

(RESEARCH ARTICLE)



## Climate change provided through the dendrochronology of the peak oak (*Quercus robur* Lat.) in the area of Sumadija- Central Serbia

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### Abstract

This paper analyzes the importance of monitoring dendrochronology study as indication aspects of the vitality of oak's trees, and general oak's forests. The task was processed on the basis of a detailed analysis of oak's forests, in the 5 experimental fields and study of numerous bibliography in these areas. Dendrochronology study basis of monitoring, and-diameter increment, and the monitoring all the elements of volume increment. Research and climate-change; has-been-conducted-on-the territory of Sumadija, in the area of forest estates of Kragujevac. The-monitoring-it-self-is-very important both because bio indicative, and future management of oak's forest.

**Keywords:** Increment; Monitoring; Oak; Dendrochronology

### 1. Introduction

The vitality of forests and trends of their race, today the basic settings that determine the level and nature of economic activity in forestry, but also need special social care and prescribing measures to restrict all forms used when necessary. Observing the responses of individual species to change environmental conditions (climate change, temperature extremes, air pollution, groundwater level) represent elementary task in the process of preserving forests, as this does not happen actually, or if quantitative indicators are proven. Research integrates ecological and dendrochronological methods to investigate the extent of natural and anthropogenic impacts on declining white bark pine communities in Sumadija- region- Serbia.



**Figure 1** Study area

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## 2. Material and methods

The study was conducted on 5 experimental fields in the oak's forest. in the area of Sumadija. Experimental fields are separated according to the methodology of forestry [1]. It was determined that the tracking oak's forests and very experimental fields located in Woodlands, Gružansko-Lepenički-Jaseničke-Forests, since this management unit includes a great number in oak's forests. Geological base pertain ferruginous (sandstone-quartz-decaying department 65 g, 65d and 65a,) and (serpentine, mostly in the wards 66a and 66b). (5 experimental fields)- Figure 1. Plots are contain eutric brown soil, in the first three wards in two others the eutric siliceous soil.

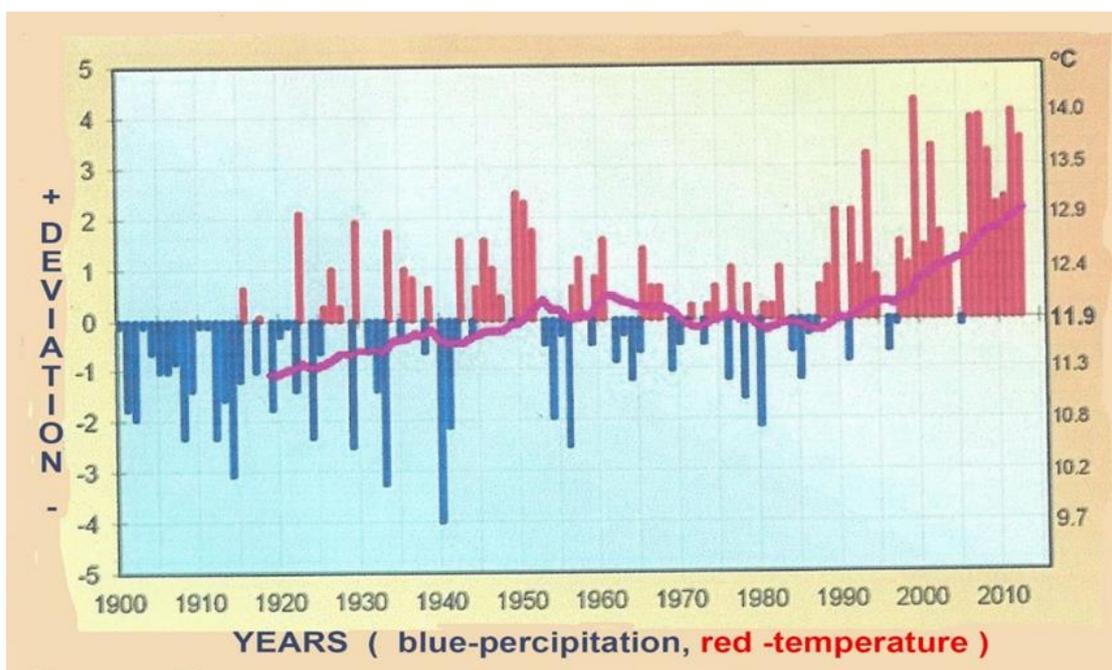
Elevation ranges from 350 m to almost 500 m above sea level which does not stand as a big range, and therefore does not have any big influence on the state of the crops. The slope of the terrain ranges from 5 to 15 degrees, which as a steep medium is exposure prevailingly to northwest and southwest. Concerning air study of the area, it is quite continental to moderately continental.

### 2.1. Climate studies

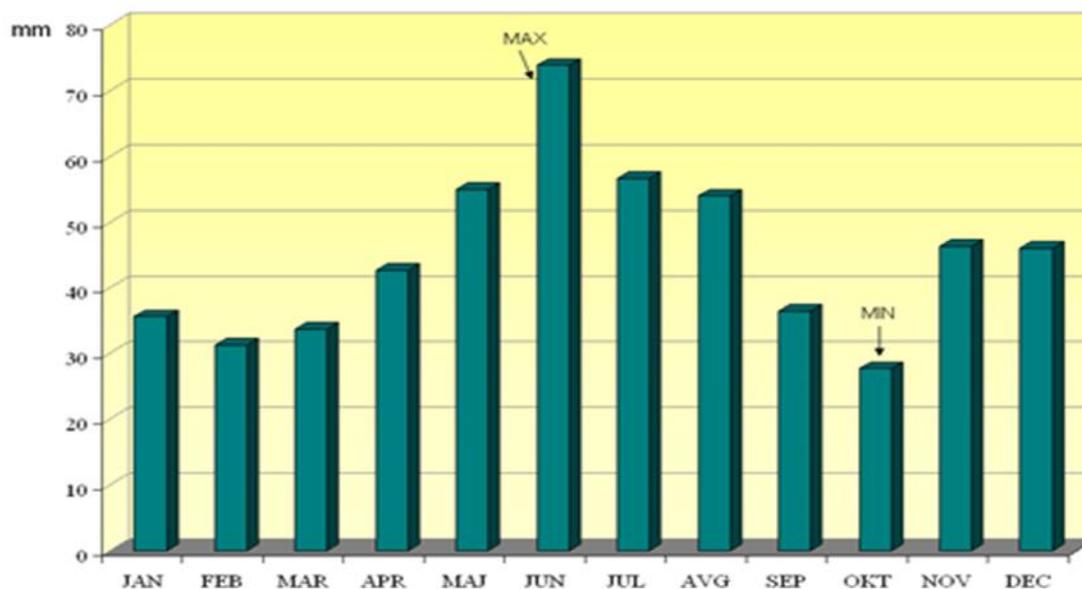
(Climate research was conducted (temperature and precipitation) as the most important climatic factors.

Concerning air study of the area, it is quite continental to moderately continental. Climatic conditions differ depending on the altitude, relief and exposure with the average annual temperature is 11.8 ° C. , the period without frost 180-215 days inbetween and the period of sunshine of 2100 hours a year. The maximum and minimum temperatures ranged in their absolute amount of 41.7 ° C - (- 37 ° C). It can be concluded that there are large fluctuations in temperature, where the hottest months are July and August, and the coldest January and February [7].

Furthermore, average annual precipitation is 681,8mm, since the winds are the most northern squally wind. The snow and wind have negative effects and fractures in oak forests are noticeableas it is well known that oak-tree has deep roots and resistant to rippings by the wind, unlike in the case with heavy snowfalls and strong winds. Precipitation and temperature data were taken from official meteorological stations located near the field of view.



**Figure 2** The graph shows the temperature changes from 1900-2010 for the region of Sumadija. If you look at the diagram you see that temperatures are rising.



**Figure 3** The diagram shows the precipitation in Sumadija with the maximum and minimum precipitation during the year.

## 2.2. In study floristic

Composition and phytosociological determination of belonging study stands, phytocoenologically captured at all sample plots obtained by the method of Braun-Blanquet's. Detailed investigations were carried out in oak forests, where there are other types of oaks: farneto oak-cerris *Quercetum farnetto* Rud.1949. This community belongs to the class syntaxonomic terms *Querco- Fagetea Br.-Bl.et Vliegen 1937, right-Quercetalia pubescentis* No. Bl.1932; regarding *Quercion; farnetto; Ht.1954*.

In all experimental fields is done the following: entire dendrometric diameter measured, diameter, height, drill punched the tree, for taking increment cores and computation of gain, by Presler method [4]. On the basis of the data, the volume and growth were calculated and measurements and analysis of growth rings were performed in the laboratory, by special instruments and related software. (Digital positionmetre, TSAP, statistical analysis, etc.).

Observing the action of both endogenous and exogenous factors was conducted, supporting on the state of the stand and directly, based on quantitative and qualitative characteristics of volume increment [2]. Monitoring the situation stands, covers, mostly components that are related to stand structure and which, together with the analysis increments allow for a realistic assessment of the current situation and future forecast development [3].

## 3. Results

The elements of stand structure (diameter, height, crown development, biological position of the trees), and in particular the volume and diameter structure, showing that the stand is in a phase of strong regressive succession. Oak's, as species, has a relatively strong impact if included the land, the ground flora, microclimate, vegetation, stand aging and site conditions. Oak's is known as a species that can regenerate its growing force, regardless a greatly suffering and damage that can suffer, so in case of favorable conditions, it can be manifested in diameter and volume increment a lot. (Figure 4)- diameter increment. This the stand is dominated by species of lower production, namely lower ecological.

In Figure 4 the growth of trees in thickness,- ( X axis shown year of tree life, Y axis shown diameter in cm.) shown is actually the total diameter increment for all five analyzed trees, for all five experimental fields, growth curves, show actually known flow, growth and development of trees in thickness, and there are no major discrepancies. If you take a closer look at the graph, we see that in II tree analysis, ie. in another experimental field, that values a little higher in the second relationship to the tree analysis, the reason is because they are in the experimental field made care measures, thinning, about 20-year of age. All other curves are more or less similar to the flow. First culmination of gain

was between the 10 and 15 years of age. Growth curves would have a different course that made care measures in another experimental field, that values a little higher.

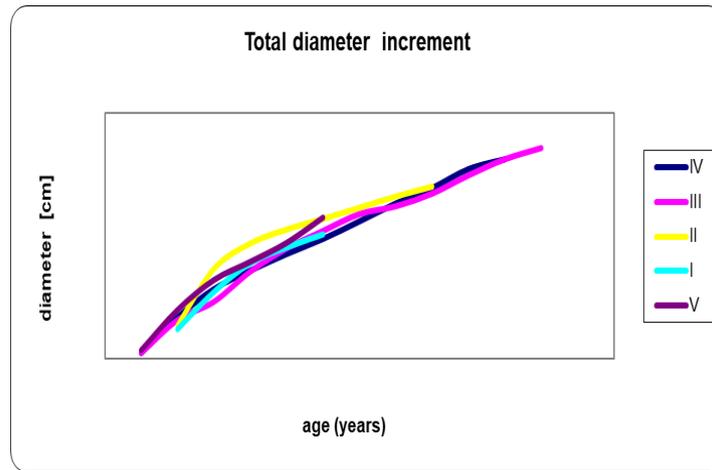


Figure 4 Total diameter increment for 5 experimental field

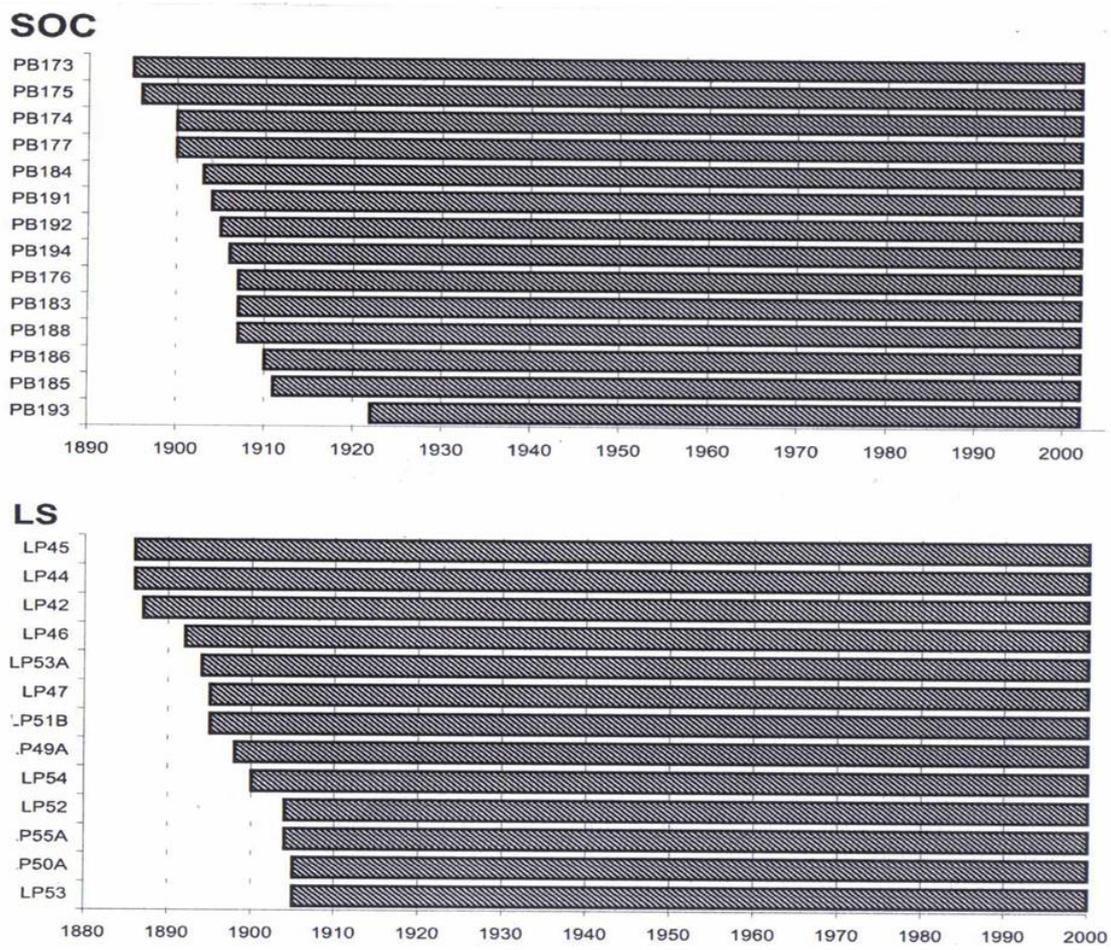
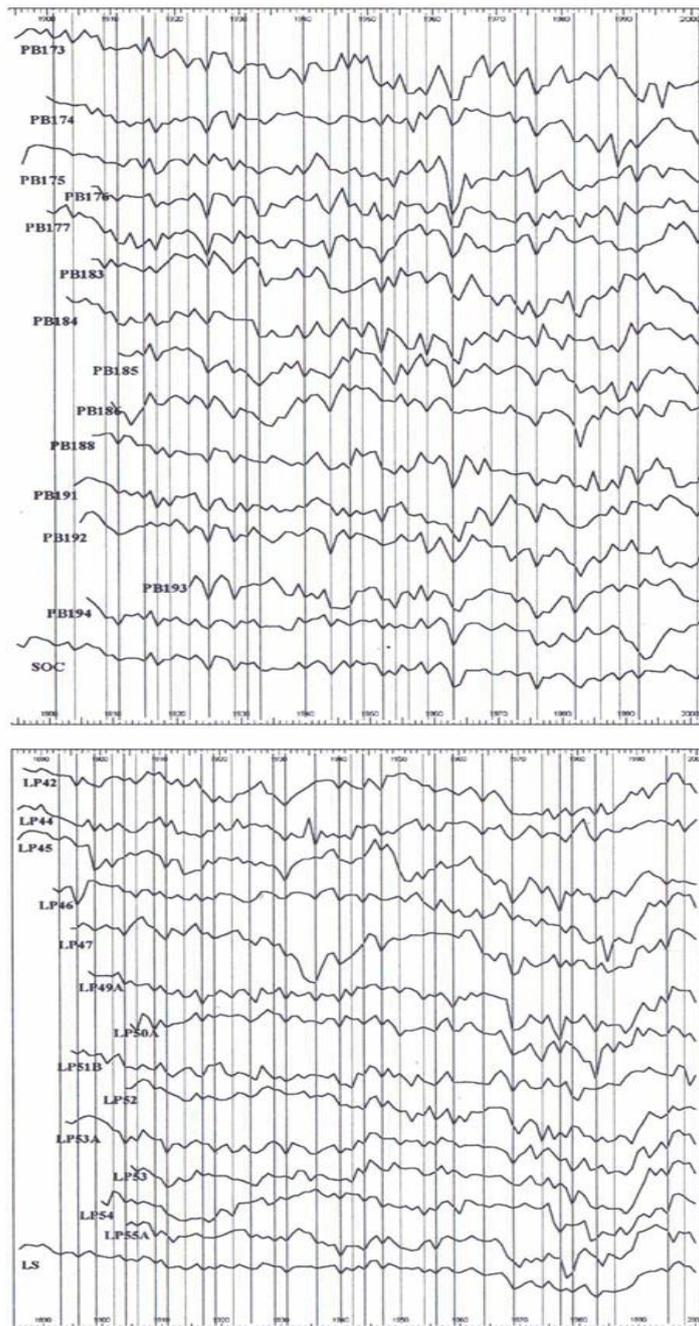
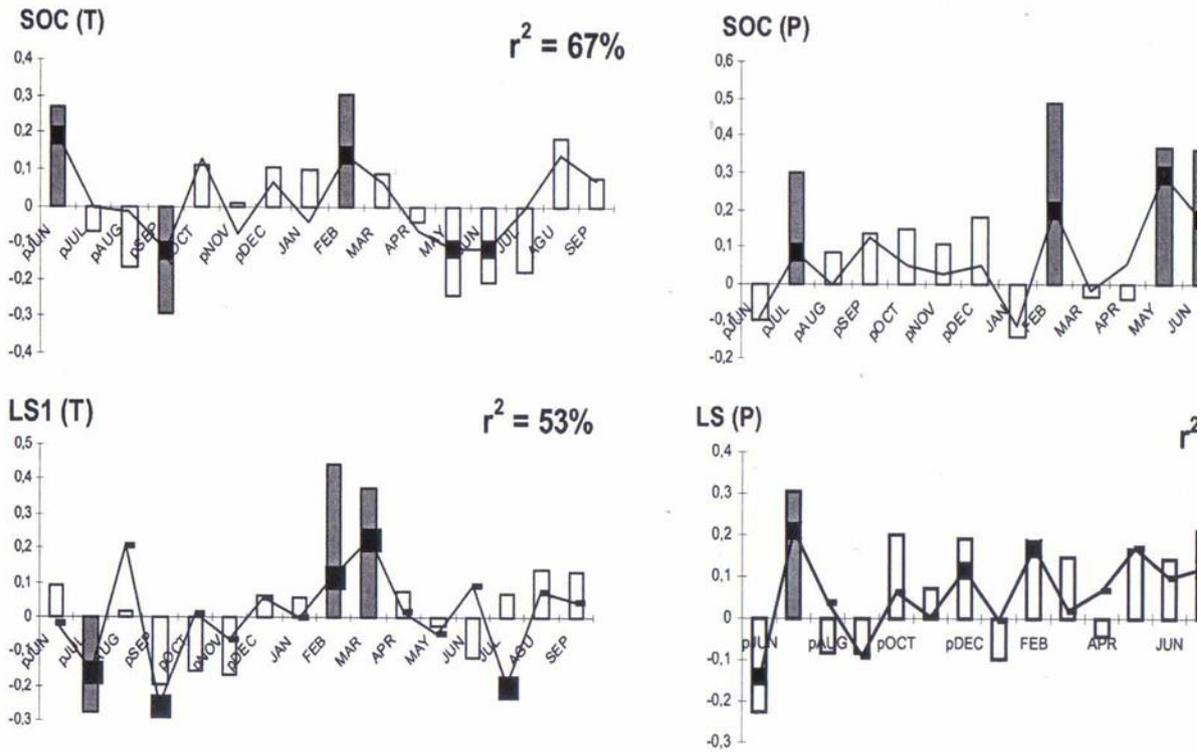


Figure 5 Spans of individual series of the radial of *Oak-Quercus robur Lat.*, (SOS) and (LS)

Explanation: Chronology SOC displays high similarity of individual dendrograms, as well as high number of signature (29 years, 10 positive and 19 negative). The chronology LS contains 10 positive years, but only 8 negative ones, altogether 18 signatures.



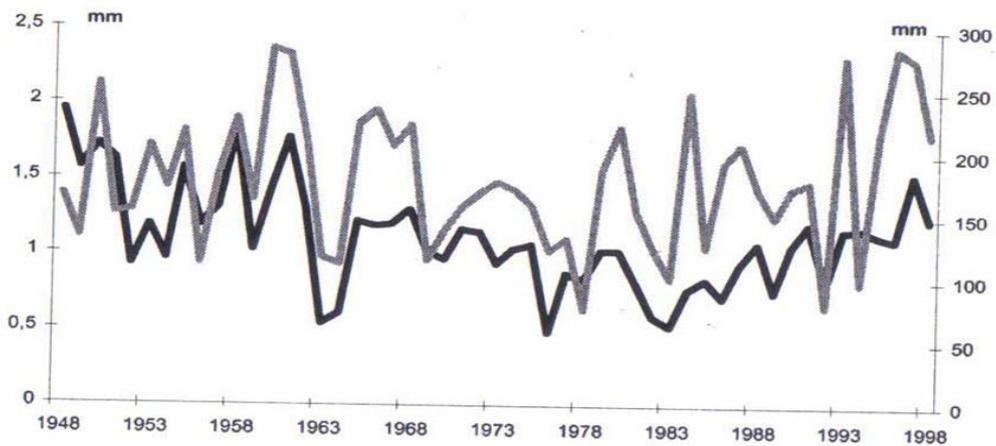
**Figure 6** Dendrochronological patterns of *Quercus robur* Lat. This is Figure 6, in connection with Figure 4. It is the diameter increment, with the difference being that in Figure 4, showing s gross-total diameter increment, and here- in Figure 5 shows each oscillation diameter increments.



**Figure 7** Results of the response function analysis and correlation coefficients for (T) Temperature and rainfall (P)...simple correlation- bars regression coefficients-lines.

Values statistically significant for  $\alpha = 0.05$ - gray bars, and black squares, SOC- *Quercus robur* LS- *Quercus farnetto*.

Note: Temperature and rainfall are the most important climate factors.



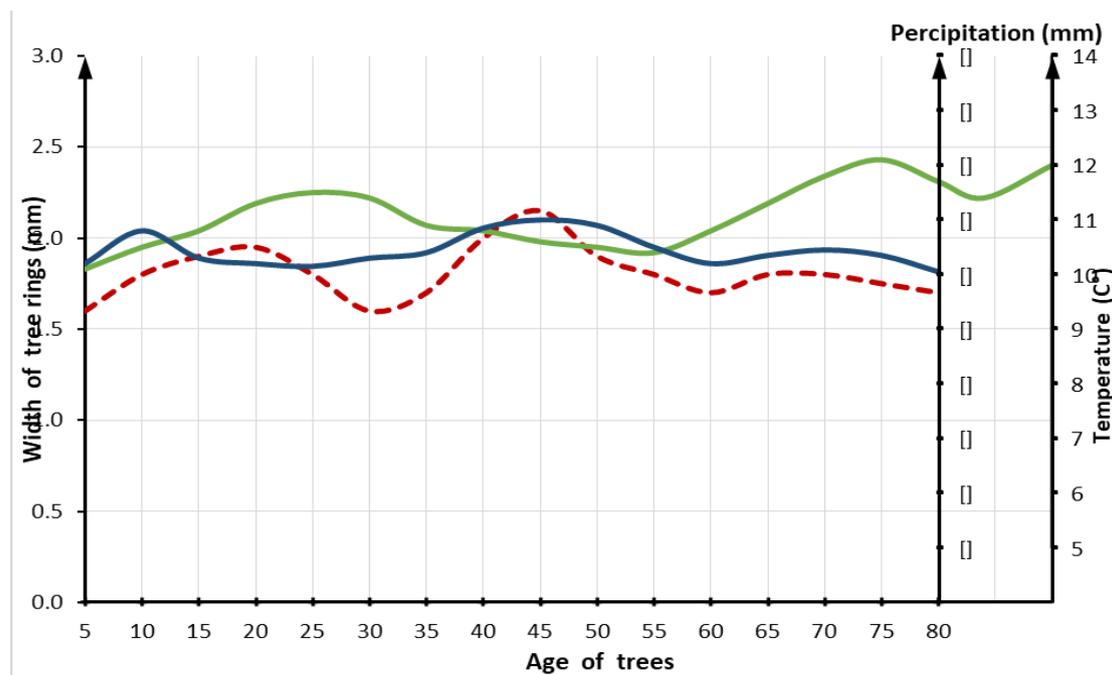
**Figure 8** Similarity between tree ring width chronology of the (Oak)- *Quercus robur* Lat.- (black) and amount of May July rainfall (gray).

Dendrochronology of oak's trees, and the character of its reactions to exogenous factors are checked by volume and the radial increment, ie the width of the growth ring [5]. In addition to the width of tree rings as a significant production indicators, the analysis of variation in the width of tree rings from wide to very narrow is of particular importance, as

bio-indicators of vulnerability of a species in a given habitat [6]. In addition to the oscillation, the width of tree rings is very important indicator of the trend of growth.

Special analysis included first biological position of oak trees, whose growth is not affected by competitors, but results from tree vitality and activity of exogenous factors. It is characteristic that the tree ring width varies in a wide range of only 0.5 mm (which is not typical for the tree and biological position), to more than 3.5 mm. Also, there is a clear tendency of decreasing of diameter increment past all years. The trees with a bit width of tree rings do not have sufficient capacity to carry water and nutrients, which in the case of dominant trees, due to the development of the crown and large transport distance, often leads to disbalance between supply and consumption of water or to revitalization and death [8].

Taking into account that the trend of growth under the influence of light, in order to minimize the influence of others, or to monitor the reaction of trees on the effect of exogenous factors on the diameter growth indices were calculated according to the formula width years.

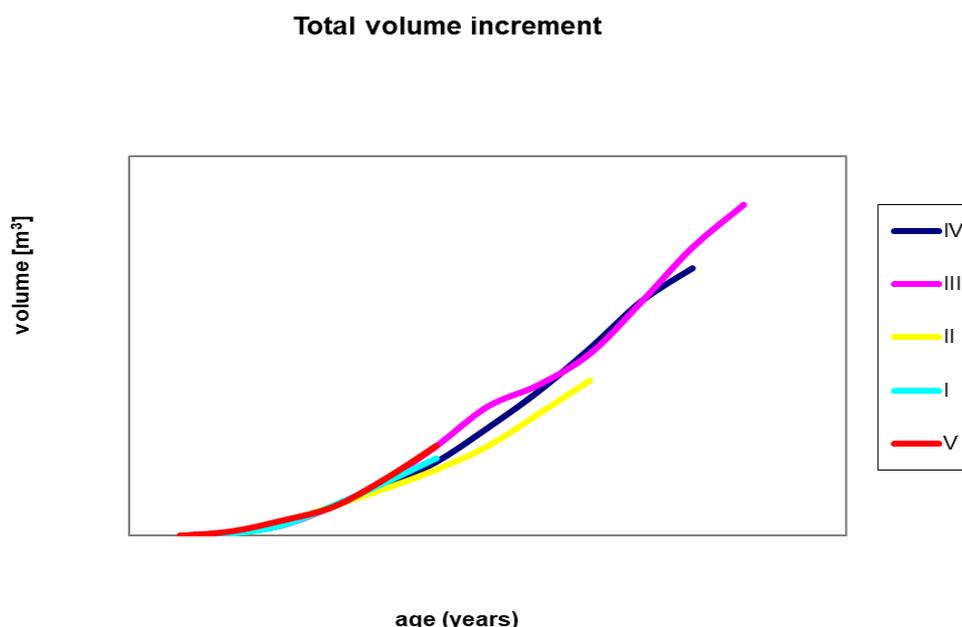


**Figure 9** It is characteristic that the tree ring width with two important: climate factors:

Green-temperature, Blue-precipitation, Red-width of tree rings.

In Figure 9, show, Similarity between tree ring width chronology of the Oak tree (*Quercus robur Lat.*) blue color indicates precipitation, green beam temperature. The red color indicates the width of the trees rings. It is noticeable if the graphic is carefully looked at, that at a slight culmination of precipitation, it grows in size and width of the years. from this it is clearly seen the climate impact on oak forests in the investigated area.

Dendrochronology of and the character of Oak tree (*Quercus robur Lat.*) Its reactions to exogenous factors are checked by volume and the radial increment, i.e. the width of the growth ring. (In addition to the width of tree rings as a significant productioning indicators, the analysis of variation in the width of tree rings from wide to very narrow is of particular importance, as Bio-indicators of vulnerability of a species in a given habitat [6]. In addition to the oscillation, the width of tree rings is very important indicator of the trend of growth.



**Figure 10** Total volume increment for 5 experimental field

In Figure 10 the volume - (X axis shown year of tree life, Y axis shows the volume of trees in  $m^3$ ) of the growth of trees, which actually means the total volume

growth of trees throughout the life. The volume growth of trees has a normal consequence, diameter and height increment and streams increment, of all five analyzed trees, have more or less similar to the current value of that volume growth during the life of the trees. Only a small, insignificant little, expressed the value of the code, II analyzed trees around 30 years of age.

One of method dendrochronology explains the observed process of dying and reducing the number of oak, trees, pointing to further adverse development courses that can be expected in the case of abandonment of the stand with spontaneous development and applying natural laws [10]. The most widely about conceding stand spontaneous development can speak only conditionally, since the character of their further development aimed at previous usage (stands thrown out of balance), or are strongly influenced by global and local changes in environmental conditions, very often both expressed through synergistic effect.

If beech and oak stands were considered economically less valuable, as it is sometimes present in practice, it could be through the seemingly spontaneous evolutionary process at first sight, justified and expressed in protective and ecological function of forests, particularly in buildings of special purpose, such as national parks [11]. Yet, if the protective and ecological potential noise produced is proportional to the organic matter is included, then the justification must be seriously questioned, neglecting the care of their composition by tree species, and the level of production of organic matter [12]. It is known that they represent extremely important ecological functions of forests, such as reducing the concentration of  $CO_2$  in the air and forming the oxygen, directly related to the balance of assimilation of the volume increment [9].

#### 4. Discussion

Conducted research and analysis show that there are many strong reasons for monitoring the vitality of forests, and forecast their future development. Monitoring activities should be complex and constant, whereby it is necessary to include the typical natural and businesses, especially those that are already indication, tending to distort the natural balance and revitalization. The knowledge of the need for ongoing security stability of forest ecosystems, and thus and existential basis of Forestry, indicate the need for in-depth research and monitoring increment of forest trees as a complex reaction trees on stimulating and disruptive action of exogenous, and endogenous-factors. Advocating for experienced, well-established procedures and schemata in forest management, as the basis of rational forestry, it must be replaced by the new active approach, directed towards learning from nature, and supporting only those natural processes, acceptable for a man. This leads to a better implementation of environmental ethics, and the boundaries

between classical forestry and applied ecology. Such an approach is void if not improving considerably more complex and expensive system of forest management used only in the event that there is a material base. Arguing for a concept close to nature forest management, it is frequently the sphere of economic realism, uncritically and without valid arguments becomes environmentally romanticism, which rests on a claim-Nature knows best. It is the last resort for resolving all issues related to forest forests. In doing so, they lose sight-of-some important facts:

Nature do not always act rationally and is not always directed towards the positive direction of movement to preserve stability, particularly when the individual anthropogenic activities important part is moved out-of-balance. In the centre of all events is the man who must solve their existential question in order to survive. Letting a forest to a spontaneous development-without proper supervision, a man of action, leading to a drastic measures, by reducing their effectiveness in comparing numerous functions of forests. It is undoubtedly true, however, that modern human survival and development owed it to the nature, which requires the assistance of the man itself.

In such circumstances, it is very important to avoid extremes and advocacy solutions that are not based on objective indicators. Orientation on short-term solutions only and relying on emotions could have devastating consequences for the forest, and nature in general. Only rational use of forest and natural renewable resources, with controlled monitoring, can provide a secure future for forests and nature at all.

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## 5. Conclusion

On the basis of all the above data, data, charts in the end, based on all the obtained results of the survey, based on the monitoring of the most important climate parameters (precipitation and temperature), based on taking all the important orographic, hydrological factors, the following can be concluded. The oak forests of the *Quercus robur* Lat. In the investigated area may be a reliable indicator of climate change, and that through woods of trees can be read-in effects of climate change. That thick-field studies are the basis of dendroclimatology and dendrochronology. Specifically, these studies, in the forests of the litter, have character-pioneering - and are based on scientific principles, which are applied in the world. Specifically, oak ore, can be characterized as a kind of wood, which is sensitive (sensitive) to climatic influences. A solid data base (climatic, dendroclimatic, forestry) was obtained for the part of Sumadija, which can be a good basis for subsequent research in this area. Hydrological impact in the explored area is very pronounced as the local area runs through the explored area by local rivers, streams, tributaries, etc. Considering the fact that during the survey, the relief (inclination, exposure), and the origin of the trees (deciduous and generative), further analyzed the density of the late tree, and that all ecological factors (biotic and abiotic) were taken In view of this, we can be sure of the reliability of the results obtained. All relevant relevant data related to meteorological and climatic research were obtained from RHMZ, and through their official web address: [www.hidmet.gov.rs](http://www.hidmet.gov.rs), which also supports the reliability and credibility of the results. On the basis of everything set out, we can be sure that the works are valid-pioneering dendro climatic research in the investigated area of G.J. Rogot.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

The author declares no conflict of interest.

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