain barns with the aid of fire. However, it has also been possible to determine how climatic conditions played a role in their occurrence.

(2) The spread of fires was highly dependent on climate and weather conditions. In accordance with earlier research, the investigation has revealed that strong winds coinciding with drought had severe propelling effects on the spread of a fire. Wildfires of considerable magnitude, such as the Kokemäki fire of 1691, left the peasantry with few options other than to warn everyone of the spread. However, those of a lesser scale could be thwarted by digging ditches, clearing not yet affected areas of organic biomass, or by using controlled burning to stop the advance of a spreading fire.

(3) Whilst the fires themselves were life-threatening, the environmental devastation they left behind could be equally disastrous. Not only did many peasant families lose their homes and personal property, but their means of making a living were often also completely extinguished. Particularly intense fires could cause such severe damage to the chemical properties of the soil that cultivated areas did not regain their former growing capacity for tens of years afterwards. Forests burning naturally led to a drastic decrease of wood resources, but also of grazing resources. This furthermore affected the peasantry's ability to produce commodities meant for export, such as livestock products and tar, but also resources meant for household consumption.

(4) In order to overcome the economic struggle of getting back on track after a fire, the peasantry was dependent on Swedish legislation that gave everyone a fighting chance to rebuild their former life. The investigation has shown how applications for fire support increased over the century. Given that the region was characterised by wealth inequality, this led to the hypothesis that those living under less favourable socio-economic conditions were worse off and were made more vulnerable as fire disasters occurred. However, the investigation of the court and tax records from Huittinen parish has shown that no distinction was made in terms of what land an applicant owned or rented, nor on the grounds of socio-economic status – that is, the size of

their homesteads. If it could be proven that the fire had not been caused by carelessness, everyone received on average a third of the value of the property lost, which was given to the applicant in the form of monetary relief, with some exceptions in particularly severe cases when larger sums were given. However, even when fire support was not granted by the local courts, the peasant communities could still decide to voluntarily give money to those they deemed deserving. Together with the possibility of applying to the county governor for three years of tax exemption, enough money could be raised so that most of the peasants who had their homes and lands devastated by a fire could ultimately rebuild their lives and continue to make a living.

It is far from an overstatement to say that fire was an essential part of early modern societies, and that the potential devastation it could wreak was well known to those living in both urban and rural environments. In this article, it has been demonstrated how fire disasters were a recurring feature of rural life during the seventeenth century and that both peasants and legislators made efforts to mitigate the negative outcomes of such events in different ways. By implementing new legislation aimed at restoring peasant households and thanks to the peasantry's volition to go beyond what the law stipulated in aiding their fellow parish members, peasant communities were able to create socio-economic safety nets that increased their resilience and ability to overcome disastrous fire events.

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REVIEW

David N. Livingstone
The Empire of Climate: A History of an Idea
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David N. Livingstone's *The Empire of Climate* arrives at a time when the impacts of climate and climate change across all facets of society are widely discussed. Livingstone aims here to historicise the many and varied ways climate has been thought to shape human destines. In this rich book, he unpacks the long history of environmental or geographic determinism; that is, a collection of ideas about how people have been shaped physically, intellectually and even morally by climatic factors – ideas which have long been reached for as a framework for assigning historical causality. Livingstone's starting point is that 'the empire of climate has continued to extend its influence over more and more regions of human life and culture' and 'in the wake of prevailing concerns over the consequences of rapid climate change, it looks set to maintain its imperial rule into the indefinite future' (here the title, *The Empire of Climate* explicitly echoes Montesquieu's oft repeated adage that the 'empire of the climate is the first, the most powerful of all empires', p. 3).

The Empire of Climate represents the culmination of Livingstone's more than three decades of writing and thinking about environmental and climatic determinism, with work on acclimatisation, empire and 'moral climatology' especially in the 'tropical world' dating back to the 1980s. Livingstone picks up on these themes but greatly expands them, structuring the book around four key spheres in which climatic determinism has been seen to shape human destinies, namely 'health, mind, wealth, and war' (p. 11). The sometimes sprawling chapters range from medical climatology to eugenics; from cognition and human evolution to mental health and meteorology; from climate and macroeconomics to labour, race and slavery; and from 'climate conflicts' and migration to the securitisation of climate change. The book thus takes a wide-ranging tour of the way climatic influences have been thought about in the past, but Livingstone also remains very interested in what this means for the present. Throughout, he diligently links historical case studies to contemporary journalistic and popular instantiations, and aims to 'set these preoccupations in a much wider historical context' (p. 11) in order to trace the 'explanatory hold climate retains among professional historians, science journalists, and popular writers alike' (p. 3). Indeed, woven throughout the chapters are extensive engagements with the uses and abuses of deterministic

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explanations in the twenty-first century, from claims about droughts and civil war in Syria to questionable research on heatwaves and crime.

Ultimately, Livingstone hopes that 'shedding light on how climate has been implicated in the reproduction of racial ideology, the justification of slavery, the rationalizing of conflict, the nurturing of eugenics, and the psychological and cultural stereotyping of major zones of the globe' will make it 'a little more difficult for a guilty humanity to stray into the habit of blaming the weather instead of undertaking to weather the blame' (p. 412). One of the key takeaways of the book is that deterministic explanations have a kind of insidious simplicity and flexibility that has seen them used to support some of the darkest imperial and social policies in human history – and that we would thus do well to better recognise and understand these tropes. Throughout, Livingstone also addresses the convoluted career of determinism in the disciplinary status of geography, concluding that 'the history of climatic determinism with its aura of fatalism and fanaticism reveals just how crippling a force it can be on human agency, equality, and empowerment' (p. 412). Livingstone points out that modern scholars are generally aware that the label 'environmental determinist' is pejorative, but this does not necessarily ensure they manage to avoid its traps. Here Livingstone points to the widely read work of Jared Diamond, whose explicitly anti-racist attempts to explain the 'rise' of Europe nevertheless problematically strip away choices and agency.

For a historical tome with one eye firmly on the present, this is nevertheless in many ways an unabashedly old-fashioned book. This is not least seen in Livingstone's self-conscious – and perhaps deliberately provocative – positioning of the work as a 'history of ideas'. Here Livingstone quotes Lorraine Daston's reflection that '"until very recently, and perhaps still … in the corner of the academic map that I come from, to call someone a historian of ideas is tantamount to calling them a tax evader or a cat murderer!"' (p. ix). For Livingstone, this risk is offset by allowing for bigger picture questions; or, as he puts it, working with the telescope rather than the microscope. Livingstone's implicit critique that scholarship has sometimes become too narrow is not without merit. However, standing behind a 'history of ideas' frame perhaps also allows Livingstone to sidestep innovative recent trends in global history and historical geography. Indeed, the scope of the book is expansive, but the focus is almost wholly on a *longue durée* of European thinking about climate stretching back to Hippocrates (with a notable exception given to Ibn Khaldūn's fourteenth century ruminations on climate and civilisation in the *Muqaddimah*). Livingstone's stated aim is to trace 'the intellectual architecture of the persistent conviction that climate exerts an ineluctable power over the human species', but the subset of humanity represented by the thinkers he discusses is ultimately quite small. Of course, Livingstone is well aware that there are ‘distortions and silences on my map’ (p. 402), and figures like Montesquieu and Jean Bodin do matter for modern thinking about climate. This focus is thus not unjustifiable, but some greater acknowledgment and engagement with these choices and limitations would have been welcome.

The Empire of Climate fits into a particular tradition of *longue durée* analysis within historical geography, echoing classic scholarship like that of Clarence Glacken and Denis Cosgrove. Livingstone is acutely aware, not least given the sometimes episodic nature of his case studies over such a long timeframe, that not all ideas about environmental determinism are the same, or all instantiations of climatic causality for the same ends. As he notes, climatic explanations have been both monocausal and part of a range of factors amidst a ‘longstanding fluidity about what the designation “determinism” actually names’ (p. 10). In taking on a long chronology, this is cast as a history of continuities, not least in the way climate and climate change are sometimes assumed to mean the same or similar things at different times (though Livingstone does acknowledge that the recent recognition that humans can be planetary scale agents might represent a rupture). Here, Livingstone suggests that ‘for all the differences between the recent tempo of global warming during what has come to be called the Anthropocene and earlier rates of climate change, there remain remarkable continuities in the history of ideas about climate’s influence on human populations’ (p. 408). Livingstone is also in dialogue with recent scholarship in geography, especially Mike Hulme’s work on ‘climate reductionism’ and the way that climate is sometimes rendered as an all-encompassing predictor, stripping the future of agency, ideology and values. Livingstone thus contributes to the project of unpicking the ways in which deterministic arguments matter to climate-changed futures. As Livingstone acknowledges, he is not alone in engaging with the problematic persistence of deterministic explanations, but *The Empire of Climate* is undoubtedly the most expansive analysis now available.

Ultimately, Livingstone’s book can and should be read as a warning. As he explains, ‘the ancient idea that climate controls or conditions, determines or directs, human life in a myriad ways has resurrected itself in new incarnations in our own Anthropocene-conscious era’ (p. 399). Deterministic tropes need to be recognised, understood and questioned, and this book goes a long way towards historicising them. Given that the spectres of climatic determinism and reductionism raise issues not only for historians and geographers, but journalists, policymakers and the public alike, this is an important book that should have a wide audience. But it also cannot be the last word, and more is needed – for example, on the ways these deterministic framings were plucked from the realm of ideas and incorporated into imperial practices on the ground (or stemmed from them), as well as genealogies of environmental determinist thinking outside a mostly elite, mostly ‘Western’ tradition. As Livingstone is right to conclude, ‘the empire of climate’ is unlikely to loosen its grip any time soon. This book is thus an invaluable starting point for geographers, historians and those within and beyond the academy interested in the long history – and present and future – of assigning historical causality to climate. Frankly, this needs to be all of us.

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