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Investigation on Effects of Climatic Variables on Zagros Oak Q. *Brantii lindl* Tree Rings: A Case Study of Shurab Park (Western Iran)

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Abstract: In order to recognize the correlation between climatic factors with oak tree ring growth, thirty samples at equal geographical condition were taken from Shurab Park, West Iran. The effects of temperature and precipitation on tree ring have been investigated by using a statistical analysis in a 20 years period. The results show that the tree ring width have strong correlation R=0.82 at 99% confidence level with mean annual precipitation before growth season, while the correlation is very low for the growth year (R=0.48). Also the minimum peaks of tree rings are synchronic with the annual number of frost days. Overall, these results show that, the oak species in the region are adjusted to arid climate condition. However, the last year's precipitation, causing increased soil moisture and groundwater levels provide favorable conditions for further growth of the oak tree. Low precipitation before growth season and hard winter leads to thin rings, while high annual precipitation before growth season and temperate winter before growth season cause formation of wide tree rings.

Key words: Tree ring · Temperature and precipitation factors · Oaks · Shurab Park

INTRODUCTION

Tree-rings can provide continuous yearly paleoclimatic records for regions or periods of time with no instrumentally measured climate data. Some research indicated the climate change effects on forest as an important vital source of our life [1]. In predicting the climate change consequent on oak tree it is very important to understand the relation between tree growth and climatic factors. However, different tree species respond to differently to climatic parameters, for example, some tree species are sensitive to moisture and others to temperature [2]. Here, we describe common species growing in Zagros and their response to climatic factors. *Q. brantii* Lindl, the dominant oak species of the Zagros-Anti-Taurus deciduous oak woodland, is most xerophiliuous oak species of the region. It is able to tolerate very low precipitation and thus constitutes the only oak found in latitude below 34° N. [3]. Some studies indicated relation between the precipitation regime and emerging the oak tree in the western Iran during the Holocene [4-7]. In most of the studies the amount of precipitation is the primary factor influencing the oak tree ring width [8]. Base on the fact that the tree ring data could be an evidence of climatic factors such as precipitation and moisture , researchers have used the tree ring documents in order to recognize the amount of precipitation and stream flow in the past [9, 10]. The relationship between the climatic factors and the tree ring of Oak tree has been surveyed as a strong tool to identify effects of environmental factors of Oak tree ring [11, 12]. In this research the effects of climatic parameters on Q. *brantii* Lindl have studied. This research will help to recognize the possible affects of climate changes of the Oak species in the region in the future.

MATERIALS AND METHODS

Study Area: Shurab park is located at 48° 10′ 17" to 48° 10′ 33" E and 33° 25′ 4" to 33° 25′ 35" N , 13 km southwest of Khorramabad city in Lorestan Province in West Iran (Fig. 1). The park is located at elevation between 1079 and 1200 meters above the sea level. Annual precipitation in the region is 482.16 mm and means temperature is 16.58°C. According to the De Martonne climate index [13]. The region is located at semiarid climate. Lithosols and Regosols are two dominant soils in the region.

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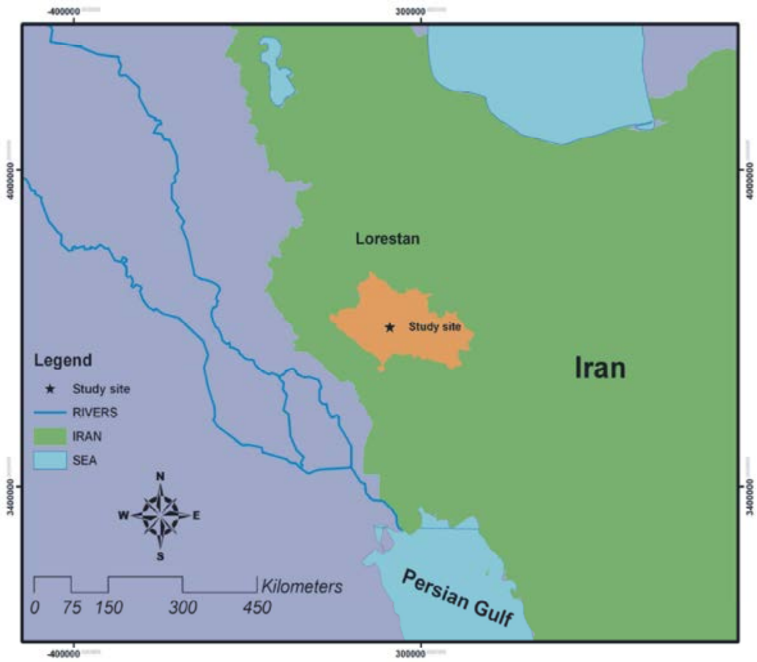

Fig. 1: The map shows the location of the study site in Iran.

Fig. 2: Some samples of the prepared discs.

Methods: After the road-making operation in the region, 30 samples from death trees were taken. To have equal number of samples, we took samples in the same elevation class and slope inclination varying from 0 to 10%. Also all samples have taken from the same soil type. At first, the location of the samples were identified on topographic map and then the location of samples were found using GPS. From each sample tree, one disc was prepared. The discs were removed from the trunks of the Q. *brantii* Lindl Oak species. North direction was identified using Sunto slope measurement. The photos of the disc with 800 dpi resolution were taken and saved in PSD format (Fig. 2).

By using of the Photoshop software, yearly increment of tree ring with 1/10 millimeter accuracy and in East-west direction was measured. To correlate the tree ring width with the climatic factors, precipitation and temperature data were taken from Khorramabad synoptic station the nearest synoptic station in the region over a 20 years period (1989-2009). Statistical analysis was performed in the Minitab and Excel software environments.

RESULTS

Growth season of oak trees in the region begin at the spring. So the annual growth of tree ring was calculated from spring season. To use climatic data before the growth season of the oak Q. *brantii* Lindl, the annual climate factors were calculated from April (previous year) to March (current year) through all 20 years. The growth ring shows a decreasing trend to the present (Fig. 3). The low growth ring begins at the second decade of the study period. The correlation between tree ring and climatic factors was measured using the Pearson correlation coefficient (Table 1).

Table 1: Correlation ratio between climatic factors and tree ring widths average

Climatic factors	*(R)*	*(P-value)*
Annual precipitation	0.485	0.03
Annual precipitation before growth season	0.82	0.000
Mean precipitation of two and one year before the growth season	0.681	0.001
winter precipitation before growth season	0.636	0.003
Spring precipitation before growth season	0.654	0.002
winter precipitation and Spring precipitation before growth season	0.808	0.001
winter and autumn precipitation before growth season	0.78	0.000

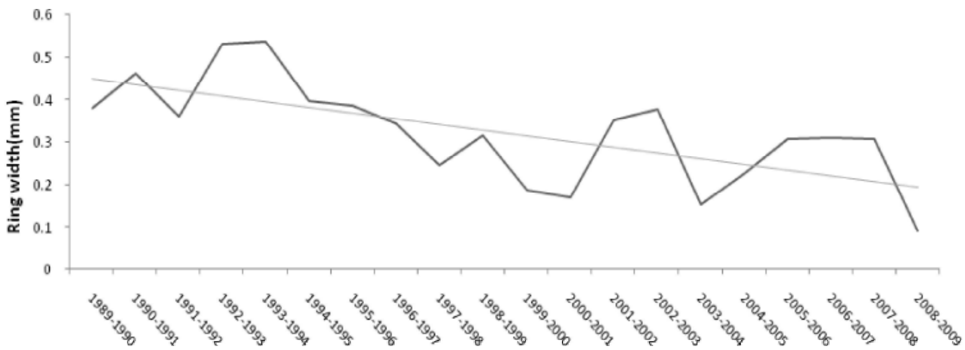

Fig. 3: Average of the trees ring increment of the samples. Trend line shows a decreasing trend to the new years.

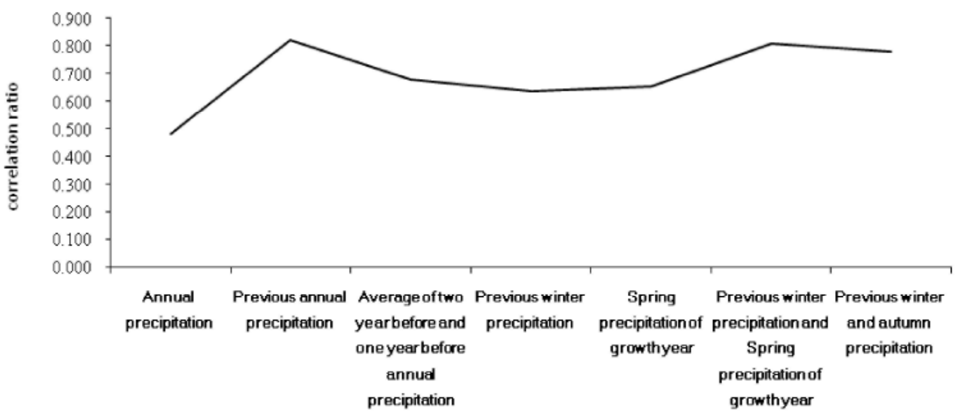

Fig. 4: The chart shows the correlation ratio between growth ring and climatic factors. The chart indicate that the before year have important effect on tree growth

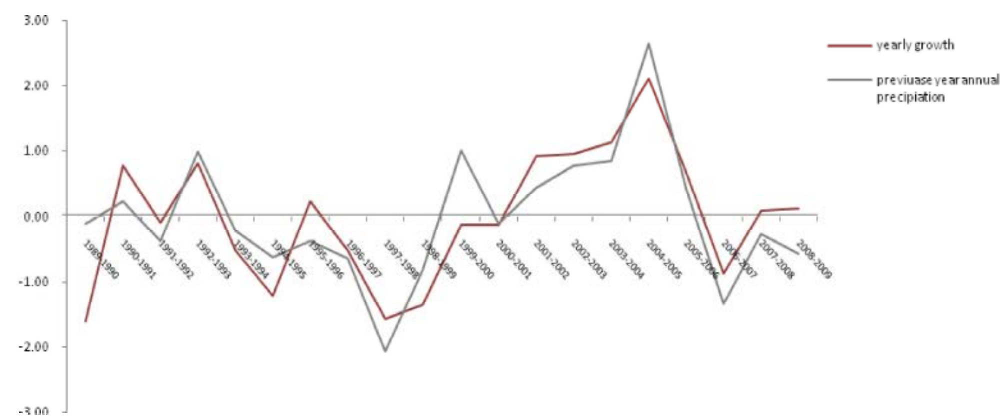

Fig. 5: Comparative chart of yearly growth and annual precipitation before growth season

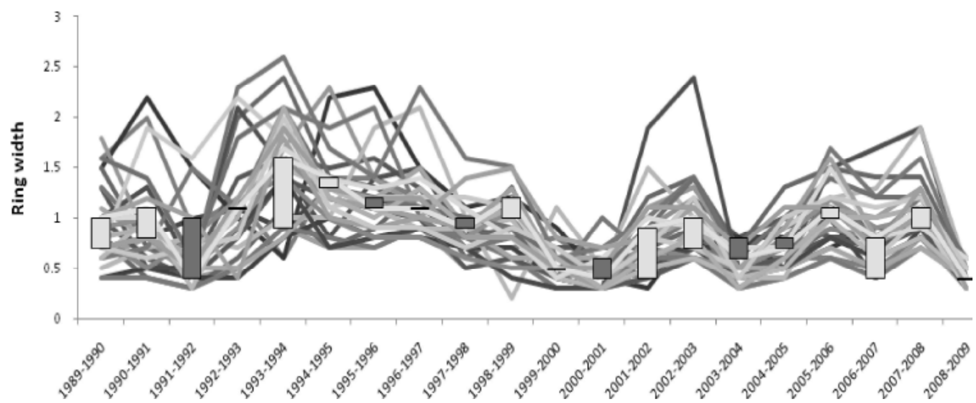

Fig. 6: up/down bars chart. The bares shows the variability of the growth ring

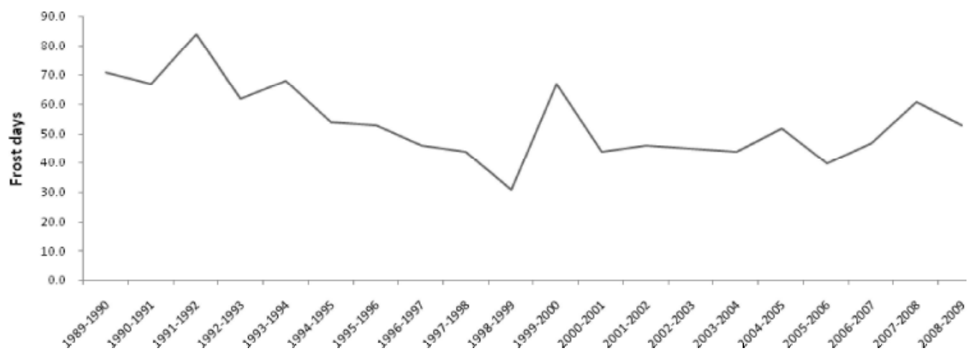

Fig. 7: Annual frost day during the study period

The results show that maximum correlation accrued between growth ring and annual precipitation before growth season (R=0.82) with 0.99 reliability. These results show that the ring growth has a close relation with all factors in relation to the humidity budget before the growth season (Fig. 4).

To show the strong relationship between growth ring and previous annual precipitation, two series of data have been standardized and then a comparative chart was produced. The annual precipitation before growth season line was fitted to the average growth ring during the study period (Fig. 5).

Also the results indicate that minimum peaks of growth ring (Fig. 6) show a weak synchrony to the total number of annual frost days (Fig. 7). The result indicates that low growth ring accrued at the years with high number of frost days. Following this condition, main minimum peak is synchronic with the years with more than 70 frost days.

Modeling the Growth Ring: For the annual precipitation before growth season (due to having the highest correlation coefficient with the growth ring), the linear regression equation was calculated.

Average growth ring = 0.024+0.00185 annual precipitation before growth season

This equation has a coefficient of determination 67.3 % with confidence level 99 % is significant (Table 2).

Independent variable coefficients in column Coef (Table 2) are listed. Regression for a variable regression coefficient shows that with a unit increasing in the amount of independent variables (annual precipitation before growth season), how much will change the dependent variable value (the average growth) (Fig, 6).

The positive coefficient indicate that with increasing the amount of independent variable, the predict variable will increase and negative coefficient shows the reverse mode.

As is inferred from Table 2, with a unit increase in independent variables (annual precipitation before growth season), the average growth increases the amount of 0.0018547.

By using values in the P and T column (Table 2) hypotheses and regression model were tested. Due to P value is lower than 0.001, the annual precipitation before growth season will affect the growth ring with a 99% Reliability.

Table 2: Regression ratios

(Predictor)	Coef	SECoef	T	P
(Constant)	0.0241	0.151	0.16	0.875
annual precipitation before growth season	0.0018547	0.0003047	6.09	0.000

[RSq (adj)](Corrected determination coefficient) =65.5%

RSq(d)(determination coefficient) =67.3%

S=0.167509%

CONCLUSIONS

Water and groundwater sources also soil moisture storage in the study area developing by the autumn and winter precipitation, therefore rainfall in autumn and winter before the growth season could have major role in growth ring of Q. *brantii* Lindl oak in the region. Due to this condition, the strongest correlation of growth rings was established with the winter precipitation before the growth season. However, the correlation with rainfall year the growth was weak. Low minimum peak of annual growth rings of oak tree indicated the resistance to dry conditions of Q. *brantii* Lindl in the region.

Also in some cases, the minimum peak of annual growth rings show a synchronic with years with hard winter. As a result, humid and warm winter lead to tick ring and dry and cold winter lead to thin ring of the Q. *brantii* Lindl in the region.

REFERENCES

1. USGS, 1997. Effects of Climate Change on Southeastern Forests, FS 93-97.
2. Garcı´a-Sua´reza, A.M. C.J. Butlera and M.G.L. Baillie, 2009. Climate signal in tree-ring chronologies in a temperate climate: A multi-species approach. Dendrochronologia, 27: 183-198
3. Djamali, M., *et al*., 2010. Indian Summer Monsoon variatios could have affected the early-Holocene woodland expansion in the Near East. The Holocene, 20(5): 813-820.
4. Griffiths, Huw I., A. Schwalb and Lora R. Stevens, 2001. Environmental change isouthwestern Iran:the Holocene ostracoda fauna of Lake Mirabad. the Holocene, 11(6): 757-764.
5. Stevens, L.R., H.E. Wright Jr and E. Ito, 2001. Proposed changes in seasonality of climate during the Late-glacial and Holocene at Lake Zeribar, Iran. The Holocene, 11: 747-756.
6. Stevens, L.R., E. Ito, A. Schwalb and H.E. Wright, 2006. Timing of atmospheric precipitation in the Zagros Mountains inferred from a multi-proxy record from Lake Mirabad, Iran. Quaternary Research, 66: 494-500.
7. Djamali, M., *et al*., 2008. An Upper Pleistocene long pollen record from the Near East, the 100 m-long sequence of Lake Urmia, NW Iran. Quaternary Research, 69: 413-420.
8. Cedro, A., 2007. tree-ring chronologies of downy oak (quercus pubescens),pedunculate oak (q. robur) and sessile oak (q. petraea) inthe bielinek nature reserve: comparison of the climaticdeterminants of tree-ring width. Geochronometria, 26: 39-45.
9. Akkemik, U., *et al*., 2008. Tree-ring reconstructions of precipitation and stream flow for north-western Turkey. International J. Climatology, 28: 173-183.
10. Fidel, A. Roig, *et al*., 2009. North atlantic oscillation signatures in western iberian tree-rings. Geografiska Annaler, 91A (2): 1-17.
11. Briffa, K.R., *et al*., 1986. Climate reconstruction from tree rings: Part 2, spatial reconstruction of summer mean sea-level pressure patterns over Great Britain. J. Climatology, 1(6): 1-15.
12. Sofia Leal, *et al*., 2007. Tree-ring growth variability in the Austrian Alps: the influence of site, altitude, tree Species and Climate. 36(4):: 426-440.
13. www.irimo.ir