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Study of vertical and horizontal forest structure in Northern Zagros Forest (Case study: West of Iran, Oak forest)

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ABSTRACT

Structure includes vertical (number of tree layers) and horizontal features. To study of forest structure in the Northern Zagros forest, Blake forest in Baneeh region, Kurdistan province in west of Iran was selected. In Blake forest 10 square sample plots one hectare (100×100 m) were selected and in each sample plot this information include: position of tree, kind of species, diameter at breast height (cm), height (m), crown height (m) and two diameters of crown were recorded. Vertical and horizontal of this forest showed in the one sample (50×50 m, 0.25 hectare). To study of vertical structure study of distribution of tree and species in the height and diameter classes (height in three and diameter in the 5 cm classes). To analysis of horizontal structure (spatial pattern), used quadrat method, variance/mean ratio, Green and Morisata index.Data analyzing was done bySPSS16, SVS and Ecological Methodological software's. results showed that the mean of forest characteristics including DBH, height, crown height, andcrown area, canopy density and density, 28.5 (±4.5), 6.2 (± 0.9), 4.2 (±0.58), 7.1 (±1.01), 21.3 (±2.5) and 301 (±9)were existed. Overall results showed Blake forest was two forest story and Quercus libani Oliv and Quercus infectoria Oliv were the most dominant woody plants and located in over story. DBH distribution graphs showed uneven aged stand and spatial pattern of this forest was uniform to random pattern. A traditional forest management practice in the Armardeh (Blake forest) has negative effect on the forest regeneration and increases the frequency of old trees.

Key words: Blake forest, forest structure, horizontal structure,vertical structure, spatial pattern, Zagros forest.

INTRODUCTION

Forests cover about 12 million ha in Iran, including 5 million ha in the mountainous Zagros region [11]. The main species in this region are *Quercus* spp. (oaks), *Pistacia mutica* (wild pistachio), *Crategus* spp. and *Pyrus*spp[12]. Most of the forests of Iran involve some kind of conventional ownership, either communal (by villages) or among families within villages. In the Zagros Mountains, especially in the northern areas, the territory of Kurdish people, this kind of conventional ownership and relationships between humans and nature are extremely strong [19]. Increasing population, low level of development and high dependence of local communities on forests for their primary livelihood needs, are the main reasons of this destruction [9 and19]. Traditional forest management is used

in Zagros for the collection of foliage (fodder) for domestic animal. Individual households manage their privately owned forests as unit. The owners of each section regulate tree growth by pruning the crowns using a method called ″ coppicing″. Harvesting is conducted solely by family members unless the family is small. Households with small families receive help from the community. This assistance is called ″Gale″ (Gala on Kurdish language). In the Kurdistan province the oak tree is used for livestock feed, this tree include: *Quercus infectoria*, *Q. libani* and *Q.libani* leaves. These oaks are used as winter fodder. Forest management is conducted via ground and canopy level cutting of newly developed branches. Two traditional forest management practices in the Kurdistan province are used including one, pruning tree crowns and regulate yields (i.e. Armardeh or Blake Village pattern (figure 3)) that branch selection is based on lateral cutting of seedling growing in branches less than five cm thick, leaving on branch to grow then. The remaining branch will contain a higher concentration of nutrients, making it suitable for future as lumber[12]. The structure of forests has become an important factor in the analysis and management of forest ecosystems. Stand structure can be defined as the species composition, size and spatial distribution of trees and other vegetation within a forest stand [13]. Vertical structure of a forest includes its differentiation into layers between the ground and the canopy [3]. The horizontal structure of a forest is composed of diameter size distribution of tree species considered individually or as a community [5]. Structure includes vertical (e.g. number of tree layers, understory vegetation) and horizontal features (e.g. spatial pattern of trees, gaps) as well as species richness [26].Vertical forest structure is an attribute of forests that is of interest to many disciplines and is consistently discussed in the Stocking (number of trees or basal area per unit area), reflects the spatial distribution of tree individuals within the forest and the distribution of different species in relation to one another [2]. Diameter size distributions are often used in management to manipulate forest stocking [5 and 7]. Stand structure is a key factor in the growth, function, and disturbance regimes of forests. Forest restoration, and management based on natural disturbance ecology, has highlighted the value of a clearer understanding of the role of structure in mediating key ecosystem processes. Traditional descriptions of stand structure have focused on stand-level collective attributes such as average tree size, density, and basal area. However, the horizontal and vertical heterogeneity of forest structure influences tree growth, plant species diversity, wildlife habitat, and fire behavior [13, 8, 17, 34 and 37].The diameter distribution has also an important role in different growth and yield study. Diameter distributions have also been used for analyzing the structure of forest, e.g., in relation to forest biodiversity [33].This several researches (forest structure) implemented in the Iran and Zagros forest in cloud:the study of structure and evolution process of Beech forests natural stands in north of Iran. The results showed that beech species was dominant with respect to height. Regarding high longevity of beech, discontinuous crown of tree, and this stand is old with two or three storied and it is far from the optimal, showing the beginning of regeneration phase and passing destruction while overlapping aggradation (increasing stage) and destruction stage [27]. Study of traditional forest management and its Application to encourage public participation for sustainable forest management in the northern Zagros Mountains of Kurdistan province and results showed that traditional forest management can offer sustained yield and can be prescribed for sustainable forest management in northern Zagros with some modifications[12].Studystructure of less degraded Oak forests in Illam province. Results show that, the stands are basically uneven-aged old forests among which Quercus persica with its vigorous existence outcrops as pure or original species of forest type [18].Investigated to determine spatial pattern of tree in the Zagros forests. He concluded that the trees were arranged in a clumped pattern[15].Investigated on heterogeneity of structure in mixed beech forest of Iran, The results showed that alder and maple combined with beech can indicate the primary stages of succession and in this state; ironwood and persimmon trees are mostly found in the middle story and understory. In this forest, trees diameter distributions are normal based on De Liocourt index [6].Study on structure of oriental beech (*Fagus orientalis* Lipsky) stand at optimal stage in north of Iran. Results showed that the stand has a closed canopy cover and distribution of stem number per diameter class was more or less homogenous (Bell shape) with a semi even-aged structure. Using Ripley's *K* function, the distribution of trees within the stand was random[14].Study of spatial pattern Manna oak trees (*Quercusbrantii*Lindl.) in Bayangan forests of Kermanshah province, zagros forest. All of the applied indicators showed a clumped pattern for *Quercusbrantii*[31]. The aim of this research was Study of vertical and horizontal forest structure in Blake forest, Baneeh region, Kurdistan province, in Northern Zagros Forest (west of Iran).

MATERIALS AND METHODS

Site description

The Zagros Mountains are divided into two parts of northern and southern. The northern Zagros is consisted of the growing site of *Quercus infectoria* Oliv and somewhat *Q.libani* Oliv and *Q.persica* J. & Sp. (*Q.brantii* Lindl.) can be observed. The northern Zagros is wetter and cooler than the southern one [19]

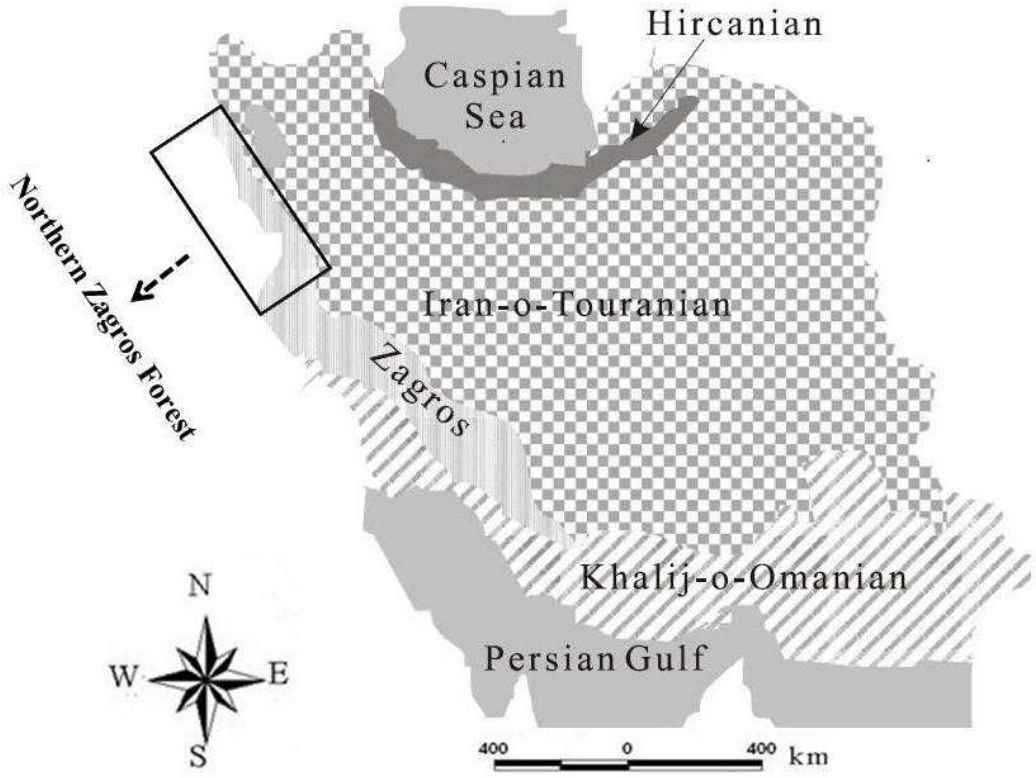

Figure 1. Distribution of four ecological zones of Iran

This research was investigated in the Baneh region, northern Zagros forest, and western Iranian state of Kurdistan(Figure 2). Blake Village is located in west of Baneh city and 10 hectare of conventional territory of this village was selected. The Blake forests are located between 1280 and 1900 m a.s.l[16].

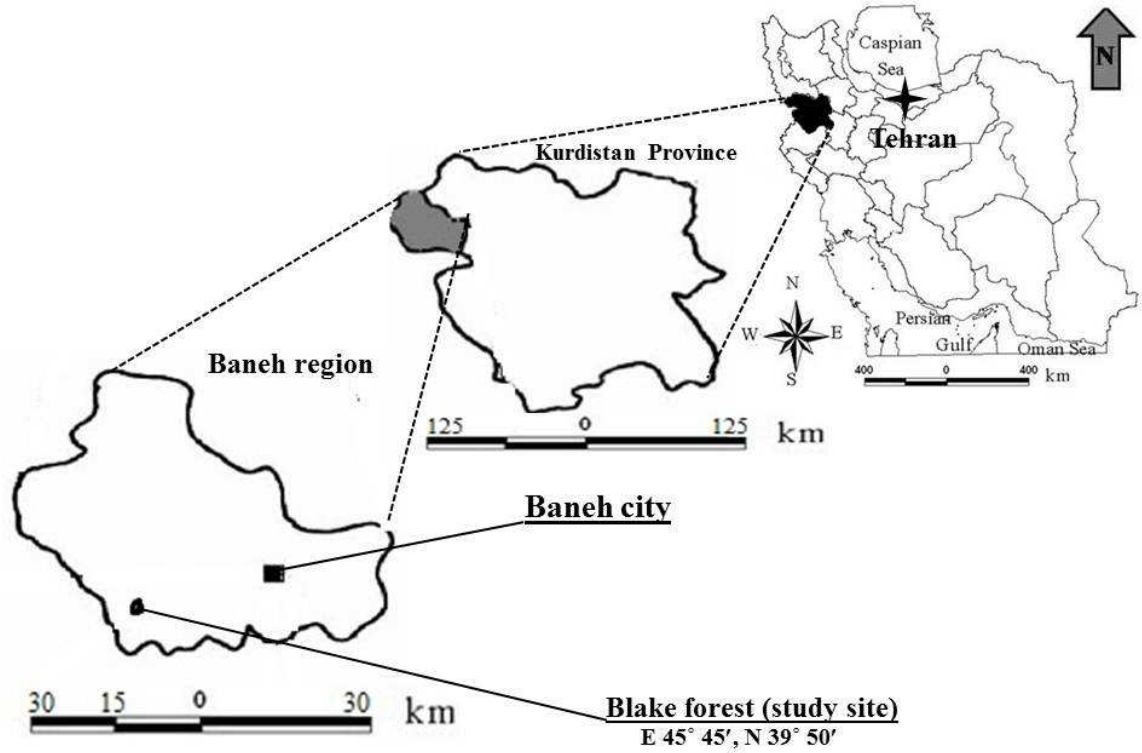

Figure 2. Study site location in the Kurdistan Province, Zagros region, Western Iranian state of Iran.

Figure 3.Traditional forest management practices in Blake forest (Armardeh Pattern).

Analysis

In this study 10square sample plots one hectare (100×100 m) were selected (Figure 4) and in every sample plot the position of tree, kind of species, diameter at breast height (cm), height (m), crown height (m) and two diameters of

crown were recorded. Vertical and horizontal of this forest showed in the one sample (50×50 m, 0.25 hectare). To study of vertical structure study of distribution of tree and species in the height and diameter classes (diameter in the 5 cm classes). To analysis of horizontal structure (spatial pattern), used quadrat method by variance/mean ratio, Green and Morisata index.Data analyzing was done bySPSS16, SVS (Stand Visualization System) and Ecological Methodological software's.

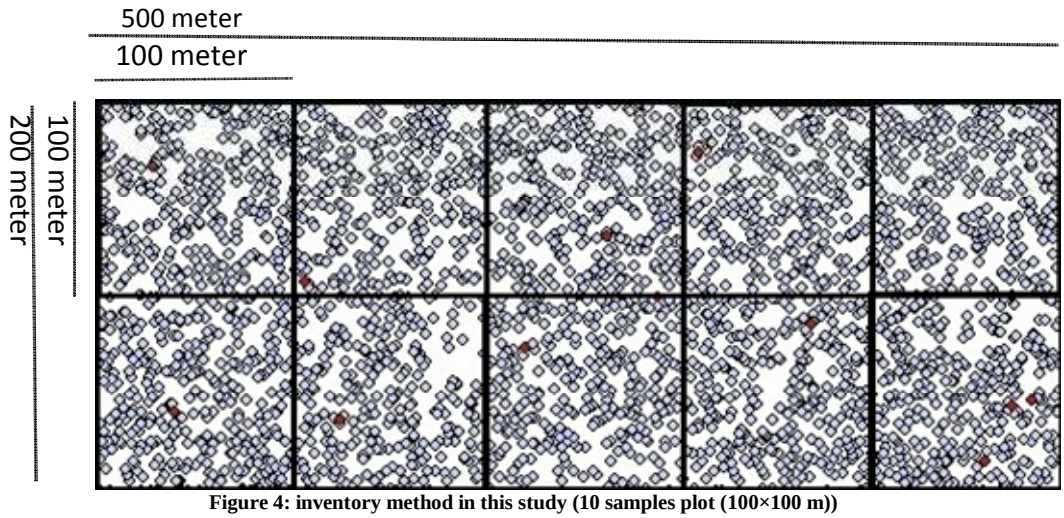

Figure 4: inventory method in this study (10 samples plot (100×100 m))

RESULT AND DISCUSSION

Tree distribution patterns vary among the species in different strata, and seed dispersal ability varies with tree height [21 and 22].Also, regeneration mechanisms depend on the vertical structure [4].Vertical forest structure is an attribute of forests that is of interest to many disciplines and is consistently discussed in the Context of ecosystem management. The vertical stratification of tree crowns is a forest attribute that influences both trees Growth and understory community structure [24].

Table 2.The mean of forests characteristics in the Blake forest

forests characteristics	mean	Standard deviation
Diameter at breast height (cm)	28.5	4.5
Height (m)	6.2	0.9
Crown height (m)	4.2	0.58
Crown area (m^2)	7.1	1.01
Canopy density (%)	21.3	2.5
Density (N/hectare)	301	9

The results of the table 1 showed that the mean of forest characteristics including DBH, height, crown height, andcrown area, canopy density and density, 28.5 (±4.5), 6.2 (± 0.9), 4.2 (±0.58), 7.1 (±1.01), 21.3 (±2.5) and 301 (±9)were existed, respectively

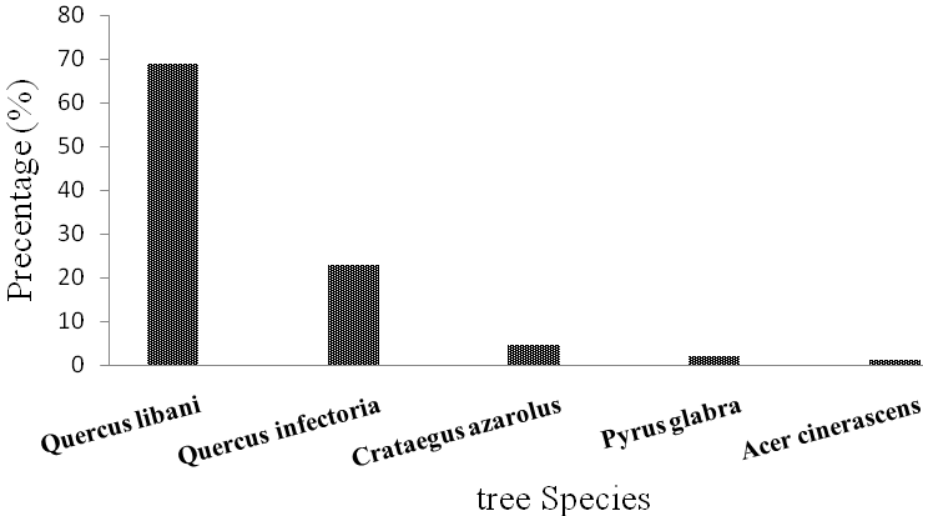

Figure 5: frequency percentage of tree species in Blake forest

Figure 5 showed thatfive tree species were found in the Blake forest and *Quercus libani* Oliv and *Quercus infectoria Oliv* were the most dominant woody plants in this area.

Table 2: the mean of species height and forest story in Blake forest

Species	Species composition (Percentage)	Tree height (m)	vertical structure
Quercus libani Oliv.	**69**	**6.21±1.11**	**over story[1*]**
Quercus infectoria Oliv.	**23**	**7.12±1.31**	**over story[1*]**
Crataegus sp.	**4.5**	**4.93±0.8**	**understory[2*]**
Acer MonspessulanumL. Subsp. cinerascens (Boiss)	**2.2**	**4.5±0.60**	**understory[2*]**
Pyrus communis L	**1.3**	**6.1±1.11**	**understory[1*]**

1 over story: tree height 5 to 9 meter2* understory: tree height less 5 meter*

Diameter distribution of trees with in the Blake forest is shown in figure 5;tree diameter distributions describe forest structure [25].

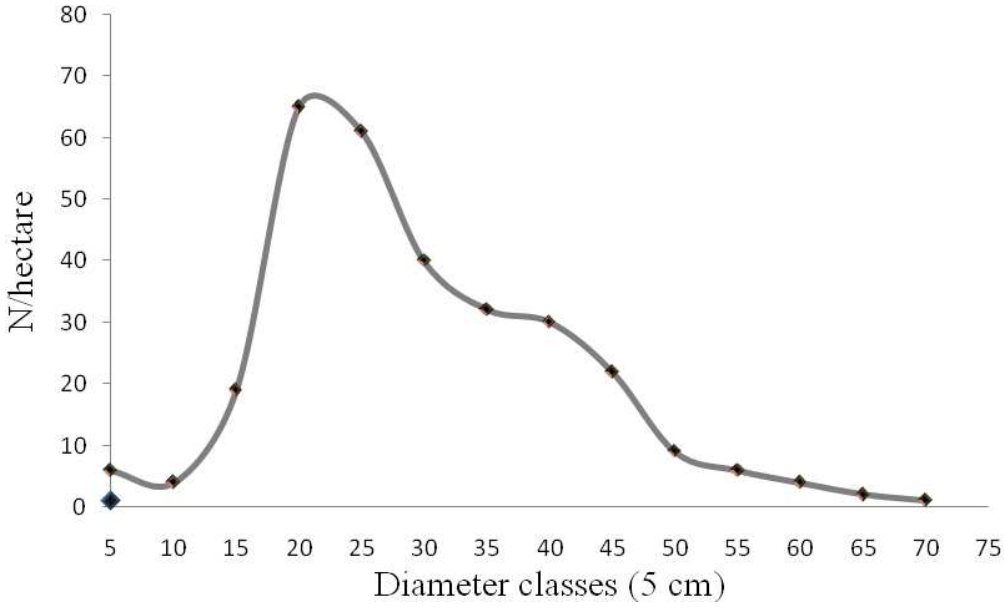

Figure 6.The number of trees in diameter classes in the Blake forests.

The diameters of the trees in the study site were measured at the breast height and recorded in classes of 5 cm. We measured DBH of trees ranging from 2.5 to 70 cm in Blake forest, respectively. The DBH distribution graphs in the stands indicate an old uneven, aged stand.

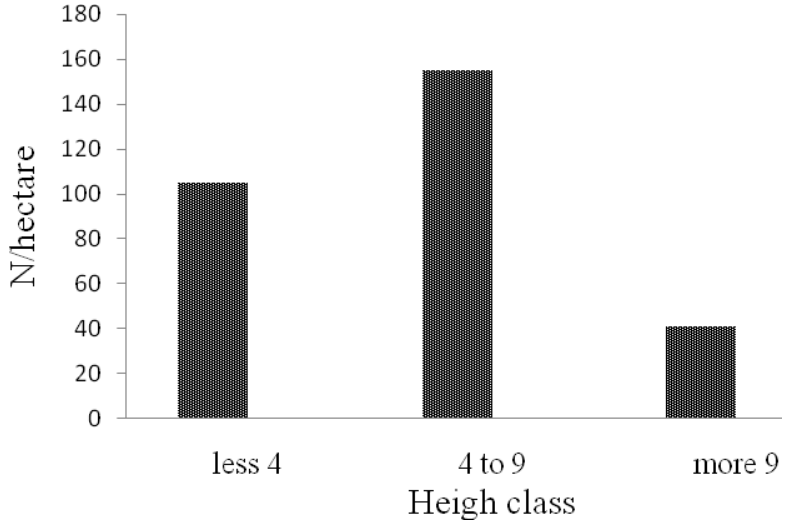

Figure 7.The number of trees in diameter classes in the Blake forests.

Figure 7 showed that the 4 t0 9 meter height class has a maximum N/hectare and this forest has a two layer story.

Table 3. The means of regeneration (N/hectare)in Blake forest

	seed regeneration	Coppice regeneration
Number of regeneration (N/hectare)	22±3.2	208±21
total	230±19	

The results of table 3 showed that the estimated number of regeneration is as follows: mean seed regeneration equal to 22 and Coppice regeneration equal to 208 in Blake forest.

Table 4.Spatial pattern of tree in the Blake forest.

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

Results showed all of the applied indicators showed a uniform to random pattern for Blake forest.

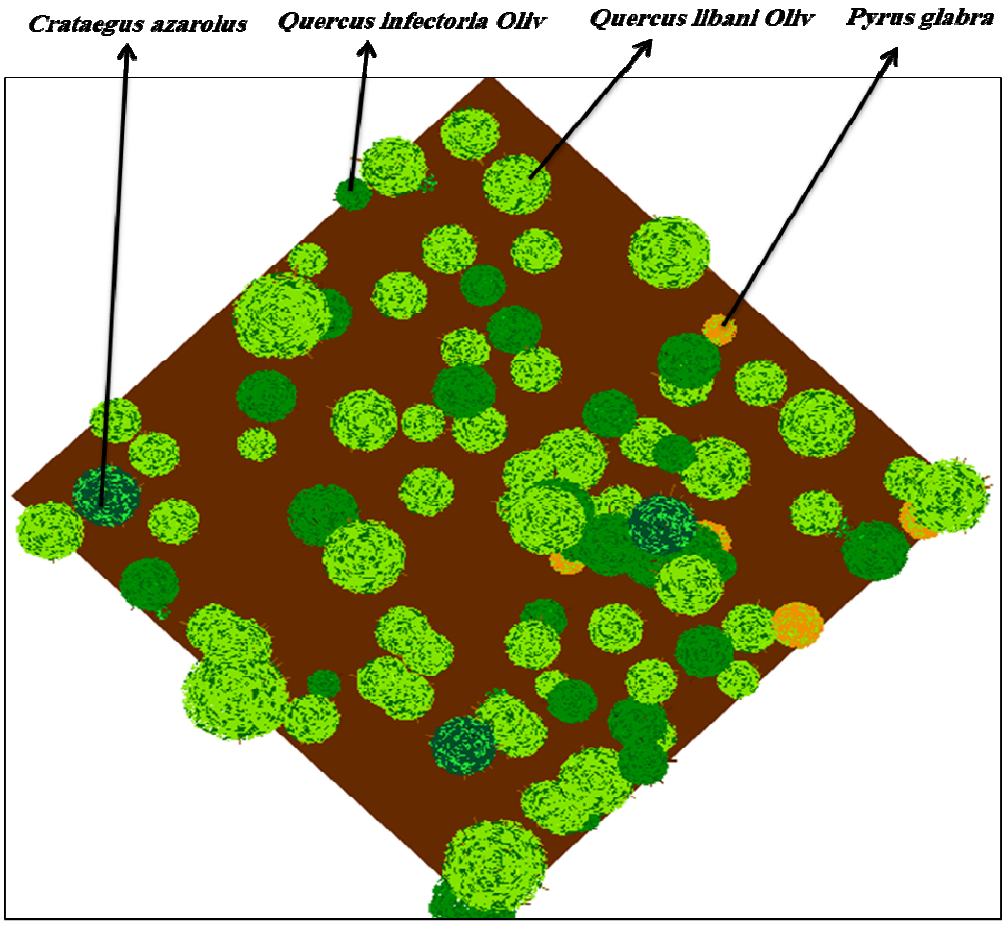

Figure 8. Stand visualization simulation of Blake forest (horizontal structure)

Figure 8 indicate spatial pattern (horizontal structure) of Blake forest was uniform to random pattern
Vertical structure plays an important role in forest ecosystems [10 and 30].

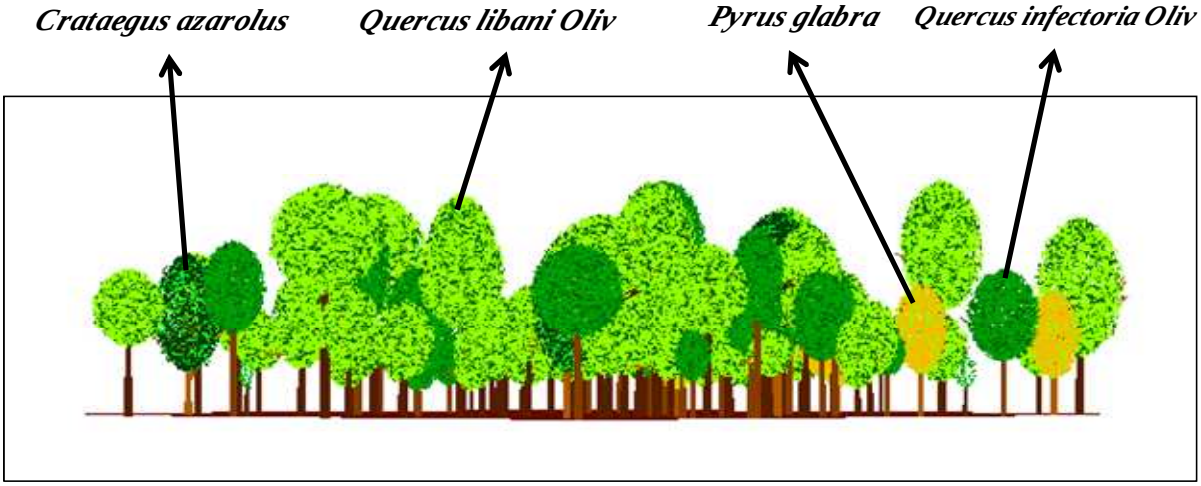

Figure 9. Stand visualization simulation of Blake forest (vertical structure)

results showed that Blake forest have to layers that *Quercus infectoria* and *Quercus libani* (average 6.21, 7.12 m height average) are in over story layer, and *Crataegus azarolus* and *Acer cinerascens* (4.93, 4.5 m height average)are in understory layer.

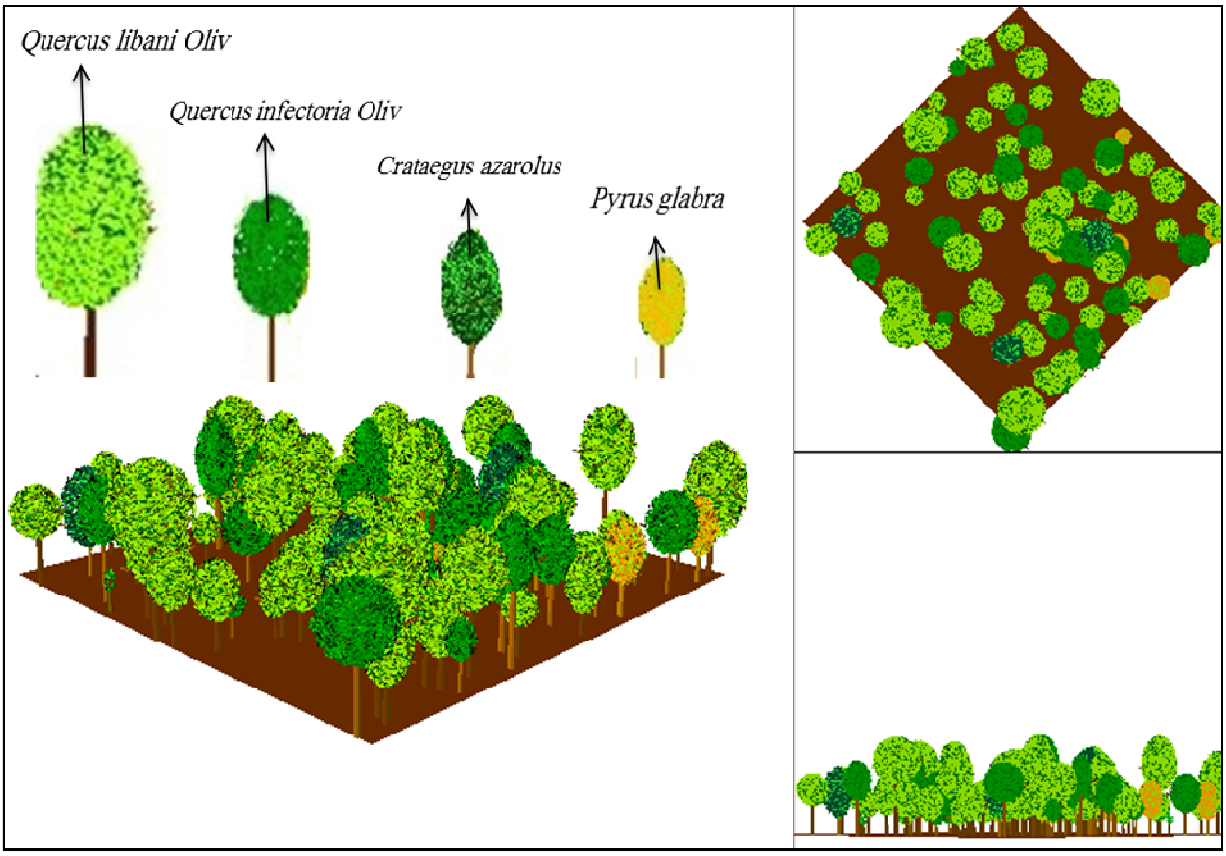

Figure 10. Stand visualization simulation of Blake forest (vertical and horizontal structure)
Figure 10 showed Blake forest have two story layers.

As traditional forest management practices are rooted in the customary life of local communities, they would appear to have widespread social acceptance, are adapted to local conditions, and have the potential to solve one of the most important problems currently facing forest management in the Zagros region [12]. Structural changes that result in differences in the amount and distribution of leaf area and cover in stands affect stand functions such as photosynthesis and respiration [35], tree growth [1 and 32], and understory plant diversity[23]. In this forest five tree species were found and *Quercus libani* Oliv and *Quercus infectoria Oliv* were the most dominant woody plants in this area (Figure 4 and table 2). To study of vertical structure use the height species and SVS output. Results showed the *Quercus libani* Oliv and *Quercus infectoria Oliv* (average 6.21, 7.12 m height average) located in over story and has major effect in this forest. *Crataegus azarolus* and *Acer cinerascens* (4.93, 4.5 m height average) are in understory layer (Figure 9 and table 2).the overall results showed that Blake forest have two story layers. The mean of diameter at the breath high ranging from 2.5 to 70 cm in Blake forest, respectively. The DBH distribution graphs in the stands indicate an uneven-aged old stands (Figure 6). Hosseinzadeh et al, 2004 [18]indicated that DBH distribution graphs was uneven-aged old stand and our study emphasis this results.On the other hand, traditional forest management of Blake forest (Armardeh pattern) increases the frequency of old trees. These data showed that traditional forest management as practiced in Blake forest can regulate diameter distributions as uneven-aged old stands system and could not support forest regeneration. The major problem in Blake forest is lack of the regeneration (Haidari, 2011; [18]). Results showed that the estimated number of regeneration is as follows: mean seed regeneration equal to 22 and Coppice regeneration equal to 208 in Blake forest (table 3), this results emphasis that the major problem in Blake forest is lack of the regeneration. Results of this study showed Blake forest (Armaradeh Pattern) have negative effect on the forest and degradation of this forest. The emphasis of traditional

managers on coppice methods and their focus on certain desired species has caused the decline of non-productive species and loss of gene flow in harvested species (Ghazanfari*et al*, 2004, [12]). Spatial pattern information for individual trees is increasingly sought by forest managers and modelers as means to improve the spatial resolution and accuracy of forest models and management scenarios (Wulder*et al*, 2004; [36]). There are three basic spatial patterns as following: clumped, random and uniform (Mitchell, 2005). Applied indicators showed a uniform to random pattern for Blake forest (table 4 and figure 8). Safari *et al*, 2010 [31], Heidari, 2006 [15] showed a clumped pattern for oak forest and in the front in our study in the Blake forest have a uniform to random pattern. Overall results showed Traditional forest management as practiced in Blake forest can regulate diameter distributions as uneven-aged old stands system and could not support forest regeneration.

CONCLUSION

Zagros forests have a highcharacteristic in society and economics. People in the Zagros regions are dependent to forest in order to grazing and providing forage [16]. Overall results showed Blake forest was two forest story and *Quercus libani* Oliv and *Quercus infectoria Oliv* were the most dominant woody plants and located in over story. DBH distribution graphs showed uneven aged stand and spatial pattern of this forest was uniform to random pattern. A traditional forest management practice in the Armardeh (Blake forest) has negative effect on the forest regeneration and increases the frequency of old trees.

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REFERENCES

[1] M.J.Arbaugh, D.L.Peterson.USDA Forest Service Research Paper, PSW-RP-217.Pacific Southwest Research Station, Albany, **1993**, 11.
[2] J.E.Brower, J.H.Zar. Field and Laboratory Methods for General Ecology.Third ed., Wm. C. Brown Publishers,Dubuque,**1990**.
[3] P.S.Bourgeron. *Structure and Function. Elsevier, Amsterdam*, **1983**, 29–48.
[4] J.Chen, G.A.Bradshaw. *Forest EcolManag*. 120,**1999**, 219–233.
[5] Davis, L.S., Johnson, K.N., 1987. Forest Management, third ed. McGraw-Hill, New York.
[6] A.Daneshvar, RRahmani, H. Habashi. *J. Agric. Sci. Natur. Resour. 14,***2007**, *1-12*.
[7] D.P.Dykstra, G.S.Kowero, A.Ofosu-Asiedu, P.Kio. Promotion de l' Ame´nagement Forester dans la Zone deForeˆt Tropical Humide d' AfriqueOccidentale ET Centrale Anglophone.PNUE/CIFOR, **1997**.
[8] D.S.Ehle, W.L.Baker. *Ecol. Monogr*. 73,**2003**, 543–566.
[9] M. Fattahi, Study on Zagros oak forests and the most important their destruction causes, Institute of Forests and Rangelands Research press,Sanandaj,**1997**.
[10] M.G.Fonseca, A.M.Z.Martini, F.A.M.dos Santos. *J. Veg. Sci*. 15, **2004**, 41–48.
[11] Forest and Rangeland Organization. Strategies for sustainable forest management in Zagros forests. Technical Report, Forest and Rangeland Organization, Teheran, **2002**.
[12] H.Ghazanfari, M.Namiranian, H.Sobhani and M.R.MarviMohajer.*Scandinavian Journal of forest science*. 19, **2004**, 65-71.
[13] R.J.Harrod, B.H.McRae, W.E.Hartl. *For. Ecol. Manage*. 114,**1999**, 433–446.
[14] M.Hassani, M. Amani. *Iranian Journal of Forest and Poplar Research*. 18,**2010**, 163-176.
[15] H.Heidari. Studying different distance methods in inventory of Zagros Forest. Ph.D. Thesis, University of Tehran, Iran, **2006**, 77p.
[16] M. Heidari. Study the vertical and horizontal structure of northern Zagrous forest and determine the appropriate inventory method to study it (case study: Blake forest), M.Sc. Thesis, University of Tehran, Iran, **2011**, 70.
[17] J.A.Homyack, D.J.Harrison, W.B.Krohn. *For. Ecol. Manage*. 194,**2004**, 131–143.
[18] J.Hosseinzadeh, M.Namiranian, M. MarviMohajer, GH. ZahediAmiri. *Iranian J.Natural Res*, 57,**2004**, 74-90.
[19] MH.Jazirehi, EM.Rostaghi.Silviculture in Zagros. University of Tehran Press, Tehran,**2003**, 520.
[20] D.A.King, S.J.Wright, J.H.Connell. *J. Trop. Ecol*. 22,**2006**, 11–24.
[21] S.Koukoulas, G.A.Blackburn. *J. Veg. Sci*. 16, **2005**, 587–596.
[22] C.J.Krebs. Ecological Methodology, Harper Collins, New York,**1989**, 653 pp.

[23] P.A.Latham. A process-related quantification of forest structure and understory diversity in inland northwest forests, from stands to landscapes, PhD dissertation. University of Montana, Missoula, **1996**,245pp.
[24] P.Latham, RZuuring, D.*Forest Ecology and Management*. 104,**1998**, 157–170.
[25] M.Maltamo,A. Kangas, J. Uuttera. *Forest Ecology and Management*. 133,**2000**, 263-274.
[26] M.Maltamo, P.Packalen, X.Yu, K.Eerikainen, J.Hyyppa, J.Pitkanen. *Forest Ecol. Manage*. 216,**2005**, 41–50.
[27] A.Mattaji, M.Namiranian. *Iranian J.Natural Res*. 55,**2003**,530-541.
[28] A.Mitchell. The ESRI Guide to GIS Analysis.Vol. 2, ESRI Press,**2005**,USA.
[29] M.L.Morrison, B.G.Marcot, R.W.Mannan. Wildlife habitat Relationships. University of Wisconsin Press, Madison, **1992**,343pp.
[30] F.M.Schurr, O.Bossdorf, S.J.Milton, J.Schumacher. *Plant Ecol*. 173, **2004**, 271–282.
[31] A.Safari, N. Shabanian, R.H.Heidari, S.Y.Erfanifard and M. Pourreza.*Iranian Journal of Forest and Poplar Research*. 18, **2011**, 596-608.
[32] F.W.Smith, J.N.Long. *J. Appl. Ecol*. 26,**1989**, 681–691.
[33] J.Uuttera, M.Maltamo. *Silva FennicaJ*. 29, **1995**, 267-285.
[34] A.E.M.Waltz, P.Z.Fule, W.W.Covington, M.M.Moore. *For. Sci*. 49,**2003**, 885–900.
[35] R.H.Waring, W.H.Schlesinger. Forest Ecosystems, Concepts and Management, Academic Press, Orlando, **1985**, 340pp.
[36] M.A.Wulder, K.O. Niemann and T. Nelson.*Int. J. Remote Sensing*. 25, **2004**, 2225-2232.
[37] A.Youngblood, T.Max, K.Coe. *For. Ecol. Manage*. 199,**2004**, 191–217.