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Tree spatial patterns in the Zagros forests (Case study: Kurdistan forests; western part of Iran)

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ABSTRACT

This research was carried out in the Blake forests, Baneh region, Kurdistan Province, northern Zagros forest, western part of Iran conducted on oak forests. The main purpose of the present study was to determine the tree spatial patterns in Blake forests. We used the quadrate methods and inventory methods designed randomize-systematic methods applying the circle sample plots 1000 m^2 in the 100×100 meter net. In each plot some information included kind and number of woody species were recorded. To analysis of data for detect of forest spatial patterns was used quadrate method using variance/mean ratio, Green and Morisata indices applying Ecological Methodological software. The results showed that five tree species were found in the Blake forest while Quercus libani Oliv and Quercus infectoria Oliv were the most dominant woody plants in this area. Based on these results the quantity of Morisata, variance /mean ratio and Green indexes indicate the uniform spatial pattern for trees in the northern Zagros forests. This result may be because of intensive human utilization as has modified the spatial patterns of these forests.

Key words: Spatial pattern, Baneh forest, Kurdistan province, Morisata, variance /mean ratio and Green index.

INTRODUCTION

Forests cover about 12 million ha in Iran [12, 13, 30 and 31], including 5 million ha in the mountainous Zagros region. The Zagros Mountains are divided into two parts: northern and Southern [1, 3, 4 and 20]. The northern Zagros is consisted of the growing site of *Quercus infectoria* Oliv. and also *Q. libani* Oliv. and *Q. persica* J. & Sp. (*Q.brantii* Lindl.) [13] are found in this part. However, the southern Zagros extending to Fars province [3, 19, 11, 12 and 13] is included *Q. persica* site. It is well known that these forests are appeared as destructed forests because of Increasing population, low level of development and high dependence of local communities on these forests for their primary livelihood needs [8]. Spatial patterns information for individual trees as a one important ecological parameter is increasingly sought by forest managers and modelers as means to improve the spatial resolution and accuracy of forest models and management scenarios [28]. There are three basic spatial patterns as following: clumped, random and uniform [33]. It has been well established that determination of trees spatial patterns in each development stage demonstrates the dynamic of stands during the time and can provide valuable information on the underlying processes, particularly in case of uneven-aged forests [29]. Studying the spatial patterns of trees, can be used to better understand processes of forest structure [21]. Also quantitative assessment of the distribution of trees in a forest stand is an initial step towards understanding the forest community dynamics [24]. Heidari (2006) in a study conducted on Zagros forests of Iran titled "Studying different distance methods in inventory of Zagros Forest" using Hopkins index to determine spatial pattern of trees found out that the most of trees are arranged in a clumped pattern [34]. An investigation (Basiri et al 2006) conducted on tree spatial pattern in Ghamishle forests (Kurdistan province, Iran) showed that mainly the trees demonstrate a clumped spatial pattern in the studying area [2].

Erfanifard et al (2009) in a study conducted on spatial pattern analysis in Persian oak forests by black and white (B&W) aerial photographs found out that C index can detect the spatial distribution of trees. Thereafter the index was used on the air photo of the study area that was made of B&W aerial photographs. The method suggested in this study provides a suitable approach for detecting the spatial pattern of trees in Zagros forests by B&W air photos [7]. Safari et al, in a study on spatial pattern of wild pistachio (*Pistacia atlantica* Desf.) in Bayangan forests (Zagros forest, Iran), found out that all indices related to plot samples indicate the clumped pattern for *Pistacia atlantica* while among the distance indices used in this study, Eberhart and Heines indices showed clumped, C index showed uniform and Hopkins index indicated random pattern for Pistachio. According to this study as a final result, the spatial pattern of Pistachio in Bayangan forest revealed a clumped pattern [23]. In a study conducted on distribution of brant's oak (*Quercus brantii* Lindl.) in Bayangan forests (Kermanshah province, zagros forest), it was found that based on all of the applied spatial pattern indicators the brant's oak trees show a clumped spatial pattern [22]. Zabihollahii et al (2012) in a study conducted in Havare khol forests (Kurdistan province, Northern Zagros forest, Iran) on forest structure, found out that based on distribution graphs of diameter in breast high of trees (DBH) the forests showed an uneven-aged young stand status and the spatial pattern of trees in these forests was uniform to clumped pattern as well [25]. According Haidari et al (2013) based on a study conducted on vertical and horizontal forest structure in Northern Zagros forests, the DBH distribution graphs demonstrated an uneven aged stand type [11]. In a study conducted in Zagros forests of Iran on the sampling methods in order to evaluation of shrub density (Askari et al, 2013), it was found out that the spatial distribution of shrub in the study sites follows a clumped pattern [29]. In spite of all these above studies in Zagros forests, there are no reports about stand structure and spatial distribution of trees in Blake forests. The main purpose of the present study was to determine the tree spatial pattern in Blake forest, Baneh region, Kurdistan Province, northern Zagros forest of Iran. We will consider the quantitative assessment of the tree distribution in these forests as well.

MATERIALS AND METHODS

The present study was an ecology – analytical study carried out in the Blake forest, Baneh region, Kurdistan Province, northern Zagros forest, Iran (Figure 1). Blake Village is located in west of Baneh city with high from sea level between 1280 and 1900 m [35]. We selected 10 hectare of conventional territory of this village as the study area. The aim of the study was determine of the tree spatial pattern in the northern Zagros forest. In this study the methods for quantifying spatial pattern of trees based on indices or on statistical techniques have been compared as well. Distance and quadrate methods were developed by plant ecologists to study vegetation communities (Ludwig and Reynolds, 1988). In this study we used and focused on quadrate sampling techniques because of better results comparing to distance sampling [34].

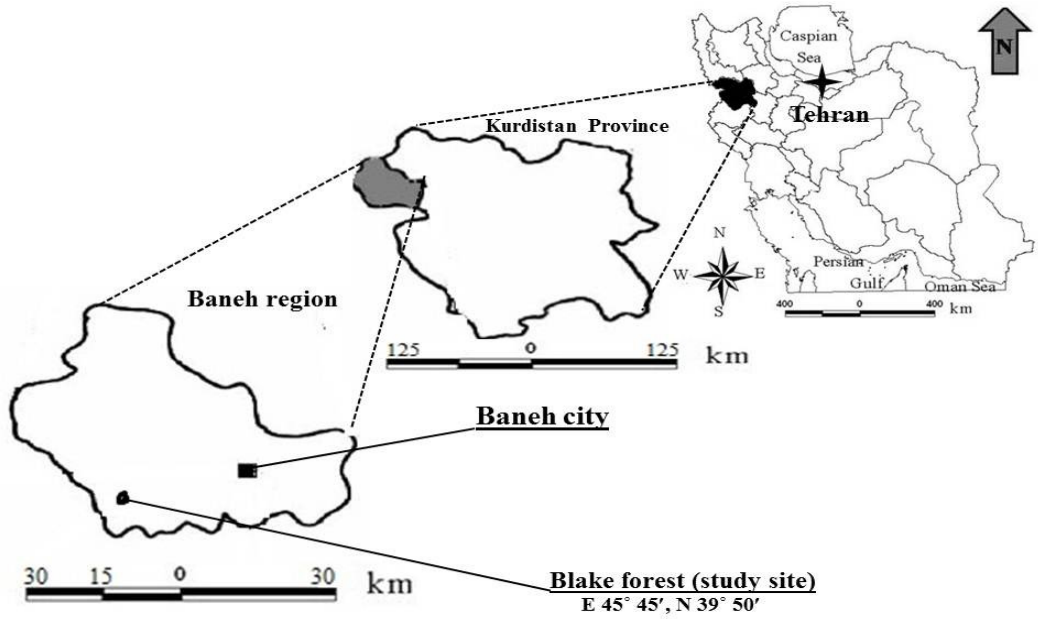

Figure 2. Study site location in the Kurdistan Province, Zagros region, Iran

Inventory methods designed randomize- systematic methods applying the circle sample plots 1000 m^2 in the 100×100 meter net. We select the 40 sample plot at all. In each plot some information such as kind and number of species were recorded. Data are summarized as means +/- SD. To analysis the data statistically, in order to determine forest spatial pattern, we used some quadrate method such as variance/mean ratio, Green and Morisata index (table 1) applying Ecological Methodological software.

Table 1: spatial pattern Indices used in this study

Indices	References	Equation
variance /mean ratio (Myers ,1978 [19])	= Variance of number of tree in per sample plot S^2 $\bar{X}$= Means of number of tree in per sample plot	$I - \frac{s^2}{\bar{x}}$
Green (Myers ,1978 [17])	X= number of tree in per sample plot = Variance of number of tree in per sample plot S^2 $\bar{X}$= Means of number of tree in per sample plot	$IG = \frac{\left(s^2/\bar{x}\right) - 1}{\left(\sqrt{x}\right) - 1}$
Morisata (Krebs, 1989 [19])	Sum of tree in sample plot x =∑ x^2= Sum Squares of number tree in sample plot∑	$I_d = n\left[\frac{\sum(x^2) - \sum x}{(\sum x)^2 - \sum x}\right]$

RESULT AND DISCUSSION

To detect the spatial pattern of trees in the northern Zagross forests of Iran we carried out a field work and descriptive study in Blake forests (Kurdistan province, western part of Iran) using quadrate methods. We selected 40 sample plot recording in which the kind and the number of each woody species. The results of the analysis of gathered data according to the role of species are presented in figure 2 and table 2 and 3.

Fig. 2 illustrates the frequency of tree species in the Blake forests. We compared overall species frequency and found statistically significant differences between frequencies of woody species in the study area ($p<0.05$). As it has showed in the fig. 2, five tree species were found in the Blake forest and between all species; Quercus *libani* Oliv and *Quercus infectoria Oliv* were the most dominant woody plants in this area.

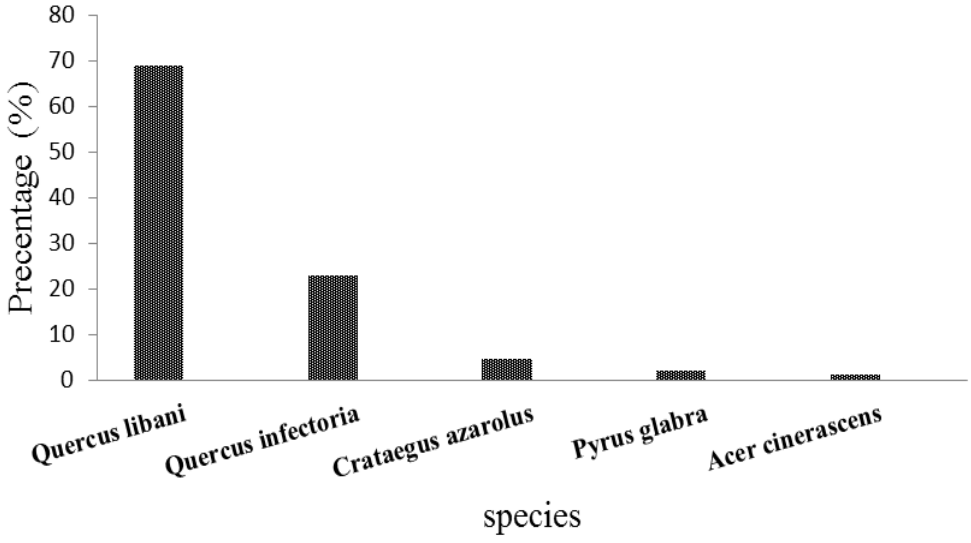

Figure 2: frequency percentage of tree species in Blake forest

Table 2: Spatial pattern classes based on the three indices

Spatial pattern	clumped, random and dispersed		
	Morisata	variance /mean Ratio	Green
Uniform	1>	1>	Negative (less 0)
Random	1	1	0
Clumped	1<	1<	Positive (more 0)

Table 3. Spatial pattern of trees in the Blake forest.

Index of dispersion	Quantity of χ^2	Quantity index	Spatial pattern
variance /mean Ratio	46.02	0.78	uniform
Green	-	- 0.0002	uniform
Morisata	45.416	0.984	uniform
Spatial pattern			Uniform

In table 2 it has been indicated the quantity of used spatial pattern indices and final result of spatial pattern based on those indices too. As presented in the table 2, results show that all of the applied indicators significantly reveal a uniform to random spatial pattern for Blake forest.

The analysis of spatial patterns is one of the ways to estimate the role of competition among trees in forest dynamics [25]. Distribution pattern for individual trees is one of the most important ecological parameter and increasingly sought by forest managers and modelers as a means to improve the spatial resolution and accuracy of forest models and management scenarios [28]. Spatial pattern of trees can possibly indicate stand history, population dynamics, and species competition [9] and it may be able to explain what controls the co-existence and diversity of species in a forest [36]. There are three main spatial patterns as following: clumped, random and dispersed [27].

According to the results of present study the quantity of Morisata, variance /mean ratio and Green indices significantly indicate the uniform spatial pattern for trees in the northern Zagros forests [table 2 and 3]. Our findings are in agreement with those of Safari *et al* (2010a) and Heidari (2006). However, the results are in disagreement with those of Zabiholahii *et al* and (2012) Safari *et al*, s studies (2010b), in that they found a clumped pattern for oak forests and reached the different results. Considering the seeds of oaks, the distribution pattern of them ecologically should be clumped but our findings do not support this fact. One possible explanation for this discrepancy is that the human utilization of Blake forests (Kurdistan Province, Zagros region, western part of Iran) is intensively and incorrectly that has been caused the modifying of spatial pattern of trees in these forests.

CONCLUSION

Spatial pattern of trees can possibly indicate stand history, population dynamics, and species competition. All applied indicators showed a uniform pattern for trees in Blake forests (Zagros region, Kurdistan Province, west of Iran). This result may be because of intensive an incorrect human utilization.

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