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Climate and the Crises of the Early Fourteenth Century in Northeastern Europe

Abstract: This article demonstrates how tree-ring material can be applied to historical research using the climate-driven crises of the fourteenth century as a case study. Medieval northeastern Europe is a promising case study for such a purpose, because climate-sensitive tree-ring data are readily available for this period and region. Whereas large areas of western Europe were affected by continuous heavy rains and bitter winters during the 1310s, this dendrochronological evidence suggests that northeastern Europe was not. Favorable climatic conditions prevailed in northeastern Europe in the late 1310s, and, more generally speaking, during the first half of the fourteenth century, as well. The juxtaposition of this new information from tree-ring analyses with the established understanding of the development of the region challenges the view that the crises of the fourteenth century reached the northeasternmost corner of Europe. The case study demonstrates how teleconnections of climate and society, like the crises of the early fourteenth century, can materialize on a societal level very different ways in different locations.

Keywords: Climate, The Great Famine of 1315, Novgorod, Finland, Russia, Tree Rings, Medieval Agriculture, Food System Resilience

1 Introduction

Medievalists are increasingly addressing topics of climate history. Studies on past human responses to variations in climate have arguably never been more needed than in the present context of ongoing anthropogenic climate change. Using written sources – for example chronicle records of different weather and climate-related phenomena – historians can reconstruct past variations of climate and weather and their impacts on society, which contributes to understanding of current climatic variations.¹ Written source material, however, for such detailed information from the pre-modern era is available only for limited areas. As an alternative, climate-sensitive natural data, so-called proxy data, allow to detect past climate variability where written sources are not available. Climate and weather anomalies can be reconstructed, for example, from

¹ Rudolf BRÁZDIL et al., Historical climatology in Europe. State of the art, in: *Climatic Change* 70 (2005), pp. 363–430.

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study of tree rings, ice cores, and speleothems.² Recent decades have witnessed a notable increase in the number, sophistication, and accessibility of such climate reconstructions, and entirely new archives have opened for medievalists. In particular, tree-ring based reconstructions have become an invaluable resource for historians of pre-modern times who aim to detect the impacts of past climate anomalies on society. The advantage of tree ring-based climate reconstructions is that these reconstructions can be dated to exact calendar years and, therefore, directly compared to written sources.

Already in 1914, Andrew E. DOUGLASS proposed that a series of climate-sensitive tree rings could provide novel material to study the environmental conditions of historical events. Harold C. FRITTS et al. addressed the historical community in 1980 and introduced modern tree-ring research and the information it made available to historical scholars.³ However, it took several decades before the historians took full advantage of the information captured in the tree rings. For a long time, it was left to natural scientists to tell the story of past climatic variations and their relationship to historical events. Bruce M. S. CAMPBELL was one of the first historian to include tree-ring data alongside written sources in his study on the connections between environment and society in pre-modern England.⁴ Since then, tree-ring data have increasingly been used as a source of supplementary material in historical research. For example, the “Old World Drought Atlas”⁵ provides evidence of the hydroclimatic conditions which prevailed over Europe and contributed to the large-scale crop failures and the outbreak of the Great Famine (1315–1317/1322) (Figure 1).⁶

The reliability, validity and relevance of climate reconstructions based on natural sources like tree rings should be evaluated as carefully and critically as written sources. Using the fourteenth-century crises in northeastern Europe (modern-day Finland and North-West Russia, Figure 2) as a case study, this article demonstrates how tree-ring data can be used as historical source. Medieval northeastern Europe is a particularly interesting case study for such research because climate-sensitive tree-ring data are widely available from this area. The written historical record from this region, on the other hand, especially along the northern shores of the Gulf of Finland and Lake

² Eugene R. WAHL/ David FRANK, Evidence of Environmental Change from Annually Resolved Proxies with Particular Reference to Dendrochronology and the Last Millennium, in: John A. MATTHEWS (ed.), *The SAGE Handbook of Environmental Change*, vol. 1, London 2012, pp. 320–345.

³ Andrew E. DOUGLASS, A method of estimating rainfall by the growth of trees, in: *Bulletin of the American Geographical Society* 27 (1914), pp. 321–335, here p. 322; Harold C. FRITTS/ G. Robert LOFGREN/ Geoffrey A. GORDON, Past climate reconstructed from tree rings, in: *The Journal of Interdisciplinary History* 10 (1980), pp. 773–793.

⁴ Bruce M. S. CAMPBELL, Nature as historical protagonist. Environment and society in pre-industrial England, in: *The Economic History Review* 63 (2010), pp. 281–314.

⁵ Edward R. COOK et al., Old World megadroughts and pluvials during the Common Era. *Science Advances* 1 (2015), pp. 1–9.

⁶ On the Great Famine see the introduction of BAUCH/ SCHENK and the contributions of CAMENISCH, KISS/ PITI/ SEBÖK et al., LABBÉ, NANNI, PREISER-KAPPELLER/ MITSIOU, SCHUH, and VADAS in this volume.

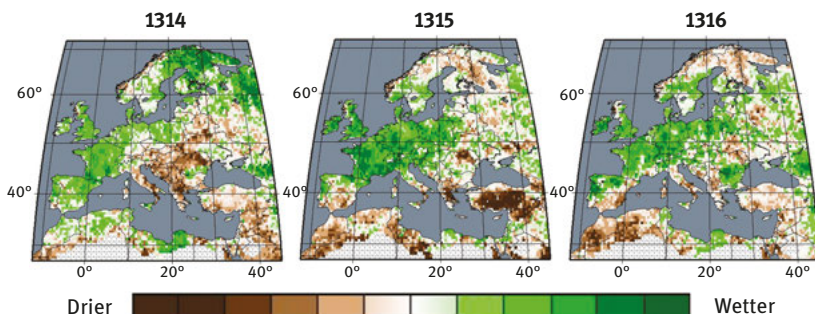


Figure 1: Tree-ring reconstructed summer season variations of drought and wetness, 1314–1316. The green shades indicate wetness and the brown drought.⁷

Ladoga, is quite limited, which has hindered the research on this area. The inclusion of scientific data in historical research thus presents an opportunity to expand scholars' understanding of the history of the region. At the same time, detailed Russian chronicles for the southern parts of the study area – including, for example, the 'Novgorod First Chronicle'^{7,8} – allow for a direct comparison of written sources and tree-ring data.

This study focuses on the northeastern corner of Europe, where Sweden (to the west) and Novgorod (to the east) were the dominating powers in the fourteenth century. The northwestern parts of the study area – i.e., roughly the areas covered by modern-day southern and western Finland – were gradually incorporated into the Swedish Realm in the thirteenth and fourteenth centuries. The urban center of the area was Veliky Novgorod, the heart of the Novgorod principality and the easternmost post of the Hanseatic League. Karelia in the northeast was of interest to both Sweden and Novgorod. Although trade was an important part of the economy in the Russian towns of Novgorod, Pskov, and Ladoga, the majority of the population in the area studied here relied on agriculture and fishing for their livelihoods with supplementary herding and hunting.⁹

2 Tree-Ring Series as a Primary Source

Tree rings hold annually resolvable climate proxies that can be transformed, for example, into estimates of growing season temperature, precipitation, and cloud cover variability. By combining tree-ring series from living, historical, archeological, and fossil materials, dendrochronologies can extend back thousands of years.

⁷ The variations of drought and wetness are indicated with self-calibrating Palmer Drought Severity Index (–6, ..., +6). See COOK et al. (note 5) for details.

⁸ The Chronicle of Novgorod 1016–1471, ed. Robert MICHELL/ Nevill FORBES, London 1914, p. 119.

⁹ Vladimir L. IANIN, Medieval Novgorod, in: Maureen PERRIE (ed.), *The Cambridge History of Russia*, vol. 1, *From early Rus' to 1689*, Cambridge 2006, pp. 188–210, here pp. 198–201. Livonia (i. e. modern day Estonia and Latvia) have been excluded from this analysis.

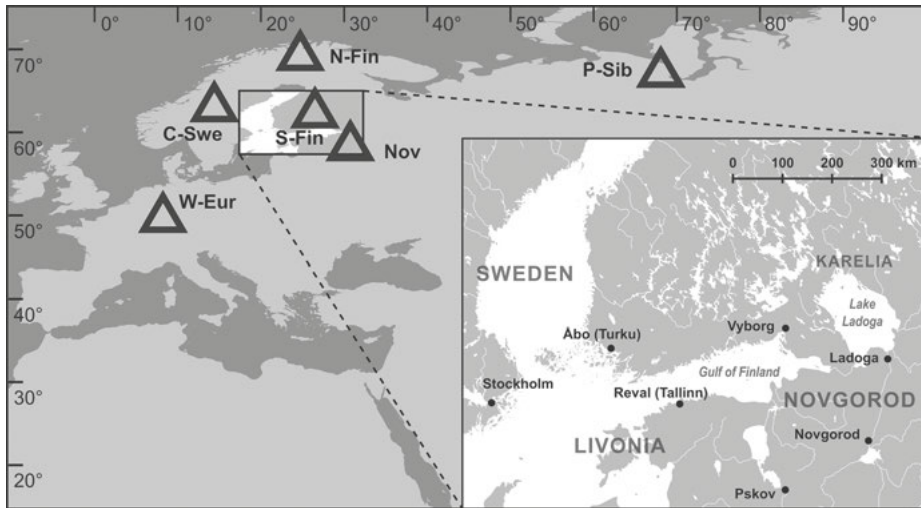


Figure 2: The area of this study and the approximate sampling sites (triangles) of the tree-ring material used in this study: S-Fin (southern Finland, reconstructed May–September temperature¹⁰ and May–June precipitation¹¹), C-Swe (central Sweden, April–September temperature¹²), N-Fen (northern Fennoscandia, June–August temperature¹³), P-Sib (Polar Siberia, June–July temperature¹⁴), Nov (Novgorod, February–May temperature¹⁵), and W-Eur (western Europe, April–June precipitation¹⁶).

To reconstruct past climate variability from these series, first a statistical relationship between the tree-ring proxy and climate needs to be established. This relationship can be then calibrated over a period when the tree-ring proxy and instrumental

10 Samuli HELAMA et al., A palaeotemperature record for the Finnish Lakeland based on microdensitometric variations in tree rings, in: *Geochronometria* 41 (2014), pp. 265–277.

11 Samuli HELAMA/ Jouko MERILÄINEN/ Heikki TUOMENVIRTA, Multicentennial megadrought in northern Europe coincided with a global El Niño–Southern Oscillation drought pattern during the Medieval Climate Anomaly, in: *Geology* 37 (2009), pp. 175–178.

12 Björn E. GUNNARSON/ Hans W. LINDERHOLM/ Anders MOBERG, Improving a tree-ring reconstruction from west-central Scandinavia. 900 years of warm-season temperatures, in: *Climate Dynamics* 36 (2011), pp. 97–108.

13 Vladimir MATSKOVSKY/ Samuli HELAMA, Testing long-term summer temperature reconstruction based on maximum density chronologies obtained by reanalysis of tree-ring data sets from northernmost Sweden and Finland, in: *Climate of the Past* 10 (2014), pp. 1473–1487.

14 Keith R. BRIFFA et al., Reassessing the evidence for tree-growth and inferred temperature change during the Common Era in Yamalia, northwest Siberia, in: *Quaternary Science Reviews* 72 (2013), pp. 83–107.

15 Samuli HELAMA et al., Something old, something new, something borrowed. New insights to human–environment interaction in medieval Novgorod inferred from tree rings, in: *Journal of Archaeological Science: Reports* 13 (2017), pp. 341–350.

16 Ulf BÜNTGEN et al., 2500 years of European climate variability and human susceptibility, in: *Science* 331 (2011), pp. 578–582.

meteorological measurement series overlap. With these established statistical relations, the proxy measurements can be translated into climate reconstruction which extends beyond the time of meteorological record keeping. The reconstruction approach is based on the assumption that the relation between the proxy and the climate variable in question was the same in the past as it is in the calibration period. Which climate variables can be reconstructed from the tree rings depends on where the trees grew and the parameters measured. For example, tree-ring width (TRW) of Scots pine in southern Finland can indicate hydrological variability in early summer, whereas in northern Finland TRW is primarily an indicator of temperature fluctuations during the summer season. However, measuring tree-ring maximum density (MXD) instead of TRW in the southern Finnish tree-ring material results in a series that is more indicative of mean temperature variability during the growing season.¹⁷

Dendroclimatologists are working on a variety of matters which may influence the reconstruction, like data homogeneity, growth coherence and removal of non-climatic trends out of tree-ring chronologies, among other things. Historians who incorporate dendrochronological research into their own studies can hardly be expected to have the same scientific skills. Nevertheless, they should apply the critical source assessment common in their own discipline to the natural sources, as well to define what exactly the tree-ring studies indicate and whether these findings are relevant and valid for exploring their own research questions.

The first step in using dendrochronological data as historical source material is to define the “response window” of the reconstruction. In other words: what climate component(s) (e.g., temperature or precipitation) are reconstructed over which period (e.g., early spring or whole growing season)? Once this has been established, the indications of the “reconstruction skill” should be considered. Reconstructions estimate climate variability with varying degrees of accuracy. Scientists commonly test the reconstruction skill by correlating tree-ring series with measured observations from nearby meteorological stations. Furthermore, it is also essential to pay attention to the results of calibration and verification statistics. In the calibration-verification approach, which is standard in dendroclimatological research, the period of overlapping tree-ring data and station data is divided into two subperiods. One period is used to calculate the reconstruction model (calibration) and the other as an independent check for the model (verification). Commonly, the calibration-verification approach is applied to the data in two steps in which both subperiods are checked against each other.

Additionally, the “spatial domain” of the reconstruction can be explored by correlating the tree-ring series with field data (see Figures 3a and 3b). Tree-ring data are

17 Stefan BRÖNNIMANN/ Christian PFISTER/ Sam WHITE, *Archives of nature and archives of societies*, in: Sam WHITE/ Christian PFISTER/ Franz MAUELSHAGEN (eds.), *The Palgrave Handbook of Climate History*, Basingstoke, Hampshire 2018, pp. 27–36, here p. 34; HELAMA et al. (note 11), pp. 175–178.

commonly collected in locations where tree growth is most sensitive to the climatic variable being examined, that is, from marginal areas of tree-growth. For example, reconstructions of temperature are often based on tree-ring material from along the timberline. Therefore, reconstructions commonly cover peripheral areas which are far away from the medieval population centers. Thus, it is important to define whether – and how well – the tree-ring reconstruction explains the climate variability in the area of interest.

The last thing that historians should consider when drawing on dendrochronological research is the “sample replication,” that is, the number of tree-ring measurement series used to calculate the mean tree-ring chronology. In general, the more samples the better. The number of samples commonly declines moving back over time. A lower number of samples might, in turn, limit the reconstruction skill and create uncertainty over the earlier centuries. Although the tree-ring mean chronology might perform well when correlated with station data (because the sample replication is commonly high over recent centuries, for which meteorological measurements are also available), the declining sample number may influence the reconstruction back in time. This matter is especially a concern of medievalists, as tree-ring based climate reconstructions with a sufficient sample replication extending throughout the Middle Ages are available only from few locations. Additionally, the results of the expressed population signal (EPS) statistics indicate how well a chronology based on a limited number of trees represents the hypothetical perfect chronology.¹⁸

In this study the analysis of several selected regional dendrochronological climate reconstructions is used to evaluate whether northeastern Europe was affected by an unfavorable climate in the 1310s, and more generally in the fourteenth century as a whole. There are a variety of reconstructions available for this period of regional, continental, and hemispheric scope.¹⁹ Although large-scale – i.e., continental and hemispheric – reconstructions provide invaluable material for comparisons of ongoing climatic change with past changes, historians are typically interested in regional reconstructions which cover their areas of interest. Several tree-ring based reconstructions are available for northeastern Europe, including the center of the study area, the city of Novgorod (see Figure 2).

18 Harold C. FRITTS, *Tree Rings and Climate*, London, New York, San Francisco 1976, pp. 15–23; Jan ESPER et al., Ranking of tree-ring based temperature reconstructions of the past millennium, in: *Quaternary Science Reviews* 145 (2016), pp. 134–151; Ulf BÜNTGEN et al., Effects of sample size in dendroclimatology, in: *Climate Research* 53 (2012), pp. 263–269.

19 For summary on available reconstructions, see, e. g.: Lea SCHNEIDER et al., Revising midlatitude summer temperatures back to AD 600 based on a wood density network, in: *Geophysical Research Letters* 42 (2015), pp. 4556–4562; Rob WILSON et al., Last millennium northern hemisphere summer temperatures from tree rings. Part I: The long term context, in: *Quaternary Science Reviews* 134 (2016), pp. 1–18.

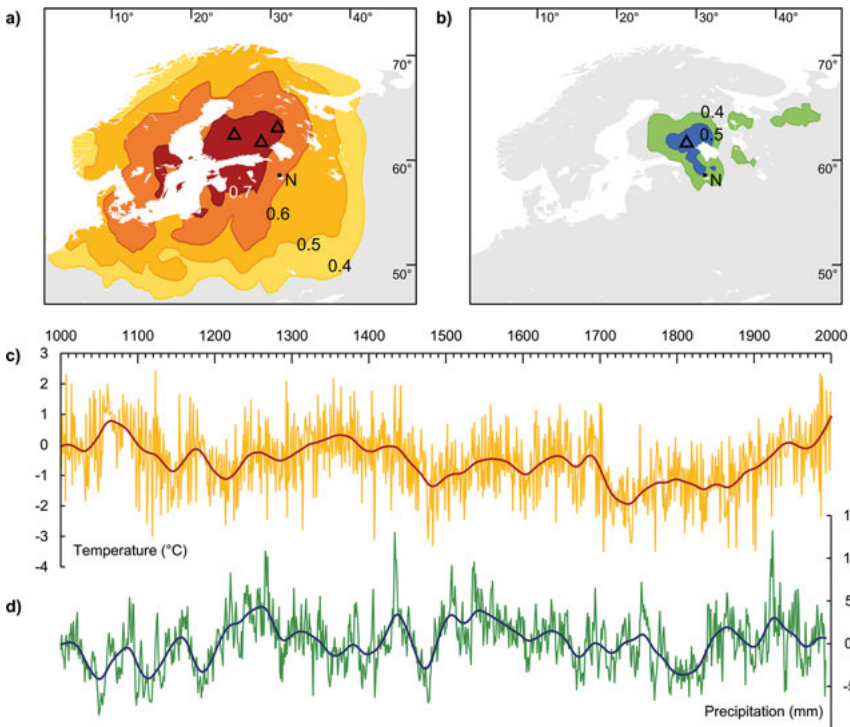


Figure 3: Field-correlations (Pearson correlation coefficient) between the CRU TS 3.24 data set²⁰ **a)** averaged May–September temperatures and reconstructed temperature²¹ and **b)** May–June precipitation sum and TRW reconstructed precipitation²² variability. The triangles indicate the average sampling site of the tree-ring material. The city of Novgorod (N) is marked on the maps. Reconstructed annual (orange, green) and long-term (red, blue) **c)** temperature and **d)** precipitation anomalies over the past millennium with respect to the 1961–1990 mean (same data as in a and b); **e)** the reconstructed winter Arctic Oscillation (AO, bars, scale on left)²³ and winter North Atlantic Oscillation (NAO, dashed line, scale on right)²⁴ indexes over the past millennium (see Chapter 4); **f)** temperature, precipitation, and the AO and NAO index anomalies over the fourteenth century with respect to the century mean.

²⁰ University of East Anglia Climatic Research Unit, Ian C. HARRIS/ Philip D. JONES, CRU TS3.23. Climatic Research Unit (CRU) Time-Series (TS) Version 3.23 of High Resolution Gridded Data of Month-by-month Variation in Climate (Jan. 1901– Dec. 2014). Centre for Environmental Data Analysis, 09 November 2015 [<http://www.cru.uea.ac.uk/>].

²¹ HELAMA et al. (note 10).

²² HELAMA et al. (note 11).

²³ Guoqiang CHU et al., Snow anomaly events from historical documents in eastern China during the past two millennia and implication for low-frequency variability of AO/NAO and PDO, in: *Geophysical Research Letters* 35 (2008), pp. 1–4. Valérie TROUET et al., Persistent positive North Atlantic Oscillation mode dominated the medieval climate anomaly, in: *Science* 324 (2009), pp. 78–80.

²⁴ Valérie TROUET et al., Persistent positive North Atlantic Oscillation mode dominated the medieval climate anomaly, in: *Science* 324 (2009), pp. 78–80.

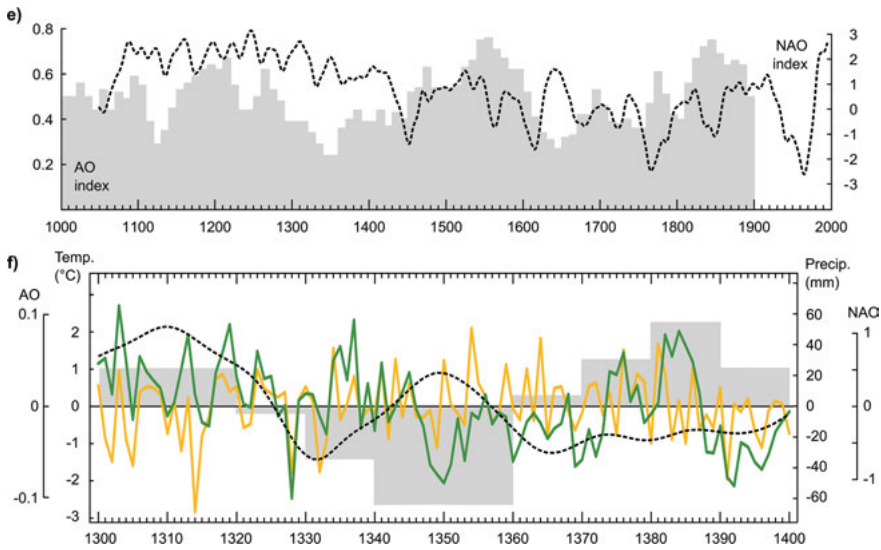


Figure 3 (continued)

Tree-ring width series from the region of Novgorod correlate with late winter and spring temperatures. Consequently, TRW series that have been compiled using archaeological material from the medieval city of Novgorod indicate February–May temperature variability.²⁵ However, the Novgorod chronology is not continuous: it has a gap of almost five hundred years from the fifteenth to nineteenth century. Moreover, the TRW series explains only 32 percent of the measured temperature variance, which is considerably lower than other reconstructions from the adjacent areas. The reconstructions with the highest reconstruction skill over the studied area and sufficient fourteenth-century data originate from southern Finland (Figures 3a and 3b). From these, the growing season (May–September) temperature reconstruction²⁶ attained from MXD data explains up to 60 percent of the measured twentieth-century variance, and the early summer (May–June) precipitation reconstruction²⁷ from TRW series accounts for 40 percent of the measured precipitation variance. The temperature reconstruction shows high spatial coherence over the whole study area, whereas the spatial coverage and the reconstruction skill of the precipitation reconstruction is less coherent (Figure 3b). This is because precipitation variability has weaker spatial synchrony over long distances than temperature. Moreover, the tree-ring response

²⁵ HELAMA et al. (note 15).

²⁶ HELAMA et al. (note 10).

²⁷ HELAMA et al. (note 11).

to precipitation is more dominated by “noise” and local site influences than the response to temperature.²⁸

In certain circumstances, tree-ring data can be used not only as a climate proxy but also to estimate past harvest fluctuations. This is because in marginal areas of crop cultivation, like northeasternmost Europe, the same climatic components largely determine tree growth and crop yields: the length and thermal conditions of the growing season. Consequently, the pre-industrial crop yield variability correlates strongly and significantly with the mean temperatures during the growing season, as does the tree-ring density (MXD) data.²⁹ Thus, annual yield ratio (harvested seed in relation to sowed seed) anomalies have been reconstructed from MXD series. This reconstruction explains approximately 50 percent of the pre-industrial crop yield variability in central and northern Finland (north of 62° N).³⁰ In addition, tree-ring based temperature reconstructions from northern Scandinavia,³¹ central Sweden,³² and Polar Siberia³³ were used for comparison along with precipitation reconstruction from western Europe.³⁴ The average sampling sites of the reconstructions are indicated in Figure 2.

3 The Great Famine

There is a longstanding debate among historians over the extent to which climate contributes to famine.³⁵ The Great Famine (1315–1317/1322) is one of the few cases in which they commonly agree that there is a strong association with adverse climate.

28 Keith R. BRIFFA et al., Tree-ring width and density data around the Northern Hemisphere. Part 1: local and regional climate signals, in: *The Holocene* 12 (2002), pp. 737–757, here p. 746; Jari HOLOPAINEN/ Samuli HELAMA, Little Ice Age farming in Finland. Preindustrial agriculture on the edge of the Grim Reaper’s scythe, in: *Human Ecology* 37 (2009), pp. 213–225, here p. 221.

29 Heli HUHTAMAA et al., Crop yield responses to temperature fluctuations in 19th century Finland: provincial variation in relation to climate and tree-rings, in: *Boreal Environmental Research* 20 (2015), pp. 707–723, here pp. 713–715.

30 Heli HUHTAMAA/ Samuli HELAMA, Reconstructing crop yield variability in Finland. Long-term perspective on the cultivation history in the agricultural periphery since 760 AD, in: *The Holocene* 27 (2017), pp. 3–11. See, Figure 2 (S-Fin and N-Fin series) for the approximate sampling sites of the tree-ring data.

31 MATSKOVSKY/ HELAMA, (note 13).

32 GUNNARSON/ LINDERHOLM/ MOBERG (note 12).

33 BRIFFA et al. (note 14).

34 BÜNTGEN, (note 16).

35 Philip SLAVIN, Climate and famines. A historical reassessment, in: *WIREs Climate Change* 7 (2016), pp. 433–447, here pp. 435–438.

A series of harsh and stormy winters combined with rainy summers and flooding in 1314–1316 caused harvests to fail in large parts of Europe and indirectly affected animal husbandry, which triggered the famine among vulnerable groups of societies.³⁶ The famine coincided with a period of exceptionally warm sea surface temperatures in the North Atlantic that provided abundant moisture for the rains.³⁷ Although the famine and its association with extreme precipitation in northwestern Europe have been investigated in detail, the northeastern extent of the famine remains undefined. Henry S. LUCAS concluded that although the written historical record from Scandinavia and northern Russia is scarce on the topic, the climatic conditions troubling northwestern Europe must have prevailed further east, as well.³⁸ Later, Wolfgang BEHRINGER proposed that the famine “reached from the British Isles to Russia and from Scandinavia to the Mediterranean,”³⁹ whereas William C. JORDAN suggested that “the far eastern Baltic was not affected directly by harvest shortfalls.”⁴⁰

3.1 Climate, Harvest and Hunger in the 1310s

According to the reconstructed drought-wetness index, the northeast did not experience consecutive wet summers like western Europe did (Figure 1). Whereas the early summer precipitation increased from 20 to 40 percent in northwestern Europe during 1314–1316, in the northeast, precipitation levels remained close to or below the fourteenth-century mean (Figure 4a). The tree-ring material thus indicates that the adverse conditions did not extend to the northeastern shore of the Baltic Sea, suggesting the opposite what LUCAS has proposed.

36 William C. JORDAN, *The Great Famine. Northern Europe in the Early Fourteenth Century*, Princeton 1996, pp. 15–21; Henry S. LUCAS, *The Great European Famine of 1315, 1316, and 1317*, in: *Speculum* 5 (1930), pp. 343–377, here pp. 345–351; Philip SLAVIN, *The 1310s event*, in: Sam WHITE/Christian PFISTER/Franz MAUELSHAGEN (eds.), *The Palgrave Handbook of Climate History*, Basingstoke, Hampshire 2018, pp. 495–515, here p. 497; Timothy P. Newfield, *A cattle panzootic in early fourteenth-century Europe*, in *The Agricultural History Review* 57 (2009), pp. 155–190, here p. 172; Sam GEENS, *The Great Famine in the county of Flanders (1315–17): the complex interaction between weather, warfare, and property rights*, in: *The Economic History Review* 71 (2018), pp. 1048–1072, here p. 1069.

37 A. G. DAWSON et al., *Greenland (GISP2) ice core and historical indicators of complex North Atlantic climate changes during the fourteenth century*, in: *The Holocene* 17 (2007), pp. 427–434, here p. 433.

38 LUCAS (note 36), here p. 347.

39 Wolfgang BEHRINGER, *A Cultural History of Climate*, Cambridge, Malden 2010, p. 104.

40 JORDAN (note 36), here p. 12.

On the other hand, rainfall alone may be a fairly insignificant factor: hydrological anomalies were not the primary cause of severe, large-scale crop failures in the studied area. As precipitation trends vary greatly from one place to another, drought and excessive rain usually caused crop failures only on a local scale in the northeastern Europe. Moreover, along the northern margin of arable cultivation, fluctuations in crop yields are influenced more by temperature than by precipitation. In these areas, especially, it was the onset and thermal conditions of the growing season that determined the success of the harvest. A late start to the growing season or a cool summer delayed the ripening of the grain and in turn increased the chances that an early autumn night frost (in August/ September) should cause the crop to fail. Trends in temperature during the growing season were fairly consistent over larger areas, meaning that in years of especially short, cool growing seasons, frosts could cause severe, widespread crop failures close to the harvest time.⁴¹ If the onset of the growing season was delayed and summer remained unusually cold in one part of the studied region, the situation was likely similar all over the region. Cool spring and summer temperature anomalies delayed the ripening of crops everywhere in the area to a period when the risk of frost at night was increased. In cases of rainfall destroying the harvest in one location, however, the hydrological conditions in other regions might have been more favorable, so that the harvests were only locally affected.

Over the early 1310s, the growing season of 1314 was extremely cool (Figure 3f), indicating that the ripening of the grain must have been delayed in that year. However, during the second half of the 1310s, the temperature reconstructions indicate rather favorable conditions. In southern Finland, the mean temperature during the growing seasons between 1315–1320 was slightly warmer than the fourteenth-century mean. In the adjacent regions of northern Scandinavia and polar Siberia, the 1315–1320 mean summer temperatures were almost one Celsius degree warmer than the century mean. Further east, in temperate East Asia, summer temperatures overall were distinctly warm between 1314–1327, possibly even comparable to late twentieth-century (1961–1990) conditions. Moreover, the spring (February–May) temperature reconstruction compiled from the archeological wood material from the city of Novgorod indicates that springs during the mid-1310s were slightly warmer than the late-fourteenth-century average (Figure 4b).⁴²

⁴¹ HUHTAMAA et al. (note 29), pp. 713–716.

⁴² Temperature reconstructions (respectively): HELAMA et al. (note 10); MATSKOVSKY/ HELAMA (note 13); BRIFFA et al. (note 14); COOK et al., Tree-ring reconstructed summer temperature anomalies for temperate East Asia since 800 CE, in: *Climate Dynamics* 41 (2013), pp. 2957–2972; HELAMA et al. (note 15).

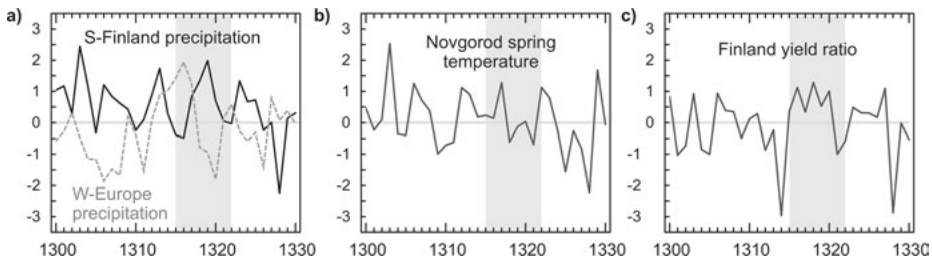


Figure 4: a) Southern Finland precipitation⁴³ (solid black line) and western Europe precipitation⁴⁴ (dashed grey line); b) Novgorod February–May temperature⁴⁵; and c) Finland crop yield ratio⁴⁶ anomalies. All series are standardized over the fourteenth century. The years 1315–1322 are highlighted.

While there is some evidence that Sweden⁴⁷ and Livonia⁴⁸ to the west may have faced severe food shortage, or even famine, in the second half of the 1310s, written sources documenting the crisis' extent further east and north are scant. Early autumnal frost most likely caused considerable crop damage in Pskov in 1314.⁴⁹ As discussed above, the growing season in 1314 was extremely cool, which most likely contributed to the severity and extent of the frost damage.

The 'Novgorod First Chronicle,' which is based on the annals of the city of Novgorod, mentions that bread was expensive in the winter of 1314–1315 in Novgorod and that, in Pskov, men were "looting villages [...] and storehouses."⁵⁰ However, the accounts of the food shortage in 1314 differ markedly from other famine narratives

⁴³ HELAMA et al. (note 11).

⁴⁴ BÜNTGEN et al. (note 16).

⁴⁵ HELAMA et al. (note 15).

⁴⁶ HUHTAMAA/ HELAMA (note 30).

⁴⁷ Gustaf UTTERSTRÖM, Climatic fluctuations and population problems in early modern history, in: Donald WORSTER (ed.), *The Ends of the Earth. Perspectives on Modern Environmental History*, Cambridge 1988, pp. 39–79, here pp. 52–53 n. 37. Ericus OLAI (died 1486) writes that in 1314 Sweden suffered from famine, see OLAI, *Chronica Erici Olai*, ed. Erik M. FANT/ Erik G. GEIJER/ Johan H. SCHRÖDER (*Scriptores Rerum Suecicarum Medii Aevi* 2), Uppsala 1828, p. 92 and six years later, a letter that is dated 26th of August 1320 documents that Stockholm was still in great need of grain, see Rainhold HAUSEN, *Finlands medeltidsurkunder* vol. 1, Helsinki 1910, no. 295.

⁴⁸ Balthasar RÜSSOW (died 1600) writes how horrifying famine ranged in Livonia from 1315 for three years, as each year both rye and barley froze on the fields, see Balthasar RÜSSOW, *Chronica der Prouintz Lyfflandt*, Rostock 1578, pp. 32–33. Also Bartholomäus HOENEKE (died circa mid-14th century) and Hermann von WARTBERGE (died 1380) documented Livonia suffering from famine in 1315, see Bartholomäus HOENEKE, *Die jüngere Livländische Reimchronik 1315–1348*, ed. Konstantin HÖHLBAUM, Leipzig 1872, p. 1; Hermann von WARTBERGE, *Chronicon Livoniae*, ed. Ernst STREHLKE, Leipzig 1863, p. 50.

⁴⁹ Matthias AKIANDER, *Utdrag ur Ryska annaler, Suomi – Tidskrift i fosterländska ämnen* 1848, Helsinki 1849, pp. 1–284, here p. 83.

⁵⁰ The Chronicle of Novgorod 1016–1471 (note 8), p. 119.

in the chronicle. For example, the chronicle describes how a century earlier, when a severe famine afflicted the region, the population consumed unwholesome famine⁵¹ and taboo⁵² foods, even resorting to cannibalism, and mothers traded their babies for bread.⁵³ All of these are typical motifs of famine events in the chronicle, but the entry for 1314 includes none of them. Moreover, the chronicle makes no mention of food scarcity or high prices from 1315–1322, when western Europe was in the grips of the famine.⁵⁴ There is no written evidence from Finland or Karelia documenting a famine or the absence of one. However, reconstruction of central and northern Finland yield ratios based on tree-ring density data corroborate the chronicle's claim that the harvest in 1314 was poor (Figure 4c). In fact, the reconstruction estimates that the yield ratio for 1314 was the lowest of the entire century.

Northeastern Europe thus seems not to have experienced the excessive rainfall that regions further west did (Figures 1 and 4a). Nevertheless, growing conditions in 1314 were unfavorable throughout the studied area. In Pskov, frost damaged the fields before the peasants had harvested them. Further north, crop yields reached the lowest point of the century. The price of bread rose over the Novgorodian lands for the following year. These adverse conditions, however, did not last into the second half of the 1310s, which raises the question as to whether one bad year was enough to trigger a famine. In other words, could the anomalously cold year 1314 paralyze the food system(s) and cause a severe shortage of food?

3.2 Food System Resilience to Adverse Climate and Weather

Food systems are dynamic systems that encompass the production, processing, distribution, preparation, and consumption of food.⁵⁵ Food systems in the area under study here differed from region to region in the fourteenth century. In northern and central Finland, the semi-nomadic Sámi people relied primarily on fishing as the source of their livelihood and supplemented this by herding reindeer and hunting game. The forest dwellers of Finland and Karelia practiced small-scale crop cultivation, fishing, and hunting, while the sedentary farmers on the shores of the Baltic Sea supplemented their livelihood with fishing and seal hunting. Residents of the

51 Such as moss, snails, pine-bark, lime-bark, lime and elm-tree leaves.

52 Horseflesh, dogs and cats.

53 The Chronicle of Novgorod 1016–1471 (note 8), p. 75.

54 However, the chronicle (*Ibid.*, p. 120) mentions enemy troops dying of hunger in 1316 while retreating and getting lost on the lakes and the swamps. Yet, it is rather clear that the hunger was temporary and resulted from military activities. Thus, connecting the hunger incident to the European Great Famine would be rather questionable.

55 Peter J. GREGORY/ John S. I. INGRAM/ Mike BRKLACICH, Climate change and food security, in: *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 360 (2005), pp. 2139–2148, here pp. 2141.

hinterlands of Novgorod and Ladoga cultivated a number of diverse crops on a larger scale. The food systems in the urban centers relied primarily on grain production in their hinterlands and only secondarily on trade over longer distances.⁵⁶

As a result of this diversity of food systems, the adverse conditions of 1314 affected only those areas where food systems depended on crop cultivation – roughly the southern parts of the area studied. Moreover, even within those areas with agrarian food systems, the diversity of crops cultivated could increase the resilience to unfavorable climatic conditions. In Novgorod and Ladoga, for example, the variety of cultivated crops was up to three times larger than in Livonia on the west at the same time. Because different crops are sensitive to different climatic factors, total failure rarely struck all the cultivated species simultaneously. Moreover, different agricultural practices, such as slash-and-burn cultivation and the cultivation of winter crops, reduced the vulnerability of the food system in the area. Vegetables grown in home gardens in the countryside and towns also supplemented the daily diet.⁵⁷

A single year of crop failure thus hardly ever paralyzed the food system. Instead, severe food shortages in the Middle Ages were usually a product of back-to-back failed harvests.⁵⁸ Written sources do not show any sign of a shortage of food in 1315–1322, and the tree-ring evidence suggests favorable conditions – warm growing season with moderate rainfall – for this period (Figure 4).

Further north, the food systems were simpler: barley and rye were the only crops routinely cultivated, which increased sensitivity to climate and weather. However, in these areas, grain products constituted only one part of the daily diet; wild resources were important components of the food system, as well. Much of the areas studied relied on fishing as a key element of food production in addition to the cultivation of crops and vegetables. The number of lakes and waterways throughout Finland and

56 Heli HUHTAMAA, Climatic anomalies, food systems, and subsistence crises in medieval Novgorod and Ladoga, in: *Scandinavian Journal of History* 40 (2015), pp. 562–590, here pp. 565–566; Jukka Korpela, Migratory Lapps and the population explosion of Eastern Finns. The early modern colonization of Eastern Finland reconsidered, in: Charlotte DAMM/ Janne SAARIKIVI (eds.), *Networks, interaction and emerging identities in Fennoscandia and beyond*, Helsinki 2012, pp. 241–261, here p. 247; Michael MONK/ Penny JOHNSTON, Plants, people and environment. A report on the macro-plant remains within the deposits from Troitsky site XI in medieval Novgorod, in: Mark BRISBANE/ David GAIMSTER (eds.), *Novgorod. The archaeology of a Russian medieval city and its hinterland*, London 2001, pp. 113–117, here p. 116; Eljas ORRMAN, Keskiajan maatalous, in: Viljo RASILA/ Eino JUTIKKALA/ Anneli MÄKELÄ-ALITALO (eds.), *Suomen maatalouden historia 1. Perinteisen maatalouden aika esihistoriasta 1870-luvulle*, Helsinki 2003, pp. 87–114, here pp. 106–114.

57 HUHTAMAA (note 56), p. 577; R. E. F. SMITH/ David CHRISTIAN, *Bread and salt. A social and economic history of food and drink in Russia*, Cambridge, 1984, pp. 8–9.

58 HUHTAMAA (note 56), pp. 575, 580; Bruce M. S. CAMPBELL/ Cormac Ó GRÁDA, Harvest shortfalls, grain prices, and famines in preindustrial England, in: *The Journal of Economic History* 71 (2011), pp. 859–886, here pp. 865–868; Bruce M. S. CAMPBELL, The European mortality crises of 1346–52 and advent of the Little Ice Age, in: Dominik COLLET/ Maximilian SCHUH (eds.), *Famines During the 'Little Ice Age' (1300–1800)*, Cham 2018, pp. 19–41 here pp. 20, 29–33.

Karelia (see Figure 2) made fish an important source of nutrition, as archeological evidence from southeast Finland and Novgorod and its hinterlands confirms.⁵⁹

Yet, cold summers, like the one in 1314, can be unfavorable for some fish species, including cyprinids and pike perch, which were the most frequently consumed fish in Novgorod. Because fry and juvenile fish are more vulnerable to climate than mature fish, the effects on fish populations usually lags from a few years to a decade behind.⁶⁰ Therefore, although the year 1314 was most likely unfavorable for the fish, it took likely several years before the consequences began to show in the fish catch. Similarly, the effects of climate on game are often delayed, as the impact of climate on game populations are commonly indirect (for example, through the variations in the availability of food).⁶¹

A further factor affecting food availability was the variety of techniques used in processing food. For example, in Finland drying was the principal form of preserving fish until the availability of salt increased after the mid-fourteenth century, after which salting slowly became the main method of preservation.⁶² Consequently, the food system was connected to the salt-producing areas, which meant local climate and weather were no longer the sole factors affecting the food system, but the conditions at the origin of salt also played a role. This is evident, for example, in the case of the Finnish famine of the 1690s: adverse weather conditions in southwestern Europe, where the salt originated at the time, caused a shortage of salt. As a result, people in Finland could not preserve fish for the winter.⁶³ In the early fourteenth century, however, the food systems in Finland and Karelia were not connected to the regions in western Europe affected by the rainy weather and resulting salt deficiency.⁶⁴ The

59 Mark MALTBY, From *Alces* to Zander. A summary of zooarchaeological evidence from Novgorod, Gorodishche and Minono, in: Mark A. BRISBANE/ Nikolaj A. MAKAROV/ Evgenij N. NOSOV (eds.), The archaeology of medieval Novgorod in context. Studies in centre/ periphery relations, Oxford 2012, pp. 351–380, here pp. 366–369; Elena A. RYBINA, The birch-bark letters. The domestic economy of medieval Novgorod, in: Mark BRISBANE/ David GAIMSTER (eds.), Novgorod. The archaeology of a Russian medieval city and its hinterland, London 2001, pp. 127–131, here pp. 128–129; Mía LEMPIÄINEN-AVCI/ Ville LAAKSO/ Teija ALENIUS, Archaeobotanical remains from inhumation graves in Finland, with special emphasis on a 16th century grave at Kappelinmäki, Lappeenranta, in: *Journal of Archaeological Science: Reports* 13 (2017) 132–141, here p. 138.

60 Jakob KJELLMAN/ Jyrki LAPPALAINEN/ Lauri URHO, Influence of temperature on size and abundance dynamics of age-0 perch and pikeperch, in: *Fisheries Research* 53 (2001), pp. 47–56; Erik JEPPESEN et al., Impacts of climate warming on lake fish community structure and potential effects on ecosystem function, in: *Hydrobiologia* 646 (2010), pp. 73–90; HUHTAMAA (note 56), p. 567.

61 Chuan YAN et al., Linking climate change to population cycles of hares and lynx, in: *Global Change Biology* 19 (2013), pp. 3263–3271, here p. 3268.

62 Tapio SALMINEN, *Vantaan ja Helsingin pitäjän keskiaika*, Vantaa 2013, p. 493.

63 J. NEUMANN/ S. LINDGRÉN, Great historical events that were significantly affected by the weather: 4, The great famines in Finland and Estonia, 1695–1697, in: *Bulletin American Meteorological Society* 60 (1979), pp. 775–787, here pp. 780.

64 SLAVIN (note 36), p. 501.

northern food systems were overwhelmingly local, with foodstuffs produced, gathered, and consumed within a limited area.

Novgorod, on the other hand, was integrated in some respects into a continental food system. The city of Novgorod was located at the crossroads of the main trade routes between Europe and the East. Still, Novgorod was not dependent on imported grain; archeological evidence suggests that the grain consumed in the city was produced locally. The fact that the main component of the food regime, grain cultivation, did not rely on the affected areas in the west that were suffering from adverse weather over three years in 1314–1316 protected Novgorod from the worst of the famine.⁶⁵

In summary, the harvest in 1314 was most likely extremely poor throughout the area studied here, but the food systems in some parts of the northeast were more diverse and in other parts less dependent on crop cultivation than many contemporary western systems. Although the food systems in the north – among the Finnish, Karelian and Sámi populations – were distinctly different from the food systems over the Novgorodian lands in the south, all of these had components that made them resilient to short-term weather anomalies. Moreover, as it was commonly back-to-back harvest failures that produced severe food shortages, it is thus rather unlikely that the crop failure in 1314 would have escalated to a famine comparable to the Great Famine that was raging in the west.

4 Crises of the Fourteenth Century in the Northeast?

The Great Famine, however, is only one component of the climate-related crises of the fourteenth century. The 1314–1316 weather anomalies were likely connected to a wider climatic shift taking place over the fourteenth century.⁶⁶ After the subsequent rainy summers of the 1310s, large parts of Europe experienced increased climatic instability over the following decades. This increased instability is commonly associated with changing patterns of climatic modes, mostly in the patterns of the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO), which, in turn, influence temperatures, precipitation, winds and storminess in large parts of Europe. Coinciding this period of climatic instability, the commoners' entitlement to food decreased and the rulers across Europe were involved in a number of territorial wars. It became more difficult to maintain the existing socio-ecological balance as a result, and European economic systems became more vulnerable. By mid-century, the tipping point had been

⁶⁵ Michael MONK/ Penny JOHNSTON, Perspective on non-wood plants in the sampled assemblage from the Troitsky excavations of medieval Novgorod, in: Mark A. BRISBANE/ Nikolaj A. MAKAROV/ Evgenij N. Nosov (eds.), *The archaeology of medieval Novgorod in context. Studies in centre/periphery relations*, Oxford 2012, pp. 283–320, here p. 317; IANIN (note 9), p. 201.

⁶⁶ SLAVIN (note 36), p. 508.

reached, so that the sudden worsening of growing conditions and the plague which reached Europe around this same time both contributed to a pan-regional crisis.⁶⁷

Bruce M. S. CAMPBELL has demonstrated how the environmental downturn of the mid-fourteenth century is evidenced in tree-ring material across Eurasia.⁶⁸ In accordance with his findings, tree-ring density series from northernmost Scandinavia and central Sweden indicate the downturn.⁶⁹ In Novgorod and southern Finland, however, climatic conditions in the mid-fourteenth century seem to differ. These local reconstructions suggest that drier and warmer summers prevailed in northeastern Europe in mid-century (Figure 3). Moreover, a spring (February–May) temperature reconstruction based on archeological tree-ring width series from the city of Novgorod indicates that, from the beginning of the fourteenth century, cold springs were less frequent than in the earlier centuries.⁷⁰

In addition, reconstructed winter NAO and AO indexes – negative NAO phase and lower pressure over Arctic – suggest that winters in the area studied were mild in the fourteenth century, especially mid-century (Figure 3). Winter weather and the onset of the growing season in northeastern Europe are dictated to a great degree by atmospheric dynamics, particularly the NAO and the AO. Years of positive winter NAO-phases, when the pressure difference between the Azores and Iceland is strong, experience milder winters in the northeast due to stronger westerly winds, while winters with negative NAO are associated with colder winters in this area. The NAO patterns, which are more regional, usually resemble the patterns of the more general AO. The AO is characterized by differences in atmospheric pressure between the Arctic and the surrounding lower latitudes. When lower pressure prevails over the Arctic, the westerlies are stronger and the cold air is trapped in the polar region, whereas higher than usual pressure over the Arctic results in weaker westerlies, allowing the cold Arctic air to penetrate into mid-latitudes. The severity of winter, and especially the duration of the snow cover (which partly dictates the onset of the growing season), is strongly associated with variations of the AO in the studied area.⁷¹

67 Bruce M. S. CAMPBELL, *The Great Transition. Climate, Disease and Society in the Late-Medieval World*, Cambridge 2016, pp. 135, 267–286, GEENS (note 36), here p. 1069.

68 *Ibid.*, pp. 277–279; CAMPBELL, (note 58), 32.

69 MATSKOVSKY/ HELAMA (note 13); GUNNARSON et al. (note 12).

70 HELAMA et al. (note 15).

71 Samuli HELAMA/ Jari HOLOPAINEN, Spring temperature variability relative to the North Atlantic Oscillation and sunspots. A correlation analysis with a Monte Carlo implementation, in: *Palaeogeography, Palaeoclimatology, Palaeoecology* 326–328 (2012), pp. 128–134; James W. HURRELL et al., An overview of the North Atlantic Oscillation. *The North Atlantic Oscillation. Climatic Significance and Environmental Impact*, in: James W. HURRELL et al. (ed.), *The North Atlantic Oscillation. Climatic significance and environmental impact*, Washington DC, 2003, pp. 1–35; Ignatius G. RIGOR/ John M. WALLACE/ Roger L. COLONY, Response of sea ice to the arctic oscillation, in: *Journal of Climate* 15 (2002), pp. 2648–2663; Sergio M. VICENTE-SERRANO et al., Role of atmospheric circulation with respect to the

Overall in the fourteenth century, and especially in the 1310s and the mid-century, the winter NAO was in a positive phase and lower than normal pressure prevailed over the Arctic. In fact, the winter AO reconstruction indicates that the lowest pressure over the last millennium prevailed over the Arctic in the mid-fourteenth century (Figure 3). This meant stronger westerly winds that brought milder winters to the area studied. Milder winters, warmer springs, longer growing seasons, and warmer summers are all favorable conditions for agriculture in the region covered in this study. As discussed above, in the northern margin of crop cultivation, the most severe production failures were commonly a result of an unusually short and/or cold growing season. Milder winters were associated with an earlier onset of the growing season, which meant that crops ripened earlier and were less likely to be damaged by early autumn frost.

The tree-ring studies thus suggest that growing conditions became, in fact, more favorable for agriculture in northeastern Europe over the first half of the fourteenth century. This was most likely due in part to the prolonged period of the positive mode of the NAO and the weakened AO, which strengthened the westerly winds that brought warm air masses to the area in winter. In other words, the very same modes of climate variability that favorably influenced conditions in the northeast brought likely the torrential rains and storms to the west.⁷²

The term teleconnections refers in climate sciences to the appearance of statistical relations between climate anomalies in distant locations.⁷³ These anomalies may occur simultaneously or with a delay, and they can influence the local weather very differently, as they did in the early fourteenth century. In this volume, the definition of teleconnections is expanded to include manifestations of these climatic anomalies on a societal level. The social consequences can also materialize with some delay and vary significantly between different locations. Various socio-environmental dynamics – including livelihood strategies, food systems, trade networks, and land use – dictate whether, when, how, and to what extent climatic anomalies influence social dynamics.

It was commonly believed that the crisis of the fourteenth century extended into the northeasternmost regions of Europe. Yet, recent analysis had suggested an increase in animal husbandry and crop cultivation in the northern forest areas over the course of the century.⁷⁴ In addition, as discussed above, the more diverse food systems of the

interannual variability in the date of snow cover disappearance over northern latitudes between 1988 and 2003, in: *Journal of Geophysical Research. Atmospheres* 112 (2007), pp. 1–15.

⁷² CAMPBELL (note 67), pp. 258, 285; DAWSON et al. (note 37), p. 430.

⁷³ Anders ÅNGSTRÖM, Teleconnections of climatic changes in present times, in: *Geografiska Annaler* 17 (1935), pp. 242–258; Heinz WANNER et al., North Atlantic Oscillation. Concepts and studies, in: *Surveys in Geophysics* 22/4 (2001), pp. 321–382.

⁷⁴ Jukka KORPELA, The World of Ladoga. Society, trade, transformation and state building in the eastern Fennoscandian boreal forest zone c. 1000–1555, *Münster* 2008, p. 218; Vladimir KLIMENKO, Thousand-year history of northeastern Europe exploration in the context of climatic change. Medieval to early modern times, in: *The Holocene* 26 (2016), pp. 365–379, here p. 372.

region were less dependent on crop cultivation than many of their neighbors' systems to the west. Moreover, because permanent agriculture was introduced into the region much later than in western Europe, the natural environment had not experienced the same level of degradation as in the west, and the agroecosystem was more resilient as a result.⁷⁵ The economy of the urban center in Novgorod strengthened notably in the early fourteenth century. Novgorod had been able to avoid the military devastation of the Golden Horde – unlike the other Rus' principalities – and resist the Swedish and Teutonic Order's aggressions on the west. Consequently, Novgorod became the region's dominant economic power.⁷⁶ This economic growth and agricultural expansion suggest that, unlike in the rest of Europe, the subsistence systems in the northeast did not become more vulnerable over the first half of the century. The 'Novgorod First Chronicle' supports this assumption, as the chronicle does not mention a single incident of frost, crop failure, expensive prices, food shortage, or famine between the year 1315 and the early fifteenth century.

In addition to the written sources and social factors, the tree-ring records presented here provide strong evidence that one of the key drivers of the European crisis of the fourteenth century – adverse climatic conditions for crop cultivation – did not extend to the most northeastern corner of Europe. The region was not able to avoid the crises completely, however, only to postpone them. Records of social unrest, war, and plague become more frequent in the Novgorodian chronicle over the second half of the fourteenth century. During the first half of the fifteenth century, coinciding with major changes in the behavior of the NAO and AO, the summers became wetter and cooler (Figure 3). Novgorod suffered what were probably its most severe late-medieval famines in the first half of the fifteenth century and gradually lost its dominating position over the region.⁷⁷

5 Conclusions

This exploration of whether the climate-driven crises of the early fourteenth century affected the northeastern corner of Europe has sought to demonstrate the potential of incorporating tree-ring data into historical research. The various sources analyzed here suggest that the adverse climatic conditions, winter storms, and heavy rains that troubled western Europe in the first half of the fourteenth century did not reach the area studied. In fact, tree-ring reconstructions suggest favorable conditions for agriculture – warm growing seasons and moderate precipitation – in the late 1310s. On the other hand, both tree-ring data and written sources indicate that the harvest in

75 HUHTAMAA (note 56), pp. 577.

76 IANIN (note 9), p. 201.

77 DAWSON et al. (Note 37), p. 433; KLIMENKO (note 72), pp. 372–373.

1314 was extremely poor all over the studied area. Yet, the food systems in the northeast were rather diverse, which made them resilient to short-term climate anomalies. Therefore, it is rather unlikely that the single bad harvest in 1314 would have triggered a famine comparable to the crisis in the west. Moreover, the written sources do not indicate any shortage of food over the years 1315–1322.

Interestingly, it appears that it was perhaps the same changes in the behavior of modes of climate variability, mostly in the winter NAO and AO, that brought adverse conditions to the west and favorable conditions to the northeast over the first half of the fourteenth century. This demonstrates how climatic teleconnections can materialize on a societal level in very different ways in different locations. Prior studies have suggested that this region experienced agricultural expansion and economic strengthening early in the century. Tree-ring material provides supplementary information on the climatic conditions of the period. The first half of the fourteenth century was marked by short, mild winters and warm summers with moderate rainfall – ideal conditions for crop cultivation in the region. Combined with the fairly resilient food systems of the region, this makes it likely that northeast Europe was able to escape, at least temporarily, the crises that western Europe was struggling with in the first half of the fourteenth century.