RESEARCHES REGARDING CLIMATE IMPACT OVER GROWTH RINGS IN OAK IN THE REGION OF BAIA MARE, MARAMURES, ROMANIA

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Abstract

A dendrochronological and dendroclimatological analysis was carried out on samples of Baia Mare oak from a site located near the city, where the influence of heavy metal pollution is high due to local industry. Anthropogenic pollution favored increased sensitivity of oak trees, to current climatic changing conditions. This data is analyzed in order to verify the influence of climate, in particular the temperature and the precipitation signal. Signal observed for the earlywood series is stronger; the maximum is calculated in relation to the maximum temperature (0.35), in April current year. Climate sensitivity analysis was performed separately for the first half of the first half of the 20th century and the second half, using correlation analysis and response functions. Since the development of local mining friction allowed soil and air pollution with heavy metals deposits and highly toxic chemical solutions used to separate gold from the remaining metals.

Key words: correlation, oak, ring width, response functions, pollution

INTRODUCTION

During the last years a large number of studies have examined the influence of climate on annual tree ring width variation both in Romania (Nechita & Popa, 2012; Levanić et al., 2012) and abroad (Čufar et al., 2008a; Dagmar et al., 2008, Friedrichs et al., 2009). The extent of the issue occurs due to current climate changes that are apparent increasingly.

Annual growth ring can store information that conditions positively or negatively, the annual increasing (Schweingruber, 1996; Nechita, 2013). In our case trees climate sensitivity is accentuated by altering the local environmental conditions, thus, Cicârlău deposit began to be systematically exploited since 1962. There are also and adjacent veins concerned Venesa, Nucuţ, Ilba, the latter is very old, it is the object of exploitation since the 16th century. Until 1962 there has worked with rudimentary means, so that environmental pollution was minimal, after this year they used cyanide to separate metals and its derivatives, so that the local environment has severely affected.

Objective of this study was to quantify the sensitivity of the oak after negative anthropogenic intervention. Separate analysis of correlation and response functions for the previous period and the subsequent pollution, providing information on behavior modification trees due to cumulative disturbance of climate change and local pollution. Analysis of intra annual growth ring provides valuable information on the time of year that is most critical in the formation of biomass deposition.

MATERIAL AND METHOD

The study area is located in the northern Romania, Baia Mare County (47°39′ N, 23°39′ E) intro hill region. The stand is constituted mainly of oak, which covers over 70 % of the stem number, but besides basic species is also found sweet chestnut and beech. The altitude is approximatively 281 m a.s.l.; stand is located near the town Baia Mare where pollution is greatest. Samples were taken following the principles of dendrochronology, at a height of 1.30 m (Fritts, 1976; Cook and Kairiukstis, 1990; Popa, 2004).

For the analysis of correlation and response functions we used the residual series of radial growth, total ring width (RW), early wood (EW) and latewood (LW). In a special way was examined statistical parameters expressed populations signal (EPS) and inter series running correlations (Rbar) to assess the theoretical number of individual series needed to build a robust mean with a maximum climatic signal. Climatic data were provided from meteorological grid box CRU TS3, with the grid resolution 0.5°, for the period 1901 – 2013 (Jones and Harris, 2008).

RESULTS AND DISSCUSIONS

Analysis of RW series, for which the values of expressed populations signal and inter series running correlations are significant, shows that mean series has a length of approximately 113 ± 18 years (Fig. 1). Time period covered by individual series is between the years 1830 - 2011, having a number higher than 10 individual series after 1890. Mean of increase for individual series, ranging from 1.43 mm·an^{-1} in first period of century, after this drops to 1.22 mm·an^{-1} on RW. This trend is observed in the series of total ring with, where after 1950 the average growth value decreases from 0.94 mm·an^{-1} to 0.7 mm·an^{-1}. In contrast to this, early wood increases in the second half of the century from 0.40 mm·an^{-1} to 0.51 mm·an^{-1}.

Statistical confidence of the series, measured by EPS index has an average value of 0.97, being significantly with a higher value after 1890. Variability explained by first principal component is greater in RW and LW series with values over 50% on the residual series and insignificant lower in radial growth values. Much lower values of this parameter define the series of early wood about 20%.

The signal to noise ratio is high, this parameter is directly related to the variability explained by the first principal component, for this reason it is normal that the highest value to be in RW an LW series. The maximum value was obtained from residual indices of latewood series, respectively

42.11. The average sensitivity is up regulated in the series of latewood to the both radial growth (0.42) and residual index series (0.40), unlike RW series which contain a lower value, respectively 0.28 (RAW) and 0.30 (RES)..

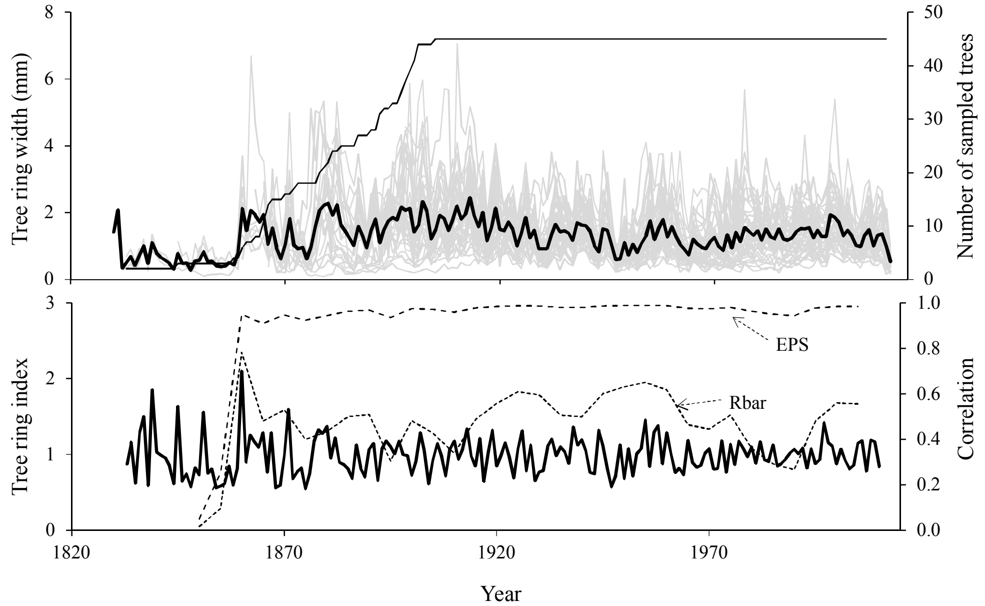

Fig. 1 The upper figure represents the individual growth series, with bold line is mean series. In the graphs below are represented residual series of RW and values of rbar and EPS.

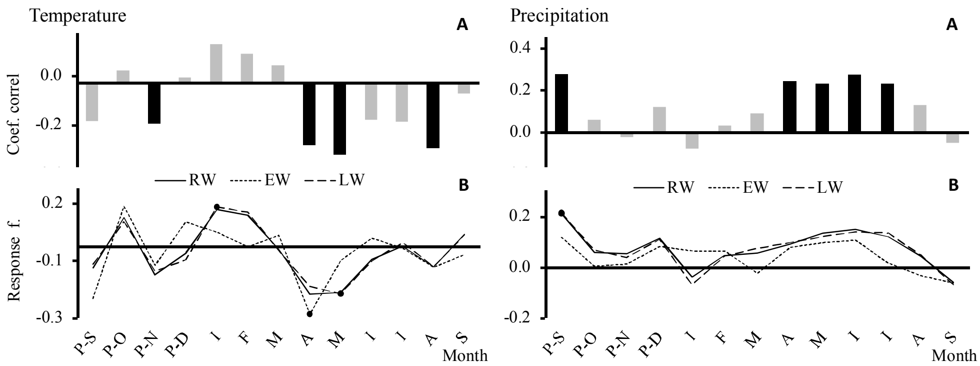

Fig. 2 Impact of monthly mean temperature and mean precipitation on growth oaks - correlation coefficients. Black bars indicate significant values

Analysis of the correlation between monthly average precipitation and residual index series RW and LW, have generated significant coefficients for September on the previous year of vegetation amounting to 0.27 concerned 0.28 (Fig. 2). Significant values were obtained for total ring series and latewood in current growing season, in the mounts of April, May, June and July. Among them the highest coefficient belongs to RW for June, its value is 0.27. Early wood has one single value significant in the current season, respectively in April (0.24). In February significant coefficient of 0.21 was calculated using response function describing the relationship between average precipitations and RW in LW series.

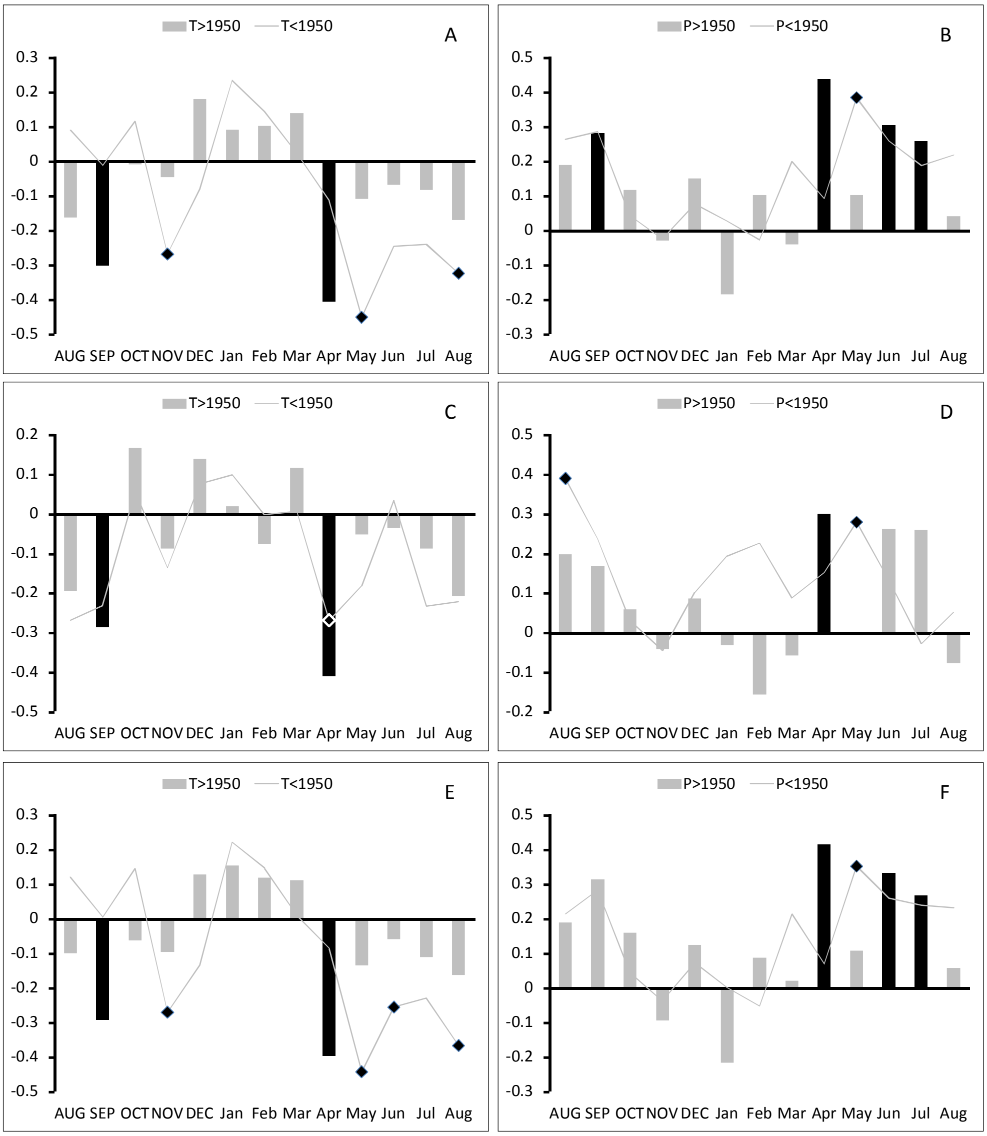

Fig. 3 Correlation coefficients between average temperature, average precipitation and growth indices; A, B – correlation with RW; C, D – correlation with EW; E, F – correlation with LW. Black bars and markers indicate significant values

Average temperatures were significantly and negatively correlated with EW series (-0.25) and LW (-0.17), in September and October previous year of vegetation. Significant values for the current season starting from April for all series, respectively -0.25 (RW), -0.32 (EW) and -0.22 (LW). In March only total ring series and latewood exceed the limit of significance with common value -0.29. Response functions examination for months with significantly influence of temperatures on growth generated values of 0.13 in January for LW series, -0.23 in April for EW and -0.16 in May for LW.

Very important are results obtained after separation of analysis in the sub-periods before and after 1950 for total ring width (Fig. 3). Thus temperatures have generated significant coefficients in November (-0.26), May (-0.45) and August (-0.32), before 1950. After this year the significant value were calculated in September (-0.34) and April (-0.46). Precipitations lead to positive and significant computation in May (0.38), in the first half of the 20^{th} century, and to September (0.28), April (0.44), June (0.30) and July (0.26) in the second half of century.

Early wood shows a high sensitivity but especially in the previous vegetation season respectively in August and May wen precipitations caused significant positive correlation (0.39; 0.27), for the period before 1950, after, one value is significant in April 0.30. This value coincides with the coefficient -0.41, calculated for the relationship between temperature after 1950 and residual index series. Also significant is the value obtained in September previous year (-0.29). Temperature between the years 1902 and 1950 revealed only a significant coefficient in April (-0.27).

Late wood reacted about the same with total ring, resulting somewhat stipulated, since latewood impose variability in total ring, and unlike the early wood which in most cases is a constant.

CONCLUSIONS

Analyzing sensitivity of annual growth for oak trees by dendrochronology method has shown that after 1950 local pollution has adversely affected the susceptibility of response to climate. Obviously the temperature increase negative effect of pollution. Unlike, precipitations which are perceived beneficial, reducing significantly the negative result from cumulating effects of temperature and pollution.

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