

CLIMATE CHANGE AND FOREST FIRES: STATISTICAL ANALYSIS OF THE IMPACT OF METEOROLOGICAL VARIABLES ON THE FREQUENCY AND INTENSITY OF FIRES IN THE VITEZ MUNICIPALITY

Muharem Čupina

1. Faculty of Technical Studies, University of Travnik, Travnik, Bosnia and Herzegovina

ABSTRACT

A statistical analysis of the impact of meteorological variables on the frequency and intensity of forest fires in the Vitez Municipality was conducted in this paper. The study is based on data collected on climate change, with an analysis of key meteorological parameters, such as average temperature, relative humidity, precipitation, and wind speed. The results reveal a significant correlation between rising temperatures and decreasing precipitation with the frequency and intensity of fires, confirming that climate change plays a crucial role in triggering forest fires. Based on the applied statistical methods, the paper offers a precise interpretation of the impact of individual meteorological variables, which facilitates improved planning of preventive measures and the development of strategies for protecting forest areas.

Keywords: climate change, forest fires, meteorological variables, statistical analysis, Vitez Municipality

INTRODUCTION

Forest fires represent a significant ecological, economic and social problem in many parts of the world, including Bosnia and Herzegovina. The Municipality of Vitez, located in central Bosnia and Herzegovina, faces an increasing number of forest fires that threaten not only forest areas but also agricultural land and rural settlements. The causes of these fires vary, ranging from natural factors, such as lightning and droughts, to human activities that include careless waste burning and negligent handling of open flames.

Climate change represents long-term alterations in temperature, precipitation, wind, and other atmospheric

elements on Earth. These changes, caused by both natural processes and human activities, have far-reaching consequences on natural and social systems. The increase in global temperatures, changes in the distribution and intensity of precipitation and the frequency of extreme weather events, such as droughts, directly influence the occurrence and intensity of forest fires.

The Municipality of Vitez, known for its forest resources and agricultural production, is increasingly experiencing the effects of climate change. Summers are becoming hotter and drier, contributing to faster vegetation drying and creating ideal conditions for fires. Reduced precipitation during critical months further complicates the natural extinguishing of

fires, increasing the risk of spreading over large areas. In addition, winds that are common in this area can quickly spread flames, making fires even harder to control.

The analysis of the impact of meteorological variables on forest fires in the Municipality of Vitez shows that local climate changes have a direct and significant effect on the frequency and intensity of these destructive events. Understanding these correlations is crucial for developing effective risk management strategies and fire response measures, which are vital for preserving natural resources and protecting local communities.

Furthermore, proper forest resource management and the implementation of preventive measures can significantly reduce the risk of fires. Educating the local population about hazards and preventive actions, such as clearing forest debris and controlled burning, is essential to prevent large-scale wildfires that could have catastrophic consequences for the entire community. Given all the above, this paper focuses on a detailed analysis of the impact of key meteorological variables, such as temperature, precipitation, relative humidity, and wind speed, on the frequency and intensity of forest fires in the Municipality of Vitez, providing a basis for the development of targeted protection and prevention measures.

PROBLEM AND OBJECTIVE

The primary issue addressed in this paper concerns the impact of meteorological changes caused by climate change on the frequency and intensity of forest fires in the Municipality of Vitez. These changes include rising average temperatures, decreased precipitation, changes in air humidity, and increased wind speed, which together create favourable conditions for the ignition and spread of fires. Specifically, local climate changes may lead to prolonged drought periods and hotter summers, which directly affect vegetation drying and increase the flammability of materials, thereby increasing the danger of fires. The goal of this research is to thoroughly understand how individual meteorological variables affect forest fires in the specified region. By analysing long-term data on weather conditions and fire occurrences, the study aims to identify the key factors contributing to an increased fire risk. This includes analysis of air temperature, the amount and distribution of precipitation, humidity, and wind speed, as well as their collective impact on fires. Additionally, the research seeks to identify specific weather patterns that preceded major fire incidents in order to better understand the conditions under which fires become more pronounced. Based on the findings, the paper will propose targeted measures that could help reduce the risk and consequences of forest fires. These measures will include recommendations for improving monitoring and early warning systems, the development and implementation of new technologies in fire monitoring and suppression,

as well as strategies for forest resource management that minimise fire risk. Furthermore, the paper will highlight the importance of educating local residents on preventive actions that individuals can take to reduce the likelihood of fire outbreaks and emphasise the need for intersectoral cooperation in developing more efficient fire response mechanisms. Ultimately, this research aims to provide concrete scientific insights that will serve local authorities, fire departments and forestry services as a foundation for formulating effective policies and actions aimed at wildfire prevention and control, improving safety and preserving vital forest ecosystems in the Municipality of Vitez.

RESEARCH METHODS

For the purpose of this research, methods of descriptive statistics and visualisation of the relationship between meteorological variables and the number of forest fires were used. Data on average temperature, precipitation levels, relative humidity, and wind speed were analysed in relation to the number of recorded fires in the Municipality of Vitez for the period 2019 to 2024. Meteorological data were obtained from the Federal Hydrometeorological Institute, while information on the number of forest fires was gathered from local fire department and civil protection reports. The relationship between climate factors and fire occurrence was analysed by comparing annual values and correlation calculations. Data visualisation through charts allowed for a clearer understanding of the relationship between individual variables and fire occurrence.

Although a simpler approach, this methodology provides sufficient insight into trends and possible cause-effect relationships, establishing a foundation for future, more in-depth statistical studies.

CLIMATE CHANGE AND FOREST FIRES

Climate change is one of the most complex challenges of the modern era, with profound effects on the environment, society and economy. Forest fires represent one of the direct and increasingly frequent consequences of global warming, and their frequency and intensity are rising worldwide, including in Southeast Europe. Increased average temperatures, prolonged drought seasons, decreased precipitation, and more frequent extreme weather events create ideal conditions for the ignition and spread of wildfires (Flannigan et al., 2009). In addition to faster vegetation drying, elevated temperatures and reduced humidity contribute to easier ignition and greater burn intensity (Abatzoglou & Williams, 2016). Furthermore, winds accompanying droughts accelerate fire spread and hinder the response of protection and rescue services. According to a report by the European Commission (EC, 2020), as many as 96% of all wildfires in the EU are caused by human activity, but their frequency and scale are significantly worsened by climate factors. In Bosnia and Herzegovina, although there is still no centralised database on fires, local reports and empirical research confirm the same trend — especially in mountainous

and Mediterranean regions of the country (UNDP, 2024). In view of these facts, it is necessary to develop climate adaptation and mitigation strategies that include forest monitoring, early fire detection, public awareness campaigns, and investment in fire and rescue service capacity. Local and regional responses must be based on scientific evidence, monitoring of climate indicators and proper spatial planning.

RESULTS

The analysis results show a clear correlation between meteorological variables and the frequency of forest fires in the Municipality of Vitez during the period 2019–2024. For this research, data on average temperature, annual precipitation, relative humidity, and average wind speed were compared with the annual number of recorded forest fires.

Based on the available data, the following trends were identified:

- Temperature showed a gradual increase from 12.1°C in 2019 to 13.8°C in 2024.
- Precipitation recorded a downwards trend from 870 mm in 2019 to 700 mm in 2024.
- Relative humidity also declined from 69% to 63%.
- Wind speed showed a slight increase from 7.2 km/h to 7.9 km/h.

During the same period, the number of forest fires varied. In 2019, there were 7 fires. The highest number was recorded in 2020 (14 fires); 3 fires occurred in 2021, 6 fires in 2022 and 5 fires in 2024, while in 2023, no fires were reported. To better understand the relationship between climate variables and fires, Pearson correlation coefficients were calculated for each variable and the number of fires.

Table 1. Correlation analysis

Variable	Correlation Coefficient (r)
Average temperature (°C)	-0.581
Annual precipitation (mm)	0.558
Relative humidity (%)	0.620
Wind speed (km/h)	-0.271

The highest positive correlation with the number of fires was observed with relative humidity, which may result from specific seasonal patterns. Precipitation also showed a positive coefficient, while temperature and wind speed had a negative correlation with fire occurrences.

The following charts further illustrate the relationships between individual meteorological variables and the

number of fires.

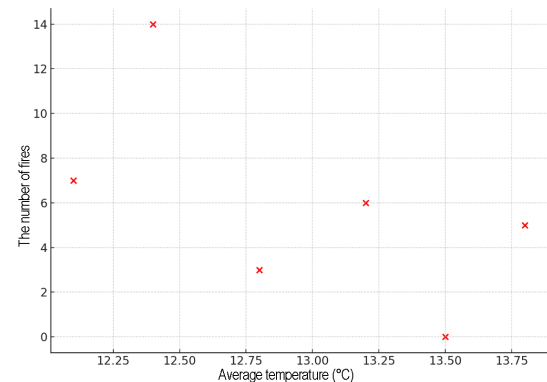


Chart 1. The relationship between average temperature and the number of fires

A slight negative trend is observed, contrary to global expectations, possibly due to local factors.

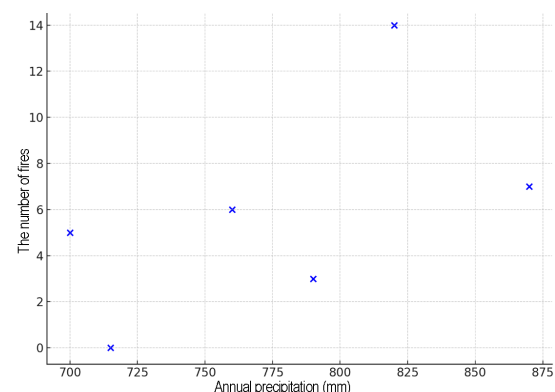


Chart 2. The relationship between annual precipitation and the number of fires

A slight positive relationship indicates that more rain does not necessarily mean fewer fires — possibly due to seasonal variations.

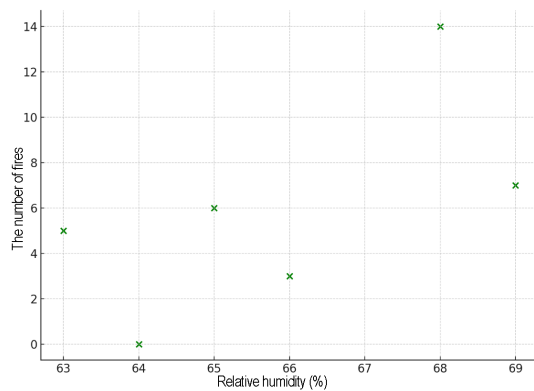


Chart 3. *The relationship between relative humidity and the number of fires*

This is the most notable positive correlation, statistically interesting and requiring further investigation.

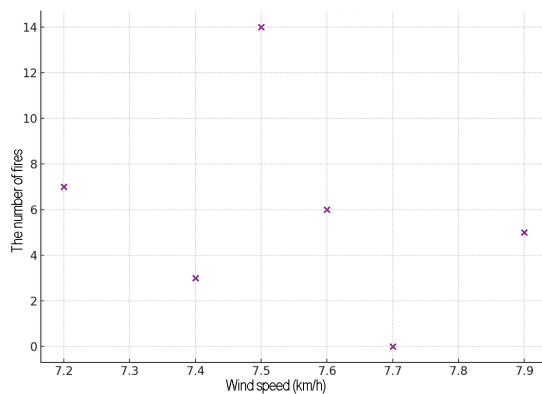


Chart 4. *The relationship between wind speed and the number of fires*

Wind speed proved to be a weak predictor of fires in this sample.

DISCUSSION

The analysed data reveal a complex and often unexpected correlation between meteorological factors and forest fire frequency. Although greater rainfall and humidity are typically associated with a reduced number of fires, a positive correlation was observed in this case. This could result from seasonal patterns in which spring rains promote vegetation growth, which later becomes flammable material. These findings confirm that simple annual averages often mask real risks and emphasise the need for analysis of seasonal and extreme values.

CONCLUSION

The research confirms that climate factors, such as temperature, precipitation, humidity, and wind speed, have a measurable impact on the occurrence and intensity of forest fires in the Municipality of Vitez. Changes in these variables are accompanied by changes in fire frequency, although relationships do not always follow expected trends. The results highlight the importance of local meteorological monitoring and the need to incorporate additional factors in future research to better plan protective and preventive measures.

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KLIMATSKE PROMJENE I ŠUMSKI POŽARI: STATISTIČKA ANALIZA UTICAJA METEOROLOŠKIH VARIJABLI NA FREKVENCIJU I INTENZITET POŽARA NA PODRUČJU OPĆINE VITEZ

SAŽETAK

U ovom radu provedena je statistička analiza uticaja meteoroloških varijabli na frekvenciju i intenzitet šumskih požara na području općine Vitez. Istraživanje se zasniva na prikupljenim podacima o klimatskim promjenama, pri čemu su analizirani ključni meteorološki parametri poput prosječne temperature, relativne vlažnosti, količine padavina i brzine vjetra. Dobiveni rezultati pokazuju značajnu korelaciju između povećanja temperatura i smanjenja padavina te učestalosti i intenziteta požara, čime se potvrđuje da klimatske promjene igraju ključnu ulogu u poticanju šumskih požara. Na osnovu primijenjenih statističkih metoda, rad nudi preciznu interpretaciju uticaja pojedinih meteoroloških varijabli, što omogućuje bolje planiranje preventivnih mjera i razvoj strategija zaštite šumskih područja.

Ključne riječi: klimatske promjene, šumski požari, meteorološke varijable, statistička analiza, općina Vitez

Correspondence to: Muharem Čupina
Faculty of Technical Studies, University of Travnik, Travnik, Bosnia and Herzegovina
E-mail: muharem.cupina@ftt.edu.ba