Dossier

Climate induced crisis: The 1430s in England, a difficult decade

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Abstract: The 1430s were one of the coldest decades in Europe during the last millennium. This was due to the high frequency of extremely cold winters. In the second half of the decade summers turned wet, and in consequence harvests failed and famine ensued. Epidemic disease, mostly plague, took hold several times over the decade. This paper assembles the contemporary evidence for extreme weather from a wide variety of sources in England. The impacts of the hard winters and wet-cool summers on people, farming, economy, infrastructure and transport are considered. In particular with regards to the famine, it is possible to identify adaptive measures by the central and municipal authorities to secure a supply of grain for London and the royal household. Notwithstanding these efforts, the extreme weather and the harvest failures raised the death rate, a trend that must have been compounded by the plague waves and other epidemic disease.

Keywords: Climate crisis; Famine; Late Medieval England.

Crise induzida pelo clima: a década de 1430 na Inglaterra, uma década difícil

Resumo: A década de 1430 foi uma das mais frias da Europa durante o último milênio. Isso se deveu à alta frequência de invernos extremamente frios. Na segunda metade da década, os verões se tornaram úmidos e, consequentemente, as colheitas fracassaram e a fome se instalou. Doenças epidêmicas, principalmente a peste, ocorreram várias vezes durante a década. Este artigo reúne as evidências contemporâneas de condições climáticas extremas de uma ampla variedade de fontes na Inglaterra. São considerados os impactos dos invernos rigorosos e dos verões úmidos e frios sobre as pessoas, a agricultura, a economia, a infraestrutura e o transporte. Em particular, com relação à fome, é possível identificar medidas adaptativas das autoridades centrais e municipais para garantir o fornecimento de grãos para Londres e para a família real. Apesar desses esforços, o clima extremo e as falhas na colheita aumentaram a taxa de mortalidade, uma tendência que deve ter sido agravada pelas ondas de peste e outras doenças epidêmicas.

Palavras-chave: Crise climática; Fome; Inglaterra tardo-medieval.

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Introduction

In the 1430s England was confronted with crises on multiple fronts. The fortunes of war in the Hundred Years War with France had turned against England. The alliance between England and the Duchy of Burgundy – which was not only a critical political, but also an important trading partner – came to an end in 1435, and the situation escalated into the Anglo-Burgundian War in 1436. The minority of King Henry VI, as well as his early personal rule which began in 1437, created a political instability within England that would finally contribute to the War of the Roses more than a decade later. Public order declined already throughout the 1430s.

Meanwhile the English also faced increasingly challenging meteorological conditions. The 1430s have long been known to constitute one of the worst climatic shocks in Europe during the past millennium, and are also suspected to have been the coldest decade over wide parts of the continent due to the harsh winters, which put society and economy under stress (Lamb, 1977, p. 457-459, 564-565; Camenisch et al., 2016, p. 2108-2010). In the second half of the decade, the summers also turned cooler, lower temperatures were accompanied by high levels of rainfall. This was the most harmful meteorological pattern for arable agriculture in medieval and early modern England, and because of the cold-wet weather, harvests failed in consecutive years – in England as on the continent – and exposed the people to the most severe famine of the fifteenth century. Starvation was not the only danger, since epidemics also posed a threat. Plague and other unidentified epidemics affected England in the 1430s; one of these outbreaks followed hard on the heels of the famine (Campbell, 2009, p. 5-8; Camenisch et al., 2016, p. 2116-2117; Pribyl, 2017, p. 189-194, 202-204).

The shock of the 1430s occurred before the backdrop of a general cooling trend in the Late Middle Ages. The Medieval Climate Optimum had come to an end around 1300. This was followed by a transition period which would finally lead into the Little Ice Age. The cooling trend during this transition stage was neither smooth nor continuous; decades of warmer and cooler, drier and wetter weather, and of higher and lower interannual variability alternated (Pribyl, 2017, p. 82-84, 150-159). The 1430s fall into the Early Spörer Minimum, a period of reduced solar activity. However, as Camenisch et al. (2016, p. 2017) have pointed out, no external driver for the frequent extremely hard winters, and normal or even warm summers in particular in the in the early 1430s, could be identified. Volcanic eruptions or a reduction in solar forcing do not tend to increase the annual temperature range. Therefore the extreme conditions of the 1430s were the result of internal natural variability.

This paper will present further information regarding the documentary evidence for the weather extremes in England, explore the impacts of these extremes on society, agri-

culture and public health, and investigate coping strategies and adaptations. The material is often very vivid and paints a colourful picture of life in – primarily – late medieval London. The paper uses the approach and methodology of historical climatology for the analysis, hence a short overview of this field will first be given.

Historical climatology

Recent decades have seen an increasing interest in past climate, its variability and extremes. Information on weather is not only preserved in early instrumental observations dating back to the mid-seventeenth century in Europe, but also survives in documentary records for the pre-instrumental period. While historical climatology can trace its origin back into the nineteenth century, the field was reinvigorated in the 1960s and 1970s with the works of Hubert Horace Lamb, a British meteorologist, and Emmanuel Le Roy Ladurie, a French historian of the *Annales* school. Their primary research interests are characteristic for historical climatology, as in its modern form, the field is situated at the crossroads of history and climatology, employing the methodology of both disciplines and mainly using documentary evidence. Historical climatology consists of three elements: reconstructing past climate with the help of written sources before or parallel to early instrumental measurements, analyzing the impact of past climatic variations or extremes on people, society and the environment, and studying the cultural history and the perception of climate and weather over time. Due to its focus largely on the pre-industrial era, historical climatology contributes substantially to our knowledge of natural climate variability prior to significant anthropogenic influence on the atmosphere (Brázdil et al., 2005, p. 363-367).

As an interdisciplinary research field historical climatology also incorporates data on past climate based on non-documentary evidence, such as tree-rings or ice cores, for comparison and correlation. These proxy data, derived from natural archives, form long homogenous series which reflect extremes as well as average conditions. They often stem from remote regions, such as the High Alps, Scandinavia or even the Arctic; not always are they annually resolved, and if reconstructions reflect specific seasons, this is typically spring and summer. Information derived from documentary sources usually focuses on meteorological extremes and the vulnerability of societies; this information hence facilitates the study of extreme events and impact studies. Documentary data describe conditions in the areas of high human activity, the information can be dated and is frequently annually or even seasonally resolved. Descriptions of winter weather, often missing in proxy data from natural archives, are available in the written record. However, average conditions are often underreported, the information is heterogenous, and the further back

in time, the more likely are gaps in the information (Brázdil et al., 2005, p. 370-377; Pribyl, 2014, p. 116).

For ensuring the use of high quality data, documentary evidence on past weather has to be subjected to historical source criticism, and the dating has to be verified. Direct weather references from medieval or early modern times have been compiled since the eighteenth century. Whereas recent compilations present high quality evidence, older compilations tend to often lack a critical appraisal of their sources and are hence less reliable (Bell and Ogilvie, 1978, p. 333-342; Brázdil et al., 2005, p. 373-375).

Original written records can roughly be subdivided into narrative and administrative sources. Narrative sources include a wide variety of types, from weather diaries, over letters, to chronicles or annals. As mentioned above, the direct weather references contained in these records usually focus on extreme meteorological conditions and their effects (and give often bio-physical information on the severity of an event, like the duration of waterbodies being frozen in winter). In individual sources gaps are possible. To allow for a quantitative analysis this type of data needs to be indexed, generally temperature and precipitation indices are made (Pfister and Wanner, 2021, p. 122-135). For the 1430s in England a number of such sources survive, including a short weather diary covering autumn and early winter in 1439 (BLO MS. Ashmole 191). During this period the long tradition of monastic chronicles was just coming to an end (except at St. Albans), the few last surviving examples were mostly focused on their own house and hardly reflect any general history (Kingsford, 1913a, p. 37; Gransden, 1982, p. 371-388). Chronicles written by lay people had become more popular, especially the Brut and various versions of the London chronicles. Despite their interrelation – the Brut was written in London and also used London chronicles as its source – there is substantial variation; some chronicles giving fuller descriptions of specific events than others, with some reporting events that others omit. The entries in the London chronicles were dated by mayoral and regnal year, and hence with the copying or amending of older passages for new versions, the dating for the 1430s is often confused. In its origin the information in the London chronicles was contemporary and reflected the general sentiment in the city (Kingsford, 1913a, p. 37, 70-75; Gransden, 1982, p. 220-230, 371-388). Occasionally indirect information on weather conditions can be gleaned from wills or early letters.

Administrative sources, e.g. municipal or manorial accounts, newsletters or reports of trading companies, can ran for long periods of time and with few or no gaps. They contain direct weather references, but sometimes also proxy data; average climatic conditions are better represented in this source type. Some of these proxies, as the dates of the vine or grain harvests, function in the same way as proxies derived from natural archives. If there is an overlap of these data with the instrumental period, this permits the reconstruction of

climate parameters, usually temperature, far back into the past. The reconstruction of summer temperatures by Chuine et al. (2004) and Labbé et al. (2019) based on vine harvest dates in Burgundy begin in 1370 and 1354 respectively, and a Swiss as well as a Czech summer temperature reconstruction using grain harvest dates reach back to 1454 and 1501 (Wetter and Pfister, 2011; Možný et al., 2012). Grain harvest dates also survived in England and allow a reconstruction of spring-summer temperature between 1256 and 1431 (Pribyl, Cornes and Pfister, 2012). However, then the series comes to an end, because the information was contained in manorial accounts, a source type unusually rich in medieval England, which gives information on profit and costs as well as agricultural and pastoral farming success on manors managed directly by the landowners. These accounts, however, thin out by 1400 and become very rare by 1435, when almost all the directly managed demesne land was farmed out, a development not independent of the crisis in the 1430s (Campbell, 2012, p. 134; Pribyl, 2017, p. 31-32).

Temperature and precipitation for (parts of) Europe post 1500 and partly even before have now been reconstructed on a seasonal level (Brázdil et al., 2010; Dobrovolný et al., 2015; Pfister and Wanner, 2021), but in the Middle Ages and Antiquity, and in regions with historic documentary records outside of Europe there remains much scope for further and deeper research.

The cold winters

The most remarkable feature of the weather conditions during the 1430s was the high frequency of cold winters. Five winters of this decade can be classified as hard or very hard in north-western Europe: 1431-32, 1432-33, 1434-35, 1436-37 and 1437-8 (Van Engelen, Buisman and Ijnsen, 2001; Camenisch et al., 2016, p. 2110; Pfister and Wanner, 2021, p. 174). Using the evidence assembled by Lamb, Kington created pressure maps for the winters of the 1430s showing the frequent Scandinavian blocking action bringing strong north-easterly airflow to England (Kington, 2010, p. 237-241).

Although the cold conditions in the winters 1431-32 and 1432-33 must have reached from the continent across the North Sea and the English Channel, in the scarce English extant evidence the latter winter left no trace. For the weather in 1431-32 only one reference is available in the English sources – for France. In mid-December 1431 King Henry VI was crowned as King of France in Paris; it was very cold and the streets were so icy that they were dangerous for riders, hence they were strewn with straw to prevent accidents of the young king and his entourage (Brie, 1908, p. 460).

The memory of the winter 1434-35 on the other hand was kept alive long term. The extreme conditions of that season were referenced in the manorial accounts from Hampshire

and Sussex (Titow, 1970, p. 341; Brandon, 1971, p. 4) and documented in greater detail in the various versions of the London chronicles and also in the popular Brut, and from these taken over into other works including Robert Fabyan's *New Chronicle of England and France* (1811, p. 608-609), the first edition of which was printed in 1516, and which transmitted the content of the London chronicles to the Tudor Age (Gransden, 1982, p. 245).

Having himself, or a close associate, worked on the later part of the Great Chronicle, a fuller version of the London chronicles, it is not surprising, that Fabyan's description of the winter 1434-35 is largely identical to that given in the earlier part of the Great Chronicle, which was written soon after the actual events. The text shows the standard phrasing used in many other London chronicles for this season; it reflects the business interests of the London merchants.

> Anno xiii[1] [Henry VI, 1434-35] [...] And in this yere was a passing grete wynter and a colde frost Which began on seynt kateryns eve [24 November] and dured into the xth day of the Moneth of Fevere than next suyng It was so stronge that no ship myght saile Wherefore the wynes of the vyntage came by londe to london in Cartes from the downes thrugh kente and ovyr sheters hille Which sieldom hath be seen or nevyr (Thomas and Thornley (eds.), 1938, p. 171-172).

This description contains the main elements that echo through many other London chronicles and later texts: the dates of the long lasting frost, beginning at St. Katherine's Day or Eve and ending sometime between early or mid-February,[2] and the landing of the wine in Kentish ports along the Thames, from where it had to be taken by cart over the North Downs and Shooters Hill to London, an evidently very rare and most expensive practice (Anonymous, 1827, p. 171, 1880a, p. 61; Gregory, 1876, p. 178; Brie, 1908, p. 503, 571).

[1] Some of the later London chronicles or other works based on them, which mainly focus on the later fifteenth or the sixteenth century, give the date erroneously as Henry VI 12 (winter 1433-34), likely due to a copying error (Arnold, 1811, p. 32; Herryson, 1840, p. 5; Nichols, 1852, p. 16; Anonymous, 1880b, p. 149; Kingsford, 1913b, p. 351-352; Marx, 2003, p. 60). Most of these texts only note a "grete frost" without further details.

[2] The dates most commonly given are 10 February (St. Scholastica's Day) (Harris, 1827, p. 120; Stone, 1902, p. 21; Brie, 1908, p. 502; Thomas and Thornley (eds.), 1938, p. 171-172; Harriss and Harriss, 1972, p. 184; Anonymous, 2002, p. 206), 14 February (St. Valentine's Day) (Anonymous, 1827, p. 171, 1880a, p. 61, 1905, p. 137; Gregory, 1876, p. 178) or 16 February (St. Juliana's Day) (Riley, 1908, p. 398; Kingsford, 1913b, p. 351-352). The Brut gives 2 February (Candlemas) as well as 4 March in another version, and 'Shroffetyde' appears in the English Chronicle 1377-1461 (Brie, 1908, p. 467, 571; Marx, 2003, p. 60). The latter two texts are not strictly contemporary, so the chance for errors was increased. The English Chronicle 1377-1461 was very close to the Brut in the 1430s (Kingsford, 1913a, p. 127-128), nonetheless it also misdates the winter 1434-35 to Henry VI 12 (1433-34), which in turn reveals that its original source most likely also ended the frost between 2 and 16 February, because in 1434 Shrovetide lasted from 31 January to 16 February, whereas in 1435 it was 20 February to 8 March. Only one text does not mention St. Katherine's Day as the start of the frost, but St. Andrew's Day (30 November) (Anonymous, 1905, p. 137).

The Thames at London was obviously frozen and further downstream floating ice must have still posed a threat to shipping.

Some London chronicles expand the information on the ports that were still operable in the Thames estuary. A version of the Chronicle of London, from 1089 to 1483 (Anonymous, 1827, p. 171-172). specifies, that the wine was landed in "Gravesende, Northflete, Greneheth [Gravesend, Northfleet, Grenehithe] and other places both on Kent side and Essex". The much later compiled Short English chronicle (Anonymous, 1880a, p. 61) also mentions the use of Gravesend as a port. A version of the Brut gives Sandwich on the east coast of Kent (Brie, 1908, p. 571); this text was written rather close to the winter 1434-35, but either the identification of Sandwich as a harbour, where wine for London was unloaded is an error, or by the end of the freezing period in winter 1434-35 indeed the whole Thames estuary had become impassable. A later work widens the view from London and states: "wherwith Temmys and other grete ryveres in Engelonde and oute of Engelonde were so herde frose that horse and cariage myghte passe over" (Marx, 2003, p. 60), so other river ports must also have been inaccessible by water.

Whereas the ice closed the waterways and impacted shipping, carting was obviously still possible, now even on the frozen rivers. It was, however, a much slower, more expensive and laborious form of transport, in particular for heavy or bulky goods, such as wine. No wonder, that the ominous person who had predicted before the winter 1434-35 that the Gascon wine would be arriving in London over Shooter's Hill instead of the Thames, – likely someone who had extrapolated from problems already being visible in the harsh winters 1431-32 and 1432-33 – had been mocked (Gregory, 1876, p. 178).

The closing of the rivers would also have affected the transport of coal, commonly known as "sea coal", as it came from Newcastle-upon-Tyne over the North Sea to the cities further south. Coal was primarily used for industrial purposes, although in the cold, people might well have been willing to compromise on their fuel source. The Brut, which in general gives very dramatic impressions of the cold winters in the mid-1430s, reports for the winter 1436-37, which was again very harsh, that "moche pepel deyed [...], for colde and for scarcite of wode and cole" (Brie, 1908, p. 470). The reduction of shipping reduced the supply of coal and possibly also of wood at a time of steeply raised demand, and the resulting fuel shortage resulted in people dying of hypothermia. The cold of that winter was so extreme, that the Great Chronicle of London described the frost as "oon of the strengest that hath be seyen" and states that bread had to be melted by the fire, otherwise one needed an axe to hack it to pieces as it was frozen so hard, that "men myght not ete it ne cut it with knyfe" (Thomas and Thornley (eds.), 1938, p. 173). Indications are that the frost lasted again a long time (Anonymous, 1827, p. 172).

A raised level of mortality went hand in hand with the extremely cold weather. For the

winter 1434-35 the Brut notes that the frost "distroyed Þe olde peple, bothe men and women, and also yong childern" (Brie, 1908, p. 467). Such circumstances, likely not limited to London, left a lasting impression. When John Caumbrigge, mayor of Norwich 1437-39, died in 1442, he left warm bedding and clothing to poor families with many children (Rawcliffe, 2004, p. 315). It is possible that in 1434-35 the reason for the increased mortality was not only a fuel shortage, but also prevailing disease, as in Canterbury Cathedral Priory an 'epidemia' (not plague) was recorded (Hatcher, 1986, p. 29-30).

Grain would be brought to London from its close environs by cart, and from regions farther away by ship. As long as the grain was sufficient, as it was in England in both cold winters 1434-35 and 1436-37, London's direct hinterland could supply the city. However, a reliance on carting would raise transport costs, and cause difficulties with regard to hay and animal fodder, as with the long snow cover and heavy frost the winter pastures were much less productive, if grass was produced at all. No evidence in relation to London for this problem survives, but manorial accounts of the Bishopric of Winchester for manors in Hampshire record that extra oats, vetches and peas needed to be given to the animals and hay needed to be purchased for the sustenance of sheep during the winter 1434-35 (Titow, 1970, p. 341).

If the mills stood idle for too long, a flour famine could ensue, even in the presence of good grain stocks. Hence the food supply was exposed to higher risk, than in average winters, although there is no evidence for bread shortages in the documentary evidence for England during the cold winters of the mid-1430s. Frozen millponds and waterways could also reduce the activity of industrial mills, so that employment could be affected in the cold weather.

The cold also posed a threat to infrastructure and buildings. In January 1437 "duryng the hard frost, [...] the gate of Þe Cite at London Brigge ouer-threwe and fell doun into Tamys to Þe hard ground, and drewe the houses after hym, bothe within and without [houses that had stood on the bridge or in front of it], to grete harm to Þe Cite and Þe brigge" (Brie, 1908, p. 471). Luckily no one came to any harm, even though a whole arch of London Bridge had collapsed with the gate and drawn houses with it in the fall (Thomas and Thornley (eds.), 1938, p. 173). Indications are that contemporaries suspected a link between the hard frost and the bridge damage and hence mentioned both in conjunction, and the Brut even continues immediately after the bridge reference that in this year "the walles of chirches, howses, and of Selers, Þat were made of chalke, broke in many places, and fell in smale pecys to the ground as dust" (Brie, 1908, p. 471). Chalk – i.e. limestone – was used as a traditional building material in England. In eastern England, it was common due to a lack of durable building stone. Some of the stone is particularly soft – it is called 'clunch' today – and when exposed to harsh weather or hard frost it can disintegrate; the sequence

of cold winters in the 1430s probably had an accumulative effect upon the stone. Ice itself could also damage riparian infrastructure. In 1440, after the famine in the late 1430s, the Abbot of St. Albans was confronted with claims, that the abbey had neglected the upkeep and repair of a number of bridges (Amundesham, 1871, p. 220); the degradation of these bridges likely stemmed either from the cold winters in the mid-1430s or the flooding in the late 1430s. It is possible, that the cold winter 1431-32, although not referenced in England, also caused damage. In the Low Countries and in northern France rivers were frozen this winter and there was a danger from ice drift. In 1432 Norwich, in eastern England, replaced its old wooden staithe with a new common quay, which was made of oak piles and freestone (Ayers, 2009, p. 116; Pribyl, in print).

The winter 1434-35 did impact the natural environment. A version of the London chronicle attributes the "grete multitude of Byrdes and fowlys dyed ffor honger" to the "grete snowe" (Anonymous, 1905, p. 137), so presumably the snow cover prevented the birds from finding fodder, ice in the marshes would had a similar effect. Ice covering the water bodies in any case must have contributed to a demise of wildlife in the water, a continuation of the Brut states "Þat froste Þat tyme distroyet oisters, and muskelles, and fresshe-water fissh, thrugh Þe moost party of Englond" (Brie, 1908, p. 571). Concern for the fresh-water fish was likely widespread, as possibly in spring of 1435, but in any case no later than spring 1440, the Paston letters, normally only devoted to important business, mention the state of the family's fish-ponds in northeast Norfolk (Davis, 2004, p. 26). Water fowls, fresh-water fish, and seafood were also important food sources and it is unclear, if their stocks would have recovered before the arrival of the famine in 1438.

Extreme winters can also negatively impact agriculture. If winter temperatures drop too low or snow cover lasts excessively long, the winter grain, wheat and rye, can be destroyed (Pfister, 1999, p. 197; Camenisch et al., 2016, p. 2116). In England there is no indication of such damage, the available wheat yields for seigneurial agriculture for the early and mid-1430s were mostly above average compared to the preceding 20 years and the wheat price in general was low. In fact producers faced with low grain prices in England petitioned the government for allowing license free grain exports, which was granted in 1436 (Rotuli parl., 4, 1783a, p. 500; Munro, 2008; Campbell, 2012, p. 141). Sensitive herbs could also succumb to the winter cold, as the Brut points out for the winters 1434-35 and 1436-37 (Brie, 1908, p. 467).

Pastoral agriculture, however, was more vulnerable to cold and snowy winters. Prolonged snowcover or hard frost would reduce the productivity of winter pasture. Long winters and late springs caused a delay in the onset of grass growth prolonging the hungry gap for livestock in this season, when winter provisions would be running out. Malnourishment could also raise the susceptibility of the livestock to disease. A murrain

had ravaged the sheep stock in 1428, a summer of endless rain (Gregory, 1876, p. 162), and sheep numbers recovered only slowly. In Kent murrain flared up throughout the 1430s, partly driven by the stress caused by the extreme winters (Mate, 1987, p. 525-526). As mentioned above in winter 1434-35 livestock, including sheep, on the estates of the Bishopric of Winchester in Hampshire received extra fodder. At least in this county and in Wiltshire the death rate amongst all sheep increased steeply, but lambs and ewes fared particularly badly: in some places ten times as many ewes and four times as many lambs than in normal years died before shearing. On the estates of the Bishopric of Winchester in a series of weight of wool fleeces beginning in 1209 and ending 1454 the nadir was reached in 1435. Sheep mortality was high in Sussex in 1432-33 and 1437-38 (Titow, 1970, p. 341; Stephenson, 1988, p. 370, 383-384; Hatcher, 1996, p. 246; Camenisch et al., 2016, p. 2117). The export of wool was of course a pillar of the English economy and worse than just a disruption on the production side was to come. The Anglo-Burgundian War 1436-39 would result in a trade blockade of the Burgundian Low Countries, traditionally the key market for English wool, just at a time when the famine of the late 1430s held England and the countries across the North Sea in its grip. Afterwards wool prices would remain low until the middle of the fifteenth century (Mate, 1987, p. 526-527; Hatcher, 1996, p. 243; Pribyl, in print).

The famine

Whereas the wheat yields in the first half of the 1430s were generally good, the famine in the late 1430s did not come without a warning. Agriculture had become more challenging in the 1420s as yields varied greatly from year to year. Weather conditions also fluctuated, and the average temperature for April to July, the grain growing season, was falling. In 1428 a cold and wet summer ruined the harvest. Food shortages and raised grain prices ensued (Campbell, 2012, p. 152-154; Pribyl, 2017, p. 82-84, 117-118, 182-184). Labour was short, agriculture increasingly unpredictable, so with the return of good harvests in the early to mid-1430s many of the landlords, that had still held on to the direct exploitation of their demesne, farmed out their land.

However, anxiety was not only raised among landlords, but also among peasants. According to the St. Albans Annals, shortly after Christmas 1430 a thunderstorm with hail and rain occurred and on the last day of December it rained and continued to rain for a further three days into the new year; this caused the peasants to worry (Amundesham, 1870, p. 57). Since it is unlikely that a thunderstorm and a four day rainy period in an English winter would in itself be perceived as remarkable, the timing of the events in the Christmas

period and around the new year might have resulted in it being considered as a portent.[3] The superstitious beliefs were typical for the popular London chronicles and the Brut, and these texts abound with signs in the sky and thunderstorms in the following decades (Maddern, 1993, p. 77-90), but superstition found its way even into the last examples of monastic chronicles or annals, as the Waltham Annals and even the St. Albans Annals.

The anxiety of the St. Albans peasants in early 1431 proved to be unnecessary, but by summer 1432 bad weather impacted the harvest again. In Devon storms and heavy rain hindered the harvest and in London people saw dragons and spirits in the sky, most likely an interpretation of unusual weather phenomena (Browne and Reichel, 1915, p. 588; McLaren, 2002, p. 71). In southern England wheat yields suffered to some degree, and while the atmosphere was tense in the year following the harvest, the shortages did not result in famine. In October 1432 the government issued an export ban for all grain. There seems to have been some shortages as in 1433 the town of Lynn in Norfolk, a county with a highly productive agricultural sector, needed to purchase grain for its own inhabitants. In northern England and on the continent the situation was far more dire. From late 1432 grain shipments from England to areas under English control in northern France were encouraged and large shipments of wheat went from Great Yarmouth, another Norfolk port, to supply Normandy and Paris, which were badly affected by the famine. In the south of England the spectre of food shortages passed quickly, as wheat yields returned to normal the following year despite occasional thunderstorms with hail, but in the north recovery was delayed and in August 1433 followed another export ban of wheat (Titow, 1970, p. 340; Campbell, 2012, p. 153; Pribyl, 2020, p. 60-61). It had been a year punctuated by anxiety, since the appearance of a comet in October and an eclipse on 17 June 1433 had additionally unsettled people, even though the latter had been calculated and predicted (Ellis, 1859, p. 483; Gregory, 1876, p. 177, 1876, p. 177; Anonymous, 1880a, p. 61, 1905, p. 136; Brie, 1908, p. 466; Thomas and Thornley (eds.), 1938, p. 171; Marx, 2003, p. 59).

After these short-lived disturbances and an interval of good harvests, the summer weather suddenly cooled and became much wetter in the second half of the 1430s. The consequent famine was the worst since the Great Famine 1315-17, although not as severe. On the continent trouble set in with the extremely cold summer in 1436, but in England an awareness that grain cultivation was heading for serious problems only arose in spring 1437. The realisation was sudden, and in May 1437 the export of wheat without a license

[3] Natural events, in particular those diverting from the normal cause of nature, such as comets or thunderstorms, were considered meaningful in revealing God's wishes – also when the natural origin and its explanation were known. Thunder-divination was popular and its use for foretelling events of all kinds in the following year depended on the month of the thunderstorm; see Maddern (1993, p. 80-87).

was greatly restricted (Amundesham, 1871, p. 157; Pribyl, 2020, p. 54). Winter 1436-37 had been hard. Administrative records from various parts of England allow a glimpse into conditions in the countryside, where problems with flooding and heavy rain appear. For the Romney marshes severe flooding can be dated to September 1436, and spring floods hit Sussex in 1437; the flooding of meadows in Middlesex and close to Norwich, in Norfolk, likely also fell to this period. The harvest period itself then was rainy (Kingsford, 1913b, p. 352; Smith, 1943, p. 203; Brandon, 1971, p. 4; Mate, 1987, p. 525; NRO DCN 1/2/52). This weather pattern was then repeated in the following year. Autumn 1437 was very windy, reinforcements for the fight in France could not cross the channel for eleven weeks between early autumn and early November (Anonymous, 1905, p. 472; Brie, 1908, p. 472). Winter was marked by excessive and continuous rains and snow that inundated the wheat seed in Hampshire, the wet conditions continued into spring. Then the wheat was damaged by mildew, which was widespread in the realm. In Sussex, too, the year was inclement and boisterous. About winter 1437-38 and spring 1438 there was flooding in the eastern counties. In Canterbury a procession praying for the end of the rain took place at the cathedral in late May. Tree-ring data do not reflect the crisis, but the harvests 1437 and 1438 were far below average, prices rose accordingly and the ensuing famine was felt all over England (Stone, 1902, p. 22; CPR, 1907, p. 148-149; Titow, 1970, p. 341; Brandon, 1971, p. 4; Campbell, 2009, p. 24, 2012, p. 153-154; Cooper et al., 2012; Wilson et al., 2013; Pribyl, 2020, p. 53-58).

Amid the crisis, the authorities, the king and the mayor of London, sought to preserve the English grain for the realm and to ensure a supply of grain to London, the royal household and the army in France. After the harvest 1438, when the famine deepened, the government banned the export of all grains. The usefulness of such a ban was doubtful, as smuggling especially to the Low Countries was easy and common. In autumn 1437 the government began a campaign to end unlicensed wheat exports from the Thames estuary and the forestalling of grain in Southampton. Municipal authorities did likewise for large- and small-scale market offences as evidence from Great Yarmouth demonstrates (Pribyl, 2020, p. 54-56). In late 1438 and early 1439, during the worst famine winter, the king acted against a small number of men who had bought up large grain stocks in Kent, Warwickshire, Leicestershire, Cambridgeshire and Huntingdonshire for speculation, and also took measures against the millers close to London, but outside the city liberty, who had coordinated to demand extortionate charges for the grinding of corn (CPR, 1907, p. 266-267). Regions such as Norfolk, that were normally not part of the London hinterland, were drawn into the city's orbit as London merchants arrived to purchase grain with and without commissions by the crown or the mayor of London. The latter also organised great quantities of rye to be brought to the city from Prussia, which was a great relief for Londoners and famine refugees, who had come to the city, even though some shipments

were diverted to the starving urban centres of the Low Countries. In the aftermath of the famine London aimed at warding off similar supply shortfalls by building a granary. During the crisis, a purveyance system was in operation for the supply of the royal household, which included the army in northern France (Campbell, 2009, p. 28; Pribyl, 2020, p. 56-57, in print).

While many London chronicles and the Brut refer to the famine and the conditions in the city, their descriptions can be taken as an indication that the royal policy of protecting London was largely successful. For 1438-39 they remember bread made of beans and barley, but they do not report high numbers of famine deaths.

> Also this yere was so gret derthe of corn that men were fayn to ete rye bred and barly, the whiche nevere ett non before; and rather thanne fayle, bred mad of benes, peses, and fecches, and wel were hym that might hav ynowe therof; for a bushel of whete was worth iii s. at London, and in sum cuntre derrere; and that mad bakers lordes: but y prey God nevere let us see that day no more yf his wille be (Harris, 1827, p. 123-124).

Elsewhere in the country the impact of the famine was much greater, especially in the North, likely Yorkshire and further north. Chroniclers, reflecting a prevailing mood, were fascinated by a story, how in some areas people had to collect fern roots, dry them and grind them down into flour (Amundesham, 1871, p. 157; Brie, 1908, p. 473, 507; Kingsford, 1913b, p. 352; Hatcher, 1996, p. 246; Marx, 2003, p. 60). In the grain growing regions the flow of grain to London, but in particular the purveyance system, was unpopular. Two food riots are known to have occurred before May 1438. One of the riots broke out in Southwold (Suffolk) where people were infuriated with barley being purchased for the Low Countries. The other incident took place in Ipswich (Suffolk), when merchants tried to acquire grain on the market, possibly to bring it to London. At Pentecost 1438 a Lollard rising in Kent, although rooted in religious dissensions (CPR, 1907, p. 200; Brie, 1908, p. 472; Thomson, 1964, p. 101; Harriss and Harriss, 1972, p. 186; Pribyl, 2020, p. 58, in print), had at least a sombre backdrop, if not some added motivation, in the high grain prices. People were also aware of another bad grain crop in the coming summer and hence feared continued food shortages, while a lot of grain produced in Kent was destined for London or the army. Evidence shows, that at least in Norfolk, people in distress turned to unlawful means to support themselves and crime levels rose sharply (Pribyl, 2020, p. 58).

Only the harvest 1439, when yields rebounded, brought relief, although prices did not return to low levels before the harvest 1440 (Munro, 2008; Campbell, 2012, p. 141, 153). Still the year leading up to the harvest 1439 had been again of a wet and stormy character from autumn until spring. In Sussex the time can be described as stormy and inclement. In Hampshire, on manors of the Bishopric of Winchester, wheat could not be sown in au-

tumn due to rain and standing water. Also in northern Norfolk administrative sources reveal a shortfall of cultivation, so this might have been a common problem (Titow, 1970, p. 341-342; Brandon, 1971, p. 4; NRO DCN 1/1/83). In late November a short but severe storm hit London and other places, there was rain, thunder, lightning and 'smoke', but more importantly the wind was so strong as to damage the lead roof of the Grey Friars and to almost destroy the town side of the Old Change; it uprooted trees (Anonymous, 1905, p. 145; Brie, 1908, p. 473). Coastal flooding occurred in winter 1438-39 and probably in late spring 1439 (CPR, 1907, p. 265-266; Riley, 1908, p. 400; Mate, 1987, p. 535). After winter 1438-39 the evidence for conditions detrimental to grain cultivation thins out. A thunderstorm in late spring disturbed people in London, and in late May in Canterbury a procession prayed for serene weather, but also for peace and other pressing issues. Tree rings indicate a dry spring-summer (Stone, 1902, p. 24; Brie, 1908, p. 473; Cooper et al., 2012; Wilson et al., 2013). One of the earliest weather diaries for England documents the weather in late 1439, and it is perhaps no coincidence that it survives for a time when weather-related anxiety – as evident in the Canterbury procession in late spring – was high and the famine was just relenting. In any case, late October to late December 1439 were largely marked by dry and serene weather, it turned cold in October and a third of November days had frost – this was so unremarkable for contemporaries, who were now accustomed to much harsher conditions, that this winter left no striking impression upon them (Van Engelen, Buisman and Ijnsen, 2001; BLO MS. Ashmole 191).

Plague waves and other disease

The famine was not the only calamity encountered by the English population in 1438-39, but parallelly to the subsistence crisis a major epidemic, likely partly plague, took hold in the country. Since the mid-fourteenth century *Yersinia pestis* was the driver of most mortality crises in England. The arrival of the disease had reduced the population by one-third to half. Afterwards, due to repeated epidemics, demographic contraction continued to about 1400, this was followed by a period of stagnation or a slightly negative demographic trend until about 1450. In the decade before the 1430s then mortality crises were frequent, a plague wave occurred in 1420 followed by more regional outbreaks in 1426 and an unidentified disease, probably influenza, in 1427 (Harriss, 2005, p. 218; Pribyl, 2017, p. 201-202).

The 1430s were equally an unhealthy period and the 1438-39 outbreak was only the final blow in a sequence of diseases that put demographic development under pressure. A plague wave had occurred in 1434, when the Brut describes, how in London "men, women and children" were afflicted, and "worthy men, as aldermen and oÞer worthi communiers" also died. It was indeed not an outbreak merely spreading in poor living conditions as

throughout the realm "peple deyed sore, bothe pore and riche" (Brie, 1908, p. 467). 1434 was also a period of crisis mortality at Westminster Abbey, and for fear of the disease the law courts were broken up and the officers of the law compelled to leave London. Spring and summer 1434 were dry according to tree ring evidence (Nicolas, 1835, p. lxxx, 282; Harvey, 1995, p. 122-123; Cooper et al., 2012; Wilson et al., 2013).

This was followed in 1435 by an unidentified disease, an 'epidemia', at Christ Church Canterbury (Hatcher, 1986, p. 29). The spread of this disease is not clear, but for late 1435 and early 1436 the Brut notes an elevated mortality level amongst bishops and prelates throughout England and Wales. Whereas it can not be excluded that the 'epidemia' in Canterbury might have been an imprecisely described plague, a mortality peak in late autumn and winter as for the prelates in 1435-36 would be untypical for this disease, which normally peaked in late summer and early autumn.

Parallel to the height of the famine 1438-39 and shortly after another epidemic affected England. Contemporaries identified it with pestilence, i.e. plague, although it has long been suspected that famine disease, waterborne in some way – fever and dysentery – or maybe typhus, played a very important role in the mortality peak (Creighton, 1891, p. 228; Bean, 1963, p. 429; Pribyl, 2017, p. 202-213, Galanaud, Galanaud and Giraudoux, 2015, p. 15-21). A London chronicle locates the outbreak in the "northe contraye" (Gregory, 1876, p. 181), so the region, where the famine had been most pronounced, and the Brut adds, that the disease was present in the whole realm, but was particularly bad at York and in the North, it killed "moche worthy peple", but also commoners, "men, women and childern" (Brie, 1908, p. 473). In fact, the outbreak must have also been bad in Norfolk, where the famine had not been as difficult as farther north, and where sparse evidence highlights a likely raised mortality. In 1439 three out of four brethren at Hickling Priory perished in the pestilence, and in late October the daughter and son-in-law of a prominent Norwich alderman died within a few days at Great Yarmouth (Ellis, 1859, p. 439; Matthew, 2013, p. 41-44; Pribyl, in print). Concerned by the pestilence which reigned more commonly throughout England than hitherto and which was perceived as highly contagious, parliament petitioned the king to omit the ceremonious kiss during homage as a form of prevention of infection in 1439 (Rotuli parl., 5, 1783b, p. 31).

Plague also flared up on a local or regional level in the 1430s, for 1431 evidence survives for the disease being on the estates of St. Albans Abbey in Hertfordshire and in Christ Church Canterbury. The plague wave 1434 stretched back to 1433 in London. According to the St. Albans annals, there was also plague in London in 1437, although the date is ambiguous (Rotuli parl., 4, 1783a, p. 420; Amundesham, 1870, p. 64; 1871, p. 127; Hatcher, 1986, p. 30).

In medieval England the majority of severe plague waves coincided with a particular meteorological pattern that concerned the summer half year, in which the mortality peak of a

major plague outbreak fell, as well as the summer and winter seasons preceding. This group of plagues occurred in summer seasons that were warm and dry and in general also warmer and drier than the preceding summer half year. These plague summers were not periods of subsistence crisis. The winter preceding a major plague outbreak was normally of average or slightly colder than average conditions, but never extremely cold. Extremely cold winters could follow after a plague and would generally mark the end of a major outbreak. The outbreak 1434 and the local or regional flare up in 1431 fall into this category. The epidemic in 1438-39 clearly does not share these meteorological characteristics and if plague did play a substantial role in it, then this outbreak belongs to the minority of major plague waves that arose in cool-wet summers and that was associated with food shortages, although the summer half year 1439, the year, when mortality seems to have peaked in the north and Norfolk, was likely drier than 1438 (Pribyl, 2017, p. 199-214). It is outside the scope of this paper to discuss the implications of these weather patterns surrounding plague for the aetiology of the disease in medieval England, but a similar bipolar pattern of meteorological conditions linked to plague outbreaks has also been identified for other regions, when better data is available during the third pandemic (Xu et al., 2011, p. 10214-10217).

The trend of the 1420s of frequent disease, and in particular plague outbreaks, was compounded in the 1430s which additionally witnessed raised mortality levels due to the famine and food shortages as well as to the extremely cold winters. It is likely that this unrelenting pressure would have negatively impacted the demographic trend. The scarce data available for population history in this period points towards the same direction: in monastic settings in southern England, at Westminster Abbey and Canterbury Cathedral Priory, life expectancy was decreasing throughout the 1420s and 1430s, although the nadir was not yet reached at the end of this period. Demographic recovery would not begin before the later fifteenth or even early sixteenth century, the reasons for this long delay remain unclear (Harriss, 2005, p. 219-221; Hatcher, Piper and Stone, 2006, p. 674, 682).

Final considerations

The 1430s were a decade, when multiple stressors linked to meteorological conditions created multiple crises in England. Extremely cold winters with the accompanying disruptions in trade and shortages of fuel raised the death rate, but also impacted on pastoral farming and damaged infrastructure and housing. Wet and cool summer half years destroyed harvests and caused famine. Interspersed between these weather events directly impacting people and agriculture came epidemic disease, mostly plague, and resulted in further mortality crises. Storms in the second half of the 1430s caused flooding, in combi-

nation with heavy rainfall as inundations along inland water bodies, but also as storm surges along the eastern coast.

As far as possible mitigating steps to reduce the impact of these extreme weather events were taken. In the cold winters alternative transport replaced shipping when possible and economically viable. Complex measures were used by national and municipal authorities to supply population centres and areas of high political interest with grain during times of shortages. Infection control against contagious disease was cautiously attempted for the king.

After the 1430s the number of weather-related disasters decreased, even though the trend towards cooler and drier conditions continued; they were particularly characteristic of the mid-fifteenth century. Nonetheless, apart from the winter 1442-43 (Van Engelen, Buisman and Ijnsen, 2001), extreme conditions of the magnitude of the 1430s were not to return for decades. Despite plague affecting England throughout the mid-fifteenth century, the next severe outbreak only occurred in the late 1470s and it was more than four decades before another famine returned to the country.

In fact, agricultural prices, which had been falling since the later fourteenth century, resumed this trend soon after the famine of the late 1430s. This crisis was followed by a general recession, in 1441 the lowest point of real gross domestic product was reached (Campbell, 2016, p. 355). The short-term shock merged into decades of lower economic activity known as the Great Slump. The situation was particularly severe in the North, and at least in the Northeast the sharp shock of the famine and epidemic disease in the late 1430s contributed to the recession (Hatcher, 1996, p. 246). While the country continued to spiral out of control politically, and times were challenging for landowners and farmers as land was cheap and rents fell, labourers benefited and wage rates peaked in the 1440s (Campbell, 2016, p. 377). The hard times that labourers and the poor had seen before 1350, the circumstances of which were temporarily approximated by the weather induced crisis of the late 1430s, would not return for a long while.

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