Proceedings of the 4th International Conference on Biological Engineering and Medical Science
DOI: 10.54254/2753-8818/61/20241490

Impact and projections of heat waves and wildfires on societies in Western Europe

Zisong Huang

Faculty of Chemistry, Silesian University of technology, Gliwice, Poland, 44-100

zh309267@student.polsl.pl

Abstract. Due to climate change, heat waves and wildfires are frequent in Europe. Over the past few years, the number of days of heat waves has been significantly increased. Understanding the relationship between the occurrence of heat waves and the spread of wildfires, the reasons why Europe is the main disaster area, and the impact on its society are important to researchers and the public. This paper, through methods of literature review and case studies, analyzes the cases of 2022 Gironde wildfires in France, wildfires in Portugal, and extreme heat events in the United Kingdom. The paper recommends that countries should establish disaster prevention mechanisms to minimize the impact of extreme natural disasters, and should start reducing carbon emissions to control global warming to reduce the occurrence of extreme disasters such as wildfires and heat waves. This study also provides the analysis of future temperature trends in order to improve people's awareness of the global warming crisis, hoping that the earth will better, and human activities and global climate change will have a virtuous circle.

Keywords: Extreme weather events, wildfire, heat waves, social impact forecast.

1. Introduction

In the 21st century, extreme weather, wildfires and heat waves have caused serious distress to people around the world, especially in Western Europe. During this period, abnormal climate such as global warming has intensified, and there is still a long way to solve this problem for the common home of mankind. The outcome of the Geographically weighted regression(GWR) analysis allowed people to identify the spatial locations such as hot spot areas, where the relationship between heat waves and wildfires is positive and significant. Hence, in hot spots, the presence of heat waves can be seen as a driver of wildfire occurrence in forest and steppe ecosystems. The findings from this study could contribute to a more comprehensive assessment of wildfire patterns in this geographical region [1].This paper will investigate the heatwaves in Western Europe from 2022 to 2024, as well as wildfires. Global warming poses increased risks of severe Composite event of drought and heat waves(CDHW) events, which are likely to increase [2].

The study of heat waves and wildfires in Western Europe can help reduce the negative impact of this event to some extent. It establishes risk prediction mechanisms at the global level, and serves as a wake-up call to what can be done to reduce the occurrence of such events rather than ignore them. This is of constructive significance for biodiversity, social stability, and sustainable economic development.

© 2024 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2753-8818/61/20241490

2. Literature Review

2.1. Heatwaves

A heat wave is a condition in which the weather is constantly excessively hot, and may be accompanied by high humidity. The word "heat wave" is commonly used in relation to a specific geographical area. Therefore, what may be considered normal temperatures for a hotter climate region could be classified as a heat wave in a place that typically experiences lower temperatures. Heatwaves are directly caused by the presence of an anticyclone or ridge of high pressure in the weather, and an anticyclone leads to a dry climate, which means that all heatwaves will cause temperatures to rise without evaporating moisture. If there are wet conditions, such as wet ground, then in a way, the ground acts as an air conditioner. There is a causal relationship between high temperatures and heat waves, and high temperatures are the result of heat waves. Heatwaves are responsible for the formation of high temperatures, which means that not all high temperatures are caused by heat waves. Extreme heat undermines the working capacity of individuals, resulting in lower productivity, and thus a decline in economic output [3]. According to Intergovernmental Panel on Climate Change(IPCC), human activity has significantly increased the likelihood of a heat wave by at least two-fold [4]. While the activities of human beings are increasing the frequency of heat waves, and heat waves are also seriously affecting human life and the global environment. The heat wave has had a serious impact on workers' motivation. Moreover, it results in higher rates of disease among the elderly and young, as well as increased energy use and reduced food yield. Therefore, a heat wave may lead to an exacerbation of energy problems, famine, and industrial stagnation, and if the government does not have an efficient measurement or a good policy, it may create serious social problems.

2.2. Wildfires

Wildfires refer to a forest fire disaster that is out of human control. It spreads and expands freely in the forest land, causing harm and loss to the forest, natural ecosystem and human beings. Forest fires may burn the animals and plants within the forest, causing damage to the ecological environment, and leading to soil erosion, huge economic losses, and even casualties. Once the climate becomes dry and hot, the hot air will suck moisture away from the soil and trees, leaving behind dry trees and bushes that can easily turn into a sea of fire. Every year, millions of hectares of land around the world are affected by wildfires, disrupting ecosystem functions by affecting on-site vegetation, soil, and above- and below-ground biodiversity, while also triggering erosive off-site impacts such as water pollution or mudslides. The intensity of a heat wave also has a significant impact on the risk of occurrence of wildfires. There is a clear relationship that higher air temperature leads to higher risk of wildfires [5]. As shown in Figure 1, there is a great possibility for the middle and south of England to have wildfires. Wildfires are more dangerous than heatwaves. Wildfires can burn a large number of homes, farmland, forests and other resources, causing huge economic losses. Wildfire is not only the most important natural disturbance for forests and other vegetation ecosystems on Earth, but also a major natural disaster for human society [6]. According to the European Forest Fire Information System, the scale of the destruction of European forests by wildfires is enormous, resulting in a significant loss of economic value. In order to keep people safe, large-scale evacuations are often required in areas where wildfires occur. This not only affected the normal life of local residents, but also brought great pressure to the evacuation work. For example, around 40000 people were evacuated due to the fires in the Gironde department of France [7]. Many Western European countries are popular tourist destinations, and the occurrence of wildfires often affects the local tourism industry. For example, wildfires near the ruins of Ancient Olympia in southern Greece have led to the evacuation of residents of six surrounding villages, which will undoubtedly have a impact on local tourism. Therefore, how to deal with wildfires is very important and difficult. This paper will analyze some cases to illustrate the importance of preventing heatwaves and wildfires.

DOI: 10.54254/2753-8818/61/20241490

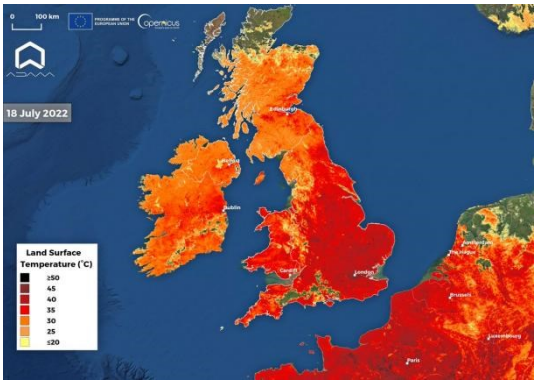

Figure 1. 2022 land surface temperature of UK [8]

3. Case Study

Wildfires and heat waves are becoming more frequent due to the effects of global warming, and followings are some specific examples. The year 2022 witnessed the second-worst wildfire season in Europe and marked the second-largest recorded burnt area in history [9]. And the UK has suffered the most severe impact.

3.1. The wildfires in Gironde District in France

In 2022, a wildfire occurred in Gironde District in France. This disaster not only led to the destruction of large areas of forest, causing serious damage to the local ecological environment and biodiversity, but also forced the emergent evacuation of 40,000 residents, causing social panic and unrest, and many families lost their homes and faced uncertainty in their lives [7]. On the economic front, the fires have had a direct impact on local tourism, forestry and other industries. At the same time, the huge costs of fighting against fires and rebuilding from the disaster also increased the economic burden. In addition, the smoke and harmful gases from the fire pose a potential threat to the health of local residents and exacerbate the instability of society. The fire has prompted the government and all sectors of society to pay more attention to fire prevention, promoting the process of post-disaster reconstruction and ecological restoration.

3.2. The wildfires in Portugal

In 2022, Portugal was hit by severe wildfires, which have had a profound impact on Portugal society. The wildfires directly threatened the lives of local people, forcing a large number of residents to evacuate urgently. Moreover, in some areas such as Leiria, some houses were burned down, and many highways were forced to close due to safety reasons, seriously affecting the daily life and transportation of local residents. Wildfires have taken a heavy cost on Portugal's economy. Large areas of land and vegetation have been burned, which not only destroyed the ecological environment, but also affected agricultural production and forestry resources. In addition, firefighting also consumed a lot of human, material and financial resources, which brought a heavy economic burden to the government and society.

In addition, wildfires have exacerbated climate change problems in Portugal. They release large amounts of greenhouse gases such as carbon dioxide during their combustion, further exacerbating the trend of global warming. A warming climate will lead to more frequent and severe wildfires, creating a vicious cycle. Finally, wildfires also have a negative impact on social psychology. In the face of sudden disasters, many people feel panic and helpless, and their mental health is under great pressure. At the same time, wildfires have also triggered deep reflections on environmental protection and climate change. In summary, the wildfires in Portugal in 2022 not only caused casualties, economic losses and ecological damage, but also exacerbated climate change problems and had a negative impact on public psychology. For instance, early onsets are likely to find the fire suppression system at insufficient preparedness levels for a safe and efficient response, while prevention and management activities should also be scheduled sufficiently in advance [10].

DOI: 10.54254/2753-8818/61/20241490

3.3. Extreme heat events in the United Kingdom

In July 2022, the United Kingdom experienced unprecedented extreme heat, with temperatures breaking historical records in many places, and even reaching more than 40°C for the first time. This extreme heat event not only tested the UK's infrastructure, but also had a serious impact on people's lives, economic activities and the ecological environment. High temperatures have caused runways in some United Kingdom airports to melt, flights have been cancelled or delayed, rail systems have been affected by thermal distortion of rails, and many railways have been suspended or speed limited. This not only affects people's daily travel, but also puts great pressure on the transportation and logistics. In addition, the high temperature have also caused a number of fires, including residential and commercial buildings and forest fires, posing a serious threat to the safety of people's lives and property. Cities such as London even declared the state of major event in response to the various challenges posed by the high temperature. In terms of people's livelihood, extreme heat has greatly affected the lives of people in United Kingdom. Since most households in the UK are not equipped with air conditioner, people have to take various measures to cool down in hot weather, such as using electric fans and going to parks. However, these measures do not completely alleviate the discomfort caused by heat, especially for the elderly, children and people with underlying medical conditions, who are more likely to have health problems. Extreme heat has negatively impacted the economy. The power supply is under tremendous pressure due to the surge in demand for electricity caused by high temperatures. At the same time, high temperatures have affected agricultural production, and dry soils have forced farmers to increase irrigation, further exacerbating water stress. In addition, retailers reported a surge in sales of cooling devices such as electric fans, air conditioning units and sprinklers, reflecting the urgent need for measures to cope with hot weather. Ecologically, extreme heat has exacerbated drought risks in the UK. According to a report released by the European Commission's Joint Research Centre, nearly half of the UK's territory is at risk of drought, which could lead to a decline in crop yields. This not only affects agricultural production, but also have long-term effects on the ecological environment. The UK has observed a rise in both the frequency and duration of heat waves based on temperature data collected at meteorological stations. These results are consistent with similar studies of heat waves in continental Europe [11]. In summary, the extreme heat event in the United Kingdom has had a wide and far-reaching impact on UK society, from infrastructure, people's lives, economic activities to the ecological environment.

4. Predictions

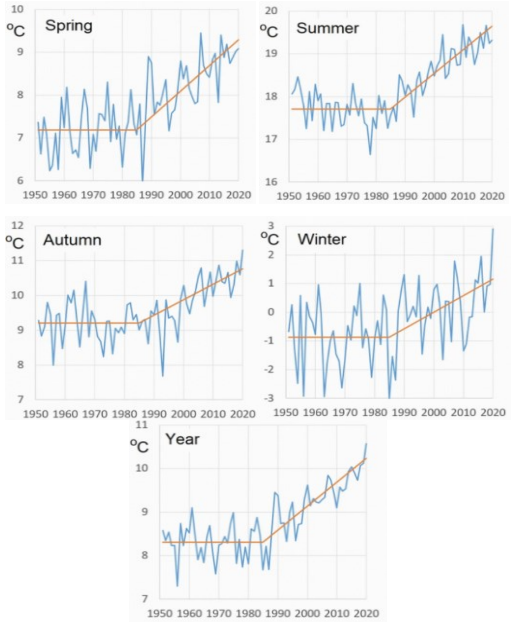

Figure 2. 1950-2020 average temperature of Europe [12]

DOI: 10.54254/2753-8818/61/20241490

From the data of Figure 2, it can be seen that the average temperature in Europe has increased significantly since 1990, and there has been a significant warming phenomenon around 2020.

Each season increases by about 2-4℃, and the average temperature throughout the year also rises by about 2.5℃.

This paper will analyze the data by correlating the frequency of heat waves in Europe with the increase in the average temperature in Europe.

4.1. Data analysis

Figure 2 shows that since 1990, heatwave events covering an area of more than 5,000,000 kilometers have started to occur. These heatwaves have been characterized by their long duration, wide coverage, high intensity, and significant impact on climate warming. The large-scale heatwave that occurred in Europe during the summer of 2022 has been ranked as the second most severe heatwave in European history [13].

4.2. Discussion

Due to the impact of wildfires, carbon emissions across Europe are also seriously affecting the weather there, forming a vicious circle. As humans began to realize that if the global temperature continued to rise in this way, wildfires and heat waves would become more rampant around the world. Influenced countries should start to limit carbon emissions and take effective measures to control temperatures. Therefore, this paper predicts that global temperatures will show a slight downward trend over the next three years, but the overall temperature will still trend upwards over the next decade. If human measures are effective, this will be a milestone for the change of European climate and the global climate.

5. Conclusion

This paper analyzes the social impact of temperatures in Europe, and heatwaves and wildfires in Western Europe, as well as shows the severity and devastating nature caused by these disasters. This paper proposes a risk estimating mechanism for extreme weather disasters induced by climate change, aiming to enhance people's awareness and preparedness. It also aims to minimize the losses incurred by such catastrophes and provide projections for the following decade.

The data used in this paper is not comprehensive and the surveys conducted are relatively in a small scale. The impact of extreme weather such as wildfires and heat waves on Europe and even around the world will continue to be studied in the future.

The study of extreme weather such as heat waves and wildfires can lead to a deeper understanding of climate change is expected to enhance our comprehension of climate change. This, in turn, can foster a positive feedback loop, leading to improvements in the climate conditions in Europe and globally. Ultimately, this paper will contribute to the enhancement of human habitat, upon which people’s survival depends.

References

[1] Mario, E., Raffaele, L., Onofrio, C., Maria, C. S. J., Valentina, B., Vincenzo, G., ... & Giovanni, S. (2024). Coupling heat wave and wildfire occurrence across multiple ecoregions within a Eurasia longitudinal gradient. Science of the total environment, 912, 169269.

[2] Tripathy, K. P., & Mishra, A. K. (2023). How unusual is the 2022 European compound drought and heatwave event?. Geophysical Research Letters, 50(15), e2023GL105453.

[3] García-León, D., Casanueva, A., Standardi, G., Burgstall, A., Flouris, A. D., & Nybo, L. (2021). Current and projected regional economic impacts of heatwaves in Europe. Nature communications, 12(1), 5807.

[4] IPCC. Climate change 2013: the physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change. In (eds. Stocker T. F., Qin D., Plattner G.-K., Tignor M., Allen S. K., Boschung J., Nauels A., Xia Y., Bex V., Midgley P. M.) 1535 (Cambridge University Press, Cambridge and New York, 2013).

DOI: 10.54254/2753-8818/61/20241490

[5] Nojarov, P., & Nikolova, M. (2022). Heat waves and forest fires in Bulgaria. Natural Hazards, 114(2), 1879-1899.
[6] Yue Chao, Luo Caiwan, Shu Lifu, & Shen Zehao. (2020). Advances in wildfire research in the context of global change. Journal of Ecology, 40(2).
[7] Pengpai News. (2022)About 10,000 people were evacuated from wildfires in the Gironde department of France, covering an area of more than 6,000 hectares. www.dutenews.com/n/article/6976022.
[8] Pengpai News. (2022)Rare and ferocious heat, climate scientists: Europe's heat wave is growing 3-4 times faster than at the samlatitude. www.thepaper.cn/newsDetail_forward_19095568.
[9] Eklöf, S., Lagarde, E., Tellier, E., Russon, D., Pradeau, C., Laflamme, L., & Gil-Jardine, C. (2023). Health Effects of Wildfires Reported in Emergency Medical Communication Centres: An Ecological Study in Gironde District, France, during the Summer of 2022.
[10] Rodrigues, M., Camprubí, À. C., Balaguer-Romano, R., Megía, C. J. C., Castañares, F., Ruffault, J., ... & de Dios, V. R. (2023). Drivers and implications of the extreme 2022 wildfire season in Southwest Europe. Science of the total environment, 859, 160320.
[11] Sanderson, M. G., Economou, T., Salmon, K. H., & Jones, S. E. (2017). Historical trends and variability in heat waves in the United Kingdom. Atmosphere, 8(10), 191.
[12] Twardosz, R., Walanus, A., & Guzik, I. (2021). Warming in Europe: recent trends in annual and seasonal temperatures. Pure and Applied Geophysics, 178(10), 4021-4032.
[13] Lhotka, O., & Kyselý, J. (2022). The 2021 European heat wave in the context of past major heat waves. Earth and Space Science, 9(11), e2022EA002567.