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Linking European building activity with plague history

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ABSTRACT

Variations in building activity reflect demographic, economic and social change during history. Tens of thousands of wooden constructions in Europe have been dendrochronologically dated in recent decades. We use the annually precise evidence from a unique dataset of 49 640 tree felling dates of historical constructions to reconstruct temporal changes in building activity between 1250 and 1699 CE across a large part of western and central Europe largely corresponding to the former Holy Roman Empire of the German Nation. Comparison with annual records of 9772 plague outbreaks shows that construction activity was significantly negatively correlated to the number of plague outbreaks, with the greatest decrease in construction following the larger outbreaks by three to four years after the start of the epidemics. Preceding the Black Death (1346–1353 CE) by five decades and the Great Famine (1315–1322 CE) by two decades, a significant decline in construction activity at c. 1300 CE is indicative of a societal crisis, associated with population stagnation or decline. Another dramatic decline in building activity coincides with the Thirty Years' War (1618–1648 CE) and confirms the devastating nature of this conflict. While construction activity was significantly lower during periods of high grain prices, no statistically robust relationship between the number of felling dates and past temperature or hydroclimate variations is found. This study demonstrates the value of dendrochronological felling dates as an indicator for times of crisis and prosperity during periods when documentary evidence is limited.

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1. Introduction

Plague is a rapidly progressing zoonotic disease, caused by the bacterium *Yersinia pestis*, that can spill over into human populations and is capable of having major and long-lasting demographic consequences. Environmental factors, including climate, influence its epidemiological behavior in space and time (Stenseth et al., 2006, 2008; Kausrud et al., 2007; Walløe, 2008; Xu et al., 2011, 2014; Schmid et al., 2015; Tian et al., 2017; Yue and Lee, 2018). Plague is infamous for having caused tens of millions of deaths in large historic pandemics, most notably in Europe during the late medieval Black Death (1346–1353 CE) (Benedictow, 2004).

Europe's economic and demographic down-turn during the fourteenth and fifteenth centuries, the so-called Late Medieval Crisis, has to a large extent been attributed by most researchers to the Black Death and the following recurrent plague outbreaks (Russell, 1972; Sandnes, 1977; Gissel et al., 1981; Herlihy, 1997; Harrison, 2000; Cohn, 2002; Benedictow, 2004, 2016; Myrdal, 2009). However, it has also been acknowledged that the crisis, in some respects, predated the Black Death and was triggered by a combination of political and religious upheavals, as well as declining average living standards, and an increasing frequency and severity of famines (Postan, 1972; Anderson, 1974; Parry, 1978; Bois, 1984; Herlihy, 1989; Bartlett, 1993; Aberth, 2001; Dybdahl, 2010, 2012; DeWitte, 2015; Ljungqvist, 2017a; Campbell, 2018).

Direct and indirect contributions of climate change to the crisis, e.g. negative impacts on agricultural productivity with the climatic cooling of the Little Ice Age (Büntgen and Hellmann, 2014), have long been suspected (see Steensberg (1951) for an early example). Following recent advancements in high-resolution paleoclimatic reconstructions for medieval Europe (Büntgen et al., 2010, 2011; 2013, 2016; Cook et al., 2015; Luterbacher et al., 2016), this view has become increasingly popular (e.g. Aberth, 2013; Campbell, 2016). Special attention has been paid to the Great Famine 1315–1322 CE (Lucas, 1930; Kershaw, 1973; Jordan, 1996, 2010; Campbell, 1991, 2009; Slavin, 2014, 2018; Geens, 2018) caused by harvest failures due to an excessive precipitation during the growing seasons of 1314–1316 CE in combination with a

highly lethal and large-scale outbreak of cattle disease 1315–1325 CE (Newfield, 2009; Slavin, 2012). The Great Famine was the most mortal, largest and longest lasting recorded subsistence crisis in European history north of the Alps, not only during the fourteenth century but for the whole past millennium, with a population decline of around 10%. The relative roles of plague and climate in relation to the Late Medieval Crisis have been hard to quantify and results are ambiguous. However, it is clear that by the late fourteenth century, the population of Europe had been heavily reduced (Campbell, 2016). Widespread desertions of farmland and villages (Abel, 1980), and even substantial reforestation of sizable portions of Europe (Kaplan et al., 2009) followed in the wake of the population collapse (Biraben, 1979).

A compilation of dendrochronological felling dates from historical construction timbers from southeastern Sweden, together with local pollen data, recently supported the view that the depopulation started with the Black Death (Lagerås et al., 2016). By contrast, Thun and Svarva (2018) showed, by felling dates alone, that Norway experienced an almost complete cessation of construction activities preceding the Black Death by some decades. The contrasting results suggest an existence of geographical variations in the timing of the onset of the crisis even within a relatively small region such as Scandinavia.

Absolutely dated tree felling dates from well-preserved historical construction timbers constitute a promising source for constraining the timing of societal crises and estimating demographic declines (e.g. Baillie, 1982, 1995; Schweingruber, 1988; Nicolussi, 2002; Eckstein, 2007), especially during periods when documentary evidence is of insufficient quantity and quality. Tree felling dates have, for example, been used to reconstruct demographic trends among the Ancestral Puebloans in the southwestern United States (e.g. Douglass, 1921, 1929; Dean, 1969; Eighmy, 1979; Berry, 1982; Berry and Benson, 2010; Bocinsky et al., 2016) as well as the settlement history in parts of the Swiss Alps (Büntgen et al., 2006), northwestern Carpathian arc (Büntgen et al., 2013), north-eastern France (Tegel et al., 2016) and in parts of medieval Scandinavia (Lagerås et al., 2016; Thun and Svarva, 2018). However, no attempts have hitherto been made to use annually resolved and absolutely dated felling dates to reconstruct past settlement and demographic dynamics on larger spatiotemporal scales in

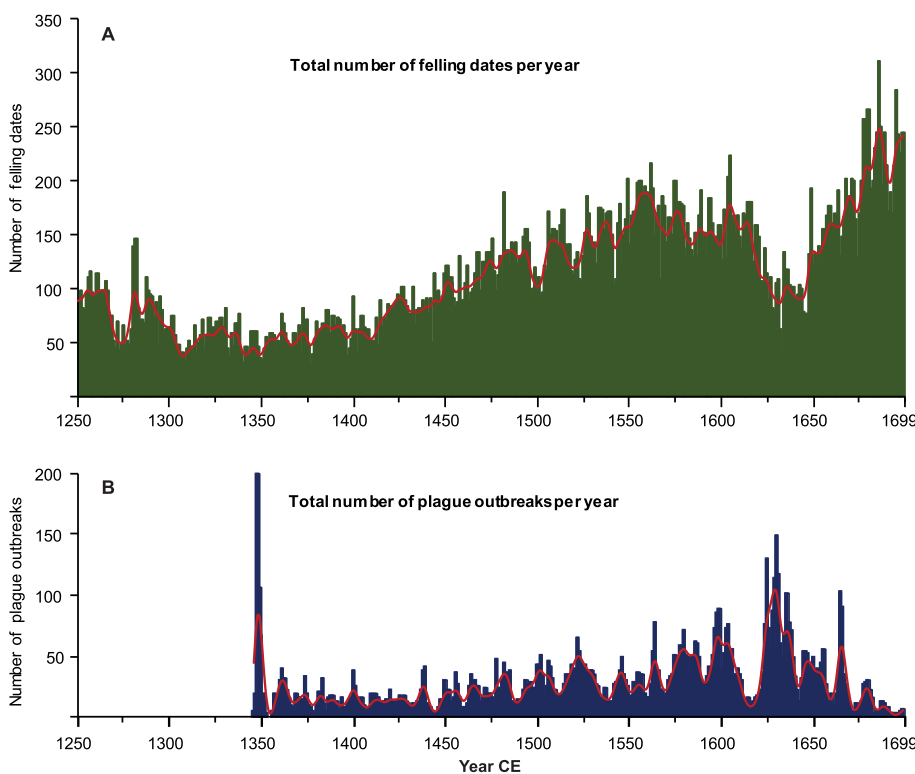


Fig. 1. (A) The 49 640 felling dates averaged across western and central Europe from 1250 to 1699 CE. (B) The 9772 recorded plague outbreaks averaged across the whole of Europe from 1346 to 1699 CE. A 10-year low-pass filter (red lines) is applied to the annually resolved values (vertical bars). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

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