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Impact of physiographical factors on the plant species diversity in the Northern Zagros Forest (Case study, Kurdistan Province, Marivan region)

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ABSTRACT

Zagros ecosystem is considered as one of the most important biological sites in the Iran. This research was investigated in the Marivan region, northern Zagros forest, and western Iranian state of Kurdistan. In this study 120 circle sample plots (500 m^2) were collected by random method in different aspect and altitude. In every sample plot the kind of species and number of trees and shrub were recorded. In the sample plots the micro plots of 5 m by 5 m (i.e. area of 25 m^2) were designed and Herbaceous and shrub information was recorded then. Aspect, slope and altitude divided the four, three and three classes. Species diversity indexes including Shannon Wiener (H'), Simpson (1-D) and Margaleff (R_1) were used to evaluate plant diversity in each sample plot. The means of different between diversity indexes in the aspect, slop and altitude class were estimated by ANOVA and DUNCAN test. Data analyzing was done by Past and Ecological Methodological software's. Results showed the tree, shrub and herbaceous species belonged to 29 families and 80 species were identified in the study area. That Rosaceae and Fagaceae families have the highest number of woody species. Moreover, Compositae and Gramineae families were most abundant amongst herbaceous species. The increasing of altitude decreased species diversity. A significant different was observed for diversity index in aspect, slope and altitude classes. Therefore, in order by increasing of altitude the plant diversity decreased, higher of plant diversity observed in the northern aspect, 0– 30 percentage slope and 1400 to 1800 meter a.s.l. classes.

Kay words: altitude, aspect, physiographical factors, Slope, species diversity, Zagros Forest

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INTRODUCTION

With due attention to climate conditions of Iran that 65% area includes arid and semi-aired and degradation rapid of north and west, because of degradation of natural resources will cause to degradation agricultural lands and human environmental [5]. Forests cover about 12 million ha in Iran [8], including 5 million ha in the mountainous Zagros region. This forest extends from Turkey and Iraq into Northeastern and Southeastern Iran (between Azerbaijan and Fars Province). Zagros is typically characterized by a semi-humid climate with extremely cold winters and annual precipitation exceeding 800 mm. The main species in this region are *Quercus* spp. (oaks), *Pistacia mutica* (wild pistachio), *Crategus* spp. and *Pyrus* spp [9]. The Zogros Mountains are divided into two

parts: northern and southern. 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.) species are found in this part. However, the southern Zagros is included *Q.persica* site which it extended to Fars province (i.e., 29º 5´ N). The northern Zagros is wetter and cooler than the southern one [19]. Physiographic is abbreviation of Physical Geography, means surface shapes of a region [15]. That has many effects on plant diversity and their variance [4]. Different researches have considered the biodiversity through considering to physiographic [3 and 20], or each one of physiographic different factors in separate aspect such as height from the sea surface [22], slope or direction or combining two slop and direction factors [21]. The study of plant diversity in the zagros forest showed in the northern Zagros Mountains since there is 165 woody species (tree and shrub) in Zagros and 182 bush and herbaceous species only in northern Zagros [12]. Investigated of biodiversity in relation to physiographical factors in mountain forest in Iran and results showed that species diversity was the greatest at north aspect and slopes less than 30% has the most amounts. Factor of altitude from the sea level did not have meaningful relation with species diversity [10]. Study of the biodiversity of Vegetation Species in Relation to Environmental Factors in Different Aspects of Zagros forest and Results showed that by increasing the altitude, the species diversity and richness are increased [14]. study on the herb Layer biodiversity in relation to physiographical factors in south of Zagros forest ecosystem and results showed that low altitudes class 1600>, south aspect and less 30 percentage have maximum the plant diversity [11]. The research investigated on the Impact of physiographic and human factors on crown cover and diversity of woody species in the Zagros forests (Kermanshah province) and Results showed that by increasing the altitude, the species diversity and richness are increased. Results showed that in the northern slopes and 25-60 percent slop category, the crown cover and species diversity were maximum [16]. Study of relationship between plant diversity and physiographic factors in Ghalarang protected area and results showed that northern aspect have higher plant diversity and while 4 trees, 3 shrubs, one bush and 78 herbaceous species were identified in Ilam forests of Zagros [18]. Study of floristic and plant species diversity of the Lebanon oak site (Quercus libani) in the western Iran and results showed the mean diversities were found the highest in northern and northwestern and lowest in northeastern aspect in the shrub layer. Moreover, Mean richness and diversity were found the highest in 1500 m a.s.l. and lowest in 1750 and 1800 m a.s.l. in the tree and shrub layers. Mean richness and diversity were found the highest in 1500 m a.s.l. and lowest in 1750 m a.s.l. in the regeneration layer. Also, the mean diversities were found the highest in elevation 1700 m a.s.l. and lowest in elevation 1800 m a.s.l. in the herbaceous layer [19]. The aim of this study was to determine effect of physiographical factors on the plant species diversity in the Marivan region, Kurdistan Province, Northern Zagros Forest west of Iran.

MATERIALS AND METHODS

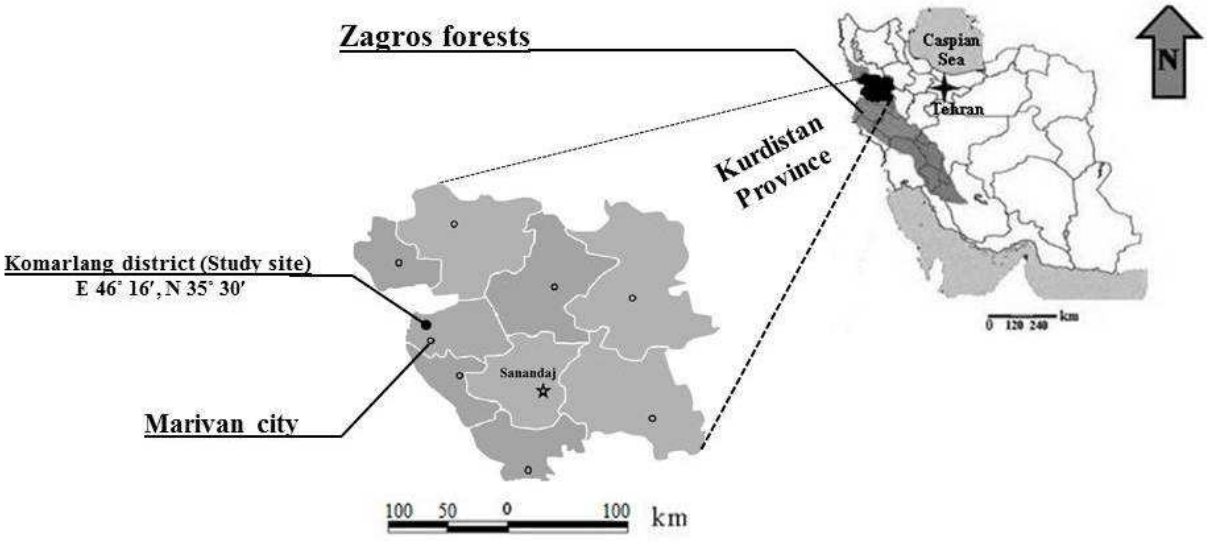

Figure 1. Study site location in the Kurdistan Province, Zagros region, Western Iranian state of Iran

Site description

Iranian habitats support about 8000 species of flowering plants (i.e. belonging to 167 families and 1200 genera), of which almost 1700 are endemic [6]. 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 (12).This research was investigated in the Komarlang district, Marivan region, northern Zagros forest, and western Iranian state of Kurdistan (Figure 1). Komarlang village is located in north of Marivan city and the 200 hectare of conventional territory of this village was selected. The forests are located between 1150 and 1920 m a.s.l. Mean annual precipitation is 909.5 mm, ranging from 590.8 to 1422.2 mm, Mean annual temperature is 13.3º C, and the length of dry season is 4 month (based on embrothermic curve) from June to August. Type of climate is sub humid with cold winters in the basis of Emberger's formula [19].

In this study 120 circle sample plots (500 m^2) were collected by random method. In every sample plot the kind of species and number of trees and shrub were recorded. In the sample plots the micro plots of 5 m by 5 m (i.e. area of 25 m^2) were designed and Herbaceous and shrub information was recorded then. Slope of the region was divided into three class: gently sloping (less than 30%), average sloping (30-50%) and high slopping (more than 50%), and the altitude was divided into tree class (class1: less 1400; class 2: 1400 – 1800 and class 3: more 1800 meter) and geographical aspect was divided into the main directions (North, East, South and West aspect). Species diversity indexes including Shannon Wiener (H′), Simpson (1-D) and Margaleff (R1) were used to evaluate plant diversity in each sample plot. The means of different between diversity indexes in the aspect, slop and high level sea class were estimated by Anova and Duncan test. Data analyzing was done by Past and Ecological Methodological software's.

Table 1: Biodiversity Indices used in this paper

Indices	References	Equation*
Shannon's (H′)	[17]	$H' = \sum_{i=1}^{S} pi \ln(pi)$
Simpson (1-D)	[17]	$1 - D = (\sum (pi)^2$
Margaleff (R_1)	[7]	$R = \frac{S-1}{\ln (N)}$

**S and pi refer to total number of species in the sample and proportion of individuals in the species, respectively.*

RESULTS

Calculation and comparison of different indices of diversity, as a favorite method is considered for study on biodiversity [2]. The assessment of biodiversity in forest has become an important issue for studying ecosystems and their conservation [1].

Table 2. List of plant species (Tree, Shrub and Herbaceous) in the studied areas

Vegetation layer	Species and families
Tree	*Quercus libani* Oliv. *(*Fagaceae), *Quercus infectoria Oliv. (*Fagaceae), *Quercus Brantii* Lindl. *(*Fagaceae), *Acer Monspessulanum L. Subsp. cinerascens (Boiss).* (Aceraceae), *Pistacia atlantica Subsp* Kurdica. *(*Anacardiaceae), *Amygdalus Communis* L. *(*Rosaceae), *Crataegus sp. (*Rosaceae).
Shrub	*Lonicera nummularifolia* Jaub & spach.*(* Caprifoliaceae), *Cotoneaster nummularius* Fisch & Mey .(Rosaceae), *Pyrus communis* L. *(* Rosaceae), *Daphne mucronata* Royle. *(*Thymelaceae), *Fraxinus rotundifolia Miller.* (Oleaceae), *Sorbus graeca* Spach. (Rosacea), *Rhus coriaria* L. (Anacardiaceae),

	Juniperus sp. (Cupressaceae), *Cerasus mahalab* L. (Rosaceae).
Herb	*Achillea millefolium* L. (Compositae), *Adonis sp.* (Compositae), *Aegilops sp*. (Gramineae), *Agropyrum cristatum* L.(Gramineae), *Alcea sp.*(Malvaceae), *Papaver orientalis.*(Papaveraceae), *Anemon sp.* (Ranunculaceae). *Vicia variabilis.* (Pappilionaceae), *Anthemis tinctoria* L. (Compositae), *Arum elongatum Stev.* (Araceae), *Lactuca serriola.* (Compositae), *Astragalus sp*. (Pappilionaceae), *Avena sp.* (Gramineae), *Trifolium repens. (*Pappilionaceae), *Boissiera sp. (*Crucifereae), *Bromus tectorum L. (*Gramineae), *Bellevalia pycantha.* (Liliaceae), *Carex sp.*(Cyperaceae), *Capsella draba* L. (Crucifereae), *Alyssum sp.*(Crucifereae), *Eryngium billardieri* F. (Umbelliferae), *Campanula sp*.(Campanulaceae), *Hordeom violaceum.* (Gramineae), *Centaurea spp. (*Compositae), *Malva neglecta* Wallr.*(Malvaceae), Rumex sp.(* Polygonaceae), *Salvia sp. (*Labiateae), *Convolvolus arveniss* L. (Convolvulaceae), *Crepis sp.* (Compositae), *Dactylis glomerata* L.(Gramineae), *Geranium tuberosum* L. (Graninaceae), *Erodium sp.* (Graninaceae), *Ferula spp.*(Umbelliferae), *Fibigia Medicus. (*Cruciferae), *Crepis sanctus. (*Compositae), *Salvia indica. (*Labiateae), *Roemeria Medic. (*Papaveraceae), *Scabiosa spp.* (Dipsacaceous), *Heilanthemum ledifolium* L. (Cistaceae), *Rosa canina.* (Rosacea), *Smyrniopsis aucheri.* (Umbelliferae), *Hypericum sp.* (*Hypericaceae), Lamium album L.* (Labiateae), *Lathyrus sp.* (Pappilionaceae), *Medicago spp*. (Pappilionaceae), *Taeniatherum crinitum.* (Gramineae), *Poa spp.* (Gramineae), *Polygonum sp*.(Polygonaceae), *Stipa sp*. (Gramineae), *Ziziphora tenuir* L.(Gramineae), *Vaccaria sp.*(Caryophyllaceae), *Trifolium purpureum* .(Pappilionaceae), *Taraxacum sp.* (Compositae), *Gundelia tournefortii.* (Compositae), *Lotus sp.* (Pappilionaceae), *Fumaria asepala*. (Fumariaceae), *Trapogon sp.* (Compositae), *Teucrium sp.*(Labiateae), *Phlomis sp.*(Labiateae), *Onobrychis cornuta* L.(Pappilionaceae), *Hibiscus sp.*(Malvaceae), *Cuscuta spp.*(Cuscutaceae), *Allium sp.*(Liliaceae) and *Bellis sp.* (Compositae).

The Tree species identified in the region studied belonged to seven tree species in the four Families. In this forest have 80 plant species, which consist of 7 trees, 9 shrubs and 64 herbaceous species. (Table 2).

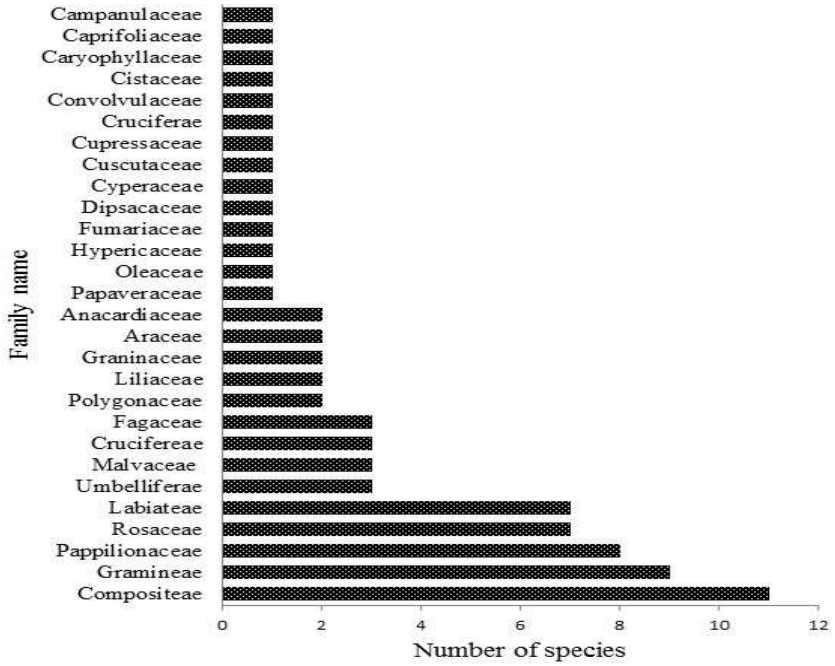

Figure 2. The number of plant species in the plant family in the study area

The tree, shrub and herbaceous species belonged to 29 families and 80 species were identified in the study area (Table 2). thus for the classes of Compositae, Gramineae, Pappilionaceae, Rosacae and Labiateae, eleven, nine, eight, seven and seven species were existed and have largest number of species, respectively (Figure 3).
Plant species diversity of three growth layers was obtained in terms of different aspects.

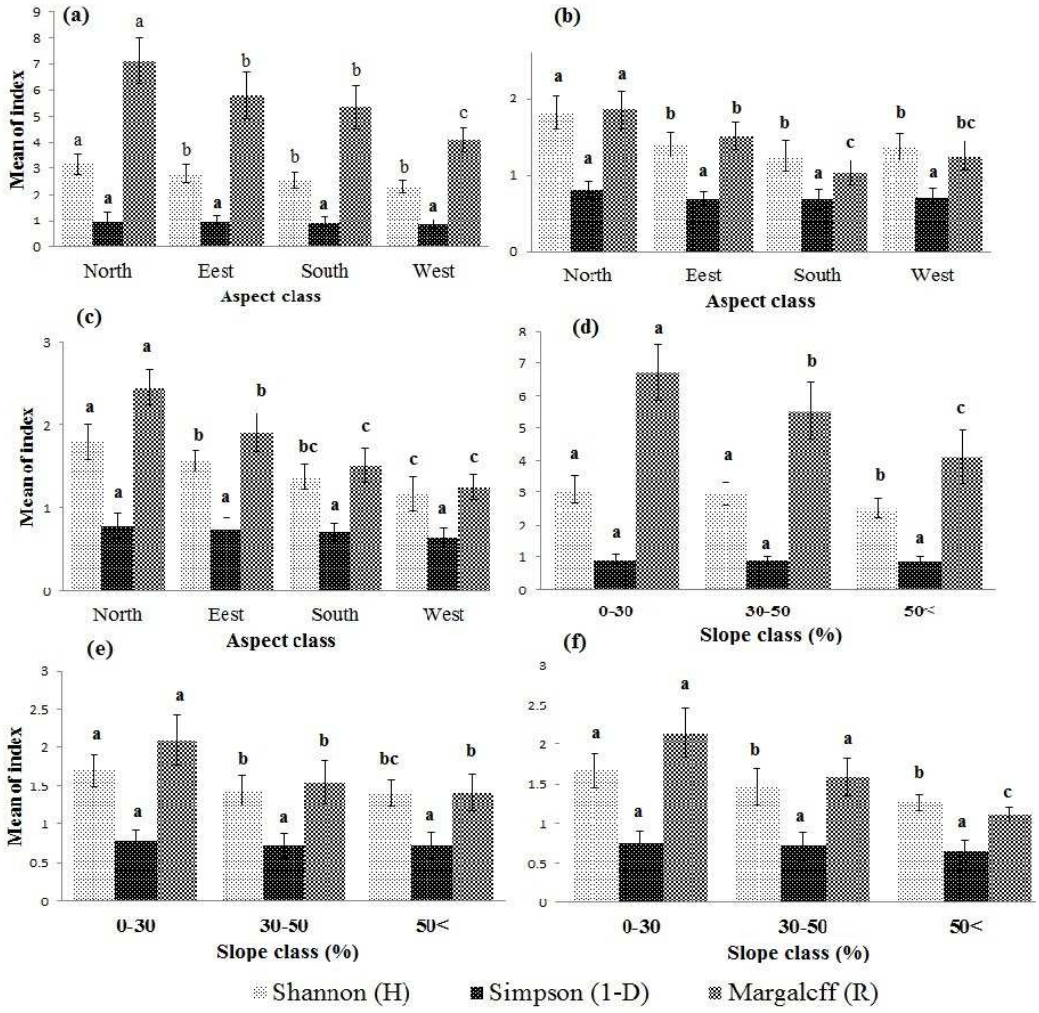

Figure 3. Mean diversity index in the: (a) Tree, (b) Shrub, (c) herbaceous, (d) Tree, (e) Shrub and (f) herbaceous layer of the aspect and slope class.

The mean diversities were highest in northern and lowest in western aspects in the tree, shrub and herbaceous layer. The ANOVA test indicated that there were significant differences mean Shannon (H) and Margaleff (R) index in the aspects classes ($P > 0.05$) (table 3). The mean diversities were highest in 0 – 30 percentage and lowest in more 50 percentage in the tree, shrub and herbaceous layer. The ANOVA test indicated that there were significant differences mean Shannon (H) and Margaleff (R) index in the slope classes ($P > 0.05$) (table 3), but Simpson index no significant differences mean in the slopes and aspects classes.

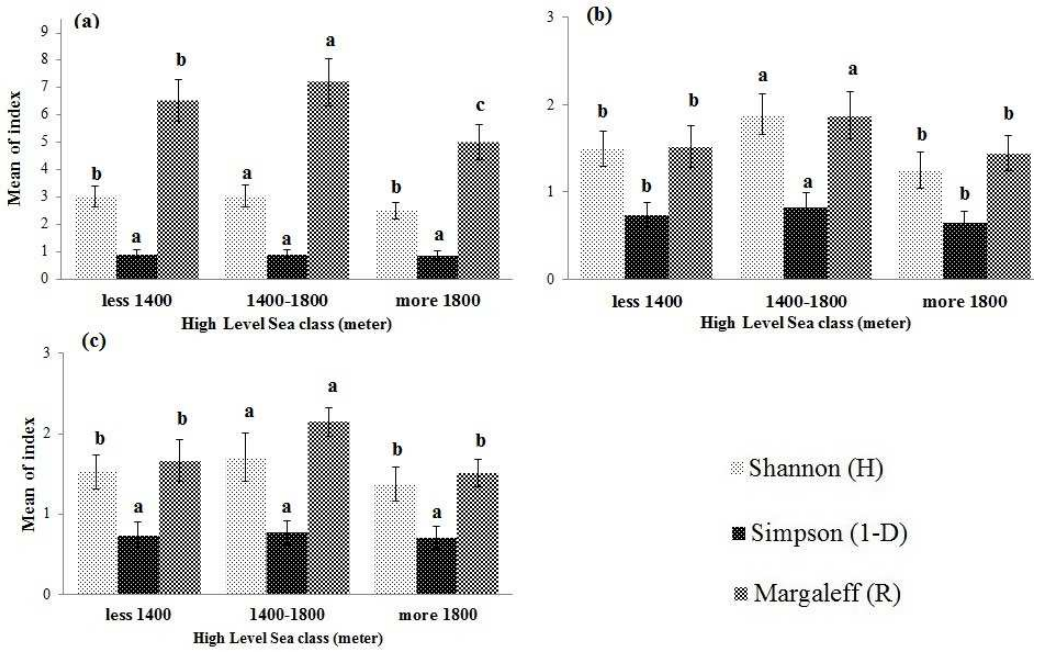

Figure 4. Mean diversity index in the: (a) Tree, (b) Shrub and (c) herbaceous layer of the High Level Sea class.

Table 3.The results ANOVA analysis to compere the mean plant diversity index in aspect, slope and High Level Sea classes.

physiographical factors	vegetation layer	Diversity index	DF	Mean Square	F	Sig.
Aspect class	Tree layer	Shannon (H)	3	0.341	10.341	0.000**
		Simpson (1-D)	3	0.043	2.908	0.064ns
		Margaleff (R_1)	3	0.435	13.672	0.000**
	shrub layer	Shannon (H)	3	0.421	13.061	0.000**
		Simpson (1-D)	3	0.0231	3.008	.094ns
		Margaleff (R_1)	3	0.532	15.913	0.000**
	herbaceous layer	Shannon (H)	3	1.451	11.071	0.000**
		Simpson (1-D)	3	0.32	2.561	0.076ns
		Margaleff (R_1)	3	2.014	14.673	0.000**
Slop class	Tree layer	Shannon (H)	2	0.463	11.045	0.000**
		Simpson (1-D)	2	0.0243	3.324	0.049*
		Margaleff (R_1)	2	0.836	10.342	0.000**
	shrub layer	Shannon (H)	2	0.480	8.351	0.000**
		Simpson (1-D)	2	0.0456	2.054	0.063ns
		Margaleff (R_1)	2	0.934	7.538	0.000**
	herbaceous layer	Shannon (H)	2	1.264	15.691	0.000**
		Simpson (1-D)	2	0.38	3.65	0.061ns
		Margaleff (R_1)	2	2.153	13.241	0.000**
High Level Sea class	Tree layer	Shannon (H)	2	0.546	10.086	0.000**
		Simpson (1-D)	2	0.0453	2.435	0.076ns
		Margaleff (R_1)	2	0.638	9.987	0.000**
	shrub layer	Shannon (H)	2	0.401	9.724	0.000**
		Simpson (1-D)	2	0.035	3.103	0.6 ns
		Margaleff (R_1)	2	0.386	8.056	0.000**
	herbaceous layer	Shannon (H)	2	1.465	18.874	0.000**
		Simpson (1-D)	2	0.39	3.143	0.051ns
		Margaleff (R_1)	2	2.013	16.873	0.000**

** Different letters indicate significant differences in 5% level, ** Different letters indicate significant differences in 1% level.*

The mean diversities were highest in 1400 to 1800 m and lowest in more 1800 meter High Level Sea class in the tree, shrub and herbaceous layer. The ANOVA test indicated that there were significant differences mean Shannon (H) and Margaleff (R) index in the High Level Sea classes ($P > 0.05$) (table 3), but Simpson (1-D) index no significant differences mean in the High Level Sea classes.

Result table 3 indicated the differences between mean Shannon (H) and Margaleff (R_1) diversity indexes in the aspect, slope and High Level Sea classes were statistically significant and differences between mean Simpson (1-D) diversity index in the aspect, slope and High Level Sea classes not statistically significant.

DISCUSSION

Biodiversity measurement is recognized as guidance for conservation plans in local scale. Species biodiversity is used greatly in vegetation studies, and environmental evaluation is one of the main criteria to determine ecosystems condition [13]. All three calculated indices in this study have been mentioned as the most applicable indices (2 and 15). A total of 80 plant species were found in the studied area, of which 16 woody species (7 trees, 9 shrubs) and 63 herbaceous species existed (Table 1) while 4 trees, 3 shrubs, one bush and 78 herbaceous species were identified in Ilam forests of Zagros (Pourbabaei et al. 2010). Therefore, it is concluded that tree richness is high in the studied area. Also, it can be deduced from Table 2 that Rosaceae and Fagaceae families play an important role in among woody species. Moreover, Compositae and Gramineae families were most abundant amongst herbaceous species**.** Results showed in this study area Compositae family have higher number of species in the study area (Figure 2). The mean diversities were highest in northern and lowest in western aspects in the tree, shrub and herbaceous layer. The ANOVA test indicated that there were significant differences mean Shannon (H) and Margaleff (R) index in the aspects classes ($P > 0.05$) (table 3). These results were confirmed by Hashemi and Babaei Kafaki, 2009 [10], Parma and Shataee Jouybari, 2010 [16], Pourbabaei et al, 2010 [18] and Pourbabaei and Navgran, 2011 [19]. The mean diversities were highest in 0 – 30 percentage and lowest in more 50 percentage in the tree, shrub and herbaceous layer. The ANOVA test indicated that there were significant differences mean Shannon (H) and Margaleff (R) index in the slope classes ($P > 0.05$) (table 3), but Simpson index no significant differences mean in the slopes and aspects classes. These results were confirmed by Hashemi and Babaei Kafaki, 2009 [10] and Heidari et al, 2010 [11] but, not are to be confirmed with gained results of Parma and Shataee Jouybari, 2010 [16].The highest mean of diversities were found the elevation 1400 to 1800 m a.s.l and the lowest in elevation more 1800 m a.s.l in the of tree, shrub and herb layer (Figure 10). There were significant differences among mean diversity indexes (i.e., Shannon (H) and Margaleff (R)) measures in the different elevations ($P > 0.05$). These results not are to be confirmed with gained results of Zagros forests in Kermanshah province (Parma and Shataee Jouybari, 2010). These results are to be confirmed with gained results Heidari et al, 2010 [11] and Pourbabaei and Navgran, 2011[19] but, not are to be confirmed with gained result Parma and Shataee Jouybari, 2010 [19]. Result indicated the differences between mean Shannon (H) and Margaleff (R_1) diversity indexes in the aspect, slope and altitude classes were statistically significant and differences between mean Simpson (1-D) diversity index in the aspect, slope and altitude classes not statistically significant.

CONCLUSION

The increasing of altitude decreased species diversity. A significant different was observed for diversity index in aspect, slope and altitude classes. Therefore, in order by increasing of altitude the plant diversity decreased, higher of plant diversity (tree, shrub and herbaceous) observed in the northern aspect, 0 – 30 percentage slope and 1400 to 1800 meter a.s.l. classes.

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