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Extreme winters during the 18th century.

Entangling climate and culture

Abstract: Cold anomalies constitute the signature events of the "Little Ice Age" (~1300–1850). During this climatic period extreme winters occurred in an almost generational rhythm (f. ex. 1709, 1740, 1771, 1784) and became a formative experience for Europeans. The dramatic impacts of these anomalies resulted from their *socionatural* character. They encompassed both physical and social aspects, with frost damage and delayed plant growth on the one hand interacting with social inequality, poor cold protection, and cultural restrictions on the other. As a result, extreme winter events constitute a rich field for studies of climate-culture-interactions. This paper presents an overview of the entangled biological and social impacts of cold anomalies during the 18th century. It draws on the Krämer/Pfister interaction model to exemplify the cascading effects of cold shocks and cultural repertoires through various societal levels. A close-up of the 1770s cold anomaly demonstrates how these momentous "twin catastrophes" connected climate and culture.

1 Extreme winters as *socionatural* events

Extreme winters constitute *socionatural* events. They encompass both physical and social aspects. Their impact originates in the interplay of biological and cultural responses: the interaction of frozen waterways, extended snow cover and delayed plant growth on the one hand and social inequality, inadequate cold protection, and cultural constrictions on the other. During the "Little Ice Age" extreme winters became a formative experience for most Europeans. In many respects, this climatic period (~1300–1850) was primarily a winter-driven phenomenon.[1] The rapidly advancing glaciers of Europe gave it its name. The break from previous climatic regimes is marked by long harsh winters, unprecedented levels of snowfall as well as frozen rivers and seaways. Some of the effects of Little Ice Age winters have remained a part of popular imagination and culture: The frost fairs on the frozen Thames River, ice skating on the Dutch canals, the crossing of the frozen Belt by the Swedish army. These residues in collective memory also respond to winter anomalies being easier to perceive than other more subtle aspects of climatic change. As a result, extreme winter events constitute a rich field for climate-culture-interactions. This paper provides a brief overview of the biological and social impacts of extreme winter events during the 18th cen-

1 Wanner, Pfister, Neukom 2022: 2.

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tury and draws on the 1770s anomaly to illustrate the cascading effects these "twin catastrophes" could enact between climate and culture.[2]

Climatological research has documented the extreme winters of the Little Ice Age period in detail. Climate historians have combined historical records and biophysical proxies to reconstruct the increasing frequency, longer duration and more extreme amplitude of winters throughout this period. This work is accessible through a variety of databases and winter severity indexes or via studies of individual events.[3] In Europe, it draws on diverse sources of evidence. They range from observations of sea-ice in the Baltic and elsewhere to temperature reconstructions based on tree-rings, the break-up dates of Scandinavian lake-ice or the eye-witness reports and early measurements of contemporary observers. They also include serial data that records the first frost, the date of spring sowing, the arrival of the first ships in harbors frozen during winter and other more dispersed phenomena. Together, they document that winters during the Little Ice Age show the strongest deviation from earlier and later climatic periods.[4]

Climate historians have also suggested a range of reasons for this shift. Some extreme winters are clearly influenced by volcanic events and the subsequent injection of ash and sulfuric acid into the atmosphere. During the 18th century this is likely the case during the Laki eruption of 1784.[5] Other events can be attributed to anomalies in the oceanic-atmospheric circulations systems. Patterns of jet stream blocking, the displacement of the subpolar gyre and swings of the North Atlantic Oscillation (NAO) have been identified as effective stressors, particularly when they overlap with solar minima.[6] Their influence matches that of volcanic shocks and can last significantly longer than this singular driver.[7] While these stressors contributed to acute winter anomalies, they were also part of the general climatological framework of the time. This connection informs the concept of LIATE (Little Ice Age type events) that places the singular winters firmly within the larger climatological environment of the Little Ice Age itself.[8]

During the 18th century severe winter extremes with cross-regional reach in Europe have been documented to occur at an almost generational rhythm. The "great frost" of 1709 marred the start of the century with an event so extreme it affected the whole continent including the Mediterranean South. It was followed by the 1740 winter that initiated socio-economic hardship across the Europe. The 1770s saw a multi-

2 On the concept of "twin catastrophes" see: Collet 2019.

3 Koslowski, Glaser 1999; Leijonhufvud 2010; Schmelzer 2011.

4 Wanner, Pfister, Neukom 2022: 3.

5 Zambri 2019.

6 Faust 2016; Moreno-Chamarro 2017.

7 The impact of these natural fluctuations was much smaller than that of modern man-made carbon emissions. However, they share the characteristic increase of extreme events that accompany climatic regime changes. Wanner, Pfister, Neukom 2022.

8 Wanner 2000.

annual anomaly with severe winters extending over three years resulting in catastrophic suffering. The century ended with the winter of 1784/85 that followed the massive eruption of the Lakigígar-fissure in Iceland. It contributed to freezing cold and substantial ice-built up across Northern Europe. Several more local anomalies occurred in between these cross-continental signature events. Some of these also reach the highest level of the "Pfister-scale" such as the winters of 1728/29 and 1766. Every generation of 18th century Europe experienced at least one extreme winter event either directly or via eye-witnesses.[9]

So far, few studies pursue an integrated approach that extends to the cultural perceptions, reactions, and consequences of the cold anomalies. This is even more obvious when it comes to literary representations and artistic appropriations of these events. Some studies explore the massive devastations of the 1709 anomaly particularly in the South of Europe.[10] Others chart the impact of the great frost in 1740 on demography and the development of epidemics.[11] Several pursue more specialized issues such as the migration flows initiated by the 1709 or 1740 events.[12] A few explore the whole range of socio-ecological effects from the biological to the cultural levels.[13]

These integrative studies engage the wider research debate on climate-society interactions. Responding to current challenges, climate historians have gone beyond earlier deterministic or reductionist imaginations of climate impacts on human society. Instead, they conceptualize past climate-culture interactions in the form of pathways, resiliences, or entanglements.[14] In the context of extreme winters, the interaction model of levelled socio-ecological impacts developed by Daniel Krämer can be particularly helpful (Fig. 1). It conceives the interplay of climate and culture as a graded pattern. Climatic shocks travel along the four suggested levels of biophysical, economic, social, and cultural consequences with diminishing intensity. While first order impacts on food and biomass production appear almost immediately, fourth order impacts on cultural responses are filtered, mediated, and attenuated by other layers and traditions. Crucially, the model suggests corresponding impacts of cultural repertoires. They cascade in the opposite direction influencing the other levels in turn. Perceptions of the frequency and relevance of cold extremes, for example, can inform social arrangements, agricultural structures, and biophysical systems. This perspective suggests not only ad-hoc entanglements, but also longer-term interactions. It tele-connects the acute shock of a singular winter with the slow-moving transformation of cultural imaginaries, social orders, and agricultural arrangements. Such an approach conceives extreme winters as both event and structure.

9 Pfister, Wanner 2021: 219–230.

10 Lenke 1964; Lachiver 1991; Monahan 1993.

11 Manley 1958; Post 1985; Deutsch, Glaser, Gudd 1996; Dickson 1997.

12 Schulte Beerbühl 2004; Geyken 2009; Engler 2013.

13 Pfister 2010; Camenisch 2016; Veale, Endfield, Bowen 2018; Collet 2019.

14 White 2023; Degroot 2022.

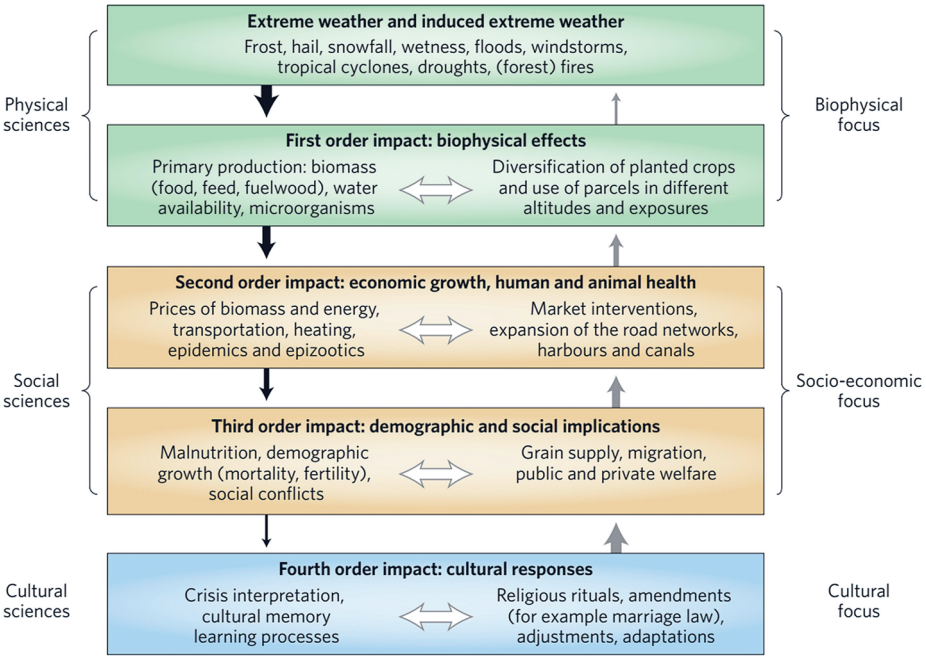

Fig. 1: Luterbacher, Pfister 2015, 248. © 2015 Schwabe.

2 Facing frost

Severe cold anomalies disturbed all levels of the 18th century societies in Europe. Next to the immediate health hazards connected to hypothermia, exposure, and frostbite, extreme winters affected agriculture, transport, trade, and the wider economy as well as social life. In theory, a harsh winter on its own carried less destructive potential than anomalies occurring during the growing season. But in the context of the Little Ice Age extreme winters were often accompanied by anomalies later in the agricultural year. Clusters of extreme rainfall during summer and fall, even entire "years without summer" occurred alongside anomalous winters with much greater frequency during this period.[15]

The enormous impact of climatic shocks, however, did not result from their physical severity alone. It was escalated by the fact that they affected societies that were already vulnerable to external disturbance. Europe at that time was dominated by socio-ecological arrangements that can be conceptualized as "grain societies".[16] Its

15 Wanner, Pfister, Neukom 2022: 3.
16 Collet 2019: 41–53.

population depended on cereal crops for most of its nutrition. In a society without cheap access to fossil alternatives, caloric intake also constituted the major source of overall energy – particularly, as grain dependence extended to many working animals. In this arrangement, extensive cereal cultivation had been the key to demographic and economic growth.

Grain, however, was also particularly vulnerable to climatic anomalies. Shortened growing seasons, unseasonal rainfall and untimely frost severely affected its yield. Alternative arrangements that deployed a more diversified and robust "polyculture" were, however, systematically discouraged. They continued only in peripheral areas. This was not only a consequence of the relative caloric efficiency of grain. Its popularity was bolstered further by its qualities as an efficient tool of governance. Dried grain could be stored for extended periods and moved over long distances. As a result, it could be used to feed armies, pay taxes, and found cities as well as barracks. Grain lent itself to expropriation, control, and regulation better than other perishable but less climatically sensitive products. In consequence, its production was privileged through a multitude of legal, governmental, and market regulations.[17] Modern researchers have variously labelled this arrangement as the "tyranny of grain dependence", as a "prison" or a "food trap". Its cultivation favored governmental expediency over ecological robustness. The resulting societies constituted "riskscapes" characterized by "slow violence" that unduly exposed large parts of the population to climatic hazards.[18] When an extreme winter occurred in these built environments, it affected a society already at risk. In this socio-ecological context extreme winters did not constitute a "natural" disaster. Their disruptive effect needs to be understood as a "twin catastrophe", resulting from the interaction of biophysical stressors and societal vulnerabilities.[19]

Great winters disturbed 18th century societies in a variety of ways. In the highly stratified polities of the time, poor people with less access to heating and protection often suffered directly from the cold. As a result, there are frequent reports of death and disability from frost exposure. Indirect challenges such as foodstuffs frozen solid, the death of farm animals or attacks of starving packs of wolves and other predators are similarly ubiquitous. However, most casualties are connected to the proliferation of disease in the wake of people huddling together for warmth or moving further in search of relief. Great winters also reduced opportunities for social interactions. Religious or municipal festivals had to be cancelled, travel was often impossible without serious risks or access to costly clothing. Postal routes shut down due to the real risk of postillions succumbing to hypothermia. With mills frozen solid and inns closing for lack of heating many people experienced not just cold but also isolation.[20] The con-

17 Ibid.

18 Kaplan 1976; Landsteiner 2005, Haber 2007; Nixon 2013.

19 Collet 2019: 7.

20 Behringer 2010: 156–160.

stant exposure to cold winters initiated cultural repercussions ranging from fashion to social interactions and included a significantly different perception of and tolerance to low temperatures.[21]

Biophysically, the effect of extreme winters on grain-based agriculture stands out. An early frost could in some cases reduce whole harvests to almost nothing. Europe used a variety of crops to maximize yields in accordance with the length of the growing seasons. Oats dominated in the far North, rye in the temperate areas and wheat in the warmer zones of the continent. As all were sown up to their respective ecological margins none of these were able to withstand a significantly reduced agricultural year. Extreme cold and extended snow cover could also damage the autumn sown summer crops that lie dormant over winter. They could exceed their hardiness or encourage the proliferation of fungi under the snow. The affected fields then needed to be resown with spring varieties that offered much smaller yields. A single late spring frost could devastate the vine and fruit harvest, at least of those trees that did not wither from frost damage itself. A long winter season also reduced the overall time available for other agricultural activities such as harvesting, tilling, sowing, and preparing the fields. In multi-annual cold anomalies these effects could stack leading to whole cycles of the agricultural year being abandoned.[22]

Extended snow cover also brought other challenges. Snowdrifts repeatedly closed roads and mountain passes for long periods. Later, excessive meltwater initiated untimely flooding of the rivers. This affected not only flooded agricultural land. It also shut down the main arteries of trade and transport in mainland Europe. Critically, this occurred during the time of year when food stocks were depleted and the need for transportation was at a premium. In extremely snowy years, floods often occurred after the freezing had already blocked the affected waterways for long periods. In the North and the Baltic Sea extended periods of sea-ice could cut off whole cities and populations and substantially reduce trade in the region. All these impacts had knock-on effects that cascaded through the wider society with reduced harvests and high food prices crippling the economy, reducing demand for non-food items, escalating the costs of labor, and throttling the provisioning of towns. It also reduced the main income of church and state, substantially diminishing their ability to provide welfare and relief. As a result, extreme winter shocks were regularly accompanied by famine, epidemics, and economic crises.[23]

21 Jandot 2017 reports that contemporaries experienced indoor temperatures of 12–15°C as comfortable, with complaints that 19°C were too hot for sustained work.

22 Collet 2019: 79–116.

23 Ibid.

3 The Great Winters of the 18th century

These interconnections between climatic and societal stressor appear in all the "Great Winters" of the 18th century. The 1709 anomaly, likely the coldest winter of the last 500 years, brought temperatures so extreme that ice covered the Adriatic Sea and the lagoon of Venice.[24] Snow blocked major transport routes for several months leaving major cities like Paris unsupplied for extended periods. Crops and vineyards were devastated, livestock killed, and olive trees destroyed even in Southern Spain. In the North the Baltic Sea remained frozen and impassable for an unprecedented four-month period. Reconstructions point to the height of the Maunder minimum of solar activity and calculate an unprecedented temperature depression of close to −7°C across Europe with daytime temperature in Berlin reaching lows of −30°C.[25]

The weak protections in place in the highly stratified societies of the time were unable to contain the impact on agriculture and trade. In the absence of robust buffer and welfare systems, food prices exploded in 1709, and epidemics spread rapidly with people desperately seeking shelter and relief. The climatic shock was escalated further by two major military conflicts ravaging Europe: The War of the Spanish Succession and the Great Northern War. They tied up important resources and were themselves heavily influenced by the inclement weather. Calculations estimate that the population of France alone dropped by 800.000 people in the aftermath of the extreme cold and the following epidemics.[26] The disruption was so substantial this "Great Frost" or "Grand hiver" is present in collective memory to this day.[27]

A characteristic response in 1709 was large scale migration. It highlights the entanglement of climatic and social triggers, with migrants strategically referencing either the cold, the dearth, the wars, or religious beliefs to legitimize their emigration. The most dramatic instance might have been the trek of close to 10.000 refugees from the German Palatinate that saw them camping in large tent cities outside London in desperate attempts to reach America. After the devastating winter, they embarked on a complicated journey through Europe that saw many succumbing to disease, outstaying their welcome in England, some settling in Ireland, many returning home, and only a minority ever reaching the New World. On their way they switched climatic and social justifications and sometimes their confessional affiliations to secure help and charity from increasingly irritated hosts. In its motivational ambivalence their fate exemplifies the complicated entanglements of climate and culture as well as the sometime strategic appropriation of extreme weather.[28]

24 Luterbacher 2004.

25 Mauelshagen 2010: 71.

26 Lachiver 1991; Monahan 1993.

27 Pain 2009; Sánchez Arreseigor 2017.

28 Otterness 2004; Geyken 2009. More than 2000 of the ‚climate' refugees turned out to be Catholics masquerading as Protestant to secure a passage to Pennsylvania: Schulte Beerbühl 2004.

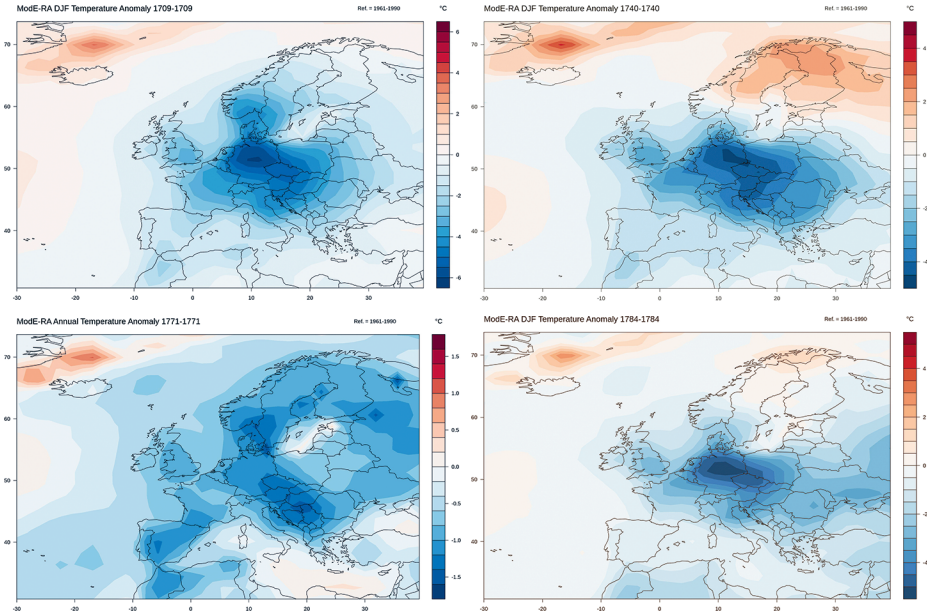

Fig. 2: Reconstruction of the winter temperature anomalies of 1709, 1740, 1784 (December, January, February) and the cold year 1771, compared to the period 1961–1990. Data from the ModE-RA Database of tree-rings and historical observations. Valler et al. 2024.

Similar developments characterized the great winter of 1739/40. Again, the temperature anomaly was so extreme that European rivers froze solid, mills ground to a halt and bridges collapsed under ice in Amsterdam. Lower Saxony reportedly experienced near continuous frost from October to March (Fig. 2).[29] Rapidly advancing glaciers buried farms in Norway and destroyed the harvest in the Nordics.[30] People died of hypothermia all the way to Persia and epidemics spread with devastating consequences in response to agricultural devastation coupled with deficient welfare and redistributive systems. The cold and its consequences also contributed to the Prussian victory in the First Silesian War 1740–42 and initiated Frederick's renown as his people's "bread father." Just like its predecessor, the extreme winter initiated large scale migratory movements, with the 1740s witnessing the first wave of mass emigration from Ireland to America.[31] The long and severe cold was so significant that it sparked an unprecedented flurry of meteorological observations. Like their predecessors in 1709,

29 Cf. the "Poem on the Winter 1739/40" by Rudolf Heinrich Georg Rüdemann in: Staatsarchiv Wolfenbüttel, VI Hs 5 Nr. 14. For an analysis of this source see: Lassen 2016. A climatological reconstruction of the event is given in: Broennimann et al. 2024.

30 Hoel 2013.

31 Collet 2019: 173–175; Behringer 2010: 156–158; Engler 2013; Dickson 1997.

these texts evaluated the merits of religious, natural, and social interpretations of the anomaly. In turn they suggested moral, economic, or political responses with some even developing a dedicated "Schnee- und Winter-Theologie" (snow and winter-theology).[32]

The cold spell of 1783–85 (Fig. 2) is marked by similar catenations of climatic stress and cultural responses.[33] It followed the extended eruption of the Laki fissure in Iceland. This time the visible volcanic haze suggested to some observers that a physical trigger lay behind the combination of disastrous cold, highly damaging ice built-up in the river systems, and corresponding harvest failures and dearth. Devastating floods carried away vital bridges in Heidelberg, Würzburg, Bamberg, Prague as well as other cities across Europe and wreaked destruction along their banks.[34] For the first time, luminaries like Benjamin Franklin speculated openly about a climatic link between the eruption of a volcano and the following depression of temperature. While their meteorological theories later proved to be correct, the men of learning were less effective in mitigating the socio-economic fallout of the event. The link between harsh winter, depressed harvests, escalating prices and the spread of disease remained as destructive as before. In the North the harvest failures of these years helped to escalate residual discontent in Norway against the perceived Danish over-regulation and -taxation.[35] Like other responses on levels more removed from climatic impacts (Fig. 1), such reactions reflect a complex blend of ecological stress, ineffective relief, and political disenfranchisement. In these composite environments, an extraordinary winter often provided a welcome catalyst to long-standing disputes and tensions. These aggregated teleconnections between climatic stress and cultural responses merit a closer look at one of the events: the three-year cold anomaly of the 1770s.

4 Cultures of climate – the 1770–1772 event

The early 1770s saw Europe shaken by one of the most severe cold/wet anomalies of the Little Ice Age. Three continuous years of extremely harsh winters and incessant rain over summer escalated the vulnerabilities of the continent's grain societies into catastrophic crisis with fatalities amounting to several million people globally. The dense historical documentation at the height of the Enlightenment period allows for a particularly detailed reconstruction. Extensive weather observations and a rich re-

32 Anonym 1740a; Anonym 1740b; Marcus 1740. For similar debates in 1709 see: Derham 1708/09; Choi, 2023.

33 Pfaff 1784; Oesfeld 1786.

34 Brázdil 2010.

35 Zambri 2019; Håland 2022.

cord of contemporary reactions enable a dynamic assessment of the entanglements of climate and culture. They illustrate both the cascading effects of climatic impacts "from agriculture to culture" and the plurality of societal responses ranging from prayer to protest and from desperation to appropriation.[36]

In Europe the biophysical shocks started in mid-1769. A sudden cooling and incessant rainfall disrupted that year's harvest in an area ranging from France to Poland and from Scandinavia to the Alps. Witnesses reported snowfall in late summer from the shores of Lake Constance, "memorably enabling people to engage in snowball fights at the height of summer". The short moment of gaiety quickly turned to concern when the anomaly continued with incessant rainfall into the harvest season. Even along the Rhine the first frosts occurred already in late September. In the German territories, reports from Franconia, the Ore Mountains and the Lausitz note the first snow falling long before the trees had shed their leaves and fruit, destroying many of them in the process. Witnesses report immense "vaults of snow" piling up in the Alps that winter. The cold continued much longer than normal with heavy snowfall covering large parts of Europe in late March. From the North Sea to the Alps reports describe buildings buried in snow and people having to be dug out to save them from freezing to death with nobody alive able "to remember such massive snowfall". People experienced a white Easter in April, with mills freezing to a halt, the river Elbe covered in ice and birds falling dead from the sky or seeking shelter inside lodgings. In the Upper Palatinate region people had to rely on horse-drawn sleighs into late May. When the snow finally melted, the seedlings underneath had rotten and died leaving only brown earth until June. Destructive floods followed with extreme rainfall dominating the second half of the year. Shockingly for many observers, the situation repeated itself in the next winter. Snow was reported in Hungary and Tirolia as early as July 1770. The constant delays due to heavy rains resulted in large scale abandonment of tilling and sowing for the next year. In Kassel desperate observers recorded 100 continuous days of rainfall that year with British newspapers speaking of a "second deluge".[37]

The winter 1770/71 brought the same continuous cold and heavy snowfall until the end of March (Fig. 2). An observer in Braunschweig testified temperatures even lower than those of 1709 and 1740. In May 1771 an eyewitness in Bavaria lamented that due to the long winter "no greenery could be observed on either trees or fields to mark the spring in the Danube area. No leaves nor blossoms were to be seen; everything was dead [. . .]". The experience was repeated across Europe with the season memorized as the "Black Spring" as far away as Scotland. By then food buffers had been exhausted and a second failure of the grain harvest resulted in severe shortages across the continent. In 1771 all major river systems in the German Empire froze for

36 Collet 2019.
37 Ibid.: 55–71.

extended periods and later flooded so severely that desperately needed transport along them became all but impossible. The cold spell continued well into the following winter with the Danube freezing solid again in Austria in January 1772. Warmer and drier weather patterns only reappeared in spring 1772. Notably, the cause of this anomaly is unlikely to have been a singular factor such as a volcanic explosion. Palaeoclimatological reconstruction and modelling indicate that it originated in the atmospheric blocking patterns and shifts in the polar jet-stream associated with the Little Ice Age period in general.[38]

The anomaly's "first order" effects on agriculture and biomass production were catastrophic. Large areas reported drastic reductions in the size and quality of the harvest. Grain often turned black or green from mold during storage. Some areas saw almost no harvest at all. The challenge of reduced yields was significantly worsened further by the societal riskscapes in place. The massively privileged production of grain was disproportionally affected. The absence of ecological buffers, caloric alternatives, or dedicated food stocks, that China for example maintained at great costs, rapidly escalated the European shortfall into a full-blown crisis.[39]

The "second order" impacts resulted in a depressed economy all across the continent with repercussions globally. As ordinary people were forced to spend all available money on ever more expensive food, demand for other products collapsed. Large-scale unemployment followed in many proto-industrial or manufacturing areas. A desperate cloth merchant reported that his produce was impossible to shift and that his stock had accumulated to such a size that "not even the largest church in town would be able to hold it". Similar calamities befell France, Ireland, and England. The "general stoppage of trade" quickly escalated into a debt-crisis.[40] Lenders demanded their money back fearing correctly that many debtors would be unable to honor their contracts under such circumstances. After the third harsh winter in 1772 the irritated financial markets collapsed. Many companies had already been under stress due to overinvestment in the boom years following the Seven Years War. Now London witnessed panicked bank-runs, leading to the collapse of 25 financial houses. Dozens of other lending companies folded in Amsterdam, Stockholm, Augsburg, Hamburg, or St. Petersburg. Even the Bank of England was forced to stop trading obligations and required a government rescue.[41]

The most notorious casualty of the crisis turned out to be the British East India Company (EIC). Its collapse in 1772 initiated global shockwaves. Significantly, its financial struggles did not originate in India, where the areas governed by the EIC were similarly struggling with catastrophic Monsoon failures and a famine that ultimately left several million of its subjects dead. Instead, the company went bankrupt when it

38 Ibid.

39 Ibid.: 101–109. On China as a storage society, see: Will, Wong 1991.

40 Freitag 1986: 120.

41 Collet 2019: 86–100.

was unable to sell the produce it had extracted with reckless resolve from its starving Indian subjects to impoverished European consumers. As tea and cloth piled up the EIC was unable to meet its debts and had to be rescued at great costs by the British parliament. Desperate to recover at least some of the investment, the parliamentarians agreed to grant the company a monopoly on the sale of tea in the American colonies. The move infuriated its American subjects, already enraged by a range of economic grievances and thoroughly displeased with yet another decision implemented without consultation. In December 1773 they responded with the Boston Tea Party marking the beginning of the American Revolution.[42]

Similar instances of extreme winters acting as a catalyst to long-standing conflicts can be observed throughout Europe. These "third order" impacts affected social order, demographic systems, and political arrangements. Across the continent people facing escalating prices and impoverishment resorted to protests. The weak relief systems of Europe were unable to cope with the sudden rise in demand. In areas that were outcompeted by richer neighbors, harder to reach, or more dependent on manufacturing, shortages quickly turned into famine – often with devastating levels of mortality. Soon, epidemics spread alongside people venturing further for help and support. In response to these threats, food riots occurred in France, England, and Ireland to the same degree they did in the German territories or Bohemia. Their targets and goals, however, could be very different depending on historical constellations and precedent.

In Ireland the *Steelboys* agitated violently against absentee landowners and political disenfranchisement. In Germany food riots targeted foreign merchants or privileged landowners. Where these were unavailable, protests would target Jewish minorities, often with the aim of spurring unwilling authorities into costly interventions. In Denmark the nobility was able to harvest popular unrest to remove and ultimately execute the Enlightened de facto regent Johann Friedrich Struensee. In Sweden the new King Gustav III drew on popular dissatisfaction to implement an absolutist coup and ingratiate himself with his subjects via paternalistic welfare schemes. In France popular discontent and suspicion was directed at the Royal government and its introduction of a free-trade regime. The king quickly replaced his administration, proceeding to blame and then dissolve the local parliaments, depriving him of a crucial scapegoat in later conflicts. The resolution of each of these conflicts often owed more to long-standing political fault-lines than the immediate ecological stress. Their unusual concurrence and geographic spread, however, would be difficult to explain without the climatic anomaly that escalated them into action.[43]

The sheer force of these combined ecological, economic, demographic, and political shocks also congealed into "fourth order" effects on the level of culture and mentalities. The perception and interpretation of the 1770s crisis differed dramatically

42 Ibid., Sheridan 1960; Godspeed 2016.

43 Collet 2019: 110–116.

across communities. The 18th century was characterized by the coexistence of religious, natural, and social explanations of disaster. Whether people understood these events as God's Wrath, a meteorological phenomenon or a manifestation of social inequality could have significant repercussions. Responses could range from prayer to protest, from advocating moral reform to building granaries or the demand for broadened political representation.

The scope of these responses was particularly broad during the 18th century. Traditional religious framings of extreme weather events as divine punishment were complemented by increasingly visible alternatives. Natural interpretations of environmental phenomena received more attention than in previous centuries.[44] In addition, sociopolitical perceptions highlighted not only governmental shortcomings but structural inequality and injustices as root causes. These ideas were now discussed much more openly, sometimes with pre-revolutionary zeal.[45] In practice, many contemporaries developed unique amalgamations that pragmatically accommodated several different strands. This often reflected the complicated realities of 18th century professional life, with many vocal commentators combining religious positions and loyalties with worldly office. At the end of the century, however, the coexistence of religious, natural, and social interpretations increasingly made way for increased competition. Natural philosophers and social critics now felt empowered to stand their own ground.

During the 1770s crisis this new competitiveness condensed in the heated Silligdebate. Johan Gottfried Sillig (1734–1792), the deacon of the small Saxon town of Döbeln, understood the cold anomaly and the consequent dearth as an opportunity. Like many church officials, he attempted to use the looming famine to reaffirm religious doctrine and reassert authority of over public morals.[46] However, the publication of his sermon to this extent met an unexpected flood of criticism. Dozens of competitors responded with pamphlets, orations, and letters. Lawyers questioned Sillig's self-righteous damnation of famine victims as "sinners". They now contended that such accusations should be debated in a court of law rather than declared from the pulpit. Physicians weighed in and observed that epidemics and weather cared little for the moral compartment of their victims. Meteorologists highlighted that the cold anomaly followed its own logic and affected large parts of Europe equally, irrespective of their religious persuasion and moral quality. Historians intervened, citing examples of previous crises to question the connection between personal sin and risk of death.[47] Here and elsewhere the extreme winters accelerated a slow cultural change: the hegemony of religious doctrine was clearly threatened and increasingly gave way to a more polyphonous perception of socio-ecological entanglements.

44 Walter 2010: 4.
45 Anonym 1772.
46 Sillig 1772.
47 Collet 2015a.

5 Appropriating climate

The extreme winters of the 1770s also show cultural responses cascading in the opposite direction, down the societal levels identified by Krämer (Fig. 1). Instead of mere responses, they exemplify cultural and social appropriations. In the small and diverse territories of the German Empire the climate anomaly often facilitated "empowering interactions" between sovereigns and subjects. Ordinary people used the weather shocks to secure increased participation, often circumventing intermediate levels of administration to gain direct access to the court. In turn, competent rulers were able to harvest the impacts of the anomaly to enact lasting administrative change. They used the crisis to stage paternalistic concern, often disempowering middling powers and rescinding the privileges of church and nobility in turn. Many territories witnessed forms of "state-building-by-catastrophe", where subjects traded short term relief against long-term empowerment of the central administrations.[48]

Where these interactions were impossible due to absent or unwilling sovereigns, new forms of agency could take their place. During the 1770–1772 disaster "patriotic" societies of concerned citizens often stepped in where governments failed. They developed a new media format in response to the crisis, the "Hungerzeitschriften" (famine papers). These journals established an emotional regime of "Fernstenliebe" (compassion at a distance) and organized charitable donations from all over Europe and across confessional divides. The profits facilitated long-held plans of pedagogical improvement and welfare reform, including workhouses and an education system informed by utilitarianism. In many territories these years are marked by the rapid expansion of a reformed school system as well as the development of an agenda of "humanitarianism" avant la lettre.[49]

Similar appropriations are apparent in other areas of knowledge. New experts in classical economics, meteorology, agronomy, statistics, or public health all used the 1770s climatic anomaly to consolidate their emerging fields and networks. In many cases their offer to "medicalize", "economize" or "mathematize" what was essentially a social issue, furthered their career as well as their discipline and ultimately paved their way into the administrations.[50]

The strategic use of climatic shocks and social disruption can also be observed on more mundane (i. e. "third order") levels of interaction. Like its predecessors the 1770s anomaly served as a catalyst for migration. While local mobility made up most cases, the years are best known for the "second Swabian trek" that saw tens of thousands of people abandoning the German territories for Hungary. A closer analysis reveals, however, that the emigrants pursued independent interests and skillfully ap-

48 Ibid., 253–263; Blockmans, Holenstein, Matieu 2009.

49 Collet 2015b.

50 Collet 2019: 264–306.

propriated the climate anomaly to legitimize long-held plans. They could also draw on migration patterns and official recruitment schemes established long before the event. Faced with cameralist governments set on forcefully retaining taxpayers they used the adverse winters, strategic (mis)communication and the administrative pressure of the disaster to realize their plans. Their striking success in repurposing climate initiated not only policy shifts. It also gave birth to the emerging concept of "overpopulation".[51]

Similar tactics are apparent in contemporary power politics: In a blatant abuse of the cold anomaly, the neighbors of Poland-Lithuania, Europe's major grain basket, used the epidemics of the time as a pretext to invade and occupy the Commonwealth's territory. Russia and Prussia harbored long standing ambitions on Polish territory. When the cold winters struck Europe and reduced the ability of their competitor Austria to intervene, their governments took the chance to put them into practice. The "sanitary cordons" they imposed on a Poland already divided by civil war, were nominally directed at plague prevention. In practice, however, they served as pretexts to facilitate the requisitioning of grain. In spring 1772 they were solidified into permanent territorial gains through the imposed First Partition of Poland-Lithuania. The new territories enabled Prussia to permanently switch to a new agroecological regime. The privileged access to cheap Polish grain, bolstered by control over Poland's major river systems and a network of canals, secured lasting benefits for Prussia well into the 19th century.[52]

As the 1770s crisis illustrates, extreme winters could facilitate the interaction of climate and culture on various societal levels. These effects go beyond mere chains of effect and are better understood as *socionatural* entanglements. In these connected environments, quick ecological shocks could serve as a catalyst for social processes that had long pathways and histories. Welfare reforms, centralized governance, or territorial gains had sometimes been planned and discussed for centuries. They were not initiated but rather facilitated by climatic turbulence. This link was particularly acute during the 18th century when competing interpretations of natural shocks widened opportunities for social, political, or scientific appropriations. In consequence, the perception and communication of extreme winter events could prove just as potent as the events themselves.

6 Connecting climate and culture

Winter anomalies exposed 18th century societies to severe ecological stress. Their impact was amplified by pre-existing social vulnerabilities inherent in the contemporary

51 Ibid., 231–251.

52 Collet 2023.

"grain societies" of Europe. As a result, they constituted *socionatural* events, rather than mere natural disasters.

The disruptions of extreme winter events such as 1709, 1740, 1771 or 1784 affected people in an almost generational rhythm. In the context of the Little Ice Age they occurred much more frequently and formed a part of a larger climatic pattern. In the context of the socio-ecological arrangements of the time, they need to be understood as "normal exceptions". They highlight societal trends that would otherwise be difficult to detect and expose the slow violence that facilitated their disastrous impact.

Climate historians have suggested interaction models that capture the socionatural character of these "twin catastrophes". They conceptualize interactions as cascades of overlapping effects that reflect both biophysical impacts and cultural appropriations of climatic shocks. Close-ups of individual events reveal that both aspects are present in all extreme winters during the 18th century. Even these pre-industrial societies were not just passive victims of ecological stress. Migration movements, social protest, or territorial conflicts showcase the potential for strategic appropriation rather than mere reaction.

The observed diversity of responses illustrates that the potential for using and abusing climate events was particularly broad in the 18th century. The coexistence and competition of natural, religious, social, and artistic interpretations at this time opened new spaces for perceiving, sense making and appropriating winter extremes. This plurality suggests that climatic anomalies need to be studied as *more-than-human* events that connect biophysical, social, and artistic perspectives. Reductionist approaches that focus exclusively on meteorological stressors or demographic consequences while ignoring their literary, cultural, or ecological frames, will struggle to adequately reflect their comprehensive impacts. In this sense, an integrated study of past extremes can also serve to challenge the current proliferation of "thin descriptions".[53] A richer study of climatic anomalies in the past can remind us how limited the technology centered debates are in the present.

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Anonym: Kurtze zufällige und vermischte Gedanken, über den hefftigen Schnee und Frostwinter, MDCCXL. Nach theologischer, historischer, philosophischer, juridischer, medicinischer und oeconomisch-moralischer Betrachtung, als ein Plan zu einer völligen Chiono- und Chimono-Theologie (einer Schnee- und Winter-Theologie) Gelehrten zu weiterem Nachdencken, andern aber, zu einem so erbaulichen als angenehmen Zeitvertreib entworffen. Tübingen 1740a.

53 Hulme 2010; Porter 2012.

Anonym: Observationes Meteorologicae, oder Historisch-Physikalische Nachrichten Von dem Strengen Winter An. 1740. Nach seiner eigentlichen Beschaffenheit, wahren Ursachen, besorglichen Folgen, und einigen merckwürdigen Umständen und Vorfälligkeiten, In einem ordentlichen Parallelismo, oder Vergleich Mit dem durch gleiche Kälte bekandten Winter An. 1709. Nach den neuesten Philosophischen Principiis zum Angedencken vorgestellet. Frankfurt am Main 1740b.

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