DENDROCHRONOLOGICAL SERIES FOR SPRUCE FROM LALA VALLEY

Timiş-Gânsac Voichiţa*

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea, Romania, e-mail: timisvoichita2004l@yahoo.com

Abstract

In this study has adopted a pragmatic approach to modeling the dynamics of radial growth, considering all the different signals of climate signal as noise. Dendrochronological series was achieved through robust biweight mean (Cook and Kairiukstis, 1990) which allows a reduction in the influence of outliers. Statistical calculation was done through the computer program routines ARSTAN ver. 4.1 (Cook and Krusic, 2006).

Pointer years constitute a major component of dendrochronological series representing both clear benchmarks in crossdating process, but also relevant information on extreme environmental conditions. The calculation of pointer years by normalization method in mobile window applied in this case followed the algorithm proposed by Cropper (1979).

Key words: (maximum 6*): spruce, tree rings, dendrochronological series, pointer years*

INTRODUCTION

Climate change is now both scientific and political debate (IPCC, 2007). Existing controversies surrounding the first northern hemisphere temperature reconstructions (Mann et al., 1999), is evidence of the importance of understanding the natural dynamics of the current climate system. Environmental impact of these changes on forest vegetation is a topical issue that sparks interest from the scientific community. Knowledge of how trees react to changing climatic factors is an essential condition grounding future development scenarios and management strategies and sustainable development of forestry sector.
The annual tree rings, as natural archives provides important information for paleoenvironment studies. Variability of environmental factors is registered by trees throughout life through metabolic processes. This temporal dynamic is recorded codified by tree ring width (Fritts, 1976; Schweingruber, 1996), density (Polge, 1963), structure (Sass and Eckstein, 1995) or the concentration of carbon and oxygen stable isotopes (Schleser *et al.*, 1999) in wood formed each year.

MATERIAL AND METHOD

Experimental plot for spruce from Lala Valley is located in an ecosystem from the upper altitudinal limit on right the technical side of the stream Lala (47°31' N, 24°54' E). The choice and location of the experimental plots considered two main aspects: maximizing climatic signal specific of the study area and evidence of climate response variability in relation to altitude. From each tree were extracted two cores at 1.30 m in height using a Pressler increment borer. Number of trees included in the survey range from 15 to 25 trees. For mountain pine was not possible to extract cores, due to deformation and low increases. For these reasons dendrochronological analysis was performed on disks taken through mechanical saw. Annual ring width measurement was performed using the system Lintab at Forest Research Station Câmpulung Moldovenesc. Accuracy of tree ring width measurements was 0.001 mm (Rinntech, 2005). Values measured for each sample were recording in separate files for each experimental plot using the standard format TUCSON format (*.rwl).

Primary data processing was done with ARSTAN software ver. 4.1 (Cook and Krusic, 2006). Individual series were checked and crossdated using the software TSAPwin (Rinntech, 2005), graphically comparing individual chronologies with average growth curve. Robustness check of crossdating process was done by statistical methods, respectively by moving correlation analysis on 50-year subperiods using the computer routines of COFECHA program (Holmes, 1983; Grissino-Mayer, 1997, 2001).

In this study has adopted a pragmatic approach to modeling the dynamics of radial growth, considering all the different signals of climate signal as noise. After testing different types of statistical models recommended in the literature to standardize growth series (Helama *et al.*, 2004) was chosen to apply a cubic spline function with frequency equal to 67% of the length of each individual series (Cook and Peters, 1981; Cook and Kairiukstis, 1990). Dendrochronological series was achieved through robust biweight mean (Cook and Kairiukstis, 1990) which allows a reduction in the influence of outliers. Statistical calculation was done through the computer program routines ARSTAN ver. 4.1 (Cook and Krusic, 2006).

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RESULTS AND DISSCUSIONS

The stand consists of a mixture of spruce and stone pine at an altitude of 1650 m, north-eastern slope. To develop the dendrochronological series in autumn 2005 were sampled 22 trees in accordance with established work methodology.

Average length of individual samples is 142±42 years, ranging between 70 and 234 years. Time period covered is between 1772 and 2005, with a replication more than 10 series after 1838. Average radial growth of individual series varies between 0.87 mm·year^{-1} and 3.65 mm·year^{-1}, with an average of 1.60±0.62 mm·year^{-1}. Standard deviation of individual series varies between 0.33 mm and 1.31 mm, with an average of 0.77±0.25 mm. In case of dendrochronological series standard deviation of average growth index series is 0.26±0.07 on standard chronology and 0.21±0.05 of the residual chronology.

Residual influence of previous year's growing conditions, quantified by first order autocorrelation is high for radial growth series ranging between 0.40 and 0.93 with an average of 0.80±0.13. By standardization of individual growth series in indices, autocorrelation drops to 0.55±0.14, being statistically insignificant for residual dendrochronological series (-0.02 ± 0.05). Average correlation of individual index series with mean chronology is 0.62, and correlation value between individual series is 0.55 ± 0.25 in the case of radial growth, respectively, 0.42 ± 0.11 in the case of residual index series. The mean EPS is 0.96, with values statistically significant after 1830 (EPS> 0.85). Dendrochronology series has a mean sensitivity, characteristic for coniferous species, being the maximum for residual index series (0.23±0.05), showing a significant dendroclimatological signal. Common variance explained by first principal component is 49.3% and the ratio of signal and noise - SNR - is 11.9.

Lack of disruption of stand structure, with growth influences is emphasized by the temporal dynamics of radial growth mean curve. In until the decade 1870 are observed variations of radial growth curve due to the relatively small number of series thereafter the dynamics is exponentially decreasing as a result of higher average age (Fig.1). Also noted that after 1870 the variance is stabilize and reduce the confidence interval for the mean radial growth curve.

Changes in growth indices of residual chronology reflect the existence of a slightly increasing trend after 1990. It is noted decades: 1870-1880, 1910-1920, 1940-1950 and 1985-1995 with low values of growth indices. Comparative analysis of the residual and standard dendrochronological series highlights differences especially in periods of below-average index values (Fig.1C). Growth index values different from the average by more than two standard deviations recorded in years: negative - 1876, 1913, 1947, 1948 and 1980, and positive - 1868, 1881, 1979 and 2001.

By applying the method of analysis in mobile window pointer years were calculated according to research methodology presented in the first part of the thesis (Fig. 2.).

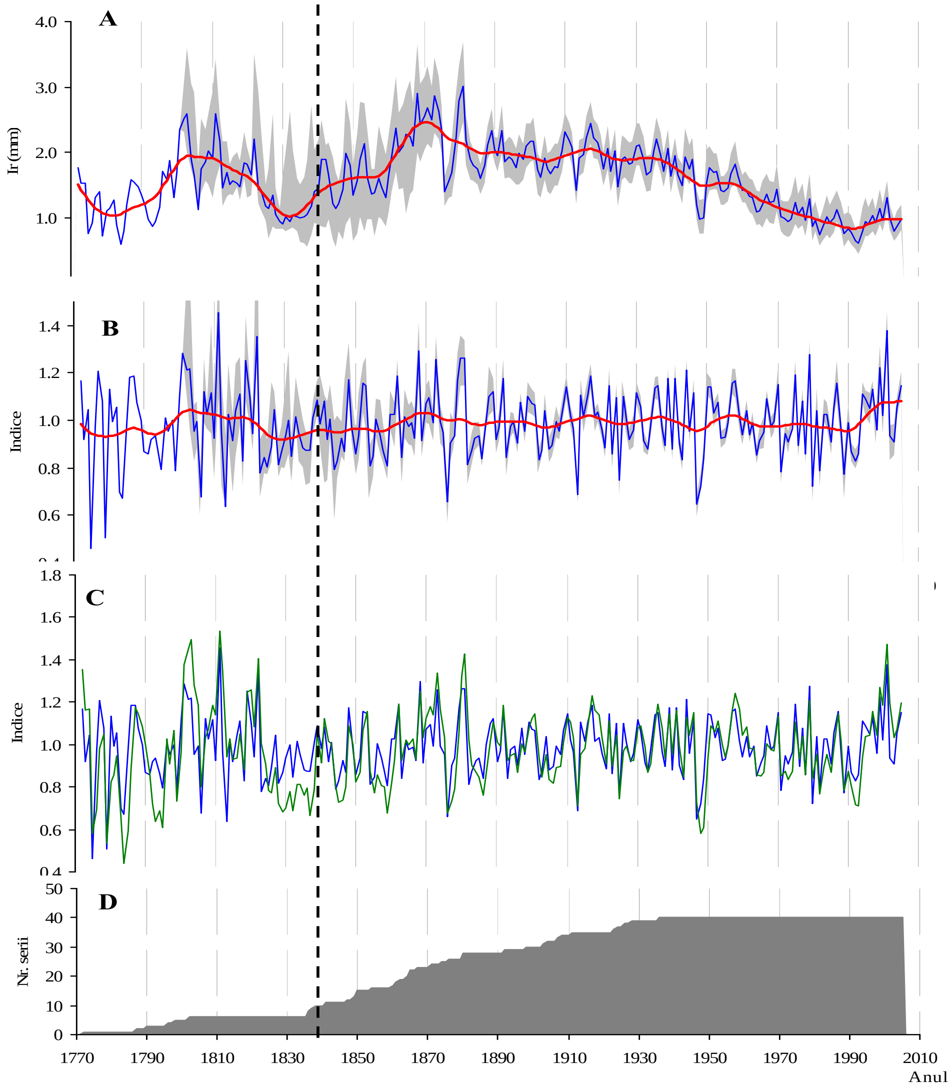

Figure 1. Dendrochronological series for spruce from Lala Valley – LALB (A – mean growth series: blue – annual values, red – 20 years spline values, grey – confidence interval; B – dendrochronological series: blue – annual index values, red – 20 years spline values, grey – confidence interval; C – comparison of mean index chronologies: bleu – residual index series, green – standard index series; D – distribution in time of individual series; black dotted line – significance limit of dendrochronological series).

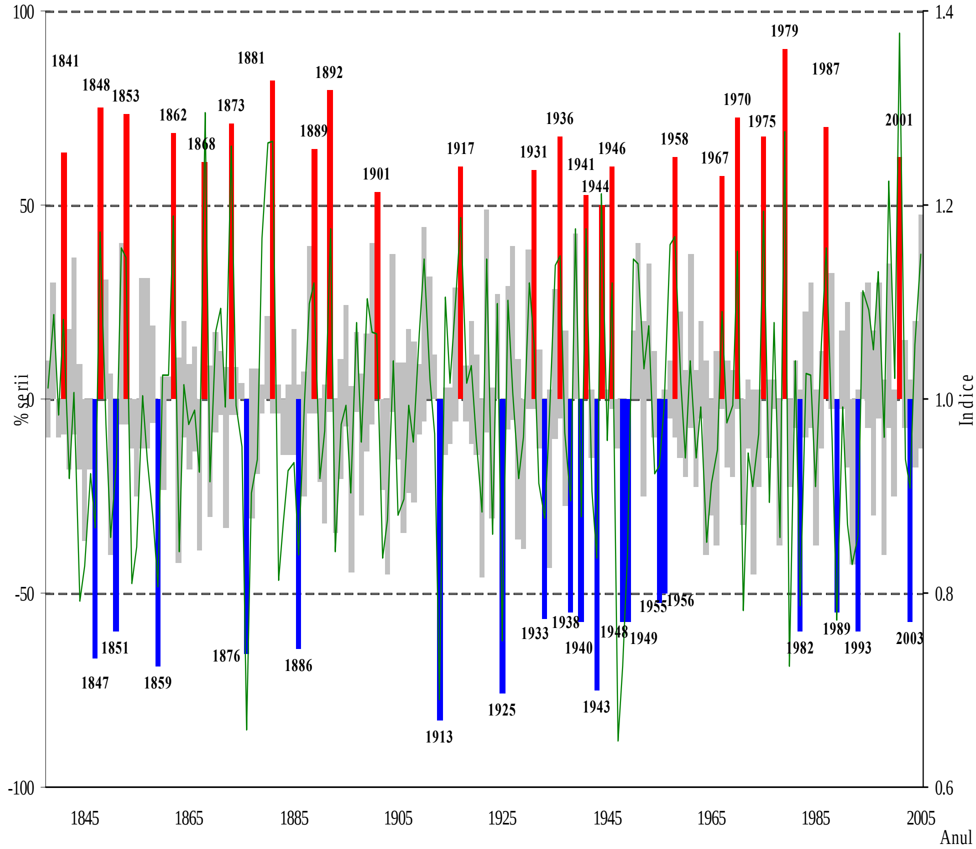

Figure 2. Pointer year for spruce chronology from Lala Valley – LALB (grey – percent from individual series having the pointer year, red – positive pointer years, blue – negative pointer years, green – dendrochronological series).

The main negative pointer of spruce series from Lala Valley are: 1847, 1851, 1859, 1876, 1886, 1913, 1925, 1933, 1938, 1940, 1943, 1948, 1949, 1955, 1956, 1982, 1989, 1993, 2003, remarking the decades 1930-1950 and 1980 - 1990 in terms of frequency. Positive pointer years are found more frequently in the period 1840 - 1900 and 1930 - 1950: 1841, 1848, 1853, 1862, 1868, 1873, 1881, 1889, 1892, 1901, 1917, 1931, 1936, 1941, 1944, 1946, 1958, 1967, 1970, 1975, 1979, 1987 and 2001.

CONCLUSIONS

Forest ecosystems located at the upper latitude or altitude vegetation limit are particularly sensitive to climate changes because of their location to limit distribution of these species. Changes in tree ring characteristics can be correlated with changes in one or more environmental factors that influence biological processes that lead to the formation of the tree ring. By inversion, this information can be extracted from tree rings and used for reconstruction of historical changes of the environment for periods of hundreds of years or at millennial.

For majority of pointer years are observed a correlation between negative and positive, in terms of the period shown. Generally positive pointer years arise during the years immediately following negative pointer years, following the restoration potential for bioaccumulation.

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