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The Little Ice Age and the Fall of the Ming Dynasty: A Review

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Abstract: Based on the climate proxy data, several recent studies have concluded that the Ming dynasty's reign in China coincided with the Little Ice Age, a global crisis. In response, scholars have published several reports in recent years addressing this topic. This paper presents a comprehensive overview of the current research findings in English regarding this subject and identifies existing research gaps. The author proposes that the impact of climate on different regions during the late Ming period remains largely underexplored. Furthermore, scholars must exercise caution when assuming that adverse climatic conditions uniformly impacted the Ming empire during the Little Ice Age. This paper also highlights the use of simplistic models by scholars linking cold and dry climates to crop failure, floods, droughts, population decline, and other factors. However, any straightforward models that presume causal determination risk ignoring historical facts.

Keywords: climate change; historical climatology; Ming dynasty; the little ice age; the Manchu conquest of China

1. Introduction

Ever since François Matthes coined the term "Little Ice Age" in 1939, scholars have used it to refer to its role in notable events in history [1,2]. The Little Ice Age (hereafter LIA) refers to the period from the 17th to the mid-19th century, when the earth's temperature experienced a substantial decline. However, unlike the current global warming trend, the LIA was not uniformly distributed across the globe. Raphael Neukom et al. discovered no indication of preindustrial universally consistent cold and warm periods over the last 2000 years [3]. As a result, the LIA is likely to have had varied impacts in different regions across the globe.

In the last two decades, scholars have re-examined the impact of the LIA on different regions in the 17th century [4–10]. From the perspective of world history, Geoffrey Parker's book in 2013 and Philipp Blom's book in 2019 offer a comprehensive picture portraying the global crisis that occurred because of climate change in the 17th century [11,12]. Several empires worldwide faced different forms of calamities and major crises in the 17th century. The Ming empire—which was no exception—could not cope with the crises, and was ultimately conquered by the Manchu military.

The Ming–Qing transition was a notable event in Chinese history. The late period of the Ming dynasty witnessed innumerable natural and human-made disasters. Studies have verified that the LIA, with temperature cooling, spanned from the 17th century to the 19th century globally [13–15]. The collapse of the Ming dynasty (or the Manchu conquest of China) occurred during the LIA. In the last decade, climatologists, meteorologists, and geographers, among others, have expressed keen interest in this topic and reported the findings of their investigations.

This paper reviews the recent studies published in English concerning the LIA and the fall of the Ming dynasty.

Citation: Fan, K.-w. The Little Ice Age and the Fall of the Ming Dynasty: A Review. *Climate* **2023**, *11*, 71. https://doi.org/10.3390/cli11030071

Academic Editor: Rajmund Przybylak

Received: 28 January 2023
Revised: 9 March 2023
Accepted: 13 March 2023
Published: 17 March 2023

2. The Little Ice Age in the 17th Century

According to studies involving high-resolution temperature reconstructions of the Northern Hemisphere, the LIA occurred during the late 16th century to the end of the 17th century [16–18]. This period was also the coldest century during the past 1000 or even 2000 years. The cause of the LIA is a contentious topic among scholars. Recent studies have suggested that the LIA could be largely ascribed to three factors, namely, solar activity, volcanic activity, and internal oscillations [19–22].

The Ming dynasty ruled China for 276 years (1368–1644), and its rule ended when the Manchu military conquered Beijing (the capital of the Ming dynasty) in 1644. Following the crisis of the Tumu Fortress in 1449, the Ming empire abandoned its military expansion to the north, leaving the northeastern border vulnerable to harassment from the emerging Jurchens (Manchus). Although the Ming government was unable to exert control over the northwestern and western territories, including present-day Xinjiang and Tibet, the coastal regions comprising present-day Shandong, Jiangsu, Zhejiang, Fujian, and Guangdong provinces thrived as prosperous regions.

Chinese scholars have used Chinese historical records to trace changes in climate across historical periods in China. A pioneering article written by Zhu Kezhen identified that 1300 to 1900 was the fourth coldest period in Chinese history [14]. Man Zhimin and Ge Quansheng published their books separately, both of which point out that the late 16th century was certainly the coldest period [23,24]. In light of the above, it is worth investigating what caused China to experience this cold period. The studies by these Chinese scholars do not offer the answer to this question. Dagomar Degroot comprehensively reviewed the LIA and society from the 15th to 18th centuries around the world [25]. Unfortunately, at the time of writing, he was not familiar with Chinese history and was unable to offer a critical review of existing research.

In 2021, Jingyao Zhao et al., based on speleothem oxygen isotope records, proposed a new concept—"the late Ming weak monsoon periods." Zhao noted that weak monsoons caused China to experience severe cold conditions and extremely weak summer monsoons during the late 16th and the early 17th century. The severest drought event was time-transgressive on a decadal scale from northern China to the Jiang-Huai region. Under such influence, a series of consequences included widespread population decline, peasant uprisings, and Manchu conquest [26].

Kefan Chan et al. applied a climatological concept of "megadrought"—a prolonged drought lasting two decades or longer—to describe the late Ming dynasty's situation. According to paleoclimatic reconstructions, a natural drought event started in 1637. Unfortunately, the tropical volcanic eruption at Mount Parker in 1641 intensified the drought. Finally, the severest drought event in China in the last millennium occurred during the late Ming period. Needless to say, the severest drought could have directly contributed to the fall of the Ming dynasty [27]. Both scientists and historians speculate that volcanic eruption and volcanic dust could have had a negative impact on weather and climate. Finally, the earth decreased its absorption of radiation and the cold period occurred. Based on Hubert Lamb's findings, William Atwell claimed that the activities of two volcanoes, Indonesia's Mt. Awu and the Philippines' Mt. Parker, had a significant impact on global climate and contributed to cool summers. Drought, famine, and plague were also prevalent under such extreme weather conditions, especially in northern China [28]. Recently, Richard Von Glahn, in his volume about comprehensive economic history, re-examined the various explanations of the economic crisis of the late Ming period. Von Glahn emphasized that Atwell's argument is still persuasive [29]. Chaochao Gao et al. also believed that the collapse of the Ming dynasty in 1644 followed a major volcanic event in 1641. However, Gao et al. also suggested that some dynasties were more vulnerable to climatic shocks than others. The Ming dynasty was particularly vulnerable during the 17th century [30].

Shen Caiming reported that the severest drought center in the Eastern region of China encountered a significant reduction in summer rainfall (approximately 50% or more) from 1638 to 1641. The drought event occurred in northern China, the Yangtze River, and the northern part of the southeastern coastal area. Shen affirmed that these exceptional drought events might have been triggered by large volcanic eruptions and El Niño events [31].

The findings of the above-mentioned studies confirm that the Ming dynasty was unfortunate to experience the most extreme weather in Chinese history during the 17th century, including the LIA, weak monsoons, volcanic activity, and El Niño, which occurred in the same period. As stated earlier, drought, famine, and epidemics also accompanied these calamities.

3. What Were the Consequences of Climate Change?

Scholars have also investigated the relationship between climate change and crisis in China during the 17th century. Jingyun Zheng et al. studied the relationship between climate change and social vulnerability. They identified three ways in which cooling, aridification, and desertification during the cold period contributed to the collapse of the Ming dynasty. First, the military farm system was destroyed; military expenditure was increased, and the national fiscal crisis was exacerbated. Second, a widespread food shortage occurred. Third, severe droughts from 1627 to 1643 triggered a peasant uprising [32].

Han Jianfu and Yang Yuda also analyzed the relationship between climate change and social vulnerability in the late 15th century in Northern China, based on reconstructed data regarding temperature, precipitation, and extreme drought events. They specifically examined the socio-economic effects of extreme drought events, which led to a sharp reduction in the military farm system and a large-scale population migration in Northern China. They reported that the local financial system was destroyed [33].

Zhudeng Wei et al. asserted that population growth and economic development have been somewhat overwhelmed since the late Ming rule. Economic fluctuations arose from the bad climate. At the same time, three instances of large-scale military actions were reported in the northwest and southwest of China and Korea during the reign of Emperor Wanli (1573–1620), which resulted in heavy taxation on farmers. Climate change impacted the key processes (military farm production, food and fiscal crises, and peasant uprising) involved in the collapse of the Ming dynasty [34]. In addition to the above-mentioned consequences, epidemic was another major negative impact ascribable to climate change. Anthony McMichael offered a global perspective linking the LIA to various diseases. McMichael specifically mentions the occurrence of smallpox and epidemics during the late Ming period [35]. Helen Dunstan conducted a comprehensive data collection regarding epidemics during the late Ming dynasty [36]. Pei Qing verified the "climate change/economy/epidemics" mechanism in historical China using statistical methods. This study adopts David Zhang's research approach and hypothesis to furnish the evidence that climate change could only fundamentally lead to epidemics' spread and occurrence; depressed economic well-being was the direct trigger of epidemics' spread and occurrence at both the national and long-term scales in historical China [37–39].

Angela Schottenhammer's research is centered on the period between 1550 and 1640, which coincides with a high number of La Niña occurrences. Studies have suggested that La Niña could have contributed to the rise in typhoons hitting South China during this era, leading to adverse consequences, such as extensive rainfall, floods, inundations, tidal disasters, and typhoons in Guangdong, Fujian, and Zhejiang provinces, resulting in the outbreak of epidemics [40]. These findings indicate that coastal regions did not necessarily experience droughts, famines, and plagues.

Qian Liu et al., through quantitative analyses of natural disasters and human wars of the final 35 years of the late Ming dynasty (1610–1644), identified six factors that led to the collapse of the Ming dynasty, namely, internal rebellions, external wars, inter-ethnic conflicts, drought, locusts, and floods. The former three were human factors, accounting for approximately 47% of the fall of the Ming dynasty, whereas the latter three were natural factors, accounting for approximately 53% [41].

In brief, drought, famine, locusts, and epidemics were accompanied by bad weather during the LIA in the 17th century. Two factors caused the fall of the Ming dynasty: peasant uprisings (1627–1658) and the Manchu conquest in 1644. However, the cold period in the 17th century lasted for over 200 years. The Ming empire fell into the abyss politically, fiscally, and economically. Tim Brook noted that China entered a cold period, and great famine occurred in the last 50 years of the Ming dynasty [42,43]. Although the weather on its own does not explain the fall of the Ming dynasty, its history cannot be fully understood without accounting for the pressure of weather on society and the state [44,45].

4. Discussion

Christian Pfister proposed three goals for historical climatology. The first is to reconstruct weather and climate prior to the modern instrumental period. The second is to investigate the vulnerability of past economies and societies to climatic extremes and natural disasters. The third goal is to explore discourses on climate [46]. The second goal focuses on human responses to climate and the terrestrial environment. Scholars have averred that institutional failure, administrative dysfunction, loss of economic vitality, peasant uprising, and the Manchu invasion were critical factors that contributed to the fall of the Ming dynasty [47,48]. Obviously, the Ming empire lost its own authority, power, and resources in response to the results of climate change.

Lingbo Xiao et al. thought that the climatic impacts on the late Ming empire were much more serious, including more rapid cooling and more extreme disasters. The Ming empire did not practice a policy of inter-regional migration to appease social unrest [49]. The author proposes the following for consideration. (1) Climate crisis in the 17th century had the same negative impact on the Manchu empire, which was located in Manchuria (modern-day northeast region of China and Outer Manchuria), including cooling temperature, precipitation, and drought. How did the Manchu empire overcome the crisis and offer a new force to conquer China? (2) The Qing dynasty established a new dynasty after the fall of the Ming dynasty. The population size decreased sharply during the Ming–Qing transition, and the decline in temperature continued. However, the Qing dynasty stepped into a prosperous age. How did the Qing dynasty deal with the climate crisis? (3) After the Manchu conquest of China, the military, people, and officials resisted the Manchu army. The wars between the Ming forces and the Manchu army had no relationship with climate change. The Ming forces persevered as dynasties shifted, and they could not but resist. When considering the relationship between external wars and climate change, one should carefully evaluate the direct causation between wars and climate change. Moreover, Zhixin Hao et al., based on reliable rainfall and snowfall records (Yu-Xue-Fen-Cun) in the Qing dynasty, reconstructed high-resolution climate data in different regions of China [50]. Hao's article offers precise data as a solid foundation for exploring climate change and the Qing empire.

Jianxin Cui et al. have offered their opinions on this topic. The Ming and the Manchu suffered from the most severe drought and winter cold of the past 500 years during the late Ming period. During this period, the Qing military occupied the Liaodong Peninsula and extended its force. Finally, the Manchu conquered the Ming capital Beijing and the Ming dynasty perished [44]. However, Cui's paper does not provide concrete evidence or historical facts regarding how the Manchu overcame the climate crisis and gained strength.

In addition, how did the leaders of internal rebellions (such as the two most critical leaders of the rebellions, Zhang Xianzhong and Li Zicheng) overcome famine and drought and organize their forces to defeat the Ming military? Scholars rarely mention Manchu governance and the leaders of internal rebellions. More emphasis should be placed on the spatiotemporal relationship between natural disasters and rebellions regarding the historical fact that the leaders of the rebellions were not peasants, but soldiers.

A research gap exists in the current literature that fails to relate scientific evidence with historical data. The above-mentioned publications fail to acknowledge the complexity of history. The chain of cause and effect whereby a colder climate precipitated crop failures, and then rebellions and invasion, is far more complicated. For example, no uprising occurred in some places, such as today's Jiangsu and Zhejiang provinces, which suffered severe famines. First, the Chinese economy's engine was in the south during the Ming dynasty. Understandably, the southern region could better cope with a spate of cooler weather [45]. Second, as Fiona Williamson noted, more and more scholars are interested in investigating interactions between climate change and culture [51]. Economist James Kung explored the history of the Qing dynasty and noted that while crop failure triggered peasant rebellion, its effect was substantially smaller in counties characterized by stronger Confucian norms [52]. Not all places experienced the same negative consequences of social unrest. However, the impact of the LIA was largely similar throughout the Ming empire in the 17th century. Research suggests that culture may have helped reduce the negative impacts of climate change. The educational level of a region may have played a role in alleviating the adverse effects of climate change. Jiangsu and Zhejiang provinces had the highest educational level in the Ming dynasty.

Natural disasters are an essential factor when explaining rebellions, but they are never the only explanation. Publications about this topic always provide examples, but they do not provide a comprehensive analysis. The duration or scale of natural disasters should be fully considered. Therefore, further research should doubtlessly pursue more in-depth and comprehensive analysis of the impact of climate change on the fall of the Ming dynasty.

Historians of Chinese history are more concerned that, first, social vulnerability in the Ming dynasty was a long-standing problem from an earlier period, and second, that the fall of the Ming dynasty be placed in the context of a global perspective. William Atwell and Frederic Wakeman believed that the Ming dynasty's monetary system was damaged by the severe consequences of the global depression from 1620 to 1640 [47,48]. Finally, the global depression triggered its entire political and social crisis. In addition, the Ming systems, including military, financial, and political systems, were destroyed [42,43]. The Ming political and economic systems lost their ability to respond to the crisis, including famine, drought, locusts, high food prices, the Manchu invasion, and rebellions. The loss of the Ming government's crisis-handling ability could be traced from Emperor Wanli's reign (1572–1620). As suggested by Xiao Lingbo, when confronted with the same crisis, the Qing government did not practice a policy of inter-regional migration to appease social unrest [49]. It is estimated that over 26% of the population was lost during the Ming–Qing transition period owing to the rebellions and the Manchu invasion [53,54]. The relationships between population size and social vulnerability have not been fully investigated heretofore.

5. Conclusions

The author has previously examined dynastic cycle and climate change in Chinese history [45,55]. The author believes that from the perspective of historical research, scholars should refrain from choosing cases that could be suitable for their predetermined stance. For example, prior to 2012, several scholars proposed that the desiccation of the steppes was responsible for the rise of the Mongols. However, new tree ring evidence, which appeared in 2012, is widely accepted by both historians and scientists to indicate that a warm and moist climate offered an ideal environment, in which Genghis Khan and his successors' invasion of the west conquered Eurasia during the 13th and 14th centuries [56,57]. It is uncontroversial that the late Ming period coincided with the LIA, as per the new findings of climate proxy data. It is time to intensify research on this topic. In the author's opinion, many historians' studies are excluded in the above-mentioned scientific papers. Many scholars rely on simplistic models, such as those that directly relate cold and dry climates to crop failure, flood, drought, population decay, and so on. Furthermore, Neukom, Tian, and Brook's findings inspire caution against assuming that the entire Ming empire was uniformly impacted by adverse climate conditions during the LIA [3,58,59]. How different provinces/regions during the late Ming period coped with the climate impact has not been adequately researched. There were economic, social, and cultural differences in different provinces/regions. A comparative analysis may reflect the complexity of the climatic effects in different provinces/regions. To better understand the nuances of climate patterns across different provinces/regions of the Ming empire, more comprehensive scientific research is required. Attempting to establish direct causation between historical events and scientific evidence may simplify the complex connections at play.

Please see An Online Map of the Ming Empire: https://depts.washington.edu/chinaciv/1xarming.htm (accessed on 10 March 2023).

Funding: This work was supported by the Research Grants Council, University Grants Committee [Project no. 9043270, CityU11609921].

Institutional Review Board Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The author declares no conflict of interest.

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