# Fires in natural systems as a result of climate change and as a factor influencing climate change

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# Introduction

The Ukrainian Polissia region is known for its abundant biodiversity, showcasing a variety of species, diverse biotopes, and ecological niches. Natural ecosystems of the Ukrainian Polissia are not isolated from external influences and affected by both anthropogenic and natural factors.

| Human related factors include | Natural factors include |
|---|---|
| deforestation<br>urbanization<br>pollution<br>human-caused wildfires<br>military activities, which significantly impact the local ecosystems. | invasive species expansion<br>nature-caused wildfires<br>climate change,<br>and related meteorological emergencies (e.g., storms) and extraordinary events (e.g., droughts) |

**In reality, we observe a combined impact and effect of these factors**

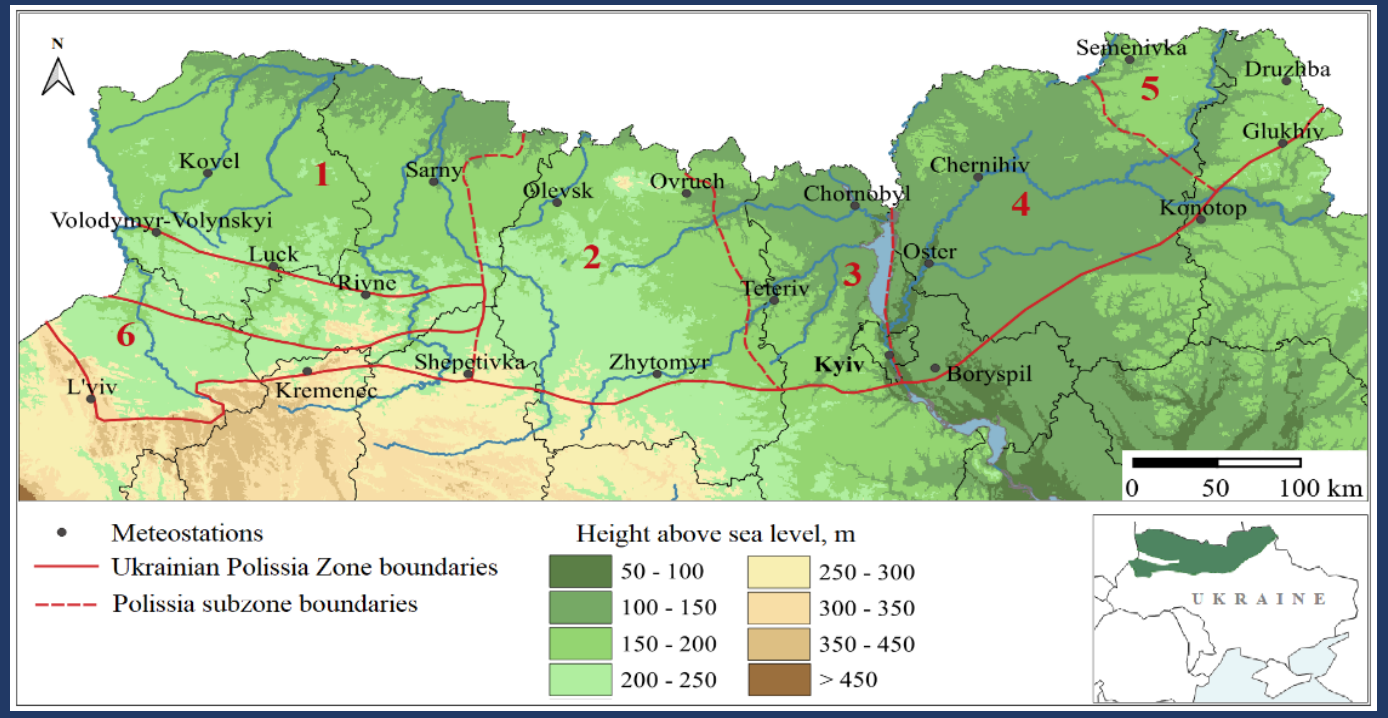
## Introduction

Among these factors, **wildfires are the most dangerous** and mainly attributed to the human activities. However, climatic conditions (e.g., long periods of high temperatures, heatwaves, droughts, a lack of precipitation) create favourable conditions for the occurrence and spread of fires.

The analysis of meteorological observation data shows that the duration and frequency of days with high temperatures have been increasing over the past decades in Ukraine and beyond, which is one of the most significant manifestations of climate change. At the same time, long-term observations in Ukraine and abroad indicate that the frequency and scale of fires in natural systems depends on the driest and hottest periods of the year and specific human activities. In particular, since 2022, as a result of the aggression of the Russian Federation, hostilities became a powerful generator of fires, which caused the destruction of landscapes and natural ecosystems.

**The purpose of this research was to analyse the features of climate change in the Ukrainian Polissia, and consider correlation of the climate tendencies and human activities with forest fires intensity.**

# Methodology




**Area of the research was Ukrainian Polissia, which comprised the following geographical subzones:**
**1 – Volynske Polissia;**
**2 – Zhytomyrske Polissia;**
**3 – Kyivske Polissia;**
**4 – Chernihivske Polissia;**
**5 – Novgorod–Siverske Polissia;**
**6 – Small Polissia.**

For the analysis of the climate tendencies, empirical data (**an annual and monthly surface air temperature and precipitation for the period 1990–2021**) were averaged in accordance with the geographic subzones of the Ukrainian Polissia. Data were obtained from Central Geophysical Observatory, primer source of data – meteorological stations located in the region.

Satellite data from the Fire Information for Resource Management System (FIRMS, NASA, USA) for the years 2001-2022 were used for the analysis of forest fire frequency in the Ukrainian Polissia zone. The FIRM's dataset is based on satellite observations by MODIS and includes data regarding the time, location, and intensity of fires (FIRMS, 2023).

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## The features of climate change in the Ukrainian Polissia region

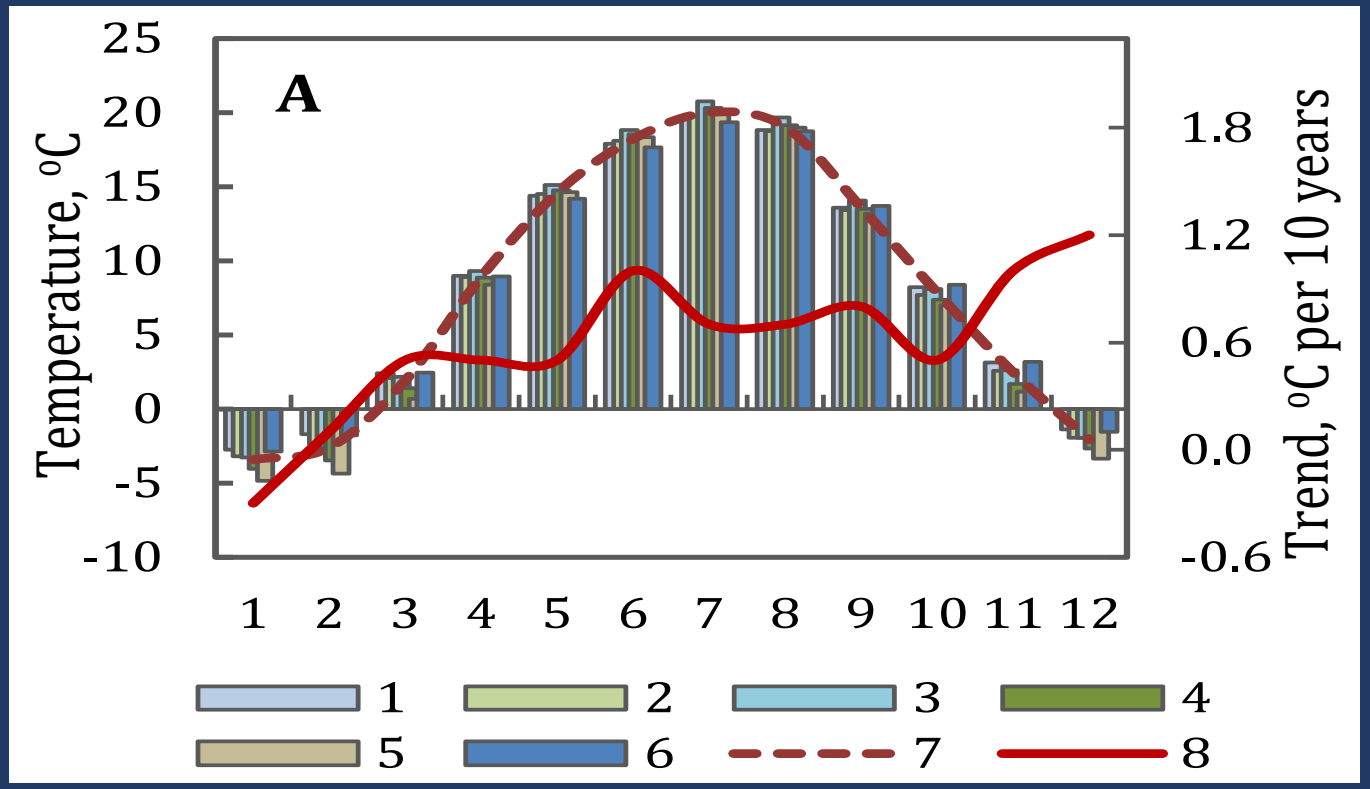
The climate of the Ukrainian Polissia is characterized by the location of the region in a moderately continental climate zone. It features a relatively mild and unstable winter with little snowfall, a warm and humid summer, and relatively dry spring and autumn seasons.

## The annual average temperature and the annual amount of precipitation and their trends for regions Ukrainian Polissia for the period 1991–2020.

| N | Regions | Temperature, °C | | Precipitation, mm/year | |
|---|---|---|---|---|---|
| | | Average for 1991–2020 | Trend, °C per 10 years | Average for 1991–2020 | Trend, mm/year per 10 years |
| 1 | Volynske Polissia | 8.4±0.8 | 0.56 | 615±71 | +7.6 |
| 2 | Zhytomyrske Polissia | 8.2±0.9 | 0.65 | 638±79 | –3.4 |
| 3 | Kyivske Polissia | 8.6±0.8 | 0.63 | 597±75 | –14.7 |
| 4 | Chernigivske Polissia | 7.9±0.8 | 0.60 | 591±73 | –32.3 |
| 5 | Novgorod–Siverske Polissia | 7.5±0.9 | 0.60 | 591±84 | –9.0 |
| 6 | Small Polissia | 8.4±0.8 | 0.60 | 705±98 | +5.0 |
| | Ukrainian Polissia | 8.2±0.8 | 0.60 | 620±62 | –6.7 |

**However, climate change has accelerated since the second half of the 20th century (IPCC, 2021)**

# Seasonal variation of temperature of the Ukrainian Polissia for the period 1990–2021

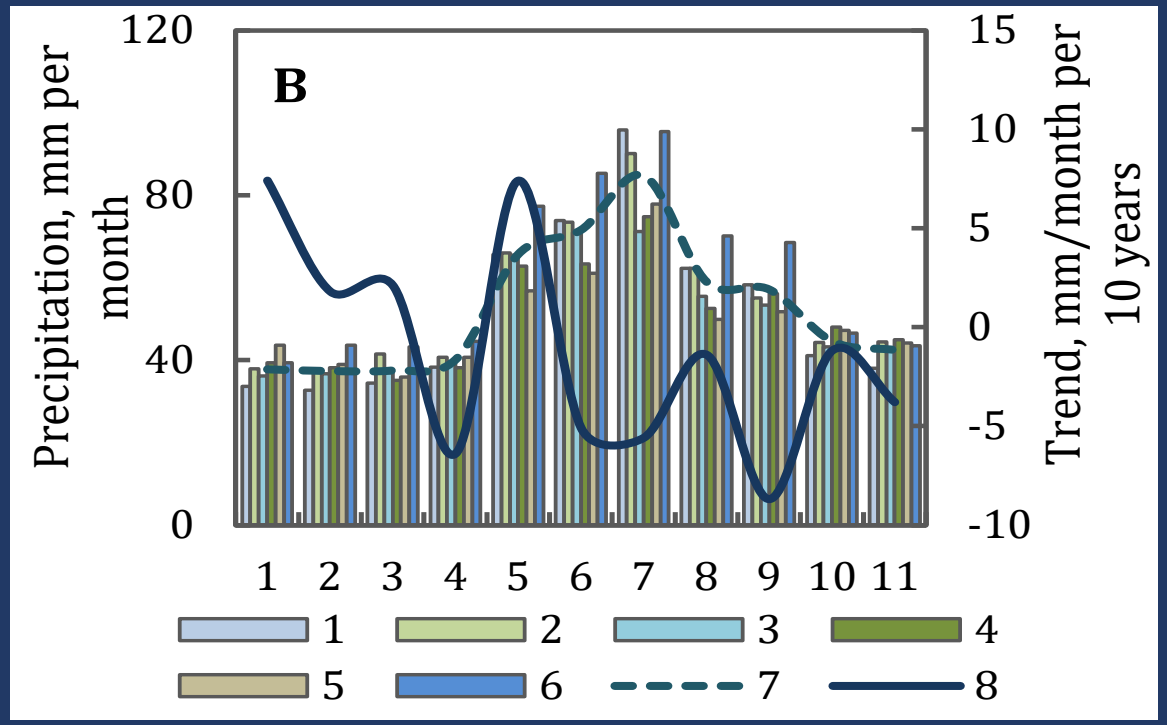



1–6 – geographical subzones; 7 – averaged for the Ukrainian Polissia; 8 – trend.

The change of the average monthly temperature for the period 1990–2021 was increasing during the whole year (by 0.1–1.2 °C/10 years), except for January, which is characterized by a decreasing trend (by –0.3 °C/10 years).

# Seasonal variation of precipitation of the Ukrainian Polissia for the period 1990–2021

The trend of decreasing precipitation in April and June–September against the backdrop of anomaly high temperatures during the warm season leads to atmospheric and soil droughts, which intensify the risks of widespread forest and peat fires in the Ukrainian Polissia. Droughts and fires have a negative, sometimes devstating impact on the productivity of ecosystems in this region.

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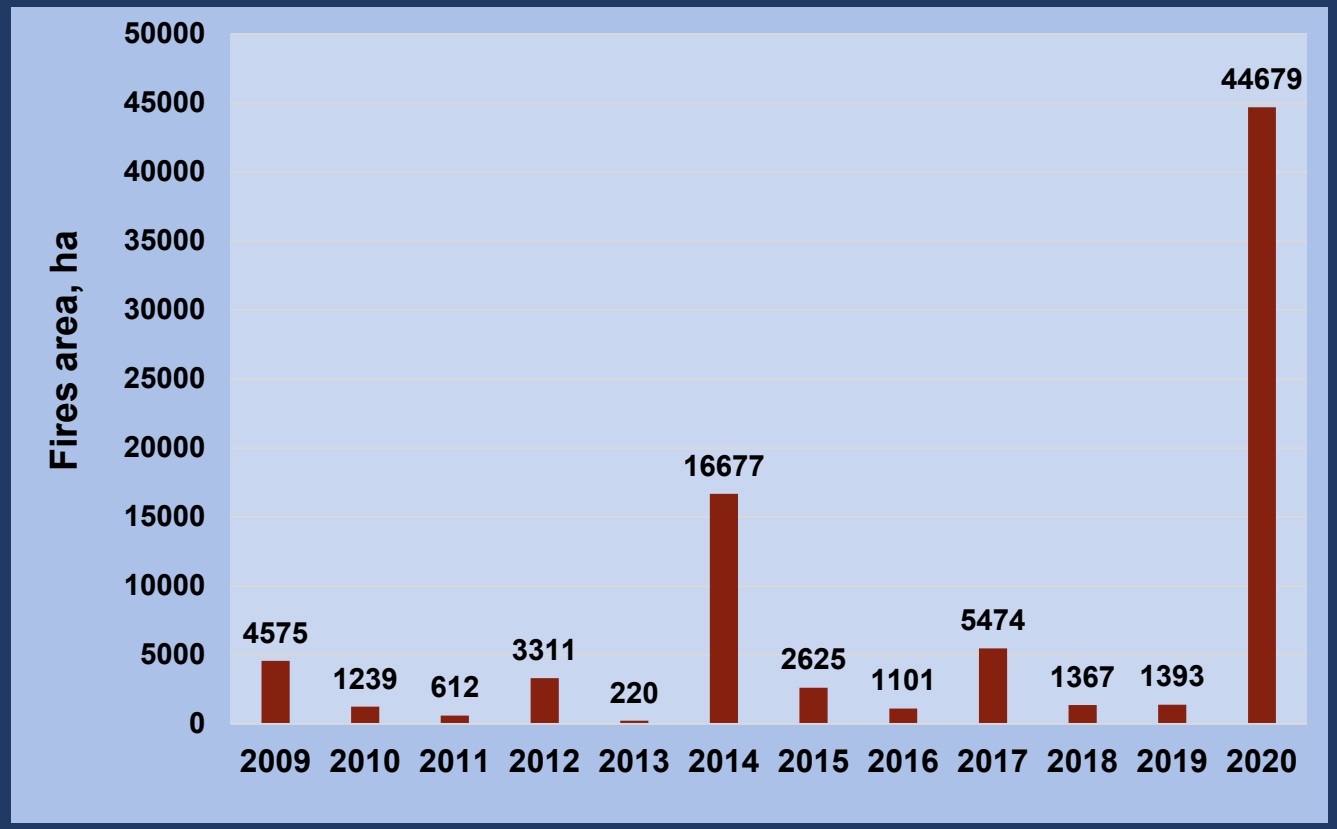
## The climatic conditions of the year 2020 and the fires




**Area of forest fires in Ukraine**

**The climatic conditions in 2020** exceeded all records in terms of their anomalies.

The unusually warm (exceeding the climatic norm for the period 1961-1990 by 4-5°C) and relatively arid (with atmospheric precipitation amounts 20-40% below the climatic norm) winter of 2019-2020 became the most anomalous in over 140 years.

The summer of 2020 was quite hot, the average temperatures exceeded the norm by 2-4°C; atmospheric precipitation amounts below the norm by up to 100% was observed in June and up to 60% in July - August.

**Such conditions promoted fires in natural systems**

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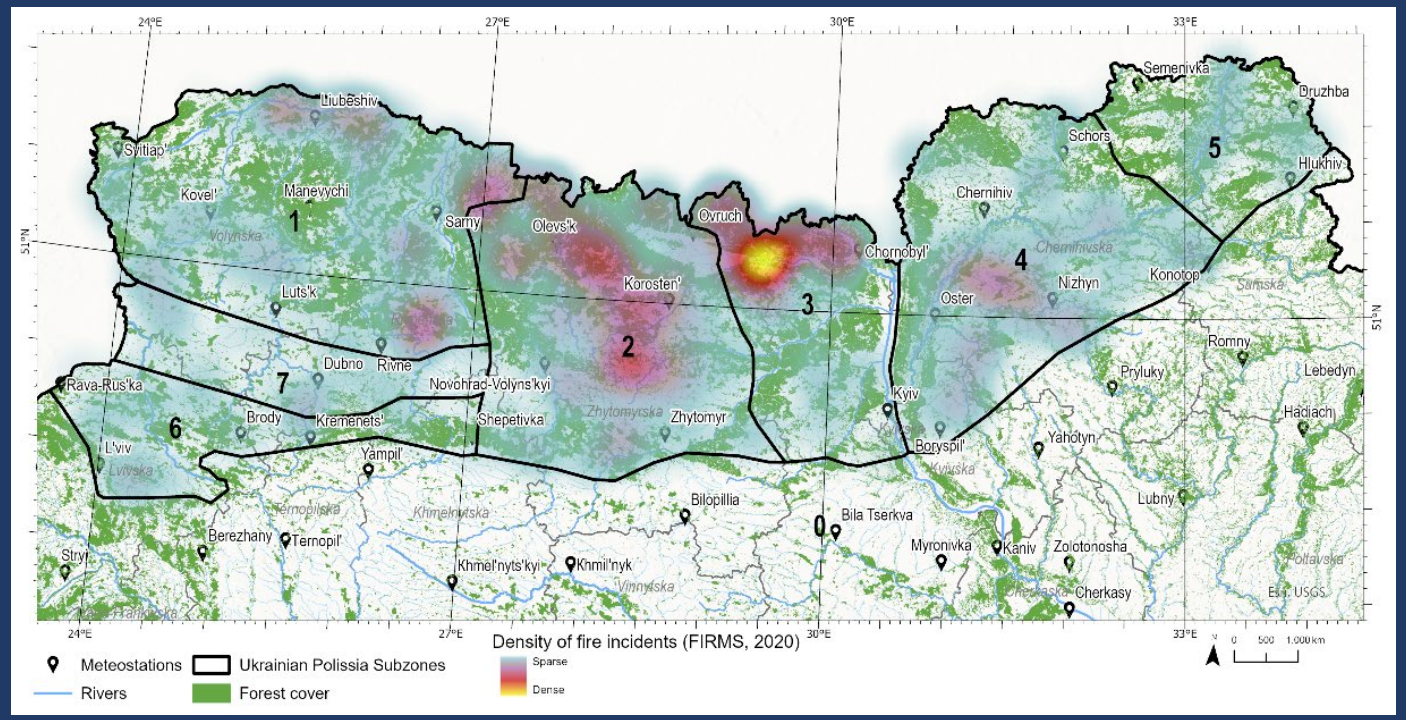
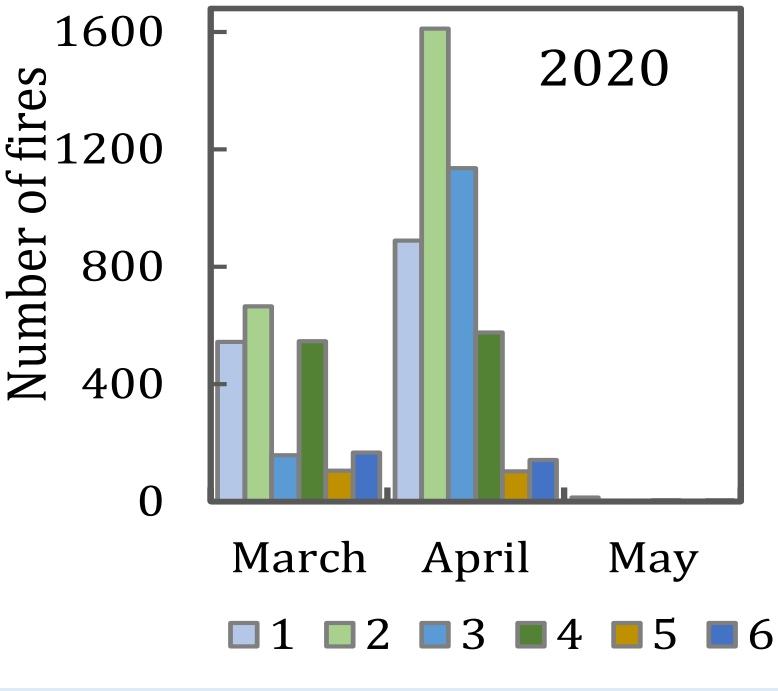
**The prevailing weather conditions in 2020 – snowless warm winter, warm arid spring, and certain accompanying synoptic conditions (e.g., high wind speeds up to 20 m/s) were the drivers promoting the forest fires and a dust pollution of atmosphere air in the most zones of the Ukrainian Polissia.**




**The spatial distribution of fire frequency in 2020 according to the satellite data (FIRMS)**

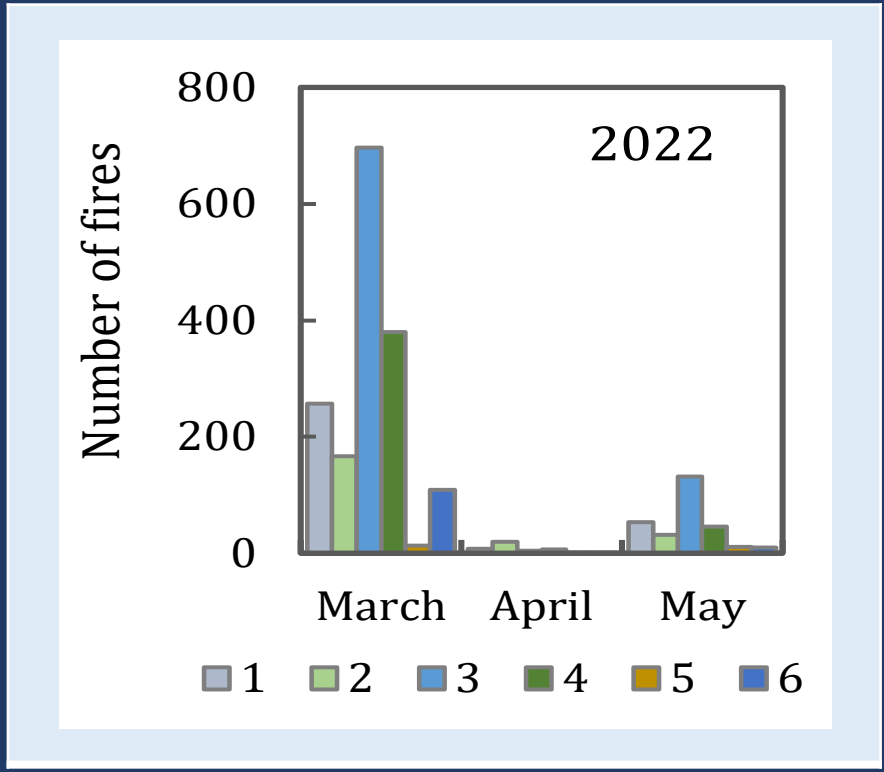



**Number of fires in Ukrainian Polissia**

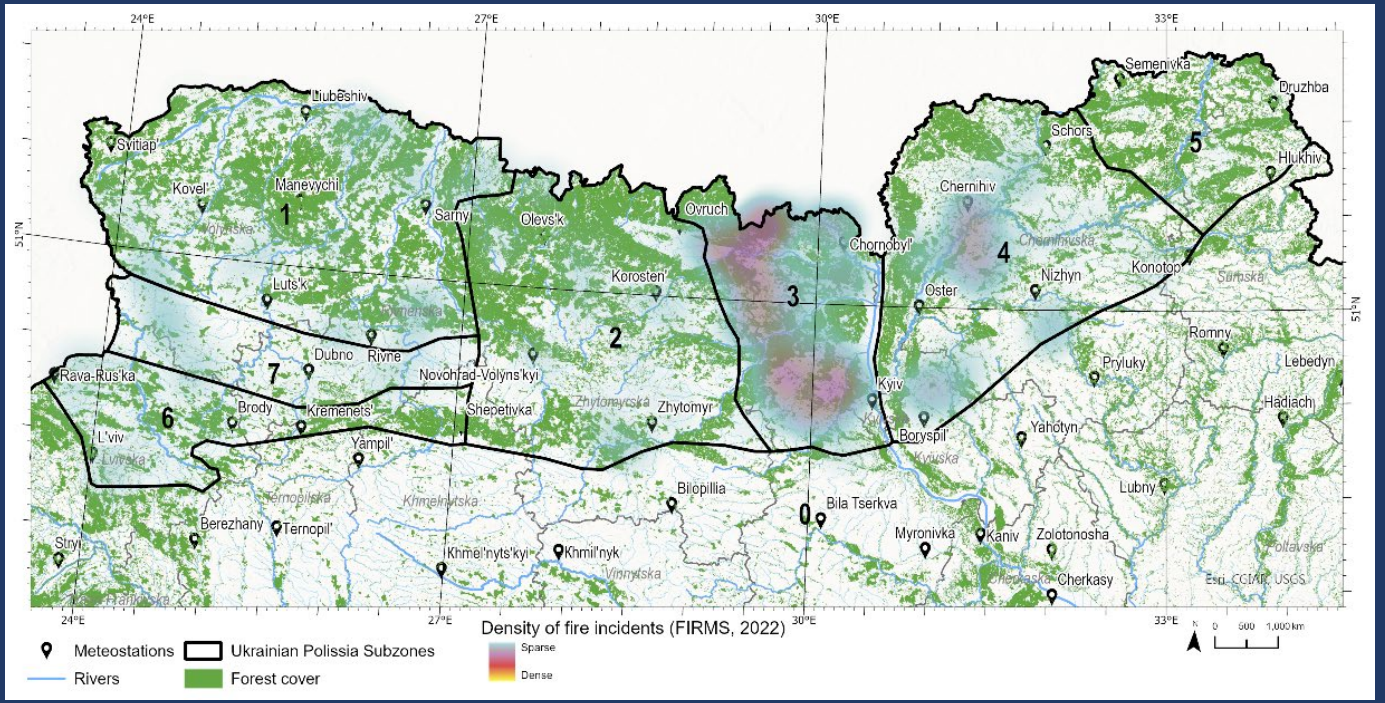
# BUP SYMPOSIUM 2023

## The climatic conditions of the year 2022 and the fires

**The weather conditions of spring 2022** were not as dry as in 2020, however, the fires engulfed a significant part of the territory of Kyiv and Chernihiv Polissia. Most fires were registered in March




Number of fires in Ukrainian Polissya

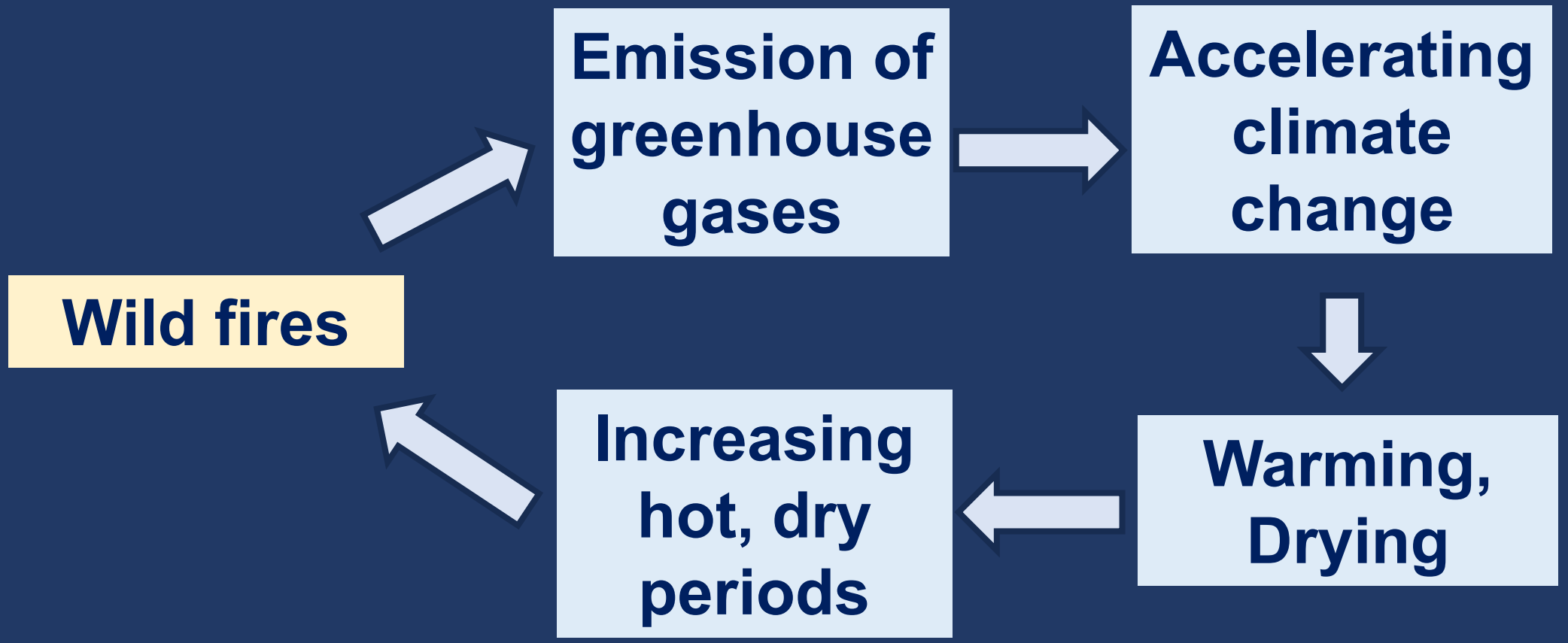



The spatial distribution of fire frequency in 2022 according to the satellite data (FIRMS)

# BUP SYMPOSIUM 2023

## The fires and greenhouse gas emissions

**Forests capture carbon from the atmosphere in the trees and soils. When forests burn, vast amounts of the stored carbon is emitted in the form of CO2, CO, dust, etc. Landscape fires burn up to 5 million $km^2$ of the Earth's surface annually and emit $2.2 * 10^{15}$ g (2.2 peta-grams) of carbon per year to the atmosphere, but also convert a significant fraction of the burned vegetation biomass into pyrogenic carbon (Jones M. at al., 2019). Fires in the Ukrainian Polissia is a small contributor to these processes.**




Forests fires accelerate climate change and contribute to the global carbon circle. Products of wild fires (CO, $CO_2$, other greenhouse gases) are released into the atmosphere and increase the greenhouse effect. The increasing of the greenhouse effect contributes to the general warming.

# Conclusion

# Climate change-provoked fires in natural and human-made systems drive climate change

# Thanks for attention!

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