

## Investigation about the Effects of Solar Radiation Parameter on Radial Growth of *Quercus castaneifolia* in Astara Forests

Bafrin Maroufi Aghdam<sup>1\*</sup>, Mehrdad Ghodskhah<sup>2</sup>, Javad Torkaman<sup>3</sup>, Sarkhosh Karamzadeh<sup>4</sup>

1. MSc Student in Forestry, Department of Forestry, Faculty of Natural Resources, University of Guilan, Iran
2. Assistant Professor, Forestry, Department of Forestry, Faculty of Natural Resources, University of Guilan, Iran (mdaryaei9@gmail.com)
3. Assistant Professor, Forestry, Department of Forestry, Faculty of Natural Resources, University of Guilan, Iran (j\_torkaman@yahoo.com)
4. MSc Student of Forestry, Natural Resources and Watershed Office of Astara, Astara, Iran (sarkhoshkaramzadeh@yahoo.com)

Received: June., 2014

Accepted: Aug., 2014

### Expanded Abstract

#### Introduction

Climate change is due to abnormal changes of climate within the earth's atmosphere and their consequences. One of the most significant effects of climate change is irreversible damage to some floral species and forest ecosystems. Tree species reflect the impact of climate changes on their ring width. Generally, tree rings vary in size each year depending upon the environmental conditions or climate variables that the tree experiences. In fact, tree rings are severely dependent on the changes of climate variables. It is considered a basis for "dendrochronology" which is the scientific method of dating based on the analysis of patterns of tree rings or investigation on the effects climate variables on the width tree rings. Many national and international studies have been conducted on dendrochronology. However, national researches investigated the effects of temperature and rainfall changes on radial growth of trees. Unfortunately, due to lack of long-term solar radiation data in most of the meteorological stations in Iran, the effect of this parameter on the radial growth of trees has not been studied so far. Meanwhile, the solar radiation has a significant influence on the width of tree rings, particularly in tolerant shaded species like oak. One of the most important tree species of Iran is the Oak tree (*Quercus castaneifolia*), due to its being spread in different areas of the country and its high economic and environmental values. Unfortunately, because of climate changes and droughts, and also overcutting of *Quercus castaneifolia* for wood and live-stuck and food supply, this precious species has been subjected to serious threats in the recent years. Hence, the role of climate in addition to improper management is significant. To protect *Quercus castaneifolia*, the first and the most important step is the scientific planning for forest management, through knowing the effective parameters of climate change on the growth and physiology of the trees. Therefore, researches about the oak species and utilization of their results are essential for their protection.

Therefore, to solve the problem related to the lack of solar radiation data, in this study, an appropriate methodology was carried out based on empirical formulas for calculating the solar radiation. Thereafter, the incoming solar radiation in the Astara Forests was calculated. In the next step, by using seven discs harvested from *Quercus castaneifolia* trees, the chronology of this species for each disc in two perpendicular directions was obtained by using LINTAB tool coupled with TSAPWin software. Finally, the relationship between tree ring widths and climate variables was determined.

#### Materials and Methods

In this research, the seven discs were harvested from *Quercus castaneifolia* trees with mean tree ages of 35 to 78 years in the Astara Forests located in the north Iran. In addition, the climate variables were collected from the synoptic meteorological station of Astara. However, due to financial, technical or institutional limitations, the solar radiation data are absent, incomplete or inaccessible in most areas of the world particularly in developing countries such as Iran. This seriously hinders the progress of forestry researches such as chronology studies that require solar radiation as a key driving input. Therefore, various methods have been explored in order to estimate, with reasonable accuracy, the solar radiation from other available meteorological data. One kind of

\* Corresponding Author: Tel: +98 9142021204

E-mail: bafrinmaroufi@yahoo.com

widely used method is based on empirical relations between solar radiations and commonly measured meteorological variables. Therefore, in this research, Angstrom-Prescott model (Eq. 1) was selected to estimate the monthly and yearly global solar irradiation ( $R_s$ ) in the Astra Forests.

$$R_s = R_a \left( a + b \frac{n}{N} \right) \quad (1)$$

In the next step, the chronology of each disc in two perpendicular directions was obtained by using LINTAB tool coupled with TSAPWin software. The Gleichläufigkeit (GLK), Crossdate Index (CDI), and Signature GLK (GSL) were used to evaluate the obtained chronology for each disc.

## Results and Discussion

According to obtained results on determination of a and b parameters of Angstrom-Prescott model for different regions of Iran, 0.404 and 0.204 were selected for Astra Forests, respectively. Then, using recorded meteorological parameters in Astara Synoptic Station, the monthly and annual global solar irradiation were estimated for Astra Forests during 1985 to 2005 (Fig. 1).

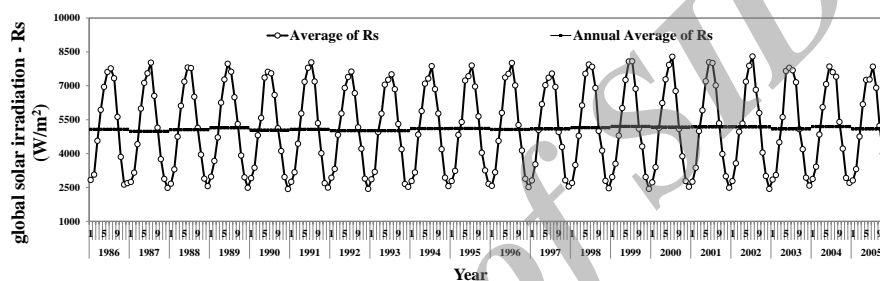


Fig. 1. Annual and Monthly Average of  $R_s$

In the next step, the chronology of species for each disc in two perpendicular directions indicated that statistical indices had appropriate values. Findings showed that the average values of chronology for each disc which were derived from two vertical directions were significant. In other words, three useful parameters for assessment of the chronology quality of all seven discs, i.e., GLK, CDI, and GSL, were more than 73, 46, and 99.9%, respectively. Thus, the average sizes of two perpendicular directions for each of the seven discs were calculated and the chronology of the average values was carried out. Only four of the discs showed proper results according to their indices. Using the chronology of the four discs, the regional chronology of *Quercus castaneifolia* trees in Astara Forests was calculated (Fig. 2). Ultimately, a statistical relation was determined between the  $R_s$  and the chronology of these trees (Fig. 3).

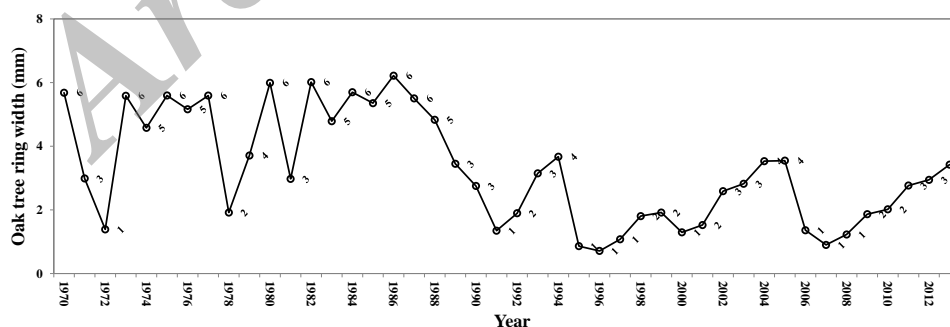


Fig. 2. Regional chronology of *Quercus castaneifolia* trees in Astra Forests

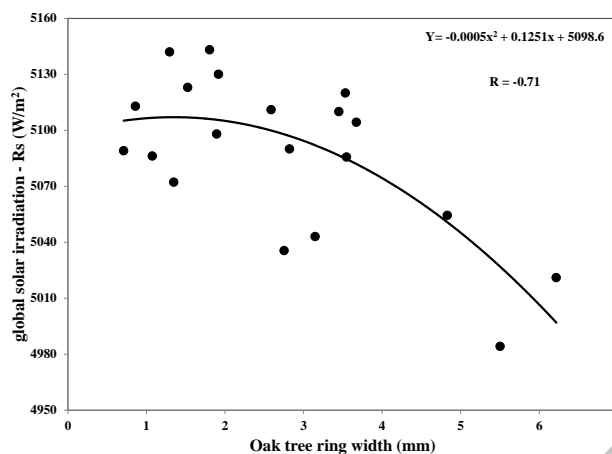


Fig. 3. *Quercus castaneifolia* trees ring widths vs  $R_s$

### Conclusion

The widths of *Quercus castaneifolia* tree rings vary with  $R_s$  by a second order polynomial function. The R value of this function (-0.71) is proper, which is an indicator of a strong relationship between  $R_s$  and *Quercus castaneifolia* tree ring widths. The negative value of R shows an inverse relationship, an expected fact which obviously reflects the shade intolerant quality of oak species. It can be concluded that the findings of the present research are reliable and justified based on the similarity of temperature and  $R_s$  and also according to the previous studies on the effects of temperature on tree ring widths, which resulted in negative R values.

**Keywords:** chronology, climate, radial growth, solar radiation.