The Role of Climate Change and Natural Disasters in Shaping Cultural Diversity in Chinese Society

Zhongqi Yu[1,2], Haiyang XI[3], Xinhao SUO[4], Shixiong CAO[5]*

1 School of Marxism, Tsinghua University, No. 30, Shuangqing Road, Haidian District, Beijing, 100084, P.R. China; 2 Military Education Office of the CPC Tsinghua University Committee, Tsinghua University, No. 30, Shuangqing Road, Haidian District, Beijing, 100084, China; 3 Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, No. 320, Donggang West Road, Lanzhou, Gansu, 730000, P.R. China; 4 College of Urban and Environmental Sciences, Peking University, No. 5, Yiheyuan, Haidian District, Beijing, 100871, P.R. China; 5 School of Economics, Minzu University of China, No. 27, Zhongguancun South Street, Haidian District, Beijing, 100081, PR China. *** Corresponding author**

Abstract: Cultural diversity is part of the foundation that has supported long periods of harmony during the long history of Chinese civilization, and has also improved resilience against natural disasters and climate change. However, there has been surprisingly little research on how China has achieved this cultural diversity. To provide some new insights, this Perspective discusses how the driving forces of climate change and natural disasters forced ancient Chinese people to cooperate when it was necessary to respond to natural disasters and common enemies, thus forming a society based on respect for the customs of other cultures. The resulting cultural diversity has not only been a response to climate change but has also been an effective means of addressing it, and this provides important insights into today's rapidly changing contemporary society and the problems it faces as a result of climate change. More and more evidence suggests that climate change is increasing the likelihood of extreme events (e.g., disasters such as flooding), making it necessary to unite the world to address these challenges. Building a harmonious, culturally diverse world that will be resilient against climate change relies on the Chinese concept of "harmony through diversity", which has proven to be an effective means to cope with crises.

Key words: Climate change, natural disasters, Great Harmony, cultural diversity, resource allocation

Introduction

Chinese history can be said to begin with the Liangzhu culture in 3300 BCE. From this starting point, Chinese culture has a history of at least 5300 years (Azzam and Kong 2021). In previous work, our research group proposed that Chinese culture has survived in a clearly recognizable form for so long due to its diversity and inclusiveness (Cao 2016). A social system based on cultural diversity has access to a wider range of possible responses to external disturbances, and accounting for diverse perspectives strengthens the social bonds and lets a society learn from each culture's responses to these challenges (Huisman 2007). Social systems resemble ecosystems in an important way: diverse societies and ecosystems can both respond more flexibly to and are more resilient against severe disturbance. By increasing opportunities for members of a society to choose from a range of solutions, institutional diversity enhances their enthusiasm for participating in socioeconomic activities and promotes social unity, stability, and prosperity through mutual respect and learning between different cultures (Huisman 2007). Although scholars acknowledge the importance of cultural diversity (Huisman 2007, Cao 2016), our literature review found no studies that attempted to account for the importance of the diversity and inclusivity of Chinese culture in the modern context of natural disasters and global climate change, both of which affect increasingly large populations due to increasing urbanization (migration of rural workers into large cities). Understanding how Chinese cultural diversity and inclusivity have developed provides an important reference value for the healthy development of future society, both in China and elsewhere.

From the perspective of social evolution, history reflects a long process of resolving resource allocation constraints that arise from the relationships between the natural environment, the need to manage production of essential resources such as food, and the need to resolve conflicts between nations and social systems (Butzer 2000, Odum and Odum 2001, Feng et al. 2019). Nature has also nurtured humanity and is also shaping the development of civilization (Salvadó 2017). However, as in the cases of natural disasters and human-driven disasters such as climate change, the driving forces are not always benign. Given the complexity of these factors and their relationships, exploring the relationship between climate change and social evolution is a challenge (Hsiang et al. 2011, Hsiang and Meng 2014). Scholars have been trying to confirm a causal relationship between climate change and large-scale social unrest (Diamond 2005, Burke et al. 2009, Büntgen et al. 2011). Many studies have confirmed that climate and climate change have been key factors in social crises (Butzer and

Endfield 2012, Rosen and Rivera Collazo 2012), such as dynastic change in China (Zhang et al. 2007), the collapse of ancient Egypt, and the collapse of the Roman Empire (Odum and Odum 2001). However, despite increasing numbers of research reports on climate change and its impact on society (Lee and Zhang 2010, Piao et al. 2010), our literature review found no scholars who have paid attention to the impact of historical climate change on the formation or preservation of cultural diversity or on how societies respond to such crises.

Understanding the impact of past climate change on cultural evolution, as well as the role of cultural diversity in responses to climate change and natural disasters, is of great significance. In today's context of climate change, research in this field is clearly urgent. In this paper, we examine Chinese historical records, archaeological data, and climate change data to provide insights into how climate change has influenced the evolution of Chinese culture, and the potential significance of cultural diversity in society's response to climate change.

Cultural evolution in ancient China

Archaeology suggests that prehistoric Chinese culture underwent two stages of development. In the first stage (3300 to 1900 BCE), the archaeological remains found in China were from independent isolated city-states. For example, these states include the Liangzhu (3300 to 2300 BCE, 119°56′E, 30°22′N), the Shijiahe (3000 to 1900 BCE, 113°03′E, 30°46′N), the Taosi (2300 to 1900 BCE, 111°06′E, 35°40′N), the Shimao (2200 to 1900 BCE, 110°18′E, 38°33′N), and more than 1000 km away, the Longshan (2500 to 2000 BCE, 36°40′N, longitude 116°50′E). The cultural relics from this period were far apart, independent, and unrelated to each other (EGXSZ 2001, white dots in Fig. 1).

In the second stage (1800 to 1500 BCE), archaeologists found relics of the next dominant culture, the Erlitou in north-central China (112°26'E, 34°27'N, green circle in Fig. 1). In contrast with the first stage, the Erlitou created a vast federal political entity that constructed multiple castles and controlled all of present-day Henan Province, southern Shanxi Province, and eastern Shaanxi Province, spanning the area between 107°40'E to 116°39'E and between 31°23'N and 36°57'N (EGXS 2001). At the same time, cultural relics from the various cultures that existed during the first stage have been unearthed in Erlitou, indicating that Erlitou is a product of the fusion of different cultures late in the first stage. That is, the Erlitou culture exhibits obvious diversity, and this feature has been inherited by subsequent Chinese cultures (Cao 2021).

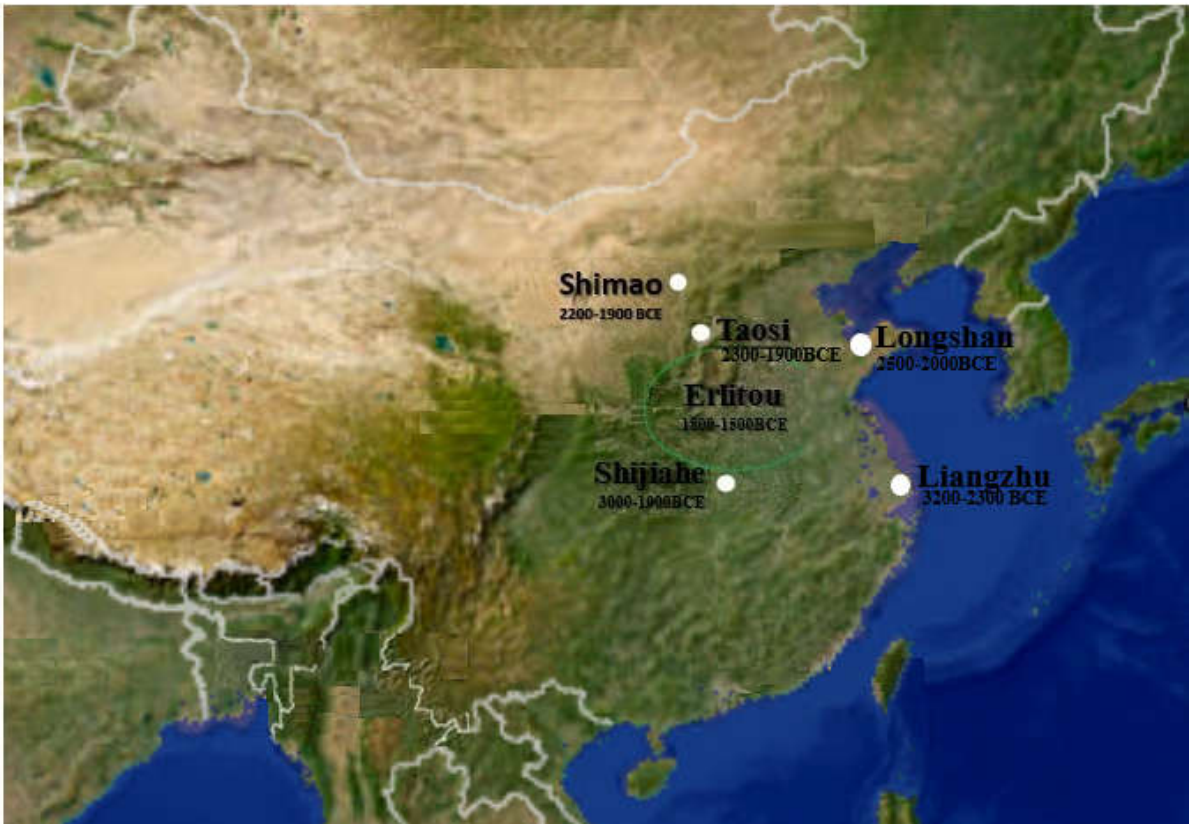

Figure 1. Archaeological findings and the geographical distribution of major cultural relics in early China (https://map.bmcx.com/jilinsheng__map).

Natural disasters and climate change in ancient China

Archaeological data confirm that around 2000 BCE (Yu 1997, Wang et al. 2016), seawater submerged most of the low-lying areas in eastern China, including the Liangzhu region, making these areas no longer suitable for agricultural cultivation. China's relatively advanced Liangzhu culture suddenly disappeared (Yu 1997). Evidence suggests that this flooding was caused by a large suboceanic earthquake that caused a tsunami (Yu 1997, Wang et al. 2016, Pei and Zhang 2014). Much of the land in eastern and southeastern China became severely salinized, and could not be cultivated for decades or even centuries until the salt was washed from the soil (Yu 1997, Wang et al. 2016). As a result of this disaster, residents of formerly independent city states across coastal areas of China were forced to leave their original homes and migrate to other areas. Since China was densely populated at this time (EGXSZ 2001, Cao et al. 2007), this inevitably brought the displaced peoples into contact with other cultures that still had arable land. Archeological evidence, such as a lack of mass graves or large deposits of weapons, suggests that rather than causing extensive warfare, the cultures mingled over a period of 100

to 200 years, and together, they evolved into the diverse Erlitou culture (EGXSZ 2001, Cao 2021).

Of course, it is also possible that two or more groups of ecological refugees formed a military alliance and jointly defeated a stronger opponent who controlled land they needed to survive and subsequently established a federal state, which has happened many times in Chinese history (Cao et al. 2019). This possibility is supported by legends from Chinese prehistoric culture and archeological evidence. For example, Chiyou, a legendary hero from the ancient Longshan culture, located in present-day Shandong Province, launched a war against the Huangdi (who ruled the ancient Shimao culture) and was defeated when Huangdi united several tribes in the Central Plains region in present-day Henan Province (Cao 2016). After the conflict was over, the tribes remained united in a diverse federation that evolved into the Xia dynasty (Cao 2016, 2021).

Figure 2 A map of the areas that were inundated by the tsunamis that caused a sea-level rise of 4 m somewhere between 2 and 57 CE and again between 465 and 527 CE in China (https://flood.firetree.net).

After 2000 years, the same natural disaster occurred again twice. The sea level rose some

time between 2 to 57 CE and again between 465 to 527 CE, and in both cases, submerged the eastern coast of China. As a result of these disasters, there were almost no subsequent traces of human activity in the areas below 4 m above sea level along China's eastern coast between 2 and 600 CE (Yu 1995, Wang et al. 2016; Fig. 2). These tsunamis may have contributed to the collapse of large and sophisticated cultures. The first tsunami overwhelmed the Western Han Dynasty (202 BCE to 8 CE) and forced ecological refugees to move westward, away from the coast, in search of arable land (Yu 1997). The second tsunami may have made the situation worse (Yu 1995). The nearly 600 years of continuous war during these dynastic struggles reduced China's population by 81.5%, from an initial 65 million to 12 million (Liao 2004, Morabia 2009). During this period, Buddhism was introduced to China and became the national religion of the subsequent unified Tang Dynasty (618 to 907 CE), coexisting alongside the former Taoist religion and significantly increasing cultural diversity and inclusivity in China (Cao 2016). Unlike the situation in Europe around the same time, coexistence of the two religions was mostly peaceful (Cao 2016).

Discussion

The vast, high-elevation Qinghai–Tibet Plateau and the Himalaya Mountains in western China create a barrier that blocks population migration, whereas in the south and east, the sea blocks migration southward and eastward, leaving only northern migration as a potential response to coastal flooding in ancient China. After Chinese society entered the era of agricultural settlements, the fertile land of the areas affected by flooding and sediment deposition by the Yangtze and Yellow rivers nourished the development of rice farming and of the Liangzhu civilization, Shijiahe civilization, Longshan civilization, and subsequent civilizations. However, tsunamis and climate change destroyed the societies of these low-elevation areas (Yu 1995, Wang et al. 2016). When crop growth decreased due to cold phases (Feng et al. 2019), the prosperous societies in this rich land may have had insufficient food to feed their large populations, and may therefore have become threats to societies in the north (such as the Shimao civilization and the Taosi civilization), where conditions were less favorable for agriculture but large crops were still possible and where pastoral societies flourished in the extensive grasslands.

After such disasters, the southern and eastern societies no longer had an overwhelming advantage over the northern societies when they were forced to migrate northward. Therefore, the people who migrated to China's Central Plains (present-day Henan Province) were either

forced into military conflict (e.g., the Chiyou example described earlier) or had to find ways to compromise and jointly deal with the disaster (e.g., the Huangdi example described earlier). The need to compromise was strengthened by the fact that the northern societies were less advanced and powerful than the more prosperous southern societies, although the gap between these societies had narrowed as a result of famine in the south. As a result, rather than engaging in wars with the ecological refugees that they were likely to lose, they looked for ways to merge with their competitors. For example, the Erlitou culture (1800 to 1500 BCE) in north-central China formed a vast federal political entity whose cultural relics show a mixture of several cultures. The pattern of cultural diversity ultimately created a form of national federalism that preserved cultural diversity because the Erlitou federalism accepted agricultural production techniques, customs, and other practices brought by different cultures from the south and north.

Compared with the colder and arid regions in the north, which had a lower human carrying capacity, the prosperous agricultural civilizations in the lower reaches of the Yangtze and Yellow rivers allowed the development of a large population. Even when nomadic ethnic groups from northern China or Mongolia conquered the southern societies, they chose to retain key aspects of Chinese culture, such as the language, and to learn from the more advanced Chinese culture in the south. This promoted the stability of the new regime because the new rulers retained the Chinese culture alongside their own culture. For example, they adopted the Chinese language and customs, and encouraged their people to learn Chinese while retaining their own language and customs. This reduced the resistance of the Chinese people to their rule. This phenomenon, which occurred multiple times, is an important reason for the formation of cultural diversity in China. For example, after the Mongols conquered the Southern Song Dynasty and established the Yuan Dynasty (1279 to 1368 CE), the new rulers claimed to be descendants of the Huangdi but retained their own culture within the Chinese culture (Cao 2016, Liu 2019). Similarly, about 400 years ago, a Manchu population of only 6 million successfully defeated the Ming Empire with a population of 200 million and established the Qing Dynasty (1616 to 1911 CE). To weaken the resistance of the Han people to this invasion, the first thing the Manchu emperor did after entering China was to go to the tomb of the legendary Han ancestor, the Huangdi, to offer sacrifices and claim that he, like the Han people, was a direct descendant of the Huangdi.

From a larger temporal and spatial perspective, global climate change resembles yet another cyclical fluctuation between alternating cold and warm periods, such as the changes

that occur during the start and end of ice ages (Overpeck and Webb 2000). This does not mean that modern climate change is benign; climate change is occurring today at a far faster rate than has ever been observed in human history, and it's unclear whether ecosystems and human society can adapt to these rapid changes. It's also worth noting that the equally drastic climate change that occurred during ice ages had catastrophic consequences for life on Earth (Walther et al. 2002, Oram et al. 2017). The delay between the collapse of one civilization and the rise of the new civilization that replaced it creates a time lag that makes it even more complex to establish ties between climate change and the rise of a new stable society. The historical experience of China indicates that this process may take years, decades, or even longer. In future research it will be important to analyze the time lag that can be expected between a natural disaster or climate change and the resulting changes in society. It will also be important to determine whether this time lag was shortened by cultural diversity that made it possible to adapt faster to the severe environmental pressures being created by disasters and climate change.

Historians have focused on the consequences of major non-climate factors, such as pandemics and corrupt governments that were overthrown by peasant rebellions, for the evolution of civilizations. Some believe that this association may be a coincidence rather than a causal relationship (Overpeck and Webb 2000, Feng et al. 2019). However, the long history we have described in this paper has demonstrated the importance of cultural diversity as a response to climate change and natural disasters. Huisman (2007) demonstrated the importance of cultural diversity for maintaining social stability and rebuilding a society after natural disasters. Although the short-term power of political elites seems to be an effective means of dealing with crises (i.e., because a dictatorship or oligopoly eliminates the need for consultation with the governed people and thereby permits faster action), this limited benefit faces significant challenges (Butzer 2012, Butzer and Endfield 2012). For example, political elites can continue to make mistakes for decades or even centuries until they are overthrown. It is the responsibility of scholars to explain the historical interactions between society and the environment, recognize the broad dynamic principles that run through all human and environmental systems, and propose necessary preventive measures that governments and stakeholders must take to prevent similar crises from happening again. We believe that cultural diversity is not only a result of climate change but also an effective means of addressing it, which is as important for the rapidly changing modern society as it was for historical societies.

Perspective

Nature can exist without humans, but humans cannot exist without nature (Cao et al. 2007). To obtain scarce resources such as water and minerals, reduce transportation costs, and improve the efficiency of commodity and information exchanges, the degree of aggregation in society continues to increase. From the initial gathering in villages to aggregations in towns, cities, and eventually even megacities, the single urban development model that has been widely adopted around the world may be leading to a loss of cultural diversity. Despite the influx of people from other regions and diverse cultures during urbanization, there is a powerful homogenization phenomenon as the immigrants are forced to adopt the customs of their new home. An additional problem is that by concentrating people and resources in the small area of a city, the people and resources become increasingly vulnerable to disasters such as earthquakes and flooding because they are increasingly concentrated in small areas. Although people's awareness of climate change risks has improved, there has been no simultaneous increase in awareness of this vulnerability to disasters, and the trend of urbanization continues (You 2023). In 2020, 55% of the global population lived in cities, and it is expected that this number will reach 70% by 2050 (Cai et al. 2019). Unfortunately, this economically favorable social development model carries enormous risks that are rarely considered, such as the risk posed by natural disasters such as hurricanes, earthquakes, floods, and fires, which increases rapidly with increasing population density (Zhang et al. 2007).

Global trade has accelerated the development of coastal areas, coinciding with global sea level rise (Pilkey and Cooper 2004). Currently, more than 100 million people worldwide live in dangerous coastal areas with elevations of less than 1 m above the sea (Seto et al. 2010). With global warming, future sea levels are likely to rise further, increasing the risk created by population aggregation in low-lying areas near the coast. Even if cities are not at risk of being submerged by rising water, they face an increased threat from hurricanes and tsunamis (Rentschler et al. 2023). For example, the Indonesian tsunami on 26 December 2004 caused at least 170,000 deaths. The 2011 Fukushima earthquake and its tsunami caused 15,878 deaths, with 2713 missing persons and more than 340,000 left homeless (Wang et al. 2016). Climate change will exacerbate these problems by increasing the frequency and magnitude of extreme temperatures and precipitation, as well as through sea-level rise, which allows storms and flood waters to reach farther inland.

Despite the threats created by increasing urbanization, the concentration of populations in

cities has potentially increased urban cultural diversity due to the influx of people from different countries or different parts of the same country. Not every society can rise from its ashes and be reborn, as China has done repeatedly throughout its history, and the resulting disasters cause immense pain that people should not be expected to bear (Cao et al. 2007). The warfare associated with the two tsunamis and the resulting social unrest between 2 and 527 CE decreased China's population by 81.5%. It has been nearly 1500 years since the second tsunami struck China (Wang et al. 2016), and a similarly huge tsunami may occur at any time. Although modern technologies may reduce the mortality rate as a percentage of the population, the larger populations at risk may result in much higher total deaths.

Although we have focused on cooperation and harmony in this paper, it's important to note that conflicts between societies and warfare have not gone away. Relationships between people and countries are increasingly tense in the modern world, increasing the risk of conflicts and of escalation to warfare. Chinese history suggests that this risk will only increase as climate change threatens food security. More and more evidence suggests that climate change is increasing the likelihood of extreme weather, such as more powerful hurricanes, but many countries continue to actively expand their exposure to increasingly frequent climate shocks by promoting urbanization in areas such as coastlines that are at high risk of such shocks (Rentschler et al. 2023), which inevitably increases the risk of harms caused by climate change.

Scientists should continue efforts to improve their ability to predict the timing or severity of natural disasters so that governments can plan to mitigate these consequences. In many cases, this response will require international cooperation that provides both increased resources and more diverse potential solutions. China's historical experience shows how despite recurring periods of disaster and societal failure, striving for the "Great Harmony" experienced during China's many periods of stability based on a willingness to embrace cultural diversity and accept differences will provide one way to cope with crises and a better path for harmonious coexistence between societies and between humans and nature.

Author contributions: S. Cao designed the research; S. Cao, Z. Yu, H. Xi, X. Suo analyzed the data and wrote the paper. All authors have approved the paper for submission.

Acknowledgments: We thank Geoffrey Hart of Kingston, Canada, for his help in writing this paper. We are also grateful for the comments and criticisms of an early version of this manuscript by our colleagues and the journal's reviewers.

Disclosure Statement: The authors declare no conflict of interest. The opinions expressed here are those of

the authors and do not necessarily reflect the position of the Government of China or of any other organization. We consent to publish this article in your journal and to transfer its copyright to the publisher once the manuscript has been accepted.

Ethical statements: All procedures performed in this study were in accordance with the ethical standards of the university. Ethical clearance and approval were granted according to the Declaration of Helsinki and the UNESCO Universal Declaration on Bioethics and Human Rights.

Funding: There was no project-specific funding for this study; it was based on the authors' research interests.

References

Azzam, R., Kong, M. 2021. Correlation of environmental parameters and the water saturation induced deterioration of earthen archaeological sites: the case of World Heritage Liangzhu City, China. Heritage 4(1), 387–400. Doi:10.3390/HERITAGE4010024

Büntgen, U. Tegel, W., Nicolussi, K., McCormick, M., Frank, D., Trouet, V., Kaplan, J. O., Herzig, F., Heussner, K-U., Wanner, H., Luterbacher, J., Esper, J. 2011. 2500 years of European climate variability and human susceptibility. Science 331, 578–582. Doi: 10.1126/science.1197175

Burke, M. B., Miguel, E., Satyanath, S., Dykema, J. A., Lobell, D. B. 2009. Warming increases the risk of civil war in Africa. Proceedings of the National Academy of Sciences of the United States of America 106, 20670–20674. Doi: 10.1073/pnas.0907998106

Butzer, K. 2000. Ecology: the human role in environmental history. *Science* 287, 2427-2428. Doi:10.1126/science.287.5462.2427

Butzer, K. W. 2012. Collapse, environment, and society. Proceedings of the National Academy of Sciences of the United States of America 109, 3632–3639. Doi:10.1073/pnas.1114845109

Butzer, K. W., Endfield, G. H. 2012. Critical perspectives on historical collapse. Proceedings of the National Academy of Sciences of the United States of America 109, 3628–3631. Doi:10.2307/41507010

Cai, Z., Liu, Z., Zuo, S., Cao, S. 2019. Finding a peaceful road to urbanization in China. Land Use Policy 83, 560–563. Doi:10.1016/j.landusepol.2019.02.042

Cao, B.W. 2021. Erlitou culture, founder of Chinese orthodoxy. Research on Central Plains Culture 2021(3), 21-26. Doi: 10.3969/j.issn.2095-5669.2021.03.004 (In Chinese)

Cao, S. 2016. Institutional diversity: why Chinese civilization survives. Time & Society 25(2), 415–426 Doi:10.1177/0961463X15577270.

Cao, S., Chen, L., Liu, Z. 2007. Disharmony between society and environmental carrying capacity: a historical review, with an emphasis on China. Ambio 36(4), 409-415. Doi:10.1579/0044-7447(2007)36[409:DBSAEC]2.0.CO;2.

Cao, S., Zheng, X., Zhang, J. 2019. Challenge of political globalization. Time & Society 28, 828-837. Doi: 10.1177/0961463X17716550.

Diamond, J. 2005. *Collapse*. Penguin US. ISBN: 9780143117001

EGXSZ (Expert Group of Xia, Shang, and Zhou Chronology Engineering). 2001. Xia, Shang, and Zhou Chronology Project: Report on Phase Achievements from 1996 to 2000. Beijing: World Book Publishing

Company (In Chinese).

Feng, Q., Yang, L., Deo, R. C. AghaKouchak, A., Adamowski, J. F., Stone, R., et al. 2019, Domino effect of climate change over two millennia in ancient China's Hexi Corridor. Nature Sustainability 2, 957–961. Doi:10.1038/s41893-019-0397-9.

Hsiang, S. M., Meng, K. C., Cane, M. A. 2011. Civil conflicts are associated with the global climate. Nature 476, 438-441. Doi: 10.1038/nature10311

Hsiang, S. M., Meng, K. C. 2014. Reconciling disagreement over climate-conflict results in Africa. Proceedings of the National Academy of Sciences of the United States of America 111, 2100–2103. Doi: 10.1073/pnas.1316006111

Huisman, J. 2007. Institutional diversity in higher education: a cross-national and longitudinal analysis. Higher Education Quarterly 61, 563–577. Doi:10.1111/j.1468-2273.2007.00372.x.

Lee, H. F., Zhang, D. D. 2010. Changes in climate and secular population cycles in China, 1000 CE to 1911. Climate Research 42, 235–246. Doi:10.3354/cr00913

Liao, T.F. 2004. Estimating household structure in ancient China by using historical data: a latent class analysis of partially missing patterns. Journal of the Royal Statistical Society 167, 125-139. Doi: 10.1111/j.1467-985x.2004.00294.x.

Liu, X.Y. 2019. On the Cause of Fusion of Southern and Northern Operas in the Yuan Dynasty. Journal of Taiyuan Normal University (Social Science Edition) 18(4), 22-26 (In Chinese).

Morabia, A. 2009. Epidemic and population patterns in the Chinese Empire (243 B.C.E. to 1911 C.E.): quantitative analysis of a unique but neglected epidemic catalogue. Epidemiology and Infection, 137(10), 1361-1368. Doi: 10.1017/s0950268809990136

Odum, H. T., Odum, E. C. 2001. A Prosperous Way Down: Principles and Policies. Louisville, CO: University Press of Colorado.

Oram, D.E., Ashfold, M.J., Laube, J.C., Gooch, L.J., Humphrey, S., Sturges, W.T., Leedham-Elvidge, E., Forster, G.L., Harris, N.R.P., Mead, M.I., Samah, A.A., Phang, S.M., Ouyang, C., Lin, N., Wang, J., Baker, A.K., Brenninkmeijer, C.A.M., Sherry, D. 2017. A growing threat to the ozone layer from short-lived anthropogenic chlorocarbons. Atmospheric Chemistry and Physics 17, 11929–11941. Doi: 10.5194/acp-17-11929-2017

Overpeck, J., Webb, R. 2000. Nonglacial rapid climate events: past and future. Proceedings of the National Academy of Sciences of the United States of America 97, 1335–1338. Doi:10.1073/pnas.97.4.1335

Pei, Q., Zhang, D. D. 2014. Long-term relationship between climate change and nomadic migration in historical China. Ecology and Society 19, 68. Doi: 10.5751/ES-06528-190268

Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., Zhou, L., Liu, H., Ma, Y., Ding, Y., Friedlingstein, P., Liu, C., Tan, K., Yu, Y., Zhang, T., Fang, J. 2010. The impacts of climate change on water resources and agriculture in China. Nature 467, 43–51. Doi: 10.1038/nature09364

Pilkey, O. H., Cooper, J. A. G. 2004. Climate: society and sea level rise. Science 303, 1781-1782. Doi:10.1126/science.1093515.

Rentschler, J., Avner, P., Marconcini, M., Su, R., Strano, E., Vousdoukas, M., Hallegatte, S. 2023. Global

evidence of rapid urban growth in flood zones since 1985. Nature, 622, 87-92. DOI:10.1038/s41586-023-06468-9

Rosen, A. M., Rivera-Collazo, I. 2012. Climate change, adaptive cycles, and the persistence of foraging economies during the late Pleistocene/Holocene transition in the Levant. Proceedings of the National Academy of Sciences of the United States of America 109, 3640–3645. Doi:10.1073/pnas.1113931109

Salvadó, F.P.R. 2017. “España no era Rusia”: la revolución española de 1917: anatomía de un fracas. Hispania Nova 15, 416-443. Doi:10.20318/hn.2017.3496

Seto, K., Sanchez-Rodriguez, R., Fragkias, M. 2010. The new geography of contemporary urbanization and the environment. Annual Review Environment and Resources 35, 167-194. Doi:10.1146/annurev-environ-100809-125336

Walther, G.-R., Post, E., Convey, P., Menze, A., Parmesank, C., Beebee, T. J. C., et al. 2002. Ecological responses to recent climate change. Nature 416, 389-395. Doi:10.1038/416389a

Wang, X., Wang, Y., Xu, C., Chen, L., Guo, S. 2016. Convergence of human populations in China: impact on sustainable development. Environmental Engineering and Management Journal 15, 2375-2382. Doi:10.30638/eemj.2016.259

You, X. 2023. Flood-prone areas are hotspots for urban development. Nature NEWS, 04 October 2023. Doi: org/10.1038/d41586-023-03128-w

Yu, X. 1995. Result of geo-environment variance in China in 4000 years. China History and Geography Review 2, 45-62 (In Chinese).

Yu, X. 1997. Variance of China geo-environment in 4000 years. Yunnan Social Science 4, 79-84. (In Chinese).

Zhang, D. D., Brecke, P., Lee, H. F., He, Y., Zhang, J. 2007. Global climate change, war, and population decline in recent human history. Proceedings of the National Academy of Sciences of the United States of America 104, 19214-19219. Doi:10.1073/pnas.0703073104