# CLIMATIC SENSIBILITY OF STONE PINE IN RODNA MOUNTAINS

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## *Abstract*

In this study the analysis of correlation between meteorological parameters and chronologies was performed both for individual monthly values (from June precedent year to August current year of ring formation) and seasonal values: pON (previous October - November) and II (current June - July). To quantify climate model explaining the process of radial growth were applied two methods: stepwise multiple regression method and response functions, realizing them is a comparative analysis.

**Key words:** *Stone pine, radial growth, climatic sensibility,, response function model*

## INTRODUCTION

Current global climate change raises heated discussions both scientific and political level (IPCC, 2007). Knowledge of forest species response and adaptation to climate change is a challenge for forestry research. Quantification of tree climate sensitivity requires an interdisciplinary approach and integrated.

Old forest ecosystems, less anthropogenically disturbed by timber extraction, is an opportunity to quantify the relationship between radial growth and changes in meteorological parameters, both in terms of statistical relationship and its temporal stability. This paper addresses issues of correlative relationship between meteorological factors (temperature and rainfall regime) and radial growth processes, expressed by growth indices, both in intensity and significance of the relationship and in terms of temporal stability. The analysis of correlation between meteorological parameters and chronologies was performed both for individual monthly values (from June precedent year to August current year of ring formation) and seasonal values: pON (previous October - November) and II (current June - July). To quantify climate model explaining the process of radial growth were applied two methods: stepwise multiple regression method and response functions, realizing them is a comparative analysis.

Study area falls in relation to regional climate in the region of mountain climate, elementary topoclimate mountain ridges, the slopes with the dominant northern and southern aspect. Province after Köppen climate is Dfk 'falling Dfbx climate zone, characterized by rainfall throughout the year, with the peak in the late spring and early summer and cold winters.

General climate of Rodna Mts. is Continental Mountain, with western and eastern Baltic influences (Toader & Dumitru, 2004).

**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 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.

In the core study area is located the meteorological station Iezer - Pietrosul Rodnei (47°36' N, 24°38' E, 1785 m) for which meteorological data were available for the period 1961-2001. The sequence of monthly average temperatures during the year is characterized by a peak in July (9.85 ± 1.47°C) and August (9.89 ± 1.54°C). Minimum values recorded in January (-6.94 ± 2.28 ° C) and February (-6.83 ± 2.60 ° C). Multi-annual average temperature from Iezer station is 1.37 ± 0.58° C.

Statistical analysis of climate data from Iezer weather station reveals relatively high negative correlations between thermal regime and rainfall. It reached maximum values in the months: May (-0.44) June (-0.51) and September (-0.55), being lower in March (-0.02), April (-0.03) and August (-0.10). In analyzing the relationship between radial growth processes and meteorological factors must be taken into account the autocorrelation between climate variables.

In order to extend the instrumental dataset we used the grid database CRU3 with a resolution of 0.5 ° x0.5 ° (Mitchell and Jones, 2005; Brohan *et al.*, 2006). Data extraction was performed on the server KNMI Climate Explorer (http://climexp.knmi.nl). Dataset used was extracted from the grid center at coordinates 47°30' N and 24°30' E, being the nearest grid cell to the study area and weather station Iezer-Pietrosul Rodnei covering the period 1901-2006.

**RESULTS AND DISSCUSIONS**

Analysis of correlation between growth indices and meteorological parameters show a specific response dendroclimatic for timberline ecosystems (fig. 1.).

It sees a positive correlation with the thermal regime of the current year of tree ring formation. Statistically significant are the average temperatures in July (0.29). It also noted a positive response and statistically significant to temperatures of the previous autumn (October and November (0.31)). Regarding the minimum and maximum temperature the positive reaction of stone pine is evident, been observed a stronger influence of minimum temperature. On seasonal level are statistically significant temperatures in growing season (June-July: 0.29) and the previous autumn (October-November: 0.36).

Regarding rainfall regime, it is positively correlated with tree ring width for the months from April to May, and negative in October last year, but the intensity of correlation is weak and statistically insignificant.

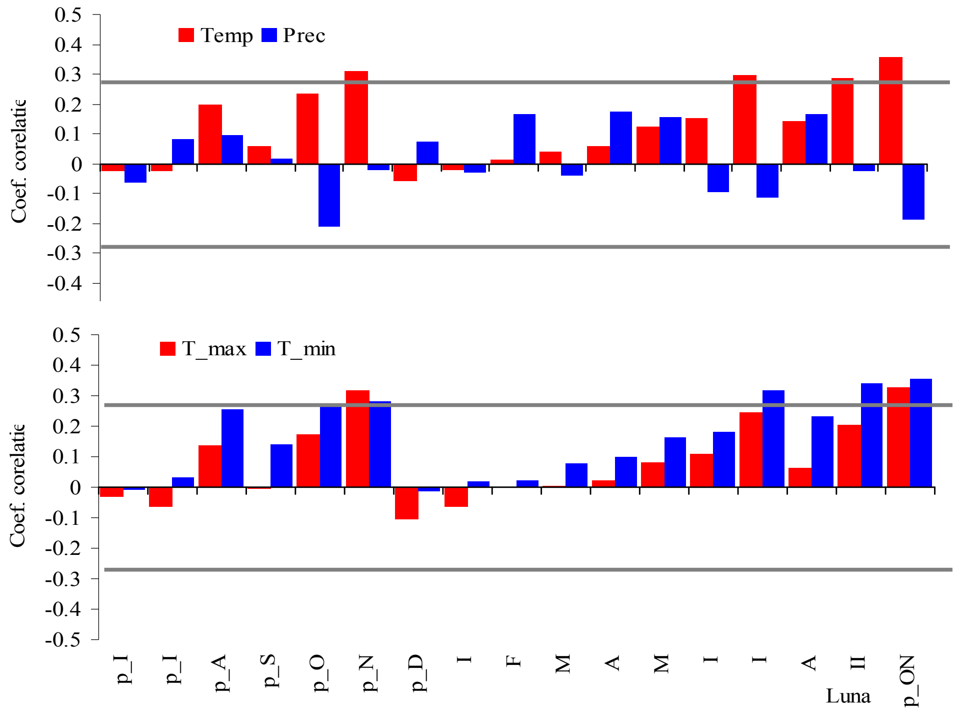


Figure 1. Correlation between climatic factors and growth index for stone pine (LALA) from Lala area.

By applying the method of analysis of response functions through which the autocorrelation between the meteorological parameters fell are confirmed and statistically significant the positive influence of temperatures from July, November (previous autumn) and the positive and significant influence of rainfall since April - May (fig. 2.).

Developing a climate model of radial growth by stepwise multiple regressions led to the following regression equation:

$$I_i = 0.434 + 0.016 \cdot T_{pN_i} + 0.032 \cdot T_{I_i} + 0.001 \cdot P_{A_i} \qquad R^2 = 0.25$$

By applying the model-derived climate response functions, including the influence of all factors climatic analyzed (temperature and rainfall regime monthly) the dynamics of residual index are similar to those obtained by regressing model, however, observing an increase in variability is explained ($R^2$=0.39) (fig.3.).

Distribution of errors of the growth indices are similar in climate models implemented in the case of stone pine from Lala. Thus on remark the periods 1913-1919 and 1953-1957 where the model overestimates the growth indices, 1973-1980 and 1995-2000 respectively in which case we have an underestimation of radial growth. Otherwise error distribution is random and remains statistically acceptable limits.

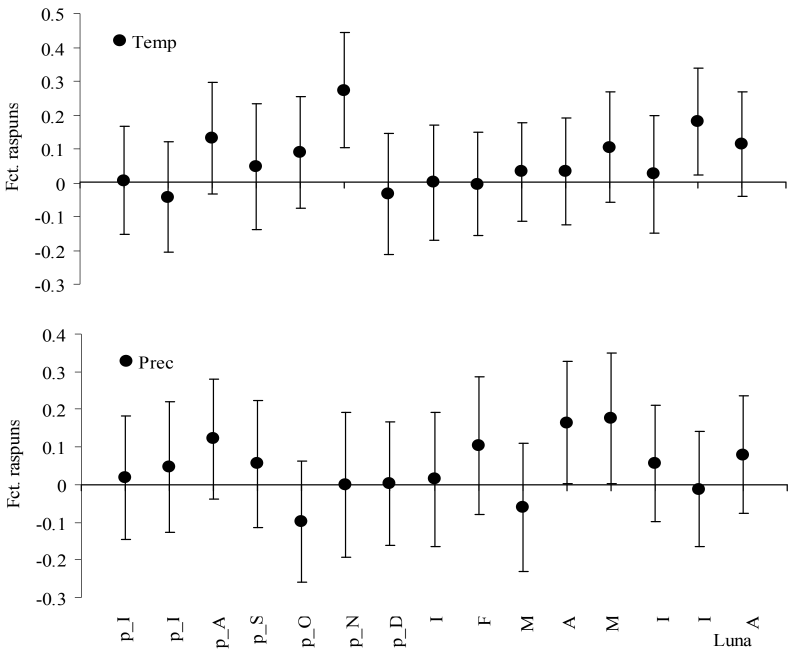


Figure 2. Response functions for stone pine (LALA) from Lala.

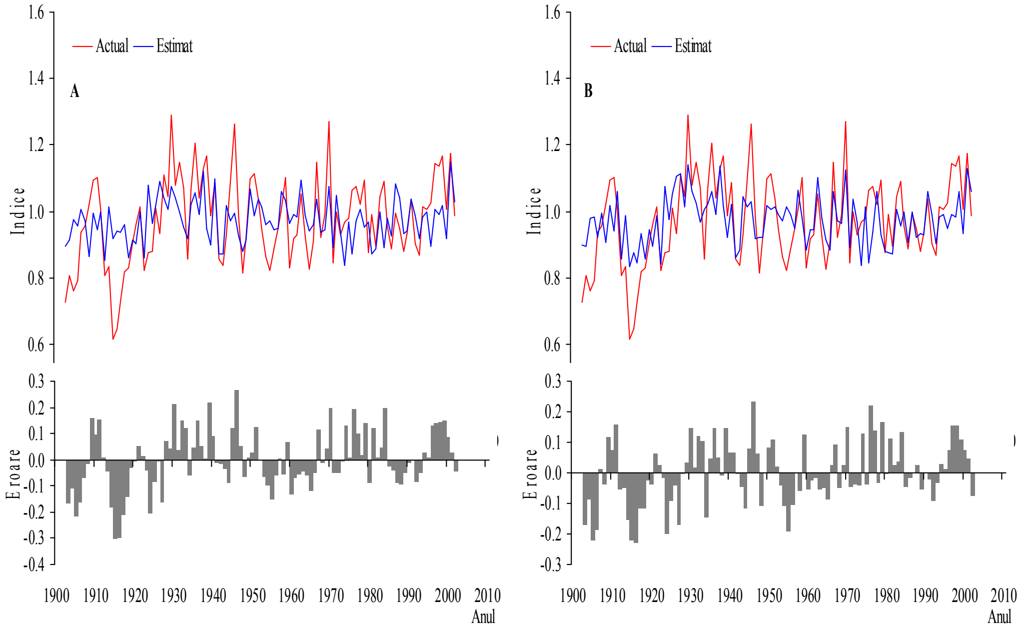


Figure 3. Climatic modelling of growth index series for stone pine (LALA) from Lala (A: stepwise regressive model; B: response function model).

Thus the formation of the tree ring for stone pine from Lala Valley is limited by thermal regime of the previous autumn and July current year.

**CONCLUSIONS**

Dendroclimatological behaviour of stone pine from Pietrosul Rodnei area is similar to Lala area.

The longest dendrochronological series from stone pine is done in Austrian Alps with a length of 9111 years (7109 BC - 2002 AD) (Nicolussi *et al.*, 2009). Using the growth series of six experimental areas of Austrian Central Alps, Pfeifer et al. (2005), notes that the stone pine radial growth is limited by low values of temperature in summer (June-August) and autumn preceding the tree ring formation (September-October) and the reduced amount of rainfall in March.

Processing of correlation between stone pine tree ring width and temperature of July, the growth limiting factor, is analyzed for Tyrol (Austria), been observed a significant difference after 1980 (Oberhuber *et al.*, 2008). Similar results on the difference between stone pine chronologies and summer thermal regime are seen in the Italian Alps (Leonelli *et al.*, 2009). Monthly correlation analysis showed a correlation with temperature decrease in June (south-western stations) and increased sensitivity to thermal regime in July (northern slope).

Dendroclimatological response of stone pine varies both temporally and in relation to age (Carrer and Urbinati, 2006). Both larch and stone pine the intensity of the relationship between radial growth and climatic factors increase in relation to age, being more evident in case of larch (Carrer and Urbinati, 2004). Contrary results obtained Esper *et al.* (2008) for stone pine in Engadin (Switzerland).

**REFERENCES**


1. Brohan, P., Kennedy, J.J., Haris, I., Tett, S.B., Jones, P.D., 2006, *Uncertainty estimates in regional and global observed temperature changes: a new dataset from 1850*. J. Geophysical Research 111: D12106.
2. Carrer, M., Urbinati, C., 2004, *Age-dependent tree-ring growth response to climate in Larix decidua and Pinus cembra*. Ecology 85:730–740.
3. Carrer, M., Urbinati, C., 2006, *Long-term change in the sensitivity of tree-ring growth to climate forcing in Larix decidua*. New Phytol. 170:861–872.
4. Esper, J., Niederer, R., Bebi, P., Frank, D., 2008, *Climate signal age effects-evidence from young and old trees in the Swiss Engadin*. Forest Ecology and Management 255: 3783-3789
5. IPCC, 2007. *Climate change 2007: the physical science basis*. In: Solomon, S. et al. (eds), Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge Univ. Press.
6. Leonelli, G., Pelfini, M., Battipaglia, G., Cherubini, P., 2009, *Site-aspect influence on climate sensitivity over time of a high-altitude Pinus cembra tree-ring network*. Climatic Change 96:185-201.
7. Mitchell, T.D., Jones, P.D., 2005, *An improved method of constructing a database of monthly climate observations and associated high-resolution grids*. Int J Climatol 25:693-712
8. Nicolussi, K., Kaufmann, M., Melvin, T., Plicht, J., Schiebling, P., Thurner, A., 2009, *A 9111 year long conifer tree-ring chronology for the European Alps: a base for environmental and climatic investigations*. The Holocene 19:909-920
9. Oberhuber, W., Kofler, W., Pfeifer, K., Seeber, A., Gruber, A., Wieser, G., 2008, *Long-term changes in tree-ring-climate relationships at Mt. Patscherkofel (Tyrol, Austria) since the mid-1980s.* Trees 22:31-40.
10. Pfeifer, K., Kofler, W., Oberhuber, W., 2005, *Climate related causes of distinct radial growth reductions in Pinus cembra during the last 200 yr*. Veget. Hist. Archaeobot. 14:211-220.
11. Timiş, V., Popa, I., 2005, *Serie dendrocronologică de referinţă pentru zâmbru (Pinus cembra) din Masivul Pietrosu, Munţii Rodnei.* Revista pădurilor 5:19-22.
12. Timiş-Gânsac Voichiţa, 2010, *Master dendrochronological series for stone pine (Pinus Cembra l.) and spruce (Picea abies (l.) karst.) from Rodna Mountain.* Analele Universităţii din Oradea, Fascicula Protecţia Mediului 15:526-529.
13. Timiş Voichiţa, Popa, I., 2010, *Spatial variability of dendrochronological series from Rodna Mountains (eastern Carpathians – Romanian,* Proceedings of Romanian Academy Series B: Chemistry, Life Science and Geoscience, 2: 167–170.
14. Timiş-Gânsac Voichiţa, 2010, *Cercetări dendroecologice şi dendroclimatologice la molid, zâmbru şi jneapăn din escosisteme forestiere de limită din Parcul Naţional Munţii Rodnei.* Teză de doctorat. Universitatea Ştefan cel Mare Suceava. 154p.
15. Toader, T., Dumitru, I. (eds.), 2004, *Pădurile României. Parcuri naţionale şi parcuri naturale*. Editura Intact Bucuresti. 295p