

Response of Trees on Climate Extremes in Uneven-Aged European Beech Stand

Stefan Stjepanović^{1*}, Dejan Stojanović², Bratislav Matović²

¹University of East Sarajevo, Faculty of Agriculture-Department of Forestry, Vlasenica, Bosnia and Herzegovina

²Institute of Lowland and Forestry and Environment, University of Novi Sad, Serbia

* Corresponding author: stefan.stjepanovicuis@gmail.com

ABSTRACT

Climate change is a major challenge for the whole planet, and consequently for the European forestry in the 21st century. Climate change and climatic extremes contribute to the reduction of growth and increment, and forests mortality. In European beech forests in Serbia there still have not been observed massive mortality, as it is the case with other species. The aim of this study was to explain how climate factors affect the growth and increment of uneven-aged European beech stand in Western Serbia, on the mountain Boranja. Samples were taken from the mountain Boranja in Western Serbia. Samples were sampled from the trees that grow in uniform habitat conditions. Sampled were 15 dominant trees. Cores were taken with Pressler's borer from two opposite sides of the tree at breast height. Samples were air-dried and sanded with sandpaper, until the annual rings were deeply polished. Samples were scanned and measured using WINDENDRO. Using visual comparisons on the screen with PAST software two opposite increments cores were merged for each tree and cross-dated. Basic statistical parameters were calculated using the software Arstan. Statistical analysis was performed in R. We came to the conclusion that high amount of precipitation in July of the current year positively affect the growth of beech in Istočna Boranja (Serbia).

Key words: European beech, uneven-aged stands, climatic extremes, dendrochronology

INTRODUCTION

Climate change is a major challenge for the whole planet, and consequently for the European forestry in the 21st century. Forests as a large producers of O₂ and consumers of CO₂ should contribute to climate change, and unfortunately the case is reversed. Climate change and climatic extremes more often serve to reduce the growth and increment of forests, rehabilitation and dry forests. There are various scenarios that predict CO₂ temperature change by the end of the 21st century, which will have a significant impact on the very principle management forests. It is expected movement areal types, and even the disappearance of some species grown on marginal habitats. European beech is the

main species in the deciduous forests of Central Europe. It has moderate moisture and soil acidity, which makes it the most extensive kind in the region (Bohn et al. 2004). Beech in Serbia is today the most wide spread and most important tree species (Stojanovic et al., 2005).

Beech forests in Serbia cover a wide band of altitudes, from 100 to 300 m in the zone of oak, and up to 1600 meters in subalpine beech forests in high-mountain regions. (Stojanović et al., 2012). Economic monodominant the most important beech forests in the zone to 800 to 1200 meters above sea level. (Tomic, 1992).

Beech forests can be found on limestone and serpentinite, on different soils and their various stages of development. In

Serbia there are 10 types of soil in which it occurs beech. These are: Delluvium, rendzina, black soil on limestone, siliceous soil humus, eutric brown, brown soil on limestone, illimerised soil, brown podzolic soil and podzol (Kenzević, 2003). Areal beech forests is determined by environmental conditions, habitat and bio-ecological characteristics beech.

The aim of this study was to explain how extreme climate factors affect the growth and increase of unequal-old European beech in western Serbia, on the mountain Boranja.

MATERIALS AND METHODS

Samples were taken from the mountain Boranja in Western Serbia. Sampling was carried out in 122. of the department, in forest menagment unit "Eastern Boranja". The basic characteristics of habitat and stand are: coordinates 44o 21' 23" N and 19 o 16' 37" E, above sea level is 700-815m, deep acidbrown soil on granodiorites, uneven-agedstands, I / II site quality.

Samples were taken from trees that grow in uniform habitat conditions. Sampled were 15 dominant trees European beech. Cores were taken with Pressler's core borer from two opposite sides of the trees at breast height. Samples were air-dried and sanded with sandpaper, until the annual rings were deeply polished. Samples were scanned and measure during WINDENDRO.

Using visual comparisons on the screen with PAST software two opposite increments cores were merged for each tree and cross-dated. Basic statistical parameters were calculated using the software Arstan and statistical analysis were performed with R. (Levanič, 2007).

Climate data were obtained from Hydrometeorological service of Serbia for the meteorological station "Loznica" for the period 1961-2010. Climate diagrams according to Walter and Lieth were created in R for two periods.

RESULTS AND DISCUSSION

The total amount of precipitation is higher in the period since 1991 to 2010. In the period since 1961 to 1990 the lowest temperature is in January (-0.1 C), and the maximum in July (20,7 C). The largest amount of precipitations are in June (99 mm) and the lowest in February (49 mm). In the period since 1991 to 2010 the lowest temperature is in January (1.1 C), and the maximum in July (22,2 C). The largest amount of precipitations are in June (112 mm) and the lowest in February (48 mm). Between 1960 and 1980 the year we can noticed increased growth in East Boranja, while in last several years we have decreased growth (tree ring widths).

On the locality Istočna Boranja found that high temperatures in September of previous year negatively affect the growth of beech, while large amount of precipitation in July of the current year positively affect the growth of beech trees in uneven-aged stands (Figure 3). Correlation between temperatures in previous September was -0.27, while correlation between precipitation in July and growth for the period 1961-2010 was 0.41. From the ecological point of view, temperature from previous year is not easy to relate with growth, which is not the case with precipitation. Precipitation during summer is very important for growths and survival of trees, especially during drought periods.

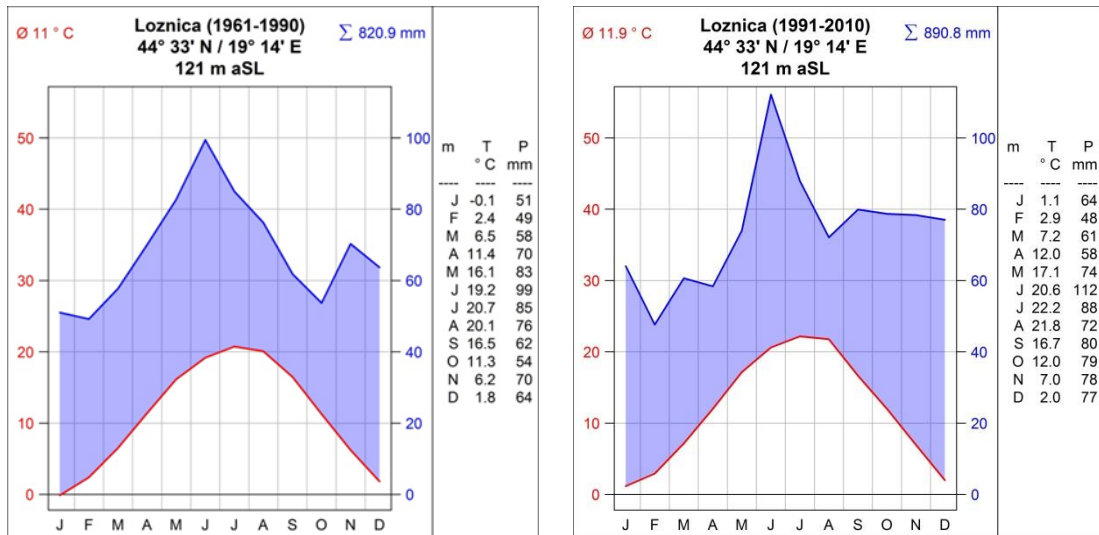


Figure 1 Climate diagrams for measuring station Loznica for the periods 1961-1990 and 1991-2010.

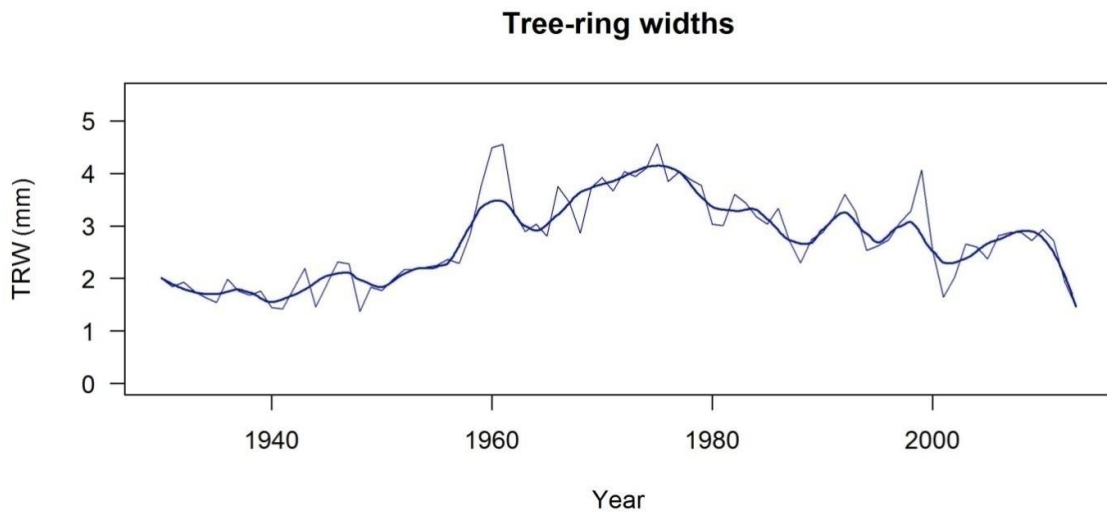


Figure 2 Tree-ring chronology of Istočna Boranja

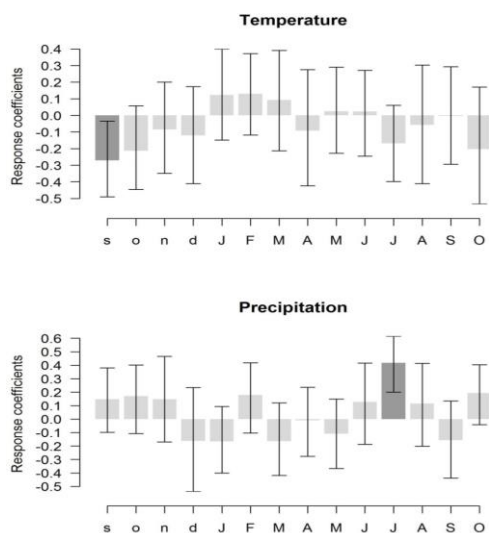


Figure 3: Istočna Boranja- Simple Pearson's correlation between the growth and and climate variables (temperature and precipitation) in beech stand for the period 1961-2010

CONCLUSION

Similar methods of climate impacts on growth were made in pedunculate oak (*Quercus robur*) forests. The aim of this study was to tackle the issue of oak floodplain forests response to water level, temperature and precipitation changes due to the altered climate conditions. In Serbia (Srem region) due to the decrease in the water level and temperature increase in the last 30 years, a general decline in growth was observed. (Stojanovic et al., 2015).

Stojanovic et al., (2014) used similar methods on river Danube in forest management unit Sombor. Long-term trend of declining water levels of the Danube, consecutive extremely dry years were the main cause of declining increment and drying trees.

Drawback of this research could be difference in elevation between meteorological station Loznica and stand Istočna Boranja. Elevation difference was about 700 m.

Why response of beech growth to the temperature and precipitation was not stronger? Istočna Boranja is one of

optimal sites for beech in Serbia, from which we can assume that observed stand was not under any limitations regarding water.

CONCLUSIONS

Careful evaluation of our results show that climate in the region of the stand Istočna Boranja has increase in the annual sum of precipitation in last decades in comparison to the referent period 1961-1990. From that point of view, we can say that extremely hot years in recent past has not have significant impact to those forests. That could be reason for mild response of tree growth to climatic variables. We found by the aims of dendrochronological methods that precipitation in July has considerable importance for the growth of European beech at Istočna Boranja stand.

ACKNOWLEDGEMENTS

The authors acknowledge the COST actions PROFOUND. This paper was realized within the COST action Profound FP 1304. STSM TOPIC "Climate change impact on European beech forests – evaluation of forest predictive model " (1st to 30th of April 2015).

REFERENCES

- Bohn, U., Hettwer, C. and Gollub, G. [Bearb./Eds.] 2005. *Anwendung und Auswertung der Karte der natürlichen Vegetation Europas / Application and Analysis of the Map of the Natural Vegetation of Europe*. – Bonn (Bundesamt für Naturschutz) – BfN-Skripten 156: 452 S./p.
- Knežević, M. 2003. Land in beech forests in Serbia. *Journal of Forestry*, 55: 97-106.
- Levanič, T. 2007. Atrics-a new system for image acquisition in

- dendrochronology. *Tree-Ring Research*, 63: 117-122.
- Stojanović D., Matović B., Orlović S., Kržić A., Đurđević V., Galić Z., Vuković A. and Vujadinović M. 2012. Upotreba indeksa suše za evaluaciju uticaja promene klime na bukove šume u Srbiji. *Journal of Topola/Poplar*, No 189/190: 117-123.
- Stojanović, D., Levanič, T., Matović, B., Galić, Z., and Bačkalić, T. 2014. Vodostaj Dunava kao faktor smanjenja prirasta i vitalnosti stabala mešovite sastojine lužnjaka i cera. *Journal of Forestry*, 3-4: 155-162.
- Stojanović, D. B., Levanič, T., Matović, B., and Orlović, S. 2015. Growth decrease and mortality of oak floodplain forests as a response to change of water regime and climate. *European Journal of Forest Research*, 134: 555-567.
- Stojanović, Lj. 2005. *Beech in Serbia*. Monography. Faculty of Forestry University of Belgrade. Association of Forestry Engineers and Technicians of Serbia.
- Tomić, Z. 1992. *Forest plant communities in Serbia*. Faculty of Forestry, Universtiy of Belgrade, Belgrade, Serbia.