EcoTER'22
29th International Conference Ecological Truth & Environmental Research
21 - 24 June 2022, Hotel Sunce, Sokobanja, Serbia
www.eco.tfbor.bg.ac.rs

CHARACTERISTCS OF WINTER TEMPERATURE REGIME IN SPRUCE FOREST ON KOPAONIK

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Abstract

The paper presents the characteristics of the winter temperature regime (December, January and February) in the spruce forest on Kopaonik. In addition, a comparative analysis of temperature conditions during the winter in spruce forest and open space was performed. The average, minimum and maximum temperatures during the winter in the period 2012-2018 at two meteorological stations in the Kopaonik National Park were studied: an automatic weather station in a spruce stand (ICP Forests - International Cooperative Programme on Forest Condition Monitoring in Europe - Level II sample plot) and the main meteorological station Kopaonik, which is located in the open space. Average monthly, average minimum, as well as average maximum temperatures are significantly higher in the spruce forest in all winter months compared to the open space. The obtained results indicate that higher temperatures occur in the spruce forest during the winter period, as well as that the forest canopy has the potential to alleviate temperature extremes during the winter months.

Keywords: winter temperature regime, spruce forests, NP Kopaonik, Serbia

INTRODUCTION

Climate change is one of the biggest environmental problems facing the world in modern circumstances. Reports of the Intergovernmental Panel on Climate Change (IPCC) indicate that, according to all possible scenarios, air temperatures will rise during the 21st century, and that there is a high probability that heat waves will occur more frequently and last longer, and that extreme climatic events when it comes to precipitation will become more intense and frequent in many regions [1]. In order to actively adapt to climate change, forest management measures should be adapted to changing environmental conditions - new knowledge and strategies in forest management are needed; the formation of new climate zones would affect the formation of new forest ecosystems, which implies significant changes in the composition of forests; it will be necessary to define new areas of species distribution, etc. [2]. Adaptation, i.e., adaptation to climate change in a broader sense implies adaptation of ecological, social and economic systems in response to the effects of climate change [3–5].

Occurrence and survival of vegetation in a specified area, its distribution, zonal distribution and height differentiation, together with other ecological factors (edaphic, orographic, biotic), are mostly conditioned, i.e., dependent on the climatic characteristics of the region [6–8]. Transitional zones between neighboring ecosystems, such as ecotones along altitude and continental gradients, where contrasting vegetation types and biomes meet, are particularly hard hit by climate change [9,10].

In addition, the world's forests affect the climate through physical, chemical and biological processes that affect planetary energy, the hydrological cycle and the composition of the atmosphere [11]. Forests respond to climate change in different ways caused by local site conditions and the adaptive potential of trees [12]. In general, forest ecosystems are characterized by high resilience and many species and ecosystems have historically adapted to changing conditions. Consequently, future changes are potentially of such magnitude or will occur at rates that are beyond the natural capacity of forest species or ecosystems to adapt, leading to local extinction and loss of important functions and services, including reduced forest carbon stocks and sequestration capacity [13].

It can be expected that the increase in global temperature and the higher frequency of climate extremes due to current climate change will affect the microclimate in forests with the potential to shape future structures of forest ecosystems, especially where natural regeneration is common practice [14,15]. This indicates the importance of studying the microclimatic characteristics of forests, especially when it comes to studying habitat conditions, bioecological characteristics of tree species, as well as the process of natural regeneration in forests [16,17].

This paper aims to indicate the climatic conditions during the winter period in the belt of spruce forests, determine whether there are temperature differences in forest conditions and the open space, as well as to indicate the importance of microclimatic measurements in the context of global climate change.

MATERIALS AND METHODS

Since 2003, the ICP Program has been running continuously in the Republic of Serbia (International Cooperative Programme on Forest Condition Monitoring in Europe). Within Level 1 of this program, a network of approximately 6000 plots (bioindication points) has been established in Europe to monitor the health status of forests and their spatial and temporal changes on a broad basis, and over the necessary period.

By establishing experimental plots in NP Fruška gora, NP Kopaonik, Odžaci, Crni vrh and Mokra Gora in the period 2009–2013, Serbia joined the European network of over 800 level 2 bioindication points where intensive monitoring of the impact of transboundary air pollution on forest ecosystems in Serbia is performed [18,19].

Experimental plot for intensive monitoring - bioindication point of level 2 on the mountain Kopaonik was established in 2010. The experimental field is located in the 74th department of the management unit "Samokovska reka" in the Kopaonik National Park in a pure spruce stand (*Picea abies* (L.) Karst.). The area of the experimental field is 0.5 ha (100x50 m).

On the experimental field in Kopaonik National Park, in addition to other parameters included in the monitoring, meteorological data are collected from the automatic meteorological station, based on which the analysis of microclimatic conditions in the context of current global climate change is performed.

For the purposes of this paper, climate data from the automatic meteorological station "WS-GP1" located on the experimental field in a pure spruce stand in NP Kopaonik, as well as data from the main meteorological station Kopaonik which is located in an open space for the period 2012-2018 were used. These meteorological stations are located in the immediate vicinity.

The paper presents a comparative analysis of temperature conditions in the mentioned period, during which the average, minimum and maximum air temperatures during the winter months (December, January and February) were analyzed.

RESULTS AND DISCUSSION

The influence of the forest canopy on the microclimatic conditions in the forest is, directly and indirectly, related to the degree of the forest canopy and the number of trees. Branches, leaves and needles reflect and absorb some of the sun's radiation during the day, allowing less energy to reach the ground below the forest canopy [20]. In addition, it is generally known that the degree of absorption largely depends on the structural characteristics of the forest, as well as on the composition of the species in the forest. Accordingly, one of the main characteristics of forest areas, when it comes to microclimatic conditions, is that they cool less during the night and limit the daily heating of the air, i.e., the temperature amplitude is lower in relation to the open space. Characteristically, this effect of equalizing the daily temperature amplitude is most pronounced on warm sunny days, and especially in stands characterized by a large number of trees [15].

Figure 1 shows the average monthly temperatures in the winter months at the meteorological station Kopaonik, as well as at the meteorological station in the spruce stand in the period 2012–2018.

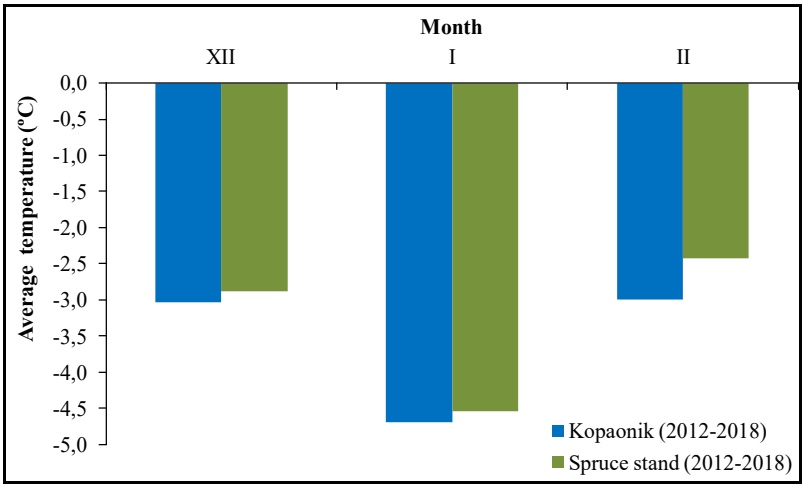

Figure 1 *Average monthly air temperatures at the meteorological station Kopaonik and meteorological station "WS-GP1" in the spruce stand in the analyzed period*

In the analyzed period 2012–2018, the average monthly temperatures in the winter months have higher values in the spruce forest compared to the meteorological station Kopaonik, which is located in the open space (Figure 1).

The average temperature in the winter in the spruce forest is -3.3ºC, while in the open space the value of this parameter is lower and amounts to -3.6ºC. The largest difference occurs in February when the average monthly temperature in the spruce forest is higher by 0.6ºC, while the smallest difference is recorded in December when the average monthly temperature is also higher in the spruce forest by 0.1ºC.

Figure 2 shows the average minimum monthly temperatures in the winter months at the meteorological station Kopaonik, as well as at the meteorological station in the spruce stand in the period 2012–2018.

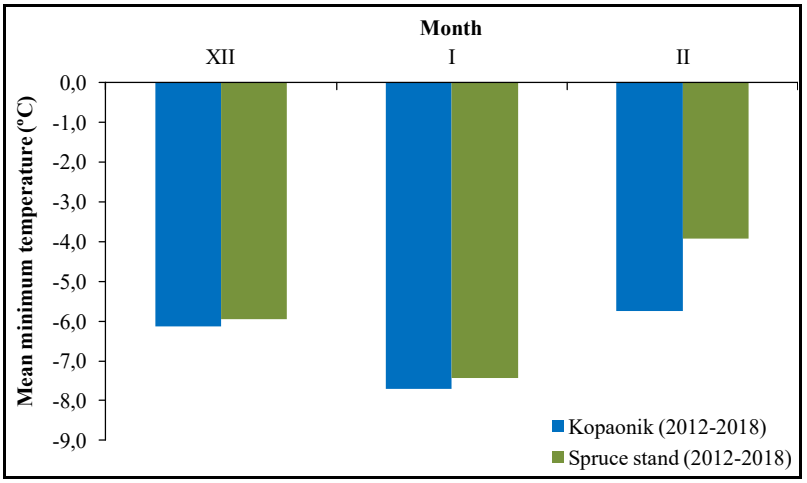

Figure 2 *Average minimum monthly air temperatures at the meteorological station Kopaonik and meteorological station "WS-GP1" in the spruce stand in the analyzed period*

The average minimum monthly air temperatures in the analyzed period 2012–2018 in the winter months are also characterized by higher values in the spruce forest compared to the meteorological station Kopaonik, which is located in the open space (Figure 2).

The average minimum temperature in the winter period in the spruce forest is -5.8ºC, while in the open space the value of this parameter is lower and amounts to -6.5ºC. The largest difference occurs in February when the average monthly temperature in the spruce forest is higher by 1.8ºC, while the smallest difference is recorded in December when the average monthly temperature is also higher in the spruce forest by 0.2ºC.

Figure 3 shows the average maximum monthly temperatures in the winter months at the meteorological station Kopaonik, as well as at the meteorological station in the spruce stand in the period 2012–2018.

The average maximum monthly air temperatures in the analyzed period 2012–2018 in the winter months are also characterized by higher values in the spruce forest compared to the meteorological station Kopaonik (Figure 3).

The average maximum temperature in the winter period in the spruce forest is 0.6ºC, while in the open space the value of this parameter is lower and is -0.1ºC. The largest difference occurs in February when the average monthly temperature in the spruce forest is higher by 1.5ºC, while the difference in December and January is identical, i.e., in both months the average monthly temperature in the spruce forest is higher by 0.2ºC.

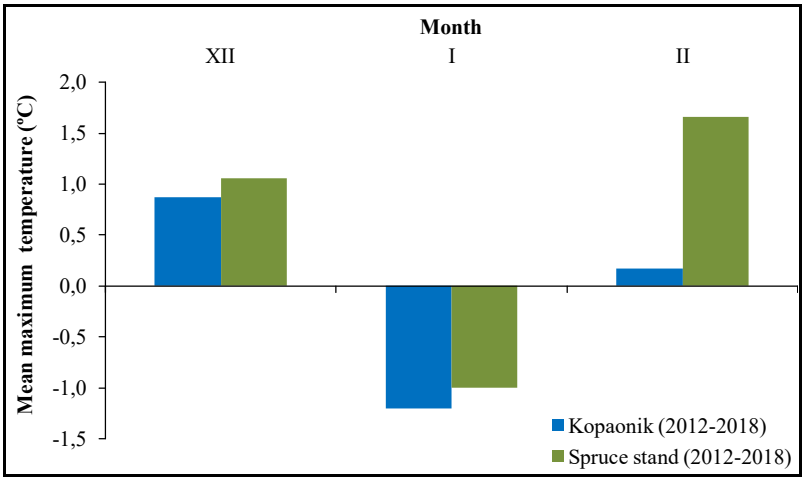

Figure 3 *Average maximum monthly air temperatures at the meteorological station Kopaonik and meteorological station "WS-GP1" in the spruce stand in the analyzed period*

The obtained results confirm the previous statements of the author that the forest canopy has the potential to alleviate temperature extremes that occur, especially during the winter and summer months [15].

CONCLUSION

The paper presents the results of a comparative analysis of temperature conditions from two meteorological stations in the Kopaonik National Park for the period 2012–2018: meteorological station "WS-GP1" which is located in a pure spruce stand and the main meteorological station of the Republic Hydrometeorological Service of Serbia on Kopaonik which is located in the open space.

For the analyzed period, a comparative analysis for 2 meteorological stations determined that in all three months of the winter season there are significantly higher average monthly, average minimum, as well as average maximum temperatures in the spruce forest compared to the open space. The largest differences were recorded in February, while the smallest differences in the analyzed parameters occur in December.

The obtained results in the paper indicate that spruce forest has higher temperatures during the winter period, as well as that the spruce forest canopy has the potential to alleviate temperature extremes during the winter months.

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