One of Europe's worst famines likely caused by devastating floods

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Researchers can combine tree ring dating with instrumental weather records to reconstruct past climate trends. Credit: “Rings of time” by giltay is licensed under CC BY-NC-SA 2.0

Europe's Great Famine of 1315–1317 is considered one of the worst population collapses in the continent's history. Historical records tell of unrelenting rain accompanied by mass crop failure, skyrocketing food prices, and even instances of cannibalism. These written records strongly suggest Europe's Great Famine was caused by several years of devastating floods that began in 1314, but they can't tell us how this flooding compares to historic averages, or its full geographical extent.

Now, new research using tree ring records confirms the historical data, showing the years of the Great Famine were some of Europe's wettest. A team of researchers from the Lamont-Doherty Earth Observatory and Columbia University quantified the extent of Great Famine flooding and found the years 1314, 1315, and 1316 were the fifth-wettest sequence of summers on record over a 700-year period.

The findings help scientists understand this historic event in the context of Europe's long-term climate trends for the first time, according to the researchers. The findings also help scientists better understand how an overabundance of rainfall has impacted agriculture in the past, when the other extreme—drought—often gets more attention.

"When we think about extreme hydroclimate events, we talk a lot about drought," said Jason Smerdon, a paleoclimatologist with Lamont-Doherty Earth Observatory and lead author of the study. "But this was a deluge. And both of those things are going to be more frequent as a consequence of climate change."

Gaining historical context

"The 14th century is one of the most dynamic centuries of the Middle Ages," said Seung Hun Baek, an earth and environmental sciences graduate student at Columbia University who presented the new findings this week at AGU's Fall Meeting 2019 in San Francisco. "This is when the [Black Death] happened, it's when the Hundred Years' War for the French throne was happening, it's also when the Irish independence movement was going on."

The Hundred Years' War, which began in 1337, and Black Death, which reached Europe in 1347, were as devastating as they were, in part, because they happened in the context of a Europe already weakened by years of hunger from the Great Famine. This was a "whopper of an event in a whopper of a century," Smerdon said.

In the new study, Smerdon and his fellow researchers quantified just how extreme the weather was during the Great Famine. With quantitative evidence, "you get a more objective and more nuanced way of describing something than you do with qualitative evidence alone." Seung said. "For instance, instead of saying 'really, really wet,' you can say exactly how wet."

The Old World Drought Atlas

To understand the extent of the deluge, the team turned to the Old World Drought Atlas (OWDA), a reconstruction of annual wetness and dryness across all of Europe that uses tree ring width as a proxy for soil moisture. Before the OWDA was published in 2015, there was no way to systematically quantify rainfall trends in Europe in a long-term, continuous way across space and time.

This resource pulls from 106 sites across Europe where multiple trees have been cored and dated. Tree rings are narrower in drier years, and wider in wetter years, and once all the trees are cross dated with one another, their widths can be compared to modern instrumental records. This is how scientists get an idea of the soil moisture level that corresponds to each width. Then, researchers can extrapolate as far back in time as the tree record goes.

Adding the tree-ring data to historical observations from the famine years tells scientists how long the rain lasted and the geographical extent of the crisis. Historical records from the time, for instance, describe unceasing rain and cold, a shortage of wine in France, and failed crops across Northern Europe. But such accounts are biased towards areas where more records have survived, and provide contradictory accounts of which year was wettest, for instance.

Trees prove to be more precise and diligent record-keepers, allowing Smerdon and his colleagues to determine the wettest year, and which regions in Europe were hit hardest or escaped almost entirely. "With the OWDA, we can show what the trees say about this event and you know, from the perspective of the trees, kind of settle those question," Smerdon said.

Reconstructing the weather with trees

Smerdon's team used the tree-ring record to determine that much of Northern Europe was experiencing annual rainfall far above average between 1314 and 1316. They were also able to determine that all three of these years taken together were the fifth-wettest sequence of years on record between 1290 and 2000, and 1315 specifically was the single wettest famine year on record in that timeframe.

By zooming in on this specific sequence of years in the past, they also noticed something that could inform future climate models. Today, Europe's dominant mode of climate variability is something called the North Atlantic Oscillation (NAO). Under the NAO, the climate varies on a north/south axis—if a year of extreme rain hits Norway, for instance, it would also likely affect Italy.

But during the Great Famine, the OWDA clearly shows that heavy rainfall affected Northern Europe only, leaving southern Spain and Italy completely dry. Today's climate models assume that the NAO will continue to be the dominant climate pattern, but if the dominant pattern has switched before, it could potentially switch again.

Of course, just like historical writing, trees can have their own blind spots and drawbacks—for instance, they only grow in summer months. Comparing the OWDA to an event with an extensive written record like the Great Famine helps validate it as a resource. Historical writing provides an "entirely independent model" that strengthens our confidence in the tree-ring-based reconstruction, Smerdon said.

Research like this can help us gain a higher-resolution understanding of long-term weather patterns and the role these patterns have played in major historical events.

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