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Historical Disaster Experiences

Towards a Comparative and Transcultural History of Disasters Across Asia and Europe

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Acknowledgments

That books also have a destiny prior to their making is well known. This volume is no exception. As the editor, I am happy and relieved that the long process of editing and printing, which really stretched the patience of the authors, has come to an end. Therefore, I wish to express my gratitude first of all to the contributors of this volume for their faith in the project.

Thanks to all those who have supported the work on the long road to printing, in particular Kristine Chalyan-Daffner, Eleonor Marcussen, Martin Bauch, Julia Itin, Benedikt Mette, Susanne Dressler-Mutz, Robert Schwank, and Andrea Hacker—all team members in Heidelberg and Darmstadt, who have contributed to the success of the preceding conferences in Heidelberg, Beirut, and New Delhi and thus to the development of the volume. Without Elaine Griffiths' thorough editing, the adventure of assembling a volume of English texts from all kinds of linguistic and cultural backgrounds into a readable whole would certainly not have been possible. Language nuances and coloring, however, are unavoidable: those who do research in a cross-cultural perspective consider variation an enrichment.

The topic of this volume may be gloomy at first glance, but it is worth the effort: research on the historical dimension of disaster experiences shows not only that cultures are sensitive tissues but also how elastic they are and what surprising patterns, combinations, and opportunities for change they offer. This book invites the reader to discover the diversity and similarities of these experiences and thus to learn about oneself. As the editor, this is what I am grateful for: the additional insight that I have gained from the collected research on the topic of this volume. I hope and wish that the readers will be able to share the same experience.

December 2015 Gerrit Jasper Schenk

Contents

When Europe Was Burning: The Multi-season Mega-drought of 1540 and Arsonist Paranoia

Christian Pfister

Abstract The year 1540 is known in German cultural history for the persecution of alleged arsonists (*Mordbrenner*) blamed for starting frequent town, village, and forest fires. Most fires were related to a ten-month long and Europe-wide record-breaking heat wave and drought. Proceeding from the blaze of the German town in Einbeck which resulted in a confessional conflict fought out on the level of the *Reich*, the article outlines the arsonist paranoia from the literature and puts it into the larger context of the mega-drought. The physical reality of this event and its multi-faceted impact upon humans and the natural environment (such as the mass death of cattle and devastating forest fires) are reconstructed from coherent narratives laid down by chroniclers from France, Switzerland, Germany, Poland, and Italy. The author concludes from their reports that palaeo-climatic evidence such as tree-rings and grape harvest dates are no longer valid indicators of the earlier climate due to the severe impact of droughts (untimely leaf-fall of trees, and the dried out grapes at the time of maturity). The arsonist paranoia is finally placed in a larger cultural historical context. Fire-raising was a gender-specific crime attributed to males, whereas witchcraft arising from cold and wet extremes such as frost, hailstorms, and cold rains since the 1430s was mainly attributed to women.

The Blaze of Einbeck

Around 6 p.m. on the evening of 4 August 1540, a fire broke out in the Protestant town of Einbeck (Lower Saxony).[1] Within a few hours, the entire town was reduced to ashes. Between 100 and 500 victims perished in the smoke and the flames. The

[1]Christian Pfister, Professor emeritus of Economic, Social and Environmental History at Bern University, is a Senior Researcher at the Oeschger Center for Climatic Change Studies. Acknowledgments are due to Dr. Antonio Contino (Palermo), Prof. Dr. Mariano Barriendos (Barcelona),

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survivors were housed by friends and relatives.[2] Town and village fires were frequent events at that time. Crowded construction, wooden houses, and thatched roofs created a favourable environment for runaway fires.[3] Admittedly, the houses of wealthy townspeople were already built with bricks and covered with tiles, but the huts of the lower urban strata still consisted of timber, straw, and shingles. In hot and windy weather, fire could seize settlements with such speed that it was not possible to save anything. In the end, this meant swift, total, and long-lasting destruction.[4] "If war, famine, disease and death were the four horsemen of the Apocalypse, fire surely could have been a fifth."[5] The conflagration of a town involving several hundred or even a thousand dwellings was a mega-disaster.[6] No wonder chroniclers put large fires on an equal footing with natural disasters such as floods, earthquakes or severe windstorms.[7] "Disasters are," in the words of Anthony Oliver-Smith, "all-encompassing occurrences, sweeping across every aspect of human life, impacting environmental, social, economic, political, and biological conditions." Consequently, disaster research literature became fragmented along disciplinary lines, with each field focussing on its own domain of interest.[8]

Urban historians have systematically investigated town fires since the emergence of disaster studies in the wake of the UN Decade for Natural Disaster Reduction (1990–2000).[9] The results of an international project on the topic,

Prof. Dr. Rüdiger Glaser (Freiburg i. Br.), Dr. Thomas Labbé (Dijon), Dr. Laurent Litzenburger (Nancy), Dr. Adriaan Kraker (Utrecht), Dr. Franz Mauelshagen (Potsdam), and Dr. Kathleen Pribyl (Brighton) for providing valuable sources on the year 1540. Thanks also to Prof. Dr. Reinhold Reith (Salzburg), Dr. Eleonora Rohland (Bielefeld), Prof. Dr. Christian Rohr (Bern), Prof. Dr. Gerrit Jasper Schenk (Darmstadt), and Dr. Cornel Zwierlein (Bochum) for providing helpful amendments and suggestions. Gerrit J. Schenk read the manuscript, and Dr. phil. Daniel Krämer and Dr. Martin Bauch invested a great deal of skillful work in formatting and correcting the footnotes. This work was supported by the Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland.

[2]Cornel Zwierlein, *Der gezähmte Prometheus: Feuer und Sicherheit zwischen Früher Neuzeit und Moderne* (Göttingen: Vandenhoeck & Ruprecht, 2011), 104.

[3]Cathy A. Frierson, *All Russia is Burning: A Cultural History of Fire and Arson in Late Imperial Russia Seattle and London* (Seattle: University of Washington Press, 2002), 53, Although this statement is about about Russia, it is also true for sixteenth-century central Europe.

[4]Frierson, All *Russia is Burning*, 66–67.

[5]Mark Tebeaud, *Eating Smoke: Fire in Urban America, 1800–1950* (Baltimore: John Hopkins, 2003), 4.

[6]Zwierlein, *Der gezähmte Prometheus*, 23.

[7]Monika Spicker-Beck, *Räuber, Mordbrenner, umschweifendes Gesind: Zur Kriminalität im 16. Jahrhundert* (Freiburg i. Br.: Rombach Historiae, 1995), 46.

[8]Anthony Oliver-Smith, "Theorizing Disasters," in *Catastrophe and Culture: The Anthropology of Disaster*, ed. Anthony Oliver-Smith and Susanna M. Hoffman (Santa Fe: School of American Research Press, 2001), 24.

[9]Gerrit Jasper Schenk, "Historical Disaster Research: State of Research, Concepts, Methods, and Case Studies," *Historical Social Research* 32, no. 3 (2007): 9–31.

summarised in three volumes of essays edited by Martin Körner,[10] stimulated much further work,[11] quite apart from the many studies devoted to city fires outside of Europe.[12] Cornel Zwierlein provides an extended review of the field in his ground-breaking study.[13] Due to its "literally undisciplined character,"[14] environmental history provides a disciplinary umbrella for historical disaster studies reaching beyond the "two cultures" (C.P. Snow).[15] This essay puts the blaze of Einbeck into the context of both cultural and climate history, with Historical Climatology considering the relationship between the two.[16] The subsequent part looks at the perception of conflagrations from the angle of cultural history, illustrating that fires were frequently attributed to arsonist plots allegedly inspired by foreigners and put into effect by paid vagrants and beggars, which resulted in these groups being persecuted as scapegoats. The third section, which concerns the climatic aspects of fire, introduces the physical connectivity of fire and drought, as 1540 is known as a record-breaking hot and dry year. The fourth part demonstrates that the scale, duration, and severity of this heat and drought event were unique, even by today's standards, highlighting the multiple physical and societal aspects of the disaster and relating back to the arson paranoia. The fifth part outlines the human and environmental impact of this extreme event. The sixth and final part situates this paranoia within a broader cultural and historical context.

[10]Martin Körner, ed., *Destruction and Reconstruction of Towns*, 3 vols. (Bern: Haupt, 1999–2000).

[11]E.g. Gerhard Fouquet, *Bauen für die Stadt: Finanzen, Organisation und Arbeit in kommunalen Baubetrieben des Spätmittelalters; Eine vergleichende Studie vornehmlich zwischen den Städten Basel und Marburg* (Köln: Böhlau, 1999); Gerhard Fouquet and Gabriel Zeilinger, *Katastrophen im Spätmittelalter* (Darmstadt: Wissenschaftliche Buchgesellschaft, 2011); Eleonora Rohland, *Sharing the Risk: Fire, Climate, and Disaster; Swiss Re 1864–1906* (Lancaster: Crucible Books, 2011).

[12]Louise Chipley Slavicek, *The San Francisco Earthquake and Fire of 1906* (New York: Chelsea House, 2008); Carl S. Smith, *Urban Disorder and the Shape of Belief: The Great Chicago Fire, the Haymarket Bomb, and the Model Town of Pullman*, 2nd ed. (Chicago: The University of Chicago Press, 2007); Anthony Mitchell Sammarco, *The Great Boston Fire of 1872* (Charleston, SC: Arcadia Publishing, 2005).

[13]Zwierlein, *Der gezähmte Prometheus*, 24–39.

[14]Uwe Luebken, "Undiszipliniert: Ein Forschungsbericht zur Umweltgeschichte," *H-Soz-Kult*, July 14, 2010, accessed April 14, 2012, http://hsozkult.geschichte.hu-berlin.de/forum/2010-07-001

[15]C. P. Snow, *Two Cultures and the Scientific Revolution Description* (London: Cambridge University Press, 1969).

[16]Christian Pfister, "Klimawandel in der Geschichte Europas: Zur Entwicklung und zum Potenzial der Historischen Klimatologie," *Österreichische Zeitschrift für Geschichtswissenschaften* 12 (2001), 7.

The Search for Culprits

Climatic extremes and nature-induced disasters are hot spots of cultural history. As Oliver Smith notes:

> In disasters the linkages between concrete material circumstances and ideological structures may be directly observed as people attempt to come to terms, to construct meanings and logics that enable individuals and groups to understand what has happened to them and to develop strategies to gain some degree of control over what is transpiring. [...] The extreme conditions created by disaster occurrence frequently challenge people's worldviews with profound existential questions for which meanings consistent with circumstances must be elaborated.[17]

There is a general tendency to blame humans for misfortunes befalling those whose behaviour did not seem to merit it. Such interventions were understood in terms of the individual, or groups of individuals, and not as the result of impersonal socioeconomic forces.[18] All the social characteristics that significantly structure people in a society will play a role in the way those meanings and explanations are constructed, giving broad disclosure to the internal variance of a community and underscoring the difficulty of reaching an absolute or objective determination of the nature of the disaster. Most research devoted to conspiracy in the early modern period deals with the impact of the Reformation "which reinforced the conspiratorial mindset. Both majority and minority groups interpreted the actions of their religious rivals in terms of plots."[19] Conspiracy theory also became relevant in the case of the arsonist scare in 1540, albeit in its own form.

In the case of Einbeck, a drunken shepherd, arrested on suspicion and interrogated under torture, confessed to having set the town on fire together with four accomplices.[20] He disclosed that he had happened to meet the bailiff of Hohenbüchen, Heinrich Diek, a person he knew superficially. Diek, an Einbeck opponent to the Lutheran confession, allegedly paid him to torch the town. Diek was arrested when he next entered the town. Under torture, he confessed to having been recruited by two lords, Claus von Mandelsloh and Christoph von Oberg, who were engaged in a plot against Einbeck and other Protestant towns. Oberg let him know that he had received 800 guilders from Duke Heinrich the Younger of Brunswick, the leader of the Catholic princes, to advance this plot, and that he had paid 50 guilders to Diek for burning down Einbeck by means of paid

[17]Oliver-Smith, "Theorizing Disasters," 38.

[18]Barry Coward and Julian Swann, eds., introduction to *Conspiracies and Conspiracy Theory in Early Modern Europe: From the Waldensians to the French Revolution* (Aldershot: Ashgate 2004), 2.

[19]Coward and Swann, introduction to *Conspiracies and Conspiracy Theory*, 4; see also Malcolm R. Thorp, "Catholic Conspiracy in Early Elizabethan Foreign Policy," *Sixteenth Century Journal* 15, no. 4 (1984): 431–448; Yves-Marie Bercé and Elena Fasano Guarini, eds., *Complots et conjurations dans l' Europe moderne* (Rome: Ecole française de Rome, 1996).

[20]Wolfgang Kampa, "Der grosse Stadtbrand von 1540," accessed June 15, 2011, http://www.einbeck1.de/html/brand_1540.html

arsonists.[21] The Einbeck conflagration raised a country-wide wave of indignation and became a major conflict fought out at the level of the Reich (Empire). The town was a member of the Schmalkaldian Alliance, which consisted of Protestant towns and princes standing against the emperor and the Catholic princes. The Landgrave of Hessen, leader of the alliance, openly accused Heinrich the Younger of Brunswick of anti-Protestant arsonist conspiracy, and Martin Luther supported this point of view in a pamphlet against "Hans Worst."[22] At the imperial diet of Regensburg in 1540, the Protestant estates demanded that Emperor Charles V should take action against a Catholic conspiracy allegedly planning to eradicate the new creed by arsonist attacks. The Pope was blamed for pulling the strings.[23] Heinrich contested the Protestants' accusation, indicating that towns had also been burnt down in his territory.[24] Organised arsonists were called *Mordbrenner* in German, which originally suggested "clandestine arsonists" but came to be understood as "murder arsonists."[25] Fragments of court records published in the early twentieth century sparked historians' interests in the *Mordbrenner*. Karl Helleiner wrote the first essay devoted to this issue in 1930.[26] The transition from the history of events to cultural history, which entails the history of individuals, led to a focus on the fate of the culprits as documented in the criminal proceedings. Thus Bob Scribner, a leading English-speaking scholar of his generation in the field of German Reformation history, investigated 125 accusations of arson from 1496 to 1569 in the South German Duchy of Württemberg, now housed in the Hauptstaatsarchiv Stuttgart.[27] In her dissertation, Monika Spicker-Beck attempted an in-depth analysis of 78 confessions by alleged clandestine arsonists caught in Southern Germany.[28]

The idea that crimes threatening the basis of society must be prosecuted by public authority goes back to Carolingian times.[29] It was *communis opinio* among jurists that secret criminal organisations, usually in the pay of a "foreign" or enemy power, were responsible for arson.[30] All arsonists were, according to their

[21]Bob Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany: Political Paranoia or the Revenge of the Outcast?" in *The German Underworld: Deviants and Outcasts in German History*, ed. Richard J. Evans (London: Routledge 1988), 29.

[22]Zwierlein, *Der gezähmte Prometheus*, 106.

[23]Johannes Dillinger, "Organized Arson as a Political Crime: The Construction of a 'Terrorist' Menace in the Early Modern Period," *Crime, History & Societies* 10, no. 2 (2006): 101.

[24]Zwierlein, *Der gezähmte Prometheus*, 105.

[25]Spicker-Beck, *Räuber Mordbrenner, umschweifendes Gesind*, 100–113, 169–70; Dillinger, *Arson*, 101.

[26]Karl Helleiner, "Brandstiftung als Kriegsmittel," *Archiv für Kulturgeschichte* 20 (1930), 326–349.

[27]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 42.

[28]Spicker-Beck, *Räuber, Mordbrenner, Umschweifendes Gesind*, 19.

[29]Ester Cohen, "Inquiring Once More after the Inquisitorial Process," in *Die Entstehung des öffentlichen Strafrechts*, ed. Dietmar Willoweit (Köln: Böhlau, 1999), 55.

[30]Dillinger, "Organized Arson as a Political Crime," 111.

"confessions," recruited in roughly the same way. They met a person who presented himself as the agent of some foreign potentate. The agent paid them a sum of money to start fires in a certain region.[31] Arson was thought to be, to some extent, the work of *Raubritter* (robber barons), members of the lower nobility, who engaged in robbery, theft, and intimidation largely as a profession. The crime was also attributed to petty delinquents and vagrants, which were excluded from the protection of the public peace.[32] Beggars and vagabonds supposedly formed secret societies, had a secret language (*Rotwelsch*), and used secret signs such as girdles made from straw to recognise each other.[33] Johannes Dillinger points out that organised arson was regarded as the most dangerous political crime of the early modern period, as the attacks were not directed to individuals, but aimed at spreading insecurity and chaos within communities and territories, similar to terrorist attacks today.[34]

Nicolaus Thoman describes the situation in his *Chronik von Weissenhorn* (near Ulm) as follows:

> In this year [1540] there was much fire-raising in all places in the land, and many of these fire-raisers, men and women, were seized and killed, but no one could learn the proper truth from whom or whence this came, and they seldom knew who paid the money. One said that someone had come to him at Strasbourg, another mentioned another place, a third something else, that people had come to him and given him money, and told him when they could come to him again to learn how much forest had been burned, and that they would give him more money for various houses or barns [. . .] and watch was kept in all the towns and villages by day and night.[35]

Thoman's report is in many respects paradigmatic. Repeat news and rumours about burnt down villages, towns, and forests maintained continuous fear of arsonist attacks. In this mood of latent insecurity and anxiety, settlements were guarded around the clock. In July of 1540, the authorities of the town of Ulm sent a warning against arsonists to the guilds.[36] In August, the council of Freiburg (Baden-Württemberg) appointed two armed guild members to stand at the city gates, to keep out foreign beggars and peddlers who might be suspected of being arsonists.[37] Forests were scoured for fire-raising gangs.[38] Special attention was paid to secret

[31]Dillinger, "Organized Arson as a Political Crime," 104.

[32]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 34.

[33]Helleiner, "Brandstiftung als Kriegsmittel," 330.

[34]Dillinger, "Organized Arson as a Political Crime," 111.

[35]Nikolaus Thomann, "Weissenhorner Historie", in F.L. Baumann (ed), *Quellen zur Geschichte des Bauernkrieges in Oberschwaben* (Tübingen: H. Laupp, 1876), 225, translated in Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 32.

[36]Zedel an alle Zünfte gegeben [Warnung wegen der Mordbrenner], 2 July 1540, StdA A 3680, fol. 283, in *Reichsstädte 3: Ulm*, ed. Susanne Kremmer and Hans Eugen Specker, in *Repertorium der Policeyordnungen der Frühen Neuzeit*, ed. Karl Härter and Michael Stolleis, vol. 8, Studien zur europäischen Rechtsgeschichte 218 (Frankfurt am Main: Klostermann, 2007), 42.

[37]Spicker-Beck, *Räuber, Mordbrenner, umschweifendes Gesind*, 192.

[38]Ibid., 198.

arsonists' marks on town gates or inn doors.[39] Police forces and emerging state authorities, cooperating with their counterparts beyond the confines of their small territories, became increasingly busy collecting, storing, and exchanging information about itinerant arsonists.[40] Even though such papers contained numerous errors and were often outdated, they had considerable influence on criminal investigations and on the idea of arson in the popular mind.[41] Arson was clearly one of those crimes that particularly well suited to inspire a feeling of solidarity between the subjects and their respective lords. No wonder that peasants and townspeople therefore supported the authorities in their fight against organised arson by denouncing supposed arsonists.[42] Likewise, Switzerland was full of fire-stricken homeless people asking for donations from residents and authorities.[43] Zürich complained about the high expenditures required to guard the long border with the German Reich.[44] The Diet of the Swiss Confederation, a meeting of cantonal delegates, decided to interrogate beggars and able bodied men suspected of starting fires throughout the country under torture. These men, they determined, should be punished or banished.[45]

Scribner refers to such behaviour as paranoia.[46] This term designates thought processes that are heavily influenced by anxiety or fear, often to the point of irrationality and delusion.[47] Paranoid thinking typically includes "persecutory beliefs, or beliefs of conspiracy concerning a perceived threat towards oneself."[48] It may be directed against innocents. As chronicler Nicolaus Thoman remarked, "many pious people were also arrested and visited to see whether anything suspicious could be found on them."[49] Bob Scribner supports his appraisal: "People seemed to have been arrested largely because they belonged to the 'dangerous classes.' Those eventually convicted were found guilty of a variety of other offences: blasphemy, petty theft, being fake beggars, crooked gambling, wife desertion, disorderly behaviour or threatening words."[50]

The lesson to be learned from this micro-history is that we often need to get pretty close to events in order to grasp their meaning and their significance for the

[39]Ibid., 192.

[40]Dillinger, "Organized Arson as a Political Crime," 112.

[41]Ibid.

[42]Ibid.

[43]"Baden. 1540, 23rd Aug/2nd Sep 1540," *Die Eidgenössischen Abschiede aus dem Zeitraume von 1533 bis 1540*, ed. Karl Deschwanden, Amtlichen Sammlung der älteren eidgenössischen Abschiede 4.1c, part 2 (Luzern: Meyer'sche Buchdruckerei, 1878), 1251.

[44]Deschwanden, *Die Eidgenössischen Abschiede*, 7/17th June 1540, 1210.

[45]Deschwanden, *Die Eidgenössischen Abschiede*, 13/23th Dec. 1540, 1280.

[46]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 33.

[47]*Merriam-Webster OnLine*, s.v. "paranoia," accessed December 12, 2011.

[48]*Wikipedia*, s.v. "paranoia," accessed December 12, 2011, http://en.wikipedia.org/wiki/Paranoia#References

[49]Franz Ludwig Baumann, quoted and translated by Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 32.

[50]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 49.

people involved. In the case of arsonist paranoia, micro-history allows for personalising the suffering of countless victims by portraying the destiny of an individual. The case of Jörg Riel from Neuenstadt am Kocher (Baden-Württemberg) is quite illustrative. In 1540, he was begging in the village of Wolpertswende. After a dispute with a woman, he threw his charity, a loaf of bread, in her face, threatening to set her roof ablaze. People then denounced him as a supposed arsonist. Riel was imprisoned with his wife Anna Keirin in the town of Ravensburg situated close to Lake Constance. At first he rejected the charge, as did his wife, even under torture. When witnesses from Wolpertswende confirmed the incident, Riel was tortured again and then confessed to having uttered the threat. However, even after enduring the torture three more times he staunchly repeated that he had done no evil. Finally, he was released, together with his wife, after having sworn never to set foot again in the Ravensburg district.[51]

The "preliminary proceedings" in this case are quite typical. Virtually all statements by the suspects were made under torture or threat of torture.[52] Scribner concedes the overreaction by authorities and settled people in persecuting vagrants for fire-raising. However, he holds that the existence of the *Mordbrenner* was "irrefutable."[53] Likewise, Spicker-Beck considers the existence of organised arson certain "because it was still an existing form of covert warfare."[54] On the other hand, Johannes Dillinger criticises the lack of plausibility in the "confessions" of the culprits and points to the lack of effective means for the alleged "employer" to control the vagabonds after payment of the bribe.[55] More surprisingly, even circumstantial evidence of individually motivated arson or accidental fire-raising was rarely found in the arson accusations levelled against vagrants, though some of them might have involuntarily raised a blaze when they sought overnight shelter in barns, by lighting a fire to keep warm amidst dry tinder in the form of hay or straw.[56]

The Spark of Sundsvall

"Disasters come into existence in both the material and the social worlds," states Oliver Smith, "and, perhaps, in some hybrid spaces between them."[57] Therefore, they offer a context in which to pursue these more inclusive understandings of the mental and the material. As already mentioned, disasters are social constructs in the

[51]Spicker-Beck, *Räuber, Mordbrenner, umschweifendes Gesind*, 256–259.
[52]Dillinger, "Organized Arson as a Political Crime," 104.
[53]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 42.
[54]Spicker-Beck, *Räuber Mordbrenner, umschweifendes Gesind*, 322–330.
[55]Dillinger, "Organized Arson as a Political Crime," 105.
[56]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 42.
[57]Oliver-Smith, "Theorizing Disasters," 24.

sense that the meanings and explanations given to such events are rooted in collective worldviews and characteristics that structure people in a society. However, to say that disasters are social constructs does not disembed them from the materiality of the world. "The physical reality of disaster explicitly challenges theoretical currents that hold that nature is a purely social construction at the ontological level."[58] Another aspect concerns the time horizon under which disasters should be conceived. For Oliver Smith, they should be considered a process, rather than an event.[59] His argument particularly relates to the connectivity of fire and drought. Droughts, if they last long enough, increase the likelihood that wooden cities and straw thatched villages will catch fire according to the same rules as fires in open country.[60] The event, the eruption of fire in a sudden flash, be it by human negligence, arson, or self-ignition, is always the final phase of a process that may have lasted for anything from hours to weeks.

Fire is a disaster traditionally attributed to human practice and is not clearly assigned the status of "natural hazard" in research. As the focus of most historical studies is upon individuals and societies, there is seldom more than an oblique reference to climate as a conditioning factor for fire.[61] Eleonora Rohland is the first historian who systematically integrated extreme climatic conditions into the history of fire. Admittedly, Marjatta Hietala, dealing with fires in nineteenth-century Finnish towns, already subsumed fires to natural disasters similar to floods, windstorms, and earthquakes. She correlates fires in Finland with the season, noting that the majority of fires occurred during the summer months. However, she does not investigate the climatic situations leading to town fires.[62] Likewise, Cathy A. Frierson remarks that the risk of town and village fires in Imperial Russia was greatest during the hottest and driest season in July,[63] when droughts often provided the fuel and opportunity for fire to feed itself.[64]

In her case study about a fire in the Swedish town of Sundsvall in 1888, Rohland notes that the spring and early summer of that year were unusually warm and dry throughout Sweden. Sunshine from a cloudless sky prevailed for weeks, and the amount of rain was extremely low.[65] Under these conditions, forests and wooden buildings became highly fire prone. On 25 June, the towns of Sundsvall and Umea, both situated in the northern part of Sweden, burnt down almost completely within a few hours. In Sundsvall's case, sparks emitted from a steamboat were sufficient to

[58]Woolgar and Tester, quoted in Oliver Smith, "Theorizing Disasters," 39.

[59]Oliver-Smith, "Theorizing Disasters," 23.

[60]Stephen L. Pyne, *Fire: A Brief History* (Seattle: University of Washington Press, 2001), 28.

[61]Eleanora Rohland, "From Wood to Stone: The Risk Management of Swiss Re in The Sundsvall Fire 1888", *Environment and History* 17 (2011): 153–169.

[62]Quoted in Rohland, *Sharing the Risk*, 16.

[63]Frierson, All *Russia is Burning*, 33.

[64]Frierson, *All Russia is Burning*, 86.

[65]Rohland, "Wood to Stone," 159–161.

trigger the fire.[66] About three dozen other fires broke out in villages, towns, and forests all over the country. According to press reports, "the sun was darkened by clouds of smoke, and in the evening looked like a blood-red ball."[67] In fact, considering that the value of the lost property was the equivalent of about 1.5 billion Swedish crowns in 1998, when Nilsson made this calculation, there are good reasons to consider this a national catastrophe. In 1868, when town fires were unusually frequent in Germany,[68] persisting extreme warm and dry anomalies as a result of quasi-stable anticyclones extended over large parts of the continent. As Rohland demonstrates, insurance companies had tried to avoid a group of fire claims within the same year by spatially extending their policies beyond the range of known fire-regimes. However, they did not anticipate the occurrence of persistent warm and dry anomalies on such a large scale. As a result, insurance companies had to pay an unprecedentedly high number of claims in 1868, which pushed the balance sheets of Swiss Re into the red.[69]

Likewise, the blaze of Einbeck was not an isolated case. Zwierlein has set up a unique historical statistic containing 8200 records of town fires in Germany. The German *Städtebücher* (town books), compiled under the Nazi regime in a huge collective effort by historians, contain reports about all settlements in Germany existing by the cut-off date of 1 January 1936, that ever held a town charter (*Stadtrecht*). This statistic also includes small settlements with a few hundred inhabitants. According to Zwierlein's statistic, 33 town fires were registered in 1540 *Städtebücher*, not counting innumerable village fires. For a year without major war-effects, this value is by far the highest known from the Middle Ages to the nineteenth century, coming close to war-related peaks during the Thirty Years War.[70] Monika Spicker-Beck accepts the hypothesis of a correlation between drought and the arsonist scare of 1540, but does not link the elevated number of *Mordbrenner* trials in the years 1536, 1556, and 1559 to this argument.[71] Scribner argues that "the exceptional weather conditions of 1540 may explain the intensity of the panic, but not the pattern of accusations or convictions." The arsonist scare "was a general phenomenon throughout the century that points to broader explanations and a broader framework within which the panic in 1540 must be located."[72] Johannes Dillinger, on the other hand, uses the exceptional drought conditions to dismiss the argument that the high number of fires might substantiate

[66]Eleonora Rohland, *Sharing the Risk: Fire, climate and disaster. Swiss Re 1864–1906* (Lancaster: Crucible Books, 2011). 125.

[67]Nilsson, "The End of a Pre-industrial Pattern," 280.

[68]Zwierlein, *Der gezähmte Prometheus*, 83.

[69]Rohland, *Sharing the Risk*, 126.

[70]Zwierlein, *Der gezähmte Prometheus*, 103–104.

[71]Spicker-Beck, *Räuber Mordbrenner, umschweifendes Gesind*, 19. The years 1536 and 1556 also had unusually warm and dry springs and/or summers. See Christian Pfister, *Wetternachhersage: 500 Jahre Klimavariationen und Naturkatastrophen, 1496–1995* (Bern: Paul Haupt, 1999), 290.

[72]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 42.

the existence of organised arson.[73] Likewise, fire historian Cornel Zwierlein is convinced that the conflagrations were generated or at least promoted by the extreme heat and drought: "1540 was a year of natural fire hazard rather than a year of arsonist plots."[74] Understanding the unusual intensity and the wide dissemination of the arsonist scare involves relating the mental to the material, as suggested by Oliver Smith. Taking an historical climatology approach allows for putting local events in a large-scale meteorological context. Jürg Luterbacher et al. systematically reconstructed seasonal temperature, sea-level pressure, and precipitation for the whole of Europe from 1500 to the present, drawing on evidence from archives as well as nature.[75] Likewise, the recurrence of extreme events can be viewed on the basis of monthly and seasonal temperatures assessed from the so-called Pfister documentary indices for Germany,[76] the Czech Republic, and Switzerland for the period from 1500 to the present.[77] In the language of sources, climatic events are usually characterised in terms of weather narratives dealing with processes on regional or local scales, and lasting from hours to whole seasons. Such narratives also discuss how (extreme) climate events affected humans, how they interpreted such anomalies on the basis of their worldviews, and how they responded to them (which is the subject matter of cultural history).

Europe's Largest Natural Disaster[78]

An Underestimated Record-breaking Event

Proceeding from the arsonist scare, the weather patterns in central Europe and their environmental and economic consequences in 1540 are investigated in somewhat more detail in the following sections.

[73]Dillinger, "Organized Arson as a Political Crime," 83.

[74]Zwierlein, *Der gezähmte Prometheus*, 107.

[75]Jürg Luterbacher et al., "Reconstruction of Sea Level Pressure Fields over the Eastern North Atlantic and Europe back to 1500," *Climate Dynamics* 18 (2002): 545–561; Jürg Luterbacher et al., "European Seasonal and Annual Temperature Variability, Trends and Extremes Since 1500," *Science* 303 (2004): 1499–1503; Andreas Pauling et al., "500 Years of Gridded High-resolution Precipitation Reconstructions over Europe and the Connection to Large-scale Circulation," *Climate Dynamics* 26 (2006): 387–405.

[76]Mauelshagen, *Klimageschichte*, 55.

[77]Petr Dobrovolný et al., "Monthly, Seasonal, and Annual Temperature Reconstructions for Central Europe Derived from Documentary Evidence and Instrumental Records since AD 1500," *Climatic Change* 101, no. 1 (2010): 69–107.

[78]Axel Bojanowski, "Hitze-Jahr 1540: Wetterdaten enthüllen Europas größte Naturkatastrophe," *Spiegel Online*, July 2, 2009. http://www.spiegel.de/wissenschaft/natur/hitze-und-duerre-1540-katastrophe-in-europa-im-mittelalter-a-978654.html

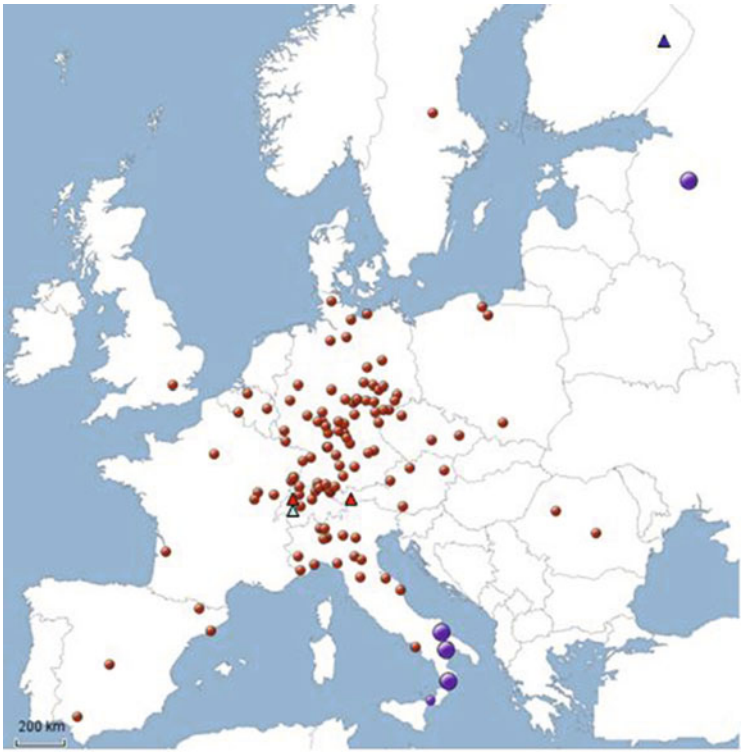

Fig. 1 Spatial distribution of 1540 documentary data related to the occurrence of drought. *Dots*: Documentary data evidence of drought (*red*) and abundance of precipitation (*blue*). *Triangles*: *red* warm anomaly; *light blue* cold anomaly; *blue* wet anomaly

Based on more than 300 first-hand documentary weather reports originating from an area of two to three million square km, Oliver Wetter et al. showed that Europe was affected by an unprecedented eleven-month-long Megadrought[79] (Fig. 1).

The summer of 1540, as a reconstruction by Jacobeit et al. illustrates (Fig. 2), was characterised by a persistent diagonal south-west to north-east oriented ridge of high pressure over Europe connected to the Azores High,[80] and surrounded by a low pressure system over the Atlantic and western Russia.

In order for us to truly comprehend the severity and dimension of this calamity, its human and environmental impact are discussed. Four specific aspects are

[79]Oliver Wetter et al., "The Year-long Unprecedented European Heat and Drought of 1540—A Worst Case," *Climatic Change* 125, no. 3 (2014): 353, doi: 10.1007/s10584-014-1184-2.

[80]Jucundus Jacobeit, Heinz Wanner, and Martin Gudd, "European Surface Pressure Patterns for Months with Outstanding Climatic Anomalies during the Sixteenth Century," *Climatic Change* 43, no. 1 (1999): 206.

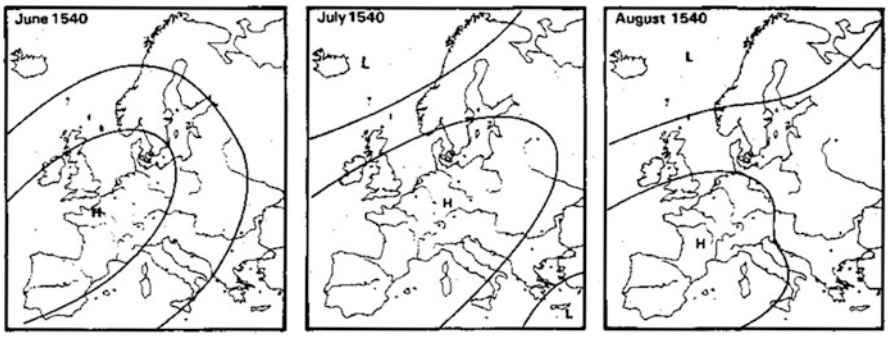

Fig. 2 Reconstruction of European surface pressure patterns for summer (JJA) 1540. Jaacobeit surface pressure patterns, 353

addressed, namely: the meteorological drought, which is the difference between actual and average precipitation computed over several decades; the hydrological drought, which is the discharge deficit of rivers, including the low level of lakes and groundwater-tables; the relationship between extreme drought and extreme temperatures; and the human impact of heat and drought and their relationship to forest and settlement fires.

The Meteorological Drought

Detailed descriptions of prevailing weather patterns and their impacts in Alsace and in the Swiss Mittelland are found in nine chronicles.[81] In the Czech lands, 1540 was the driest year and the driest summer season in the past 500 years.[82] Regarding east central Europe, reliable data on precipitation frequency were obtained from the only weather diary for 1540 known in Europe, kept by Marcin Biem, a theologian and the president of Cracow University.[83]

Many chroniclers reported the date of rain spells and the quasi-rainless period in between as a proxy for drought severity. Dealing with sixteenth century documentary evidence prior to 1582 involves correcting dates from the Julian to Gregorian calendar by adding ten days. All dates hereinafter are given in Gregorian Style. In England, no rain fell "from June [about 10 July] to eight days after Michaelmas (18 October)." In Louny (Bohemia), it rained only once between 26 May and

[81]Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Poland.

[82]Petr Dobrovolný et al., "Precipitation Reconstruction for the Czech Lands, AD1 1501–2010," *International Journal of* Climatology 35, no. 1 (2015) doi: 10.1002/joc.3957.

[83]Wetter et al "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Poland, source 1.

Table 1 Number of precipitation days in the Swiss Mittelland in 1540 compared to the 20th century average and the minima measured since 1864

	Spring	Summer	Autumn	Year
1540	4 (18%)	15 (41%)	8 (30%)	38* (29%)
1901–2000	34.3	36.6	29.2	130
Minimum	22 (1934)	20 (1949)	18 (1920)	95 (1921)

[a]The annual value includes 10 precipitation days for January, for which observations are missing

13 October, on 8 August.[84] More detailed reports on rainy spells from Alsace and Switzerland allow a rough assessment of the number of seasonal rain days. Some chroniclers—Stolz in Guebwiller (Alsace), Ryff and Meyer in Basel, Bullinger in Zürich, and Salat in Lucerne—began keeping track of the time and amount of precipitation events with the growing duration and intensity of the drought. Ryff in Basel counted three "short and feeble" rain spells between the "beginning of summer" and St Martin's Day (21 November), each lasting no more than two or three days. Heinrich Bullinger, in Zürich, mentions six days between the beginning of February and 29 September, insisting that it never rained "during an entire day or an entire night" (Table 1)

Days with precipitation in spring, summer, and autumn were much lower than the twentieth century average, and even below the absolute minima of the period of regular network observation (since 1864). The annual value is 81% below the twentieth century average and even 40 % below the driest year since 1864.[85] The Lucerne botanist and politician Renward Cysat emphasises in this context that Alpine meadows were literally "irrigated" every morning by abundant dew, possibly generated by the intensive evaporation of firn fields and glaciers during the day which, at that time, were in their advanced "Little Ice Age" position.[86] Another remarkable feature of this summer was the absence of thunderstorms.[87]

[84]Wetter et al. "The Year-long Unprecedented European Heat and Drought," supplement, table S1, United Kingdom, source 2; ibid., table S1, Czech Republic, source 2.

[85]Wetter et al. "The Year-long Unprecedented European Heat and Drought," 355.

[86]Renward Cysat, "Stationes Annorum. Witterung. Missjahre. Teuerung," in: *Collectanea chronica und denkwürdige Sachen pro Chronica Lucernensi et Helvetiae, Abt. 1: Stadt und Kanton Luzern*, Bd. 1 Teil 1: "Collectanea chronica und denkwürdige Sachen zur Geschichte der Stadt Luzern, ed. Josef Schmid," Lucerne: Diebold Schilling Verlag, 1969, 898–962, here 905.

[87]Concurrent observations by Hirzel, Samuel, ed., "Die Chronik des Fridolin Ryff 1514–1541, mit der Fortsetzung des Peter Ryff 1543–1585," in *Basler Chroniken* vol. 1, Leipzig: S. Hirtzel, 1872, 18–192, here 115. Wolfram Stolz, *Die Hans Stolz'sche Gebweiler Chronik. Zeugenbericht über den Bauernkrieg am Oberrhein*, Freiburg i. Br.: Wolfram Stolz, 1979, 373 and an anonymous chronicler from Lindau quoted in Karl-Heinz Burmeister,"Der Heiße Sommer 1540 in der Bodenseeregion," in *Schriften des Vereins für Geschichte des Bodensees und seiner Umgebung*, vol. 126, (Lindau: Stettner, 2008) 59–87, here 61.

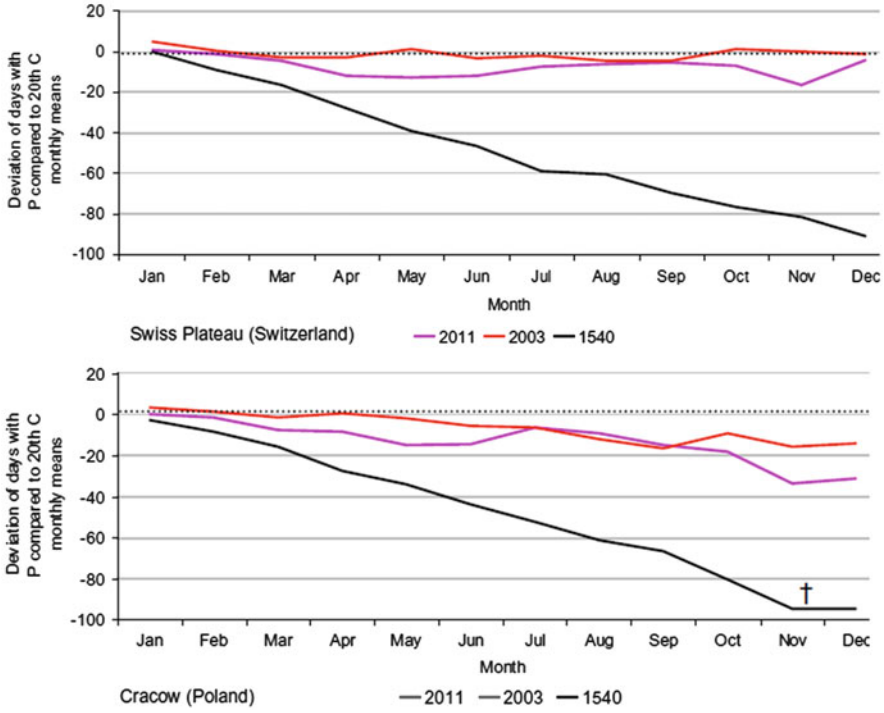

Fig. 3 Cumulative deviations of precipitation days in 1540 in Northern Switzerland and in Cracow (Poland) in comparison with twentieth century values. Source: Wetter et al. "The Year-long Unprecedented European Heat and Drought of 1540—A Worst Case," p. 355

Considering the cumulative deficit of precipitation days from the 1901–2000 average (Fig. 3), the 1540 drought was significantly more persistent and extreme than the recent events in 2011, 2003 and 2015. Eye-witness observations about extreme soil desiccation and soil cracking confirm the hypothesis of a record-breaking soil moisture deficit. Some cracks were so wide that people could put their feet into them.[88] Ploughing the ground in autumn was not possible in Moncrabeau (France) due to the drought, which suggests persistence of the extreme soil moisture deficit until October.[89]

The amount of precipitation depending on the observed rain days was estimated through a hierarchy of statistical models. From Figure 4, it can be concluded that

[88] Johann Jakob Goldschmid, "Erzellung seltsammer Natur-Geschichten [...] so sich bey uns in der Statt Wintertur zugetragen haben (bis 1543)," Ms fol. 3, Stadtbibliothek Winterthur, Winterthur.

[89] "En ceste temps habions faulte de pluye et le monde ne povoyt semer les blez faulte de pluye les laboreurs enuys." Philippe Tamouzey de Larroque, ed., *Livre de raison de la famille Dudrot de Capdebosc (1522–1675)* (Paris: Libraire Alphonse Picard, 1891), 16.

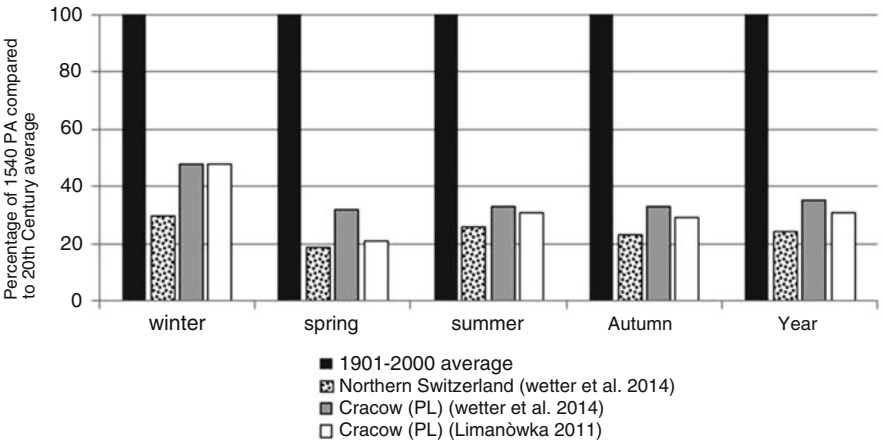

Fig. 4 Estimated 1540 seasonal precipitation in northern Switzerland and Cracow (%) compared to the twentieth century average. Source: Christian Pfister. "The 'Black Swan' of 1540: Aspects of a European Megadrought." In *Climatic Change in Europe*. Klaus Leggewie and Franz Mauelshagen, eds. Leiden: Brill, 2017.

throughout spring, summer, and autumn of 1540 the precipitation in western Europe remained significantly below the minimum of the previous hundred years. The reconstructed annual precipitation of 236 mm (24%) is somewhat below the estimate made by the author in 1984.[90] No event of a similar severity is documented within the period in question. In Poland, the drought, though somewhat less severe, likewise persisted over three seasons.[91]

A region of two to three million square km, ranging from France to Poland and from central Italy to northern Germany, suffered from a dust-dry spring, followed by a torrid summer and an almost rainless autumn, which made 1540 the worst drought year of the last five centuries.

The Hydrological Drought

Hydrological drought is associated with the effects of periods of precipitation shortfall (including snow) on surface or subsurface water availability (i.e. streamflow, reservoir, and lake levels). A great number of observations detail the level of lakes and rivers. Many chroniclers report that brooks and wells, even those that had

[90]The author estimated "a third at the most". Christian Pfister, *Das Klima der Schweiz von 1525 bis 1860 und seine Bedeutung in der Geschichte von Bevölkerung und Landwirtschaft*, vol 1, (Bern: Paul Haupt,1984),138.

[91]Wetter et al., "The Year-long Unprecedented European Heat and Drought," 355.

so far never failed, fell dry between late spring and early summer.[92] In this situation of acute water shortage, people dug more than 1.5 m in vain for water in the bed of the Suhre, a small river in Canton Lucerne.[93] In Bad Gastein (Austria), several Alpine areas were not used for grazing because they lacked sufficient drinking water for cattle.[94]

Last but not least, this conclusion relates to the case of Einbeck. The town is situated at a small brook named "Das Krumme Wasser" (sinuous water). At the time of the disaster, the brook had most likely dried out. That is to say, water was not even available to put out a kitchen fire, not to mention a major blaze. In early August, the rivers Elbe, Saale, and Eger in Saxony could be crossed in the dry by stepping from one stone to the next.[95] The Rhine had become a runnel, still fed by the rapid melting of extended firn fields and glaciers in the Alps.[96] At Mülheim, downstream of Cologne, some people could cross the river on horseback.[97] Likewise, most rivers in France could be waded.[98] The level of the Thames was so reduced that salt water flowed upstream beyond London Bridge.[99] The eastern end of Lake Biel (Switzerland) completely dried up over a distance of 750 m.[100] Lake Constance dropped to such a low level that the lake floor, with its mountains and valleys, emerged over considerable distance. The island of Lindau was connected to the coast, so that people could walk around it.[101] This level cannot be properly

[92]Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1.

[93]Jakob Bächtold, ed., *Hans Salat. Schweizerischer Chronist und Dichter aus der ersten Hälfte des XVI. Jahrhunderts. Sein Leben und seine Schriften*, (Basel: Bahnmaier's Verlag, 1876), 56.

[94]"Gasteinerische Chronica, (ed. von Heinrich Zimburg und Herbert Klein, Herbert)" *Mitteilungen der Gesellschaft für Salzburger Landeskunde*, 81 (1941): 62.

[95]"Elbe/Saal und Eger [near Meissen, Saxony] will man durchwaden/auch von einem Stein auf den andern trucken übergehen." Christian Lehmans Sen. *Weiland Pastoris zu Scheibenberg Historischer Schauplatz derer natürlichen Merckwürdigkeiten in dem Meißnischen Ober-Erzgebirge* (Leipzig: Tietze, 1699), 91.

[96]Bächtold, *Salat*, 56.

[97]"Der Rhein wart so klein, das einer bei Mulhem under Coln dardurch reit." K. Höhlbaum, ed., *Das Buch Weinsberg. Kölner Denkwürdigkeiten aus dem 16.Jahrhundert*. Vol. 1, (Leipzig: Duerr 1886), 52.

[98]"Dans tout le Royaume de France fut si grosse sécheresse, que les rivières furent, dois [dès] le mois d'apvril jusques environ à la fin de novembre, si basses que l'on passoit à pied." N.N. Gauthier, ed., "Livre de raison de la famille de Froissard-Broissia de 1532 à 1701," *Mémoires de la Société d'émulation du Jura*, 4th ser., 2 (1886), 27–105, 34.

[99]"The Thamis was so shalowe, and the freshe water of so small strength, that the Salt water flowed aboue London bridge, till the raine had encreased the freshe waters. Charles Wriothesley, *A Chronicle of England During the Reigns of the Tudors, from A.D. 1485 to 1559,* ed,William Douglas Hamilton, vol. 1 (Westminster: Camden Society, 1875), 87.

[100]"Unser see zu biellen [Biel] von rechberger hüsly garnach den halben theil bis gon Vingelz abgieng." A[rnold] Bähler, *Bendicht Rechbergers Bielerchronik 1524–1566* (Biel: Buchdruckerei Schüler, 1902), 14.

[101]"Der See war im Sommer so klein, daß man rings umb die Stadt gehen und im Wasser Berg und Thal sehen konnte." *Sc'nell'sche Chronik*, Lit 29: 99, Stadtarchiv, Lindau.

compared to those of the instrumental period, because a railway dam was built in 1843 between the island and the mainland. However, the island of Lindau was also connected to the coast in March, 1672. Joseph Wittmann, the author of a scientific compilation about hydrological droughts of the Rhine and Lake Constance, equates the level of the lake in March 1672 with that in February, 1858, when it dropped to the lowest level ever measured so far. Under these circumstances, archaeological relicts were found on the dry floor of the lake.[102] A similar episode is known for 1540, when a woman named Anna Schmid came across a pot containing 900 silver coins from the time of Emperor Augustus.[103]

Year-long Heat

The conditions under which temperatures rise to record-breaking levels were intensively investigated after the hot summer of 2003. There is consensus that soil moisture- temperature interactions were a key driver in the sequence of events that led to the exceptional heat wave in early August 2003. Under average conditions, a considerable part of incoming solar energy, called latent heat, is used to evaporate water. The remaining sensible heat warms the air. After an extremely dry spring, less water is available for evaporation in the case of a persistent warm-dry spell in early summer. This tendency leads to a supplementary increase in air temperature. At the same time, it further intensifies soil moisture deficit and thus sensible heat via a feedback effect.[104] Erich Fischer et al. demonstrated from modelling experiments that, in the absence of soil-moisture feedback, summer 2003 would still have been warm, but it would not have been such a devastating event as it turned out to be.[105] With regard to record-breaking heat, the situation in western and central Europe in the summer of 2003, so far discussed in over one hundred scientific papers, is usually taken as a benchmark for future extreme events of this kind. According to an influential paper in the renowned journal (*Nature*) the heat of spring/summer 2003 was "probably even higher than in any other year since 1370." This conclusion was based on the analysis of a series of grape harvest dates from Burgundy (France).[106] Grape harvest dates are the best known phenological

[102]Wetter et al., "The Year-long Unprecedented European Heat and Drought," 973, 979.

[103]Burmeister, *Bodenseeregion*, 77.

[104]An extended review is provided by Sonia Isabelle Seneviratne, Thierry Corti, and Martin Hirschi, "Investigating Soil Moisture: Climate Interactions in a Changing Climate; A Review," *Earth Sciences Review* 99, no. 3–4 (2010): 125–161.

[105]Erich M. Fischer et al., "Soil Moisture–Atmosphere Interactions during the 2003 European Summer Heat Wave," *Journal of Climate* 20 (October 2007): 5081–5099.

[106]Isabel Chuine, Pascal Yiou, Nicolas Viovy, Bernard Seguin, Valérie Daux Emmanuel Le Roy Ladurie, "Grape ripening as a past climate indicator," Nature 432 (2004): 89–290.

proxy, dating back to the late Middle Ages.[107] From a series of tree-ring maximum latewood density measurements in Lötschental (Canton Valais, Switzerland), it was concluded that the summer 2003 was the hottest since 755 CE.[108]

Oliver Wetter and the author challenged these findings with a view to the drought of 1540.[109] Temperature patterns may, to some extent, be derived from detailed phenological observations in chronicles. Most chroniclers, in order to allow comparisons of outstanding anomalies over time, referred to indirect (bio) physical proxy data in the natural environment. They present such observations within their meteorological context, which allows for cross-checking the mutual comparability of narrative meteorological and (bio)physical proxy data. Unsurprisingly, phenological information is widely available for 1540.[110]

The month of March (Julian style), i.e. the period from 10 March to 10 April, 1540, except for the first three days when it rained, was consistently dry and sunny, albeit without the early appearance of cherry blossoms.[111] Ulrich Meyer (Winterthur) relates the lack of early blossoms to persistent cold winds.[112] In Guebwiller, ice was found every morning. The subsequent rapid development of vegetation suggests that the following four months were extremely warm: cherry trees were in full flower around 10 April in Ancy-sur-Moselle (France). One month later, cherries in the same region were already ripe.[113] The flowering of grapes in Schaffhausen and in Biel-Bienne ended in late May (10 June), about a month earlier than usual.[114] In Schaffhausen, the grapes were soft by 5 July and sampled on 4 August.[115] Reformer Heinrich Bullinger in Zürich tasted the first grape must (*Sauser*) on 10 August.[116] It was concluded from this evidence that the likely time of full grape maturity in 1540 was somewhere between 12 and 24 August.[117]

Pierre de Teysseulh, an official of the church of Limoges (central France), notes that "the grapes were like roasted and the leaves of the vines had fallen to the

[107]Emmanuel Le Roy Ladurie, Daniel Rousseau, and Anouchka Vasak, *Les fluctuations du climat: 'De l'an mil à au'ourd'hui* (Paris: Fayard, 2011), 61.

[108]Ulf Büntgen, David C Frank, Daniel Nievergelt, Jan Esper, "Summer Temperature Variations in the European Alps, A.D. 755–2004," Journal of Climate 19 (2006): 5606–5623.

[109]Oliver Wetter and Christian Pfister, "An Underestimated Record Breaking Event: Why summer 1540 was likely warmer than 2003," *Climate of the Past* 9, no. 1 (2013), 41–56.

[110]The following evidence is based on Wetter and Pfister, "An Underestimated Record Breaking Event," supplement, doi: 10.5194/cp-9-41-2013.

[111]Ulrich Meyer, *Chroniken 1540–1576*, Stadtbibliothek Winterthur Ms Quarto 102.

[112]. Malachias Tschamser, *Chronique de Thann* (Colmar; Buchdruckerei von K. M. Hoffmann, 1864), 62.

[113]E. de Bouteiller, ed., *Journal de Jean le Coullon*, 1537–1587 (Paris: D. Dumoulin, 1881), 22.

[114]Hans-Oswald Huber, *Schaffhauser Chronik*. ed. by Jakob Bächtold, Schaffhausen, 1906, 24 Bähler, Rechberger, 15.

[115]Huber, *Chronik*, 25.

[116]Heinrich Bullinger, *Diarium (Annales Vitae),* ed Emil Egli*, Quellen zur Schweizer Reformationsgeschichte* 2 (Basel: Basler Buch- und Antiquariats-Handlung, 1904), 98.

[117]Wetter and Pfister, "An Underestimated Record Breaking Event," 46.

ground like after a severe frost."[118] Vine-growers in Schaffhausen were "waiting for rain to begin the harvest," as chronicler Oswald Huber relates. Nevertheless, he writes, "they finally tackled the work because the plants were withering."[119] Vine-growers at the shores of Lake Constance and in Alsace, after having picked the juicy grapes, interrupted the harvest because the remaining ones were almost dried out.[120] In Dijon (France), the beginning of the grape harvest was officially settled at 3 September, i.e. 20 days later than in 2003.[121] But this date is much later than the period of full maturity, because grape harvests were postponed until the next rain spell (Fig. 5).

By harvest time, many grapes had turned into raisins.[122] This led to the unintentional discovery of *Spätlese*, i.e. sweet, late vintage grapes yielding a sweet sherry-like wine which—due to an abundant harvest—was quite cheap. No wonder many people during that time were found completely drunk, lying in the streets and behind hedges "like pigs," as chronicler Hermann von Weinsberg reported from Cologne. He himself competed for drinking with his fellow students till he vomited and suffered from a hangover.[123] In Würzburg (Germany), the premium wine of 1540, stored in a nicely decorated barrel, was only offered to guests of the court. This sweet wine was so famous that Swedish soldiers conquering the town in 1631 searched for the precious barrel, though in vain, because it was hidden behind a wall.[124] Like the vines, trees also suffered from drought stress. According to chronicler Sebastian Fischer from Ulm (southern Germany), leaves fell to the ground at the peak of the worst heat wave in early August "as if it had been in late autumn."[125] Drought impacts may be the reason why tree-rings from Lötschental (Canton Valais), situated in the rain shadow between two Alpine mountains, indicate a cool summer.[126]

[118]Alfred Leroux, ed, "Extraits du Journal de Me Pierre de Teysseulh, chanoine de l'église de Limoges, 1533–1568", in *Chartes, chroniques et mémoriaux pour servir à l'histoire du Limousin* (Tulle : impr. Crauffon, 1886), 181–289, here 259.

[119]Huber, *Chronik*, 25.

[120]Burmeister, *Bodenseeregion*, 64; Stolz, *Gebweiler*, 379.

[121]Thomas Labbé and Damien Gaveau, "Les dates de bans de vendange à Dijon: Etablissement critique et révision archivistique d'une série ancienne," *Revue historique* 657 (2011): 31.

[122]Josua Kessler, *Chronologie Santgallischer Begebenheiten vom Jahr 1540 bis Ende des Jahres 1645, aufgezeichnet durch J. K., Stadtschreiber in St. Gallen*, Handschriften Nr. 74, Stiftsarchiv St. Gallen.

[123]Hermann von Weinsberg, *Gedenkbücher*, 1:150, accessed June 29, 2011. http://www.weinsberg.uni-bonn.de/Edition/Liber_Iuventutis/Liber_Iuventutis.htm

[124]Rüdiger Glaser, Rudolf Brázdil, Christian Pfister,Petr Dobrovolný, "Seasonal Temperature and Precipitation Fluctuations in Selected Parts of Europe during the Sixteenth Century," *Climatic Change* 43 (1999), 169–200, here, 192.

[125]Sebastian Fischer, "Chronik besonders von Ulmischen Sachen", ed Karl Gustav Vesenmeyer, in *Verein für Kunst & Alterthum für Ulm und Oberschwaben*, Ulm, 1896. 29.

[126]Wetter and Pfister, "An Underestimated Record Breaking Event," 49.

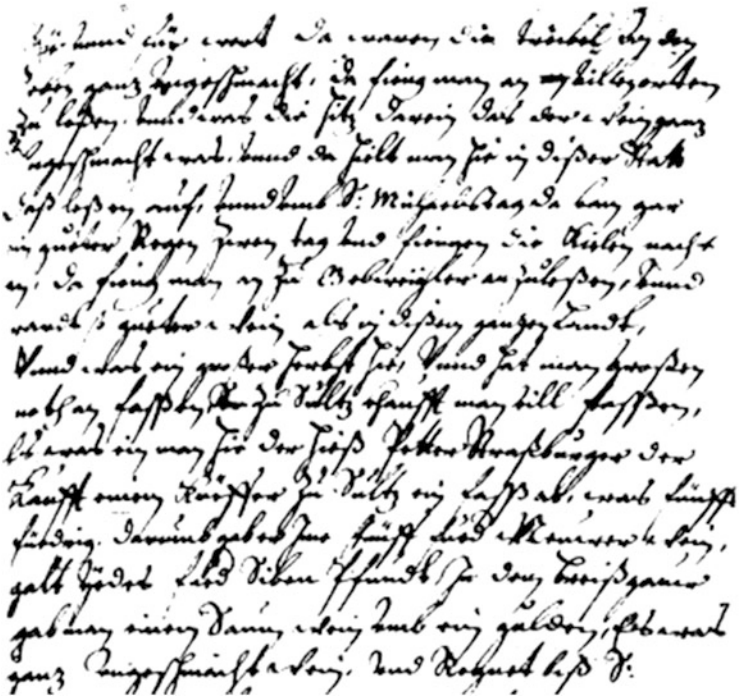

Fig. 5 Extract from the chronicle of the vine-grower Hans Stolz (?-1540) from Guebwiller (Alsace) for 1540. "When the scorching heat went on and on, people in many places began picking grapes, but these were dried out, hence the vintage was stopped [in Guebwiller]. On St. Michaels Day [8th October] there came a good rain for two days and nights became cooler. Subsequently people began [again] picking grapes and the vine was excellent" (Stolz, Gebweiler, 379)

The heat appears to have become unbearable from early June, considering the fact that quarrymen in Besançon (France) got time off from hard physical work.[127] People in this town used to take refuge in cellars after 9 a.m. because they could not stand the heat in the streets during the day.[128] Streets in Cologne stank unbearably from the accumulated refuse and faeces not being washed away by rains.[129] "July became deadly torrid until the end" (i.e. 10 August), wrote Hans Stolz in Guebwiller.[130] The Reformer Martin Luther interpreted the "unspeakable heat and drought persisting day and night" as a sign of the imminent Last Day, according to the Book of Revelation of John. "Welcome dear, Last Day," he

[127] Archives Municipales de Besançon, B.B.21, f111v.

[128] Gauthier, Froissard *Livre de raison*, 37.

[129] Weinsberg, *Gedenkbücher* 1:151.

[130] Stolz, *Gebweiler*, 371.

wrote.[131] The holding of rogations for rain is reported from Anglican England and Northern Italy,[132] while Protestants resorted to prayers. On 2 August, the town council of Ulm ordered the clergy to preach "about the hot and dry weather, begging God for rain."[133] According to a source from Dijon (France), guards against "incendiaries" (arsonists were "reinforced on 9 August."[134] This was the day when Einbeck burnt down. Based on a new long series of Swiss grape harvest dates (1444–2011), temperatures from April to July were statistically assessed at 4.7–6.8 °C higher than the 1901–2000 average. Thus this period of the year was very likely 2.7–4.1 °C warmer than the corresponding 2003 value measured in Basel.[135] Orth et al. concluded from a modelling approach that there is a high probability that maximum summer (June–August) temperatures in 1540 exceeded those in 2003 whereas the probability for mean summer temperatures is rather low.[136]

Concluding from observations of a second bloom of roses in Ulm (Germany) as well as cherry and apple trees and vine flowers in Guebwiller (Alsace) and Winterthur (Canton Zürich), autumn was much warmer in 1540 than in 2003, when October was already frosty and wintery.[137] Pastures were rich enough to feed small livestock and cattle. Cherries in Lindau, on the shore of Lake Constance, even reached maturity for a second time.[138] The reports of many chroniclers agree with each other in that the warm spell continued until Christmas (4 Jan 1541). It was sunny and warm weather "like in April" without any frost, and snow never covered the ground until Christmas (4 Jan 1541). At that time, in early January 1541, several individuals demonstratively swam across the Rhine at Schaffhausen, eager to

[131]"Es ist allhier solche Hitze und Dürre, das unsäglich und untrüglich ist Tag und Nacht. Komm, lieber jüngster Tag." Martin Luther to his wife, 16. [26.] July 1540, accessed July 4, 2014, http://www.glaubensstimme.de/doku.php?id=autoren:l:luther:briefe:an_seine_frau_16_07_1540

[132]England: George W. Bernard, The King's Reformation: Henry VIII and the Remaking of the English Church (New Haven: Yale University Press, 2005), 579. Northern Italy: C. Borghi, ed.,"Cronaca Modenese di Tomasino De' Bianchi detto De'Lancellotti, 1538–1540," in *Monumenti di Storia Patria delle province modenesi, Serie delle Cronache*, vol. 7, (Parma: Fiaccadori, 1868), 114.

[133]"Do huben die prediger uff der kantzel an, die leytt zu ermanen das man herzlich zu gott schreyen selte, und gott um regen bitten." Spicker-Beck, *Räuber, Mordbrenner, unschweifendes Gesind*, 48.

[134]"[L]e 31.07 [n. s. 9.08], nouvelle procession pour la pluie. On renforce le guet contre les incendiaries." Sign. B 181, Registre des délibérations de la ville de Dijon, Les Archives Municipales de Dijon, Dijon.

[135]Wetter and Pfister, "An Underestimated Record Breaking Event," 51.

[136]Orth, René; Vogel, Martha; Luterbacher, Jürg; Pfister, Christian; Seneviratne, Sonia, Did European temperatures in 1540 exceed present-day records? Environmental Research Letters, 11 (2016): 1–10.

[137]Wetter and Pfister, "An Underestimated Record Breaking Event," 58.

[138]Burmeister, *Bodenseeregion*, 62.

capture the attention of chroniclers. Oswald Huber includes this episode in his narrative to demonstrate how extraordinarily warm, maybe about 15 °C, the water still was at the end of what is now the longest known bathing period in European history.[139] In conclusion, the record-breaking heat in 1540 was an analogue case to the 2003 event, albeit more intense, broader spatially, and much longer-lasting.

An Evidence-based Worst-case Scenario

The sufferings of both humans and animals, in many ways dreadful, are only scantily described in the sources. Where all wells and fountains were completely dry, people had to carry water over considerable distances, usually during the night.[140] For example, the inhabitants of the small village of Goldiwil situated 500 meters above the town of Thun (Canton Bern) had to get water from Lake Thun.[141] Well water was priced and became increasingly expensive in some regions.[142] Restrictions on bathing are reported from Schaffhausen and washing clothing except napkins was forbidden in Ulm.[143]

"The enormous heat promoted a widespread epidemic named the Big Death, killing about 3000 people in [Schaffhausen] and two-fifths in the countryside." Although these figures may be exaggerated,[144] they nevertheless point to a very high mortality rate, as is also reported from Germany. Rather than "plague," as Hermann von Weinsberg thinks,[145] dysentery or other intestinal diseases may have been the main cause, as is mentioned in reports from England and the Low

[139]Wetter and Pfister, "An Underestimated Record Breaking Event," 58.

[140]Schmid, *Cysat, Stationes,* 905.

[141]Gertrud Züricher, ed., *Karl Friedrich Ludwig Lohners Chronik der Stadt Thun: In kurzen Auszügen zusammengestellt* (Bern: Haupt, 1935).

[142]Gabriel Walser, *Neue Appenzeller Chronik oder Geschichte des Landes Appenzell der Innern und Äussern Rhoden* (St.Gallen: self-published, 1740), 484.

[143]"Wurde den Badern nur noch wöchentlich «drü malen Bad zu halten» erlaubt." Eduard Im Thurn, *Chronik der Stadt Schaffhausen*, vol. 3, *Von Wiedererlangung der Reichsfreiheit bis zum Eintritt in den Bund der Eidgenossen, 1415–1501*, Historische Gesellschaft zu Basel 223 (Basel, 1844), 68.

[144]"In Folge der grossen Hize des vorigen Jahres entstand in diesem eine höchst mörderische Krankheit, welche der grosse Tod genannt wurde und nach unverbürgten Nachrichten an 3000 Personen in unserer Stadt, sowie zwei Fünftheile der Bewohner unserer Landschaft wegraffte." Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Switzerland, source 2c.

[145]"Anno 1541 hat die sterbde an der pestilenz zitlich im jar gruwlich iren fortgank gewonnen, dan wiewol im jar zuvor 40 vil folks gestorben war, so hat doch diss jar seir weit ubertroffen, das fil tausent menschen gestorben sint, nit allein in Coln, dan allenthalben in Dutzlande starb es schrecklich." Weinsberg, *Gedenkbücher*, 1:150.

Countries.[146] Considering the extreme heat combined with the long-lasting drought, we may assume that many people depended on drinking contaminated water.[147] That the loss of lives can be enormous under those circumstances is known from countries in the tropics today. Likewise, high mortality is documented in a well-researched case study from France, where a dysentery epidemic following the extreme drought in 1719 took 450,000 additional lives. This corresponds to 2 % of the entire French population at that time.[148] Around forty million people may have lived in western Europe around 1540. No data are available for the rest of the continent.[149] Assuming an excess mortality equal to that in France in 1719, the "Big Death" in 1540 may have killed more than one million people in Europe in excess, many of them being small children. In addition, tens of thousands were dispossessed by fire. Hundreds, perhaps thousands of innocents, vagrants, and beggars were tortured for arson and often cruelly put to death. Three branches of the economy particularly suffered from the drought: cattle breeding, water driven trade, and transportation. Watering of cattle and small livestock became critical. Animals were driven to drink over long distances up to more than ten kilometres.[150] Hay harvests completely failed and prices skyrocketed.[151] Cattle all over Europe died of thirst and hunger, as chroniclers from England, Alsace (France), Cologne (Germany), and Modena (Northern Italy) reported.[152] In many cases, animals

[146]"In y latter ende of this moneth, was vniuersally through the realme greate death, by reason of newe hote agues and Flixes, and some Pestilence." Raphael Holinshed et al., *Chronicles, comprising the Description and Historie of England, Ireland, and Scotland*, augmented and continued John Hooker (London, 1587), 841. "Many people fell ill," we read in a chronicle from Ghent (Belgium), "[. . .] and there was red melisoen [illness] which in particular affected people's defecation very much, because many people died from mid-August until December which was caused by the great vehement heat." MS 2543, fol. 16, University Library, Ghent. Kindly provided by Adriaan de Kraker, Utrecht University).

[147]David Boyd Haycock, "Exterminated by the Bloody Flux," *Journal for Maritime Research* 4, no. 1 (2002): 18.

[148]Marcel Lachiver, *Les années de misère: La famine au temps du Grand Roi, 1680–1720* (Paris: Fayard), 414–417.

[149]Population in Germany France, The Low Countries, Switzerland, (Southern) England and (Northern) Italy may have been about 40 million in 1550. Jean-Pierre Bardet and Jacques Dupâquier, *Histoire des Populations de l'Europe,* vol. 1. *Des origines aux prémices de la ré volution démographique* (Paris: Fayard 1997), 369.

[150]"Das Baursvolck muoßt an etlichen enden weit her [. . .] mit dem Viehe zuo trencken / fahren" (Christian Wurstisen, *Basler Chronik,* Basel: Henricpetri, 1580, 79). "In divers partes of this realme the people caried their cattle six or seven miles to watter them." Wriothesley, *Chronicle*, 123.

[151]"Und ward das heuw thur, und das veche fast wolfeill."August Bernoulli, ed., "Die Anonyme Chronik bei Schnitt sammt Fortsetzung 1495–1541", *Basler Chroniken* vol. 6, 187–235, here 220.

[152]For England: "Muche cattell died for lacke of water." Grafton, Richard, *A chronicle at large: and meere history of the affayres of Englande, and kinges of the same* [. . .] vol. 2 (London: J. Johnson et al, 1809), 74. For Alsace: Stolz, *Gebweiler*, 376. For Cologne: "Vil beisten storben." Weinsberg, *Gedenkbücher*, 1:150. For Modena (Northern Italy): "Dominica a di 25 Questo dì [. . .] è stato et excessivessivo caldo [. . .] fu uno secho antiquamente tanto grande che li poci [pozzi] se seccono per tutto el modeneso e moriva bestie assai de fame e de sete" [Sunday 25 July/4 August was an unbearable heat and a drought of such extent that the wells fell dry in the entire region and animals died from hunger and thirst.] Borghi, *Cronica Modenense*, 56.

may have died from heat stroke. Many more were probably slaughtered. Hence, prices for milk and dairy products soared.[153]

The main source of energy collapsed with the ebbing of water. For preindustrial societies, the worst effect of this situation was a standstill of mills except those within big rivers. Mills pulled by horse-drawn capstans were set up as a substitute in some places. In others, people resorted to the use of hand mills. Surging prices for flour and bread and the lack of water resulted in life-threatening circumstances, especially for poorer people.[154] Trades such as hammer mills fell idle, leaving the workers unemployed and dependant on begging.[155]

Likewise, rivers were important ways for transportation prior to the creation of railway networks. For example, preindustrial river transport before the early nineteenth century accounted for 90% of goods transported on the Middle Rhine.[156] Highly-priced goods comprised the lion's share of the upstream cargo and bulky goods dominated the downstream cargo.[157] Erich Weber demonstrated in his illustrative dissertation that river navigation on the Middle Rhine was impossible during "extreme low flows,"[158] although they were above those described in 1540. The situation of river navigation that year was not much better on the High Rhine. Ships between Lake Constance and Schaffhausen carried less than half their usual cargo,[159] whereas goods hauled downstream to the Basel fair were transported exclusively by land.[160] Navigation on the river Po in northern Italy was discontinued until late November, at which time water levels were usually high due to rains in the Apennines.[161]

The impact of these events on the natural environment is only casually mentioned. Oswald Huber reports that graylings (*Thymallus thymallus* L.) in the Rhine, in their unsuccessful search for cold water, finally died and were caught *en masse* by

[153]Hirzel, *Ryff*, 86.

[154]Glaser et al., *Seasonal*, 192.

[155]"Die Flössen/Mühlen und Hammer=Hütten [near Meissen, Germany] stunden müssig/die Hammer=Arbeiter liessen betteln." Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Germany, source 86.

[156]Erich Maria Weber, *Untiefen, Flut und Flauten: Der Güterverkehr auf dem Rhein zwischen 1750 und 1850; Die Modernisierung der vorindustriellen Rheinschifffahrt aus einer wirtschafts-, sozial- und umweltgeschichtlichen Perspektive betrachtet* (Bern: self-published, 2005,) 501.

[157]Weber, *Untiefen, Flut und Flauten*, 429.

[158]Weber, *Untiefen, Flut und Flauten*, 457.

[159]"Der Rhein war so klein und dünn, dass die schiff nicht halb geladen mochten herab kommen." Huber, *Chronik,* 96, Wetter and Pfister, "An Underestimated Record Breaking Event," supplementary material Sc3.

[160]"Uff diese Baszler mesz diesz fierzigisten jorsz alle gutter über lant und mit wegen musten obenherab gfurt werden." Hirzel, *Ryff* 86.

[161]"Il fiume Po è in secca proprio nel periodo autunnale [che generalmente è caratterizzato da piene, legate alla piovosità degli Appennini e della Pianura Padana]" [TheRiver Po was dry in autumn, whereas usually it reaches flood levels due to rainfalls in the Appenine Mountains and in the Po valley.] Borghi, *Cronica*, 58.

hand.[162] Likewise, graylings died in the Rhine in great numbers as a consequence of water temperatures above 26 °C in August 2003.[163] Considering the drying up of all brooks and smaller rivers over large parts of Europe in 1540, along with the extremely low levels of large rivers, the multi-seasonal drought in that year may have caused the greatest fish mortality rate in the second half of the last millennium. Forest fires that no one could get under control became rampant in many parts of the continent, such as the Vosges Mountains,[164] the Black Forest,[165] the Bohemian Forest, Thuringia, the Spessart Mountains,[166] Hungary, and Poland.[167] Contemporaries like Martin Luther anticipated the far-reaching consequences of this calamity in terms of rising prices of timber and firewood.[168] School-teacher Hans Salat left a ghastly account of the situation: "On Mary Magdalene's day (22 July) I went to Solothurn," he writes. "It was unbearably hot, everybody complained about water shortages. Forests were burning everywhere around. The sun and the moon, looking reddish at their rising and setting, were shining pale during the day, because the sky was dark of mist and smoke. Mount Pilatus (above Lucerne) could hardly been seen in the morning during fog conditions like in autumn."[169] Similarly, the inhabitants of Schneeberg (Saxony) complained about eating stinking smoke during the night emitted from forest fires.[170] The scientist Marcin Biem reported from Cracow that the sun often retained a reddish colour throughout the day due to the presence of smoke in the air. Glaser et al. argue that this smoke could have been the effect of forest fire aerosols in the air, as a consequence of the frequent forest fires subsiding during the night.[171]

[162]"Der Häwmonat war so häiss, dass die Jfer und Escher im Rhein ans land schwummen, kalt wasser zusuochen, und ehe sie wider recht ins wasser kommen mochten, fielen sie für grosser hitz an den ruggen, dass die fischer die in grosser menge mit den händen fiengen, waren faisst und guot." Huber, *Chronik*, 96.

[163]Stephan Bader, Daniel Dévanthery, *Auswirkungen des Hitzesommers 2003 auf die Gewässer. Dokumentation*. Schriftenreihe Umwelt 369 (Bern: BUWAL, 2004), 74, 137.

[164]Tschamser, *Thann*, 65.

[165]Spicker-Beck, *Räuber Mordbrenner, umschweifendes Gesind*, 231.

[166]Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Germany, source 2.

[167]Glaser, *Seasonal*, 193.

[168]On 26 July/4 August Martin Luther wrote to his wife: "ist ym Düringer walt mehr denn tausent acker holtz abgebrand vnd brennet noch, dazü sind heüte zeitung, das der wald bey werda aüch angangen sey. Vnd an vil orten mehr, hilfft kein lesschen.wills wil theür holtz machen." Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Germany, source 92.

[169]"Um M. Magdalene [31 July n. st] gieng ich gen Soloturn [. . .] [es war] unbillich heiss, clagt sich all welt fast um wasser, und, und was am uf- und nidergang sunn und man bluot rot; schinendn ouch ganz bleich, dann der himel was tunkel von itel hitznebel. Es brunnend die weld an vil orten, [. . .] an eim morgen was es uf der wyti nit anders von rouh und hitz, als im herbst mit nebel, dass man Pilatusberg kum sehen moht." Bächtold, *Salat*. 56.

[170]Christian Meltzer, *Bergkläufftige Beschreibung Der Churfürstl. Sächß. freyen und im Meißnischen Ober-Ertz-Geburge löbl. Bergk-Stadt Schneebergk* (Schneeberg: Meißner/Pfützner, 1684).

[171]Glaser, *Seasonal*, 193.

These congruent descriptions by Salat in Lucerne and Biem in Cracow—two cities situated at a horizontal distance of 900 km—bear witness to the fact that the record-breaking heat and drought of this year had turned the environment into a breeding ground of wildfires, leaving large parts of the continent under a dome of haze and stinking smoke. The fire disasters in 1540 affected a large area, far larger than other known large-scale natural hazards such as severe floods or violent winter storms. These facts give reason to believe that settlements became fire-prone at about the same rate as the forests. Hence, large parts of Europe might well have had a peacetime maximum of town and village fires in 1540, analogous to Zwierlein's findings for Germany.[172] If the spring/summer drought of 1888, considering the financial losses, were a national catastrophe for Sweden,[173] the multi-seasonal drought of 1540 was a large-scale disaster for continental Europe outside Russia. This calamity may have acted as a major break in economic development. According to Eric L. Jones, "net capital formation was held down in the preindustrial world, not merely by lower incomes and lower savings propensities, but by a weaker capacity to control and recover from natural and social calamity," among which he includes urban and rural fires.[174] The longer-term economic impact of the drought in 1540 was, in addition to burnt-down settlements, multiplied by the large-scale destruction of forest and substantial losses of cattle, thereby reducing the availability of draught power and the manure needed for grain production over the subsequent decades.

Conclusion: Scapegoats of Climatic Extremes

Through reports on and the experience of unprecedented wildfires and settlement fires, people became aware of the heightened risk of fire and responded to this threat with a kind of fire paranoia. The "emergency situation" in the environment thus entailed an emergency situation within society. Though some chroniclers realised that forests merely caught fire from heat and drought,[175] the notion that town and

[172]Zwierlein, *Der gezähmte Prometheus*,104.

[173]Nilsson, "The End of a Pre-industrial Pattern," 280.

[174]Eric Lionel Jones, *The European Miracle: Environments, Economies, and Geopolitics in the History of Europe and Asia* (Cambridge: Cambridge University Press, 1987), 39.

[175]E.g. "Dorauff im Sommer eine gewaltige Hitze und Dürre erfolget, daß die Wälde um die Stadt [Annaberg, Saxony] allenthalben zu brennen angefangen." Georg Arnold, *Chronicon Annabergense continuatum* (Annaberg: Hasper,1812). "Dann es seindt an vill ortten durch vberschwenckhliche hitz die meder angezundt worden vnd außbrunen." Chronik von A.P. Gasser, 2° Cod. Aug. 40., Stadtbibliothek Augsburg. "Jm dürren Sommer war ein solche Hitz / daß es viel Brunsten [town and village fires] / so von der Sonnen angiengen" Johann Ginschopf, *Chronica Oder Eygentliche Beschreibung vieler Denckhwürdigen Geschichten die sich im Fürstenthumb Württemberg sonderlichen vmb Stutgart her zugetragen und beschrieben worden* (Tübingen: Brunn,1630), 48. Michael Kleinlawel writes for 1534 in his Strasbourg Rime Chronicle: "Eine solche Hitz ist dazumal/ [1534] in dem sommer entstanden / das Häuser von der Sonnenstral/ angiengen und verbrandten," quoted in Spicker-Beck, *Räuber, Mordbrenner,*

city fires might be started independent of human intervention was outside people's experience and beyond their imagination. No wonder that the proliferation of fires was attributed to conspiracy.[176] As the fires had a continental dimension, it goes without saying that the related fire scare and conspiracy theories very likely also reached beyond the regions studied by Scribner and Spicker-Beck. Only fragments of evidence are available to date. The Turks, occupying Hungary, were blamed for arsonist attacks in the Hapsburg Empire.[177] On 4/14 May 1540, the Lower Austrian authorities announced an extremely rich bounty of 80 talers to be paid for information about arsonist plots.[178] The arsonist scare is also attested in Dijon (France).[179]

Societies therefore met the danger in three ways: through appealing to God and the saints about the root problem, which was the drought; through reducing the risk of fire by placing guards; and finally through a kind of "symbolic policy" by hunting vagrants and beggars. Though the blaze of Einbeck occurred at the peak of a several-month-long heat wave and drought, it may never be established with certainty whether the fire broke out by self-ignition, by accident, or through malicious arson.[180] In a situation when timber, be it in the environment or fitted into buildings, had become fire-prone, a careless handling of domestic fire still entailed the greatest risk.[181]

Scapegoating was, and still is, a widely-known practice for explaining the inexplicable. Barry Coward and Julian Swann argue, with regard to early modern Europe, that in case of loss of control due to unexpected political or religious upheavals, conspiracy theory offered plausible and convincing explanations.[182] Their assessment also applies to unprecedented natural disasters. Fear of "outsiders suspected of being engaged in espionage" had a genuine basis in the considerable

umschweifendes Gesind, 224. Spontaneous ignition is mentioned in the case of Nossen (Kreis Meissen, Saxony) on 22/31 July 1540. Zwierlein, *Der gezähmte Prometheus*, 104.

[176]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 47. "Und es waren auch uiel beser [böser] brenner im Landt hin und wider, allenthalben, die gelt namen, und branten dörfer holtz und weid." *Villinger Chronik*, quoted in Spicker-Beck, *Räuber Mordbrenner, umschweifendes Gesind*, 231.

[177]Helleiner, "Brandstiftung als Kriegsmittel," 331.

[178]Helleiner, "Brandstiftung als Kriegsmittel," 338.

[179]'[L]e 31.07 [n. s. 9.08], nouvelle procession pour la pluie. On renforce le guet contre les incendiaries.' Sign. B 181, fol. 6, Registre des délibérations de la ville de Dijon, Les Archives Municipales de Dijon, Dijon.

[180]Andreas Heege, *Einbeck 1540: Brandstiftung! Der Einbecker Stadtbrand von 26. Juli 1540; Archäologischer Befund und politische Hintergründe* (Einbeck: Einbecker Geschichtsverein, 2005).

[181]For example, villagers from the Schaffhausen region asked the town authorities for fire-fighting equipment which they got with the warning not to house foreign vagrants overnight. Wetter et al., "The Year-long Unprecedented European Heat and Drought," supplement, table S1, Switzerland, source 139.

[182]Coward and Swann, introduction to *Conspiracies and Conspiracy Theory in Early Modern Europe*, 2.

number of people continuously on the move in sixteenth-century Germany.[183] Opposition to them had the effect of teaching sixteenth-century society to "accept the idea of territorial organisation."[184]

Klaus Graf suggested that the arsonist paranoia might be a "functional forerunner of the witches craze after 1560."[185] Johannes Dillinger deals with this argument in somewhat more detail by pointing out that gender stereotypes played an important role in the construction of the arsonist conspiracies.

> Even though there were of course itinerants of both sexes, the members of the imaginary arsonist gangs were all supposed to be male. Women were eliminated from the alleged arsonists' conspiracy. On the other hand, there was a competing picture of gender-specific crime, that of witch.[186]

According to Wolfgang Behringer, one frequent ground for witch hunts appears to have been accusations of indulging in weather magic that was then presumed to be the cause of "unnatural weather."[187] However, the witchcraft craze seems rather to have been a forerunner of the arsonist paranoia than vice versa. The new crime of sorcery in terms of weather magic emerged as early as the 1430s, in the territories of the Duchy of Savoy, when the frequency and severity of winters increased, causing a series of Europe-wide famines and mortality crises.[188] However, it needed the disastrous "witches hammer," published in 1486 by Heinrich Kramer, to propagate the idea that witches were in fact an occult sect enabled by their pact with the devil to commit horrible crimes against a fictitious collective in the form of crop destruction by hailstorms, untimely frost, and cold rains. The designation of witches as a sect necessitated applying trial according to the rules of the inquisitorial procedure, which, in contrast to the accusational procedure, allowed authorities to conduct the investigation and prosecution on the basis of secret denunciation.[189]

This kind of trial severely restricted the right to a fair hearing. It allowed application of torture to force confession and convictions from indications. In particular, the notion of sects inspired the application of torture to get the names of other members of the sect.[190] It seems that this practice only became more

[183]Scribner, "The 'Mordbrenner' Fear in Sixteenth Century Germany," 43.

[184]Dillinger, "Organized Arson as a Political Crime," 112.

[185]Klaus Graf, review of *Die Hexen und ihr Prozeß: Die Hexenverfolgung in der Reichsstadt Esslingen*, by Günter Jerouschek, *Zeitschrift für die Geschichte des Oberrheins* 141 (1993): 438.

[186]Dillinger, "Organized Arson as a Political Crime," 110.

[187]Wolfgang Behringer, "Climatic Change and Witch-Hunting: The Impact of the Little Ice Age on Mentalities," *Climatic Change* 43, no. 1 (1999): 335, 339.

[188]Wolfgang Behringer, "Detecting the Ultimate Conspiracy, or how Waldensians became Witches," in Coward and Swann, *Conspiracies and Conspiracy Theory in Early Modern Europe*, 13–34. Chantal Camenisch et al. The 1430s: A cold period of extraordinary internal climate variability during the early Spörer Minimum with social and economic impacts in Northwestern and Central Europe, *Climate of the Past*, 12 (2016) 2107–2126.

[189]Cohen, "Inquiring Once More after the Inquisitorial Process," 51.

[190]Walter Rummel and Rita Voltmer, *Hexen und Hexenverfolgung in der Frühen Neuzeit* (Darmstadt: Wissenschaftliche Buchgesellschaft, 2008), 238–240.

generally accepted after the climatic deterioration in the late sixteenth century.[191] Whether the persecution of arsonists might have spurred the application of exceptional procedures in the case of climate-related crimes needs to be further investigated. Thus there seems to have been a dichotomy between male arsonist conspiracy, blamed for "warm" disasters in the human realm, and female magic generating "cold" disasters in the natural world.

Findings of historical climatology suggest that arsonist paranoia, like the witches craze, grew out of a longer-term climatic trend. Summers in central Europe during the 1530s were 0.9°C warmer than the twentieth century average, when disregarding the period after 1990 influenced by global warming. Three hot summers involving an effect of repetition and increasing intensity are documented in the seasonal statistic set up from Pfister Indices for this period: 1534 (rank 10), 1536 (rank 2), and finally 1540 (rank 1).[192] An arsonist scare during the heat and drought of 1536 is documented for Württemberg, as the government kept lists of supposed arsonists who were searched for between Tuttlingen and Frankfort, and Trier and Munich.[193]The multi-season drought of 1540 and the resulting wildfires in central Europe are comparable to the 2010 wildfire disaster in Russia,[194] but disregarding conflagrations in Portugal, Greece, Australia, and California within the last decade. There are also striking similarities in the way such disasters were conceived in the recent past and today, as they are still blamed on arsonist activities to some extent. Fire is a good servant, but a bad master, as the saying goes. In the latter case, it gets out of human control, but according to the self-image of humans, it is still man-made. The experience of drought-induced conflagrations of towns and villages in central Europe involving a loss of control over fire contradicts human experience and imagination. Thus, as in the case of Einbeck, conspiracy theory directed against political opponents offered a means of explaining the seemingly inexplicable. In the public imagination, vagrants and beggars living outside of parish structures formed a criminal counter-society hidden from the authorities and the public. Such qualities made it plausible to suspect them as the perpetrators of organised arson.[195] In conclusion, 1540 was not just a year with a dry summer. Rather, western and central Europe were suffering from a five-hundred-year drought beginning with a

[191]Behringer, "Climatic Change and Witch–Hunting;" Christian Pfister, "Climatic Extremes, Recurrent Crises and Witch Hunts: Strategies of European Societies in Coping with Exogenous Shocks in the Late Sixteenth and Early Seventeenth Centuries," *The Medieval History Journal* 10, no. 1–2 (2007), 1–41.

[192]Data from Dobrovolný et al., "Precipitation Reconstruction for the Czech Lands," see also Oliver Wetter and Christian Pfister, "Spring–Summer Temperatures Reconstructed for Northern Switzerland and South-Western Germany from Winter Rye Harvest Dates, 1454–1970," *Climate of the Past* 7, no. 4 (2011): 1307–1326.

[193]Spicker-Beck, *Räuber, Mordbrenner, umschweifendes Gesind*, 12; Dillinger, "Organized Arson as a Political Crime," 112.

[194]David Barriopedro et al., "The Hot Summer of 2010: Redrawing the Temperature Record Map of Europe," *Science* 332 (2011): 220–224.

[195]Dillinger, "Organized Arson as a Political Crime," 110.

dust-dry spring giving way to a torrid summer and ending in a hot and almost rainless autumn. It was a disaster beyond the imaginable worst-case scenario, both then and today. It therefore comes as no surprise that arsonist paranoia (in terms of a conspiracy theory) posed great appeal as a means to explain the inexplicable.

The memory of the Megadrought of 1540 was kept for centuries. In Zürich, a few handfuls of (durum) wheat grown during that year were preserved for this reason until the late eighteenth century.[196] The last bottle of the 1540 vintage, containing the world's oldest still-drinkable wine, is exhibited today in Würzburg civic hospital.[197] Apart from that, the "Hot Summer" faded from the collective consciousness to become a "Black Swan," a low-probability, high-impact event of unimaginable magnitude.[198]

[196]Johann Jakob Goldschmid, "Varia mixta: Geschichtliche Collectaneen," Ms fol. 29, Stadtbibliothek Winterthur, Winterthur.

[197]Glaser et al., *Seasonal*, 192.

[198]Nassim Nicolas Taleb, *The Black Swan: The Impact of the Highly Improbable* (London: Penguin, 2007), xxv.