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Investigation of oak decline and its relation to physiographic factors in the forests of West of Iran (case study: Ilam Province)

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Abstract

The forest trees decline is important phenomenon that usually it emerges or increases due to climate change. Recently this phenomenon has occurred with extensive trees decline in the Zagros oak forest. The purpose of this study is identifying centers of decline associated with topographic factors, investigating the correlation tree diameter with tree decline and comparing the decline between seed tree and coppice tree in Ilam province. With this purpose was investigated the 1700 hectares area in forests of Ilam Province. We used one hundred percent inventory method and it was measured and recorded the qualitative and quantitative characteristics of all declined trees. Variance analysis results obtained from comparing the effect of elevation and aspect on oak decline indicated that elevation hadn't significant effect on the extent of oak forest decline. Also results showed that slope had a significant effect on the extent of oak decline. This meaningfulness is positive, as increased by increasing slope percentage on oak decline. Pearson's correlation results about topographical factors and oak decline showed that slope has a positive signification correlation with the extent and percentage of oak decline. Correlation results in regard to decline relationship with elevation and aspect variables suggested lack of meaningful correlation between these factors.

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Introduction

It has been proposed that West Iran's oak (*Quercus brantti*) forests may be entering an extended period of poor growth and susceptibility to droughts and invasive pests (Ahmadi *et al* 2014), a situation that has been a national forest health problem since recent years. The deterioration of oak forest health, evidenced by multiple symptoms and precipitated by various causal factors, is collectively termed "oak decline" (Thomas and Boza, 1984; Lawrence *et al*., 2002; Ahmadi *et al*, 2014). Oak decline results from the interaction of predisposing stress factors (drought, defoliating insects, poor site quality, and advanced tree age) and processor factors (secondary insect pests and disease) (Starkey and Oak, 1989; Manion, 1991; Lawrence *et al*., 2002). This multitude of stresses eventually weakens oak trees resulting in sparse foliage, thin crowns, crown dieback, reduced radial growth, and eventually death (Lawrence *et al*., 2002). Sanitation efforts to reduce tree mortality have included crown stand density reductions, increasing resistant species diversity and removal of unhealthy oaks (Clatterbuck and Kauffman, 2006). Because oak decline is a complex combination of predisposing, contributing and processor factors (Manion, 1991; Oak *et al*., 1996), there is need for basic data, long-term studies, and new analytical procedures (Kessler, 1989; Nebeker *et al*., 1992; Oak *et al*., 1996). The decline and mortality of oaks have been noted across its range in the Western of Iran forests since 2000 and oak decline is one component of the wider issue of oak sustainability (Mirabolfathy, 2013; Ahmadi *et al*., 2014).

In recent years, oak decline has been occurring in Zagros forests that in many regions resulted in the destruction of oak trees. Among them, it could be referred to the occurrence of decline in expansive area cowered by oak trees in Ilam province. This oak declining is increasing and caused concerns in the inhabitants and professionals (Hamzehpoor *et al*. 2011). With regard to the importance of this forests to water and soil conservation and prevention of various forms of erosions and the necessity of preserving these forests in order to conserve genetic reservoirs and biodiversity for future generation in a sustainable form, it is necessary to being informed about the extent and situation of oak decline and its relationship to the conditions of habitat, to present proper procedures and policies to prevent this event in endangered zones and confront to contaminant regions for natural resources planning and management.

Oak decline is one of improper and sorrowful events that is occurring in Zagros forests during recent years and increasing on a daily basis. Forest pathologists believed that pests and diseases among oak trees wouldn't be the only cause of occurring such environmental disaster. Actually factors such as forest destruction, subsequent draughts, and recent soil and dust particles play an effective role in the oak decline in Zagros region.

Nelson *et al* (2007) in their research about British pine forests in Columbia mentioned that lows of trees in faceted by beetles was located in altitude 800-1000 m above sea level, also western and so then geographical directions. Also, they mentioned that the extent of infection in older trees and canopy is 30-80% more then other parts. Other researchers in their results claimed that there is a meaningful relationship between trees' infection degree and vegetation and structural factors and affected by these factors. In Jones *et al* study in the southern California (2013), it was appeared there is no meaningful effects in relation to elevation difference or host species on the presence of *Agrilus anroguttatus*. The purpose of this study is identifying centers of decline associated with topographic factors, investigating the correlation tree diameter with tree decline and comparing the decline between seed tree and coppice tree in the Ilam province.

Material and methods

Study area

The considered region is a part of great mountain Banckol, in Ilam province (Fig 1). This region with

1700 hectare located in altitude 1300- 1900 m above sea level. Totally it is mountainous region with heterogonous topography located on the border of Sarab village in Ayvan County. This region was selected based on the existence of oak decline, physiographical heterogeneity, neighboring population centers in regard to leisure and recreation aspects, also with regard to the importance of its forests.

Fig. 1. Location of study area.

Methodology

In this study after referring to natural resources office of Ilam province and determining and receiving the scope of considered forest region and field visiting, primarily, this study attempts to prepare basic digital maps. The polygon of studied region was packaged in digital form in GIS space. In next stage digital topographical maps 1: 25000 are used to create DEM[1] (Topo to raster tools used to produce this model in Arc GIS. 10 software). Elevation, slope percentage and aspect were extracted from DEM. We also combined and overlaid these layers in order to produce to topographically homogenous units. After determining environmental homogenous units, we have introduced their data and scopes in to GPS system and a code was determined for every one of them in order to prevent problems in field exploitation. To select respective data in every homogenous unit, it was used one hundred percent inventory method, and it was measured and recorded the qualitative and quantitative characteristics of all declined trees and endangered ones accompanied to a series of secondary data.

Results

Highest origin form is coppice. With respect to Table 1, it could be said that the rate of decline is more in coppice than single-trunked (Table 1). Totally 30.2% of considered varieties classified in a rank with decline less than 25% and complete decline (100%) showed highest frequency, it could be said that 35.3% while considered species were declined 100% (Table 2).

By considering and studying declined oak, it was shown that their decline occurred in trunks, trunks plus branches and branches simultaneously. In respect to this variable, considering general situation showed that 61.3% trees were declined in trunks plus branches (Table 3).

In 60.8% of decline oak tree, it was observed the symptoms of charcoal disease (*Biscogniauxia mediterranea*) and milk secretion from trunk and in 87.9% of them, the presence of flat-headed borers in the form of producing pore, and feeding epidemic cambium layer by borer larvae (Table 4). Also in 60% of declined oak trees, it was observed the effects of tillage and farming under the floor of oak forests (Table 4).

Correlation coefficient results between decline and oak's growth variables

Considering relationship between dependant variable (decline percentage) and independent variable declined trees' height and diameter showed that there is a negative signification relationship between both variables in level p= 0.01, but it was not observed a signification relationship in regard to trees crown diameter in p= 1% and 5% (Table 5).

Variance analysis results obtained from comparing the effect of elevation and aspect on oak decline indicated that elevation hadn't significant effect on the extent of oak forest decline (Table 6). In the other

[1] - Digital Elevation Model

words, there is no significant difference between oak decline and increasing or decreasing elevation.

Variance analysis results obtained from comparing the effect of slope percentage on oak decline showed that this variable had a significant effect on the extent of oak decline (Table 6). This meaningfulness is positive, as increased by increasing slope percentage on oak decline.

Correlation results between physiographical variables and extent of oak decline

Pearson's correlation results about topographical factors and oak decline showed that slope has a positive signification correlation with the extent and percentage of oak decline (Table 7). In regard to aspect factor, the test result suggested lack of specific meaningful relationship with the extent of oak decline (Table 7). As, we would claim that the pattern of oak decline distribution in the considered region doesn't obey a specific direction and is observed in all of aspect directions. Of course, western directions had higher decline rate in regard to other directions. Also the variable elevation from sea didn't show a signification statistical difference in regard to the extent and percentage of oak decline (Table 7).

Correlation results in regard to decline relationship with elevation and aspect variables suggested lack of meaningful correlation between these factors.

Table 1. Growth form frequency distribution of dried oak trees in the area.

Statistics	Growth form		sum
	Coppice	single-trunked	
Frequency	1865	1271	3100
Frequency percent	58.3	41.7	100

Table 2. Decline percent frequency distribution of dried oak trees in the area.

Statistics	Decline percent				Sum
	Less than 25%	26 to 50 %	50 to 75 %	More than 75%	
Frequency	936	620	450	1094	3100
Frequency percent	30.2	20	14.5	35.3	100

Table 3. Decline percent frequency distribution of dried oak trees in the area.

Statistics	Decline status			Sum
	Trunks plus branches	Trunks	branches	
Frequency	617	583	1900	3100
Frequency percent	19.9	18.8	61.3	100

Table 4. Primary or secondary factor of oak decline in the area.

	charcoal disease	flat-headed borers	understory cultivation
Frequency	1884	2724	1860
Frequency percent	60.8	87.9	60

Table 5. Spearman correlation coefficients between the variables studied.

Variables	Decline percent	Tree height	Trunk diameter	Canopy diameter
Correlation coefficient	1	-0.155**	-0.023**	-0.006ns
Sig.	.	000	000	0.331

** Significant at 1% level, ns not significant

Table 6. One-way analysis of variance to compare oak decline in relation to physiographic factors.

Variables	df	F	Sig.
Elevation	5	1.69	0.177 ns
Aspect	3	1.22	0.115 ns
Slop	3	3.729	0.008 *

*Significant at 5% level, ns not significant

Table 7. Pearson correlation coefficients between physiographic factors and oak decline.

	Elevation	Aspect	Slope
Oak decline	0.151 ns	0.095 ns	-0.720 *

*Significant at 5% level, ns not significant

Discussion

Since the beginning of 1980, reducing forest health is one of main public and political concerns due to intensity of observed damages in the central European forests (Schütt *et al.*, 1983; Lammel, 1984). Decline in crown conditions and increased mortality of persian oak has been reported in western Iran since 2000s (Mirabolfathy, 2013; Ahmadi *et al.*, 2014). The phenomenon of oak decline, which weakens Persian oaks and can eventually induce mortality, can be promoted by a variety of biotic and abiotic stresses. Oak decline is widespread in the western of Iran, and given that few studies have been done in this area, and consequently specific causes for the phenomenon remain elusive. In our study area, the combination of even-aged, over-mature forests and additional agents such as insects and pathogens may be important features influencing decline in oak-dominated forests.

Most frequent growth form is related to estimate declined trees observed as coppice in the region (1865 trees or 58%), that was corresponds to Hamzehpoor *et al* (2011) findings, they have done an introductory study about Persian oak decline in Fars Province. In Hamzehpoor *et al* study (2011) 58% of decline trees were coppice and classified as having mean diameter. Totally 61.3% were decline at branches. This result suggested oak decline is begun from crown and head branches, which are the reason of reducing access to nutrition's. In 60.8% infected oak trees, it was observed infection and milk secretion from trunk and in 87.9% of them the effects of charcoal disease and producing pores and feeding epidemic cambium layer, also, in 60% declined trees; it was observed the effects of understory cultivation and tillage. Hamzehpoor *et al* (2007) found that most decline oak trees were classified in more that 75% decline, in the majority, it was observed the effects of pest activity, mainly flat-headed borers.

The results of considering topographical factors' effect showed that slope had a signification effect on the infesting of oak decline but elevation and aspect factors had no signification effect on oak decline. Results of the effect of slope on decline correspond to results of various studies (Lawrence *et al*, 2002; Kabrick *et al*, 2008; Kane and Kolb, 2007). But results of the effect of elevation and aspect are contrary to mentioned studies. In this study, because solar radiation is more intense in western and southern directions and receives more direct radiation and thermal energy which increasing heat,

evaporation and respiration and they lose humidity in a less time, while northern and eastern directions receive less energy, are colder. Trees located in a limited water conditions (sunward gradients) are more affected by decline (Suarez *et al*, 2004). Slope factor has a meaningful effect on the intensity of oak decline and the highest percentage of decline trees located in slope gradients above 60%. By increasing slope, the percentage of weak trees increased and the percentage of healthy trees reduced, because by increasing slope, humidity, soil depth and litter thickness will be reduced and soil is deteriorated. This factor resulted in physiological loss of oaks and increasing weak trees percentage (Momeni *et al*, 2012).

Based on this research result, despite of the increasing decline in higher elevation, it was not obtained a meaningful relationship between decline intensity elevations. Suarez *et al* (2004) obtained the same result in their research. Dorhan *et al* (2002) found that Acer trees decline in Pennsylvania often occurs in higher elevation. In a series of studies performed in sari forests, Hosseini *et al* (2013) has determined that in higher elevation, the intensity of trees' damage is more.

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