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The Little Ice Age, NASA, Colonial Virginia, and the Conundrum of Anomalous Weather Conditions

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Abstract

The relevance of what has been termed as "The Little Ice Age" and its effect on the two earliest English settlements at both Jamestown and the "Lost" Colony of Roanoke in present-day coastal Virginia are still being widely discussed within the scientific community. Recent NASA surveillance findings concerning the events surrounding temperature anomalies at that time, how these affected the Earth's spheres, as well as their interactions, are still being widely debated and discussed, and new research seeking answers for several growing hypotheses are being actively pursued. This study explores a select group of these ongoing studies. It exposes the potential causes for various situations presented by the Little Ice Age, plus the results and implications these had on all spheres of the planet. It additionally focuses on the problematic preconceived notions that early European settlers had about the conditions awaiting them in a vast and relatively unknown New World, and touches upon the aftermath of making that dangerous miscalculation. It also posits any future implications these recent findings could have on the future of the planet. Finally, it is important to note that like most American and European research studies on this topic, the foci discussed here will not specifically address the localized indigenous populations already living near these two settlements, albeit these groups undoubtedly suffered in a similar manner to their European counterparts. Instead, it will briefly shed light on how Native populations were relevant to the demise of these two English settlements.

Keywords

Little Ice Age, Glacial Melt, Lost Colony, Roanoke, Reforestation, Deforestation, Volcanoes

1. Introduction

It was the Dutch-American geologist François Émile Matthes (1874-1948) who first coined the term "Little Ice Age" to designate an anomalous cooling period within the historical record that lasted from about 1300 to 1750 (Wilson & François, 1908). Calling this period an "Ice Age" is a misnomer, however, since it had no direct correlation to what is often referred to as the actual geological Ice Age that ended around 11,500 years ago. Although the exact dates of the significant lowering of global temperatures during this time are still debated, many scientists now believe that it happened sometime after what is known as the "Medieval Warm Period" and was potentially caused by several environmental factors (Huddart, 2010). Concerning European colonization of the New World, and more specifically the area of the United States along coastal Virginia, where settlers from England first arrived during the 16th and 17th centuries, the Little Ice Age caused insufferable conditions such as starvation, drought, extreme weather, longer winters, reduced crops, illness, and death. Both the colonies of Roanoke and Jamestown, Virginia's initial English settlements, strongly evidenced situations of extreme hardship due to anomalous weather conditions in contemporary journals, logs, and other period writings (Fagan, 2019).

2. NASA's Hypotheses about the Little Ice Age

Through work at NASA's Earth Observatory, scientists now know that the Little Ice Age had a more localized impact at various points throughout the planet, and the North Atlantic area of what is now the United States was one of those places heavily affected. While these findings appear to be supported by geological and environmental science, it should also be noted that the Little Ice Age was still considered a more widespread global catastrophe (Zhang et al., 2011). Field experts note separate intervals of dropping temperatures, each beginning during three specific years within the geological record, i.e., 1650, 1770, and 1850, respectively, and with some elevated temperatures occurring in between. Moreover, the locations where cooling temperatures occurred evidence climate shifts still independent from other areas of the globe. When compared to other climate-changing natural disasters causing cooling temperatures, however, the Little Ice Age still appears to be relatively modest (Hunt & Elliott, 2006).

Potential causes of the Little Ice Age have been noted from several key events, possibly working in conjunction with one another or coinciding. One notable explanation is that these anomalies were initially caused by an increase in volcanoes, hence reducing solar activity for the planet. In 1315, Mount Tarawera in what is now New Zealand erupted, but prior to that, another large volcano occurred in 1257, with three smaller ones following within the next 100 years. What proved unique about this succession of volcanoes is that these were known as "stratovolcanoes," a condition where magma leaves and forms various layers within different eruptions, causing unusually high levels of ash and toxic gases, hence contributing to longer-lingering and changing temperatures (Lorrey et al.,

2014).

Additionally, NASA surveillance systems have detected 16 major eruptions followed by cooling events from the beginning of the 1600s, which coincides with the Jamestown settlement period, causing sunspot activity due to orbital forcing and escaping greenhouse gases. Each time a volcano erupts, ash and magma form clouds within the Earth's atmosphere, blocking out solar radiation and thus causing cooling periods. Because cloud coverage varies depending on the location and size of the eruption, different places on the planet will experience various levels of cooling. Moreover, this cooling effect can have implications for the entire planet, since major cooling within an area of the hydrosphere can affect ocean currents and ultimately lead to increased sea levels and potential coastal flooding. In addition to detrimental effects on the hydrosphere and lithosphere, any volcanic eruption, especially those following in succession, will also influence atmospheric circulation, and cyclical lows within solar radiation will also cause changes within the ocean's circulation (Ellis et al., 2013).

2.1. Anomalous Winters and Hotter Summers

Concerning early European settlement in Roanoke and Jamestown, extremely harsh winters were recorded by the inhabitants, ultimately leading to food shortages. Mistakenly, early colonizers of the Americas wrongly predicted that the climate in certain latitudes of the New World would be similar to those of Europe. Instead, early settlers found much harsher living conditions once they arrived, with colder winters and hotter summers, and due to the corresponding time period with the Little Ice Age, this only worsened throughout the duration of the two settlements. The colonists' unpreparedness eventually led to impossible harvesting periods, war with indigenous populations who were also fighting to survive on the same scarce resources, and the ultimate collapse of both settlements. A recent archaeological excavation at the Jamestown site showed that English settlers had even resulted to cannibalism, coinciding with period documents and literature that had denoted the same. Additionally, worsening relations and fighting with local Native populations over food shortages had forced settlers to spend long periods within an enclosed fort, further preventing them from harvesting or hunting game, and exacerbating an already dismal situation (Wolfe, 2020).

2.2. Axial Tilt

NASA scientists have pointed out that during the time of the Jamestown settlement, changes to the planet's axial tilt and how it orbits around the Sun, i.e., orbital forcing, had occurred, further affecting the situation by causing shorter and much colder summer periods with more precipitation than average (Graeber & Wengrow, 2021). More recent studies have also proven that at the time period of the Jamestown settlement it was one of the coldest periods within a millennium. In the case of the older settlement at Roanoke, NASA researchers uncovered that drought was another major issue during the Little Ice Age. Surveillance systems

detected that in the latter settlement's case, the Roanoke colony had experienced the largest drought period within the last 800 years, with the colonists arriving at the very initial stages of a seven-year drought period. In both situations, however, the combination of unusually cold weather, plus war with neighboring indigenous peoples over already scarce resources, led to severe population decreases. Moreover, the conditions of the Little Ice Age caused parasites and mosquitoes to thrive and develop faster and heartier within the marshy geological conditions present at both settlements, further contributing to illness and death (Cronin et al., 2002).

2.3. Pack Ice Movement

Another theory NASA scientists have been investigating concerns pack ice moving in a southwardly direction within the North Atlantic, as did glaciers around Greenland. From radiocarbon dating samples of dead plant material collected from the bottoms of ice caps that died due to glaciation, scientists have discovered that colder summer temperatures and rapid ice growth occurred rather quickly between 1275-1300, followed by a massive increase in glacial activity from around 1430-1455 (Broecker, 2000). It was the first cold period that could have triggered and enhanced the large eruption of the Samalas volcano in 1257, which has also been linked as a contributing factor to the long volcanic winter period experienced by early settlers. Moreover, from 1560-1630 scientists additionally discovered that a worldwide glacial expansion had occurred, known as the "Grindelwald Fluctuation", which also corresponded with this same time period of early English colonization (Hunt & Elliott, 2006).

3. Hydrosphere

Concerning the hydrosphere, NASA scientists now know that anomalous temperature changes occurred preceding the Little Ice Age, causing the Baltic Sea to freeze over twice within the three centuries preceding the settlements and even led to an eventual rise in water levels within the Caspian Sea. With these temperature changes also came lengthier and harsher cold seasons, heavy levels of precipitation, and violent storms. Sea ice in locations like Iceland extended for several kilometers in all directions, closing harbors to shipping and leading to the further demise of the isolated colonies within the aftermath. Moreover, the entire area of Greenland became cut off from the outside world due to ice around coastal areas that lasted from 1410-1720 (Free & Robock, 1999).

The rapid cooling periods of this time also contributed to sometimes extreme and erratic weather conditions such as unseasonal snowstorms and droughts, even altering the European crop practices of the settlers and forcing them to adapt to a shortened and much less reliable growing season, leading to famine and death. These conditions further exacerbated the already poor living conditions for both humans and livestock. Furthermore, diseases brought on by these conditions, and causing an inability to labor in fields and tend crops, caused a deadly feedback loop for the settlers. Without possible contingency plans, like

trade with local Native populations, which decreased due to growing hostility, superstitions, and scapegoating of the dismal predicament concerning food scarcity and disease, the situation became further exacerbated.

4. Lithosphere

Within the lithosphere, the settlements' demise due to the Little Ice Age can also be traced by looking at both the area's residue samples and those far away. Studying charcoal fragments and pollen taken from the sediment at the Jamestown site, researchers have deduced the actual amounts of volcanic ash residue, plus the years this became heightened. Farther away in the hydrosphere of the North Atlantic, sediments examined there have been accumulating since the end of the last Ice Age around 11,500 years ago, and these show regular increases within levels of coarse sediment grains deposited from melting icebergs within the Atlantic (Pitman et al., 2009). These studies and comparisons are relevant because they indicate cooling events and periods throughout time. From this valuable data, researchers have now deduced that the planet's most recent cooling event was the Little Ice Age.

Area tree-ring data studies support the finding that cold episodes occurred from 1520 to 1670, coinciding with the two settlements. From also studying the rate of stalagmite growth in the area, scientists have additionally validated that a cold period occurred from 1500 to 1800 (Lockwood et al., 2017). Stalagmite record temperature reconstructions even indicate that the Virginia colonists were in the coldest region of the mid-Atlantic at that time, and data also shows an impact to the hydrologic cycle. In fact, historical mappings by the settlers supports the new findings that significant reductions to area waterways were present when comparing them to maps of more recent time periods (Kreutz et al., 1997).

5. Biosphere

Conditions concerning the biosphere may have further affected the settlements at Roanoke and Jamestown. One hypothesis claims that depopulation heavily influenced the cooling temperatures. European contact with Native Americans, leading to death for up to 90% of the indigenous population at the time of European contact could be to blame, as well as the Plague in Europe, which killed 30% to 60% of the population there. Some scientists believe both could have contributed to the Little Ice Age. Significant population decreases before the settlements were established would have caused a general lack of agricultural activity and reforestation. This would have also caused significant decreases in human-set forest fires, reducing the biomasses within wooded areas, and also contributing to additional carbon dioxide uptake from the Earth's atmosphere and eventually leading to anomalous weather and further cooling temperatures. More recent studies of soil and sediment cores have also supported that carbon dioxide uptake via reforestation might have actually contributed to the cooling

temperatures experienced by the early settlers (Alchon, 2003).

Concerning forestation, a different hypothesis suggests that during population recovery times after the European plagues, that shorter periods of increased deforestation occurred affecting the Earth's reflective surface. Since the planet's "albedo", or reflective abilities, affects temperature increases and decreases, this is not implausible. Any changes to the Earth's surface such as deforestation, reforestation, or agricultural clearing can all cause situations of lesser or greater surface snow coverage, affecting the planet's reflective abilities and thus the temperatures on the planet (Dull et al., 2010).

6. Conclusion

Evaluating all the evidence, scientists know that another Little Ice Age could happen for several reasons. Orbital forcing from the cycling that occurs due to the planet's orbit has definitely caused northern hemispheric cooling incidences (Turner & Fischer-Kowalski, 2010). That could continue into the future and eventually lead to a similar situation, or worse, another Ice Age. However, due to existent climate changes from greenhouse gas emissions, many scientists are seeing a reversal of that possibility. Also, researchers have evidenced a change in the planet's thermohaline circulation due to large amounts of fresh water coming into the North Atlantic caused by periods of warming. Furthermore, any shutdown or slowdown of the thermohaline circulation can easily result in warming periods continuing for longer durations (Broecker, 2000).

In conclusion, data, analysis, and research have all suggested that during the time of the first English settlements at Roanoke and Jamestown that temperatures within the Mid-Atlantic region were the coldest on record within a 1000-year period. Multiple obstacles, both human-induced and natural, were to blame, ultimately contributing to the downfall of both colonies. From analyzing what went wrong for the early settlers of the New World, scientists at NASA are still garnering valuable information to circumvent any future devastating situations from happening again. Based on all the causes, locational data, and evidence that have been evaluated, some questions still remain open and exhibit further study.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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