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Regression and Correlation Analysis Between Vegetative Parameters and Physiographical Properties in Darab Kola Forest

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Abstract: The goal of this study was to determine whether and how differences in tree canopy cover and elevation at sea level affect the understory herbaceous cover and trees stock growth in the Darab Kola forests of Mazandaran province, Iran. Correlation and regression analysis were used to determine the dependence between different vegetative parameters and physiographical properties. Results showed that there wasn't significant relationship between trees density and elevation at sea level (R^2=0.05; p>0.05; r=0.22). There was no significant relationship between canopy cover and elevation at sea level (R^2=0.11; p>0.05; r=-0.33). Trees volume per hectare was increased by increasing canopy cover (R^2=0.12; p=0.05; r=0.35). An intensive photosynthetic activity of trees with extensive canopy is main reason of this phenomenon. Total herbaceous cover decreased significantly as percent canopy cover increased (R^2=0.56; p<0.001; r=-0.75). This can be explained in terms of forest succession. Limited light availability as the result of increasing canopy cover is often associated with a decrease in herbaceous species richness. Percent canopy cover and percent herbaceous cover was 71% and 35%, respectively. Regression analysis detected a negative relationship (R^2=0.16; p=0.05; r=-0.40) between trees volume per hectare and elevation at sea level. There was no significant relationship between herbaceous cover and elevation at sea level (R^2=0.04; p>0.05; r=0.19).

Key words: Regression, Correlation, Vegetative factors, Physiographic, Darab Kola

INTRODUCTION

The total forest area of Iran is approximately 12.4 million hectares, which makes only 7.4% of the total land area. Therefore, Iran is categorized under Low Forest Cover Countries (LFCC). However, it is a rich country from the aspect of plant biodiversity with almost 8,000 vascular plant species. The real temperate commercial deciduous forests, with an area of almost 2 million ha, are extended in the north of Iran, in the Caspian Region, the so-called Hyrcanian forest [1]. Hyrcanian forests with an area of about 1.9 million hectare are located in north of Iran, in southern coast of Caspian Sea. It is exclusive site for some valuable and unique species like *Gleditsia caspica* Desf., *Parrotia persica* C.A. Meyer. and *Pterocarya fraxinifolia* (Lam.) Spach [2, 3]. Physiographical properties of a forest are widely known as a factor potentially important in generating differences in ecosystem characteristics. Its impacts are various due to its compound character, potentially encompassing external variables such as solar radiation budget [4], exposure to air streams [5] hydro meteoric inputs [6] and cloud cover [7, 8].

Many studies have indicated relationships between individual species, but none have related combinations of overstory variables to understory herbaceous vegetation in broad leaved forests of Iran. In Ponderosa pine/Gambel oak ecosystem, scientists used canonical correlation analysis to relate overstory variables (canopy cover, basal cover and density) to herbaceous vegetation cover variables. This analysis showed that among herbaceous cover variables, Oregon grape, Kentucky bluegrass, sedge and foxtail barley; and among overstory variables, the density and the basal cover of Ponderosa pine indicated the highest positive contribution to the correlation of the two linear combinations,while the density and canopy of Gambel oak negatively affected the canonical correlation [9].

After the analysis on the linages of species, the fractal dimensions of vegetation and soil in a managed

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larch (Larix gmelini) forest in Daxingan Mountains, NE China were estimated separately and their scale correlation was discussed. The fractal dimension in the large scale range from 200 to 400 m was lower than that in the small scale range from 0 to 200m in the forest, indicating the different variation regularities of spatial heterogeneity in different scale ranges. The inflection point at 200 m was one of the key scales of spatial hierarchy of the larch forest. The scale variation of the forest was correlated with that of soil pH on large scales, which reflected the indirect control of the dominant species to the spatial pattern and species distribution of understories by changing soil acidity in the forest and the indirect effects of forest management [10].

The goal of this study was to determine whether and how differences in tree canopy cover and elevation at sea level affect the understory herbaceous cover and trees stock growth in the Darab Kola forests of Mazandaran province, Iran.

MATERIALS AND METHODES

Study Area: Darab Kola forest with an area of 2612 hectare is located in watershed 74 and in southeastern of sari city, Mazandaran province, Iran (36° 33' 20" to 36° 33' 30" N, 52°14' 40" to 52° 31' 55" E and elevation 180-800 meter at sea level). The average slope of forest is about 40%. The forest site has four kinds of soil including (I) non development randzin to washed randzin soil, (II) brown with alkaline soil pH, (III) washed brown with calsic and (IV) washed brown with pseodoglay [11] (Fig. 1).

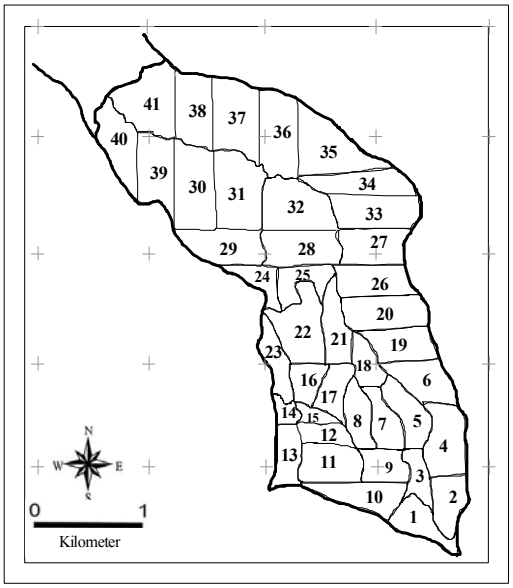

Fig. 1: Geographical position of the study area (Seri 1 in Darab Kola forest)

Data Collection and Analyses: Required data were collected from Darab Kola forestry plan which were confirmed by forests and rangelands organization of Iran. Correlation and regression analysis were conducted using Pearson and REG procedures in SAS statistical programming software, respectively. Linear regression model was used to determine the dependence between different vegetative parameters and physiographical properties.

RESULTS AND DISCUSSION

Trees canopy openness is predicted to increase the prevalence of herbaceous species in forest sites via two mechanisms operating at two scales. At the site scale, canopy openness should favour the germination and growth of herbaceous species and at the landscape scale the presence of open canopy should increase the seed rain and therefore the colonization rate of forest sites by herbaceous species [12]. In this study, overstory and understory data were collected in 32 compartments. The mean of vegetative parameters and physiographical properties of Darab Kola forest has been shown in Table 1.

Results showed that there wasn't significant relationship between trees density and elevation at sea level ($R^2 = 0.05$; $p > 0.05$; $r = 0.22$) (Fig. 2a). There was no significant relationship between canopy cover and elevation at sea level ($R^2 = 0.11$; $p > 0.05$; $r = -0.33$) (Fig. 2b). Trees volume per hectare increased by increasing canopy cover ($R^2 = 0.12$; $p = 0.05$; $r = 0.35$) (Fig. 2c). Total herbaceous cover decreased significantly as percent canopy cover ($R^2 = 0.56$; $p < 0.001$; $r = -0.75$) increased (Fig. 2d).

Percent canopy cover and percent herbaceous cover was 71% and 35%, respectively (Table 1). Regression analysis detected a negative relationship ($R^2 = 0.16$; $p = 0.05$; $r = -0.40$) between trees volume per hectare and elevation at sea level (Fig. 2e). There was no significant relationship between herbaceous cover and elevation at sea level ($R^2 = 0.04$; $p > 0.05$; $r = 0.19$) (Fig. 2f). Herbaceous cover was negatively related to total canopy cover (Table 2). A significant relationship was found between western juniper canopy cover and

Table 1: Basic information about the compartments of Darab Kola forests

Com*	Area (ha)	Elevation (m)	Slope (%)	Density (No ha^{-1})	Volume(m^3 ha^{-1})	Canopy cover (%)	Herbaceous cover (%)	Aspect
1	42	780	0-30	173	309	60	75	NW
2	54	770	0-30	228	205	70	25	N-NW
3	42	780	0-30	186	205	75	30	N
4	82	720	0-30	234	238	75	30	N-NE
5	57	650	0-30	167	307	65	50	N-NE
6	70	610	0-30	176	419	95	10	W-NW
7	35	620	0-30	177	303	65	25	N-NW
8	39	580	0-30	155	331	70	25	N-NW
9	64	680	0-30	206	302	60	50	NW
10	61	700	0-30	194	291	60	55	N
11	53	680	0-30	182	309	70	40	N
12	33	650	0-30	154	273	55	40	N-NE
13	50	700	0-30	141	260	65	35	N-NE
14	25	650	0-30	146	206	70	20	N-NE
15	19	640	0-30	215	250	65	35	N-NW
16	32	600	0-30	201	342	85	35	NE
17	51	570	0-30	113	304	65	56	N
18	34	510	0-30	191	323	75	15	N-NW
19	38	550	0-30	171	399	90	15	N-NW
20	100	500	0-30	168	384	70	35	W-NW
21	54	450	0-30	202	335	75	15	NE
22	74	550	0-30	162	365	70	50	NE
23	52	600	0-30	173	306	70	30	NE
24	52	520	0-30	181	332	70	25	N-NE
25	62	470	0-30	166	317	85	20	NE
26	57	500	0-30	174	352	65	50	W-NW
27	115	450	0-30	150	286	65	55	W-NW
28	76	450	31-60	207	300	75	30	E
29	76	450	0-30	146	249	70	25	N
30	110	300	0-30	Afforestation	Affores..	Affores..	Affores..	N
31	93	350	0-30	175	264	65	55	E-NE
32	78	350	0-30	186	346	80	25	E-NE
33	125	450	0-30	164	316	85	30	E-NW
34	61	400	0-30	Afforestation	Affores..	Affores..	Affores..	E
35	61	400	0-30	Afforestation	Affores..	Affores..	Affores..	E
36	93	400	0-30	Afforestation	Affores..	Affores..	Affores..	E
37	82	350	0-30	Afforestation	Affores..	Affores..	Affores..	E
38	89	300	0-30	Afforestation	Affores..	Affores..	Affores..	E
39	83	320	0-30	Afforestation	Affores..	Affores..	Affores..	E
40	54	270	0-30	Afforestation	Affores..	Affores..	Affores..	E
41	84	370	0-30	Afforestation	Affores..	Affores..	Affores..	E
Mean	64	528	0-30	177	304	71	35	N

*Compartment

Table 2: Pearson correlation coefficients for various vegetative parameters and elevation at sea level

Code	Vegetative parameter	1	2	3	4	5
1	Elevation at sea level	1				
2	Canopy cover	-0.33^{ns}	1			
3	Herbaceous cover	0.19^{ns}	-0.75***	1		
4	Number per hectare	0.22^{ns}	-0.05^{ns}	-0.09^{ns}	1	
5	Volume per hectare	-0.40*	0.35*	-0.12^{ns}	-0.13^{ns}	1

*,***: Significant in probability level of 5 and 0.1 %, respectively; ns: not significant.

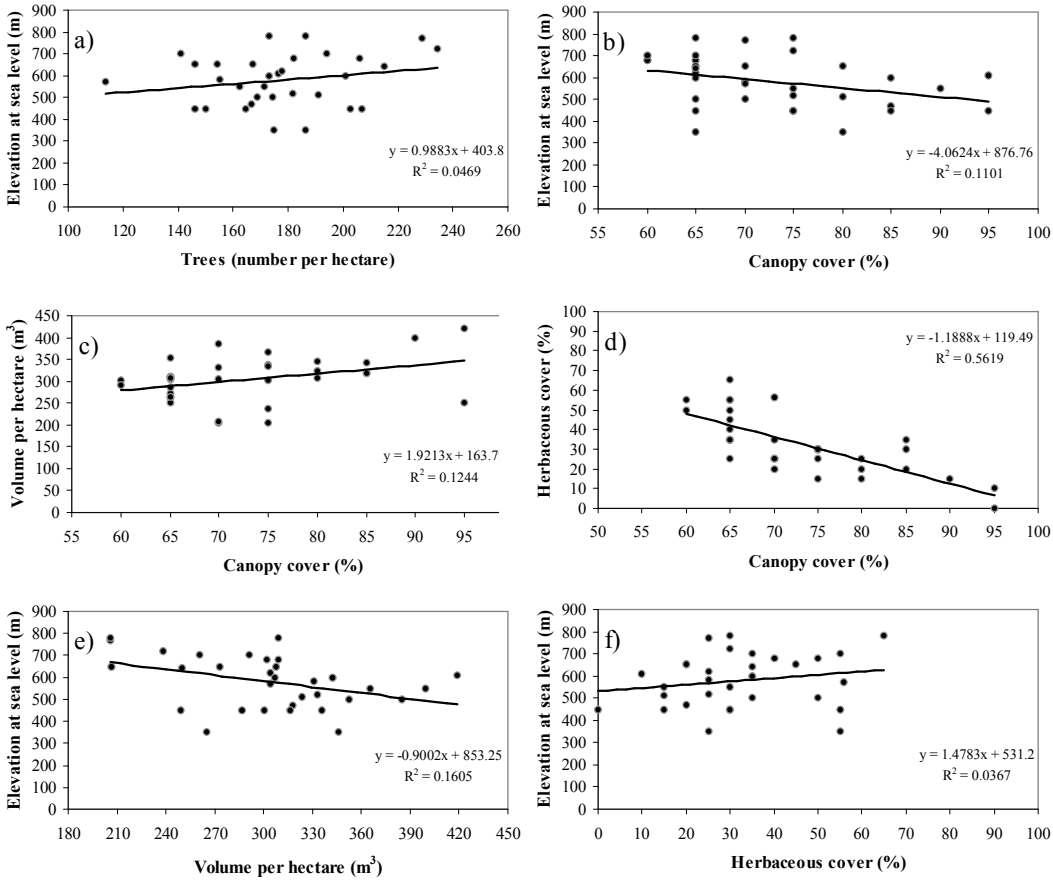

Fig. 2: Linear regression analysis between various vegetative parameters and elevation at sea level

understory species richness, shrub cover, forb cover, total grass cover, cheat grass cover, herbaceous productivity and bare ground. Removal of western juniper increased total grass cover, cheat grass cover and productivity and reduced bare ground [13].

An experimental study was undertaken by Grouzis and Akpo [14] on a complex ecological system in the semi-arid Sahelian region of Senegal. In this study the effects of tree cover on the above and below-ground phytomass of the herbaceous layer were examined. The results show that: (1) herbaceous above-ground production was 1.5 to 4 times greater under the canopy than in the open sun light; (2) understory root phytomass was about two-fold greater than the root phytomass of the open grassland; and (3) the root/shoot ratio was 2.5 higher in the open than in the shade. Increased herbaceous layer productivity was interpreted as a result of better climatic conditions and greater soil fertility within the canopy zones. Grouzis and Akpo [14] concluded that by promoting the development of herbaceous vegetation, trees increase the long-term production potential of the zone and, in consequence, improve conditions for livestock husbandry. In this study herbaceous cover was decreased significantly with increasing canopy cover. This is consistent with previous research reported by Miller and Wigand [15] and Vaitkus and Eddleman [16], which confirm that reductions in shrub and herbaceous plant cover were associated with succession toward closed woodlands.

CONCLUSIONS

Regression analysis detected a negative relationship between trees volume per hectare and elevation at sea level. It seems that the reduction of soil depth and fertility in higher places and also difficult condition causes that the trees volume per hectare be reduced. Also, trees volume per hectare increased with increasing canopy cover. An intensive photosynthetic activity of trees with extensive canopy is main reason of this phenomenon. Herbaceous species richness was greatest when the canopy cover was low. This can be explained in terms of

forest succession. Limited light availability as the result of increasing canopy cover is often associated with a decrease in herbaceous species richness.

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