Relationships between Geopedological Characteristics and Vegetation Cover: A Case Study in the Dagh-Finou Catchment, Hormozgan Province, Iran

M. Zaremehrjardiri[A]

[A]**Scientific Member of the Agriculture & Natural Resources Research Center, Bandar-Abbas, Iran.E-mail: zare_mehrjardi@yhoo.com**

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Abstract. The objective of this study was to assess the relationship between vegetation, landform and physicochemical properties of soil. At the first terrain map unit were provided using the landsat thematic mapper (TM) satellite images, aerial photograph, topographical and geology map. Field sampling was done in the representative area using plot sampling. 104 plots 100 m2 were sampled in each plot landform parameters (slope, elevation, aspect), percentage of vegetation cover, were measured and stoniness and browsing damage were estimated and one soil sample was taken for measuring EC, pH, and texture. Relationship between vegetation and environmental factors was based on correlation analysis, box plot and Kruskal Wallis test (multiple comparisons). Correlation analysis showed a positive correlation between vegetation cover with slope and elevation and a negative correlation with EC. Based on the Kruskal Wallis test there was significant difference in vegetation cover between different geopedological map units. No significant relationships were found between vegetation cover and other soil properties such as pH and texture.

Keywords: Vegetation Cover, Geopedologic, Dagh-Finou Catchment, Bandar Abbas.

Introduction

Vegetation cover and species distribution pattern are two important factors in rangeland management and need accurate mapping and monitoring. Most soil scientists and range managers believe percentage cover and plant species are function of landform, soil characteristic, and that vegetation cover is a complex issue but it is possible to make correlation between vegetation type, landform and kind of soil for their classification. Using this method as a tool, one can also improve rangeland as well as rehabilitation of rangelands especially in the semiarid and arid area of Iran.

A large part of Iran is located in the arid and semi-arid region, where, by any criterion, low and erratic rainfall is the most outstanding characteristic of the land. Most of Iran's rangelands are in a state of instability mainly due to overgrazing and the lack of appropriate grazing systems, especially with regard to the problem of mixed herds of domestic livestock. These factors in combination with climatic condition and deterioration of soil condition seem to be some of the main causes for the instability of rangelands condition Farahpour (2002).

Vegetation is the product of environment Mannetje (1978). Therefore there are relationships among environmental factors and vegetation properties Abdollahi (1997). Under natural condition, the vegetation cover is determined by the interaction of environmental factors such as climate, geology, soil, aspect, slope-steepness, elevation and terrain position Mohammadi 2000). Considering the relationship between vegetation and environmental factors is very important. This helps us to better monitoring and mapping plant species.

Distribution and density of vegetation is affected by biotic factors such as topography, soil, geomorphology and climate. A number of studies have found relationship between canopy vegetation cover and environmental variables. Bayat Movahhed (1998) studied the relationship between vegetation cover and some environmental variables. According to his study, altitude had a significant direct effect on total vegetation cover and negative effects on annual grasses. In contrast, perennial forbs and grasses had significantly affected by altitude. All of the forbs (Except annual grass which had the higher amount in south aspect) had the maximum amount in north aspect. Slope steepness had negative non-significant relationship with vegetation cover. Mirakhorlo (1998) studied the influence of several environmental factors on vegetation cover and available forage in rangeland ecosystems. He concluded that slope, aspect, altitude and climate statistically show a significant relationship with vegetation cover and available forage. The highest correlation was found between slope and vegetation. He also found a highly significant correlation between vegetation cover and available forage which allows prediction of available forage based on vegetation cover. Most of the studies show that canopy cover in North aspect was higher than South aspect, because generally north facing slopes is cooler and more humid than South facing slopes which are warmer and more arid. The amount of both daily extraterrestrial radiation and monthly global radiation in slope areas is the highest on the south aspect and the lowest on the north aspect Zuviria (1992). Less solar radiation on the northern aspect causes less evapotranspiration and thereby higher water availability (Frahnak and Movahhed 1997). Also a high correlation has been observed between precipitation and elevation in semiarid landscapes (Smith *et al.* 1990). Moisture availability is important variable that affected the vegetation cover in arid zone. According to Zohary (1973), canopy cover in the cliffs and rock outcrops is more than other stony habitats, because in rock crevices fine soil material is accumulated and most of rain into these clefts is well preserved and protected against evaporation.

For better management in rangelands and consequently for the implementation of soil conservation and prevention of land degradation this research was conducted. The aim of this study was to determine the relationship between vegetation parameters and environmental factors. Then simple spatial model was developed for the assessment of mapping the vegetation cover.

Materials and Methods

Daghfinoo catchment is located in Hormozgan province, Iran between latitudes (27°50′ 27°57′ N) and longitudes (55° 58′ 56° 15′ E). The study area was18000 ha and is situated in mountain and hill area having elevation ranging from 860 m to 3081 m (Fig. 1). The climatic condition of study area is influenced by medium elevation (1500 m) above sea level, with temperatures never below zero. In addition, the study area is affected by the air mass systems mentioned above, whereas the first and third portions have a more influence on precipitation. Annual rainfall is 214 mm, mean temperature 24.33, average maximum temperature 31.25 ^{0}c and average minimum is 17.35 ^{0}c. The soils of the study area are mostly shallow. The soils in outcrop, of mountain are very shallow and rocky. In mountains without outcrop, there is coarse debris of material so that the soil is still shallow and stony. The mountains have only suitability as rangeland for herd grazing. In hills the depth of soil is more than mountain, but the soil is still shallow and stony.

In this study black and white aerial photographs from August 1957 were available. The aerial photo interpretation was based on geomorphology and geology. This was done by stereoscope before the fieldwork. The boundaries of interpretation are then corrected during the fieldwork.

A terrain map unit (TMU) was created by stratification of the study area into relatively homogenous areas that are Terrain Units. The area was divided into three main units based on geomorphology. Then each main unit subdivided into sub-units based on lithology and morphology. The final TMU shows the distribution of 15, land unit in the study area. The summarized data for each land unit are shown in Table 1.

Fig. 1. Location of the Study Area

In this study the quadrate plots were used for measuring vegetation parameters. For each TMU unit 4 to 19 plots using stratified sampling method was selected. The observation sites were established by the help of topography, TMU and vegetation type map. In this study size of sample were chosen based on minimal area method that was 100 m2 (10 x10). Within each plot 3 plots 1m2 were taken. In this study for determined number of samples,

TMU map was crossed with vegetation type map and taken three plots (10 x 10m) in each unit. Totally 104 plot with 100 m2 size were taken. At each plot (100 m2) a relevee data sheet was filled in. At first, a visual estimate of browsing damage, %grass cover, %forbs cover and %shrub cover was recorded in the plots of 100sqm. Then three 1m2 plots were randomly taken inside the main plots (100m2). Percentage cover of each species of vegetation type was measured in each plot (1 x 1m).

Table 1. Legend of TMU of the Daghefinoo Area

Nr	Landscape	Relief	Landform	Lithology	Symbol
1	Mountain	Ridge (Mo1)	Slope Facet Complex (SFC)	Massive Dolomite, Limestone	Mo111
2			Highly Dissected	Limestone	Mo121
3		Hill (Mo2)	SFC	Marl, Limestone, Sandstone	Mo211
4			SFC	Calcareous Sandstone	Mo221
5			SFC	Salt, Gypsum, Red Sandstone	Mo231
6	Hilland	Hill (Hi)	SFC	Marl, limestone, Sandstone	Hi111
7			SFC	Calcareous Sandstone, Silt, Gypsiferous Marl	Hi121
8			Highly Eroded SFC	Brown and Green Marl	Hi131
9			SFC	Calcareous Sandstone	Hi141
10			SFC	Calcareous Sandstone	Hi151
11		Glacis	Tread	Boulders, Pebble, Gravel, Sand, Silt and Clay	Hi211
12			Tread	Marl, Limestone, Sandstone	Hi221
13	Piedmont	Fan (Pi1)	Moderately Dissected	Alluvium and culluvium	Pi111
14			Slightly Dissected	Culluvium	Pi121
15	Valley	Terraces Fan complex (Va1)	Tread Complex	Alluvium	Va111

Parameters of slope such as slope length, slope shape, slope percent and aspect were measured by compass and altimeter in plots of 100m2. One soil sample was taken for measurement of EC, PH, texture and colour of soil. Field data were entered analyzed by Excel. Exploratory data was analysed using box plot, correlation, regression, and Kruskal-Wallis test for finding the relationship between environmental variables and vegetation.

Result Geopedologic Map Unit vs. Vegetation Cover

There was a difference in vegetation cover in different geopedologic map units (Fig. 3).

The highest vegetation cover occur in Hill with glacis relief-type, moderate slope percent, dominate class altitude was 1200-1400 and deep soil. Lowest cover percentage of vegetation occurs in Valley. There was a significant difference in canopy cover percentage of vegetation between glacis (Hi211) and other landform except some part of mountain with soil cover (Mo221). Also it was found that significant differences in vegetation cover of Valley with Mountain and Hill (Table 2)

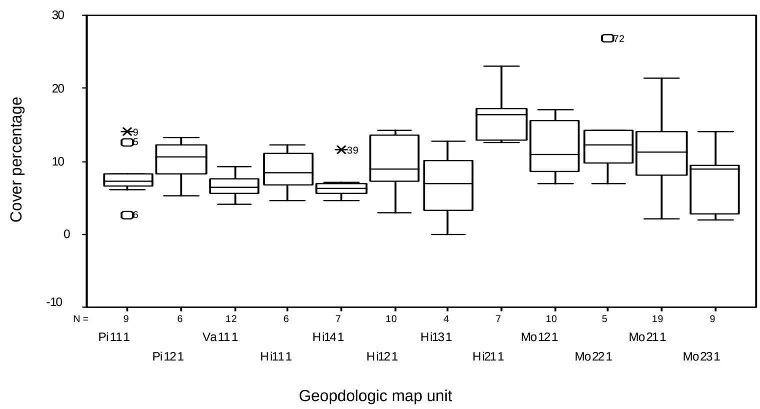

Fig. 3. Box Plot of Canopy Cover % of Vegetation in Geopedologic Map Units

Table 2. Multiple Comparisons between Cover % of Vegetation and Geopedologic Map Units Based on Kruskal-Wallis

MU	Hi211	Mo121	Mo221	Mo211
Va111	12.62 (p=0.00)	11.551 p=0.001	6.819 p=0.009	9.023 (p=0.003)
Hi141	9.8 p=0.002	7.467 p=0.006)	5.545(p=0.019)	5.621 (p=0.018)
Pi111	8.48 (p=0.004)	5.231 p=0.022		
Mo231	9.10 (p=0.003)			
Hi111	9.0 (p=0.003)			
Pi121	7.0 (p=0.008)			
Hi121	5.49 (p=0.019)			
Hi131	5.14 (p=0.023)			
Mo121	4.2 p=(0.04)			
Mo211	5.21 (p=0.022)			

Altitude vs. Vegetation

There was a low positive correlation between altitude and vegetation cover (r=0.22, p= 0.02). When altitude increased, vegetation cover is also increased. There was significant difference in canopy cover percentage of vegetation between altitude <1200 and 1200-1400 (Kruskal-Wallis test P<0.01). Figure 4 shows the difference in vegetation cover between different altitudes.

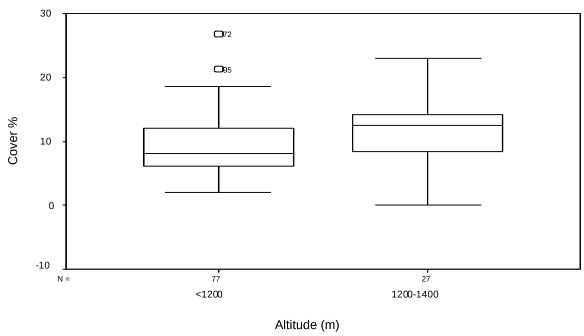

Fig. 4. Box Plot of Canopy Cover % of Vegetation Versus Class Altitude

Slope vs. Vegetation

There was a positive correlation between vegetation cover and slope. When slope increased vegetation cover is also increased and there was difference in vegetation cover between different slope class (Fig. 5) and some of these differences were significant (Table 3). There was a significant difference in vegetation cover among slopes >65 and slope 0-10 and 10-35.

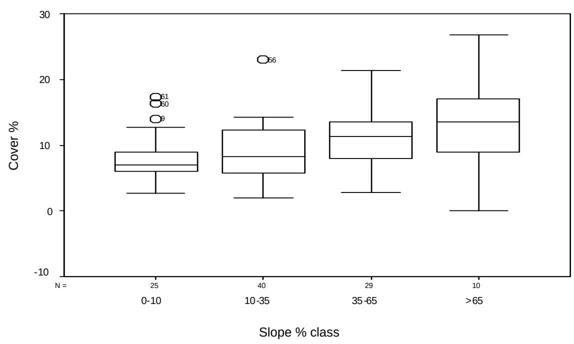

Fig. 5. Box and Whisker Plots of Average Cover Percentage Against Slope Classes

Table 3. Multiple Comparisons between Cover % of Vegetation and Slope % (Kruskal-Wallis)

	0-10	10-35	35-65
>65	6.9 (p=0.009)	6.4 (p=0.01)	1.34 (p=0.24)
35-65	10.2 (p=0.001)	6.37 (p=0.01)	
10-35	0.42 (p=0.52)		

Aspect vs. Vegetation

There was a difference in vegetation cover between different aspects (Fig. 6), but this difference was not significant. High temperature, low soil depth on the hillsides have caused low top soil moisture. There was no considerable impact of different aspect on increase of the soil moisture and consequently vegetation cover.

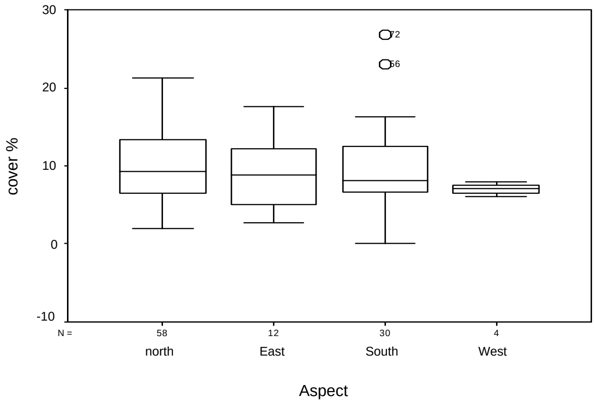

Fig. 6. Box and Whisker Plots of Average Cover Percentage Against Aspects

Soil vs. Landform

The properties of soil vary from place to place. Natural soil bodies are the result of climate and living organisms acting on parent soil material with topography or local relief exerting a modifying influence and with time required for soil-forming processes to act. For the most part, soils were the same wherever all elements of the five factors were the same (Soil survey manual). The soils are affected by topography and parent material, therefore difference in soil belongs to parent materials and topography. Based on soil analyses for texture, EC, PH, there were no significant variations in the area, except in one of the mountainous landform that parent material was salt dom. Also there were some variations in the soil depth, with changing in landscapes, it means that in mountains and hills the soil depth was shallow and in piedmonts was deep.

Soil Map Units vs. Vegetation

There was a difference in vegetation cover percentage in different soil map units (Fig. 7) and some of them were significant

(Table 4). Lowest canopy cover occurs in B soil map unit that consists of Tyipic Xerofluvents, Loamy Skeletal and Tyipic Xerorthents, Loamy Skeletal. There was a significant difference in canopy cover between soil map unit A, B, D and E (α=0.01, p<0.003) and between soil map unit A, D, E and, C (α=0.05, p<0.03). Soil map unit influence distribution of plant species and each species has different canopy cover in different soil map unit (Fig. 7). Highest canopy cover of *Cymbopogon* and *Platychaete* occurs in E soil map unit, whereas highest canopy cover of *Astragalus* and *Artemisia* occurs in D soil map unit.

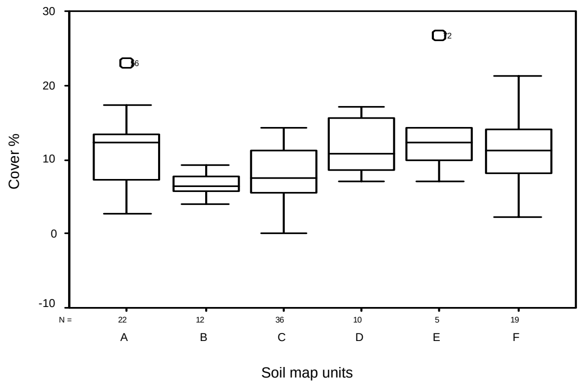

Fig. 7. Box-Whisker Plot of Cover % of Vegetation Again Soil Map Unit

A= Typic Xerorthents, Loamy Skeletal over Fine Loamy

B= Typic Xerofluvents, Loamy Skeletal and Typic Xerorthents Loamy Skeletal

C= Typic Xerorthents, Fine Loamy over Loamy Skeletal

D= Rock and Lithic Xerorthents, Loamy Skeletal

E= Lithic Xerorthents, Loamy Skeletal and Typic Xerorthents

F= Lithic Xerorthents, Loamy Skeletal and Rock and Typic Xerorthents

Table 4. Multiple Comparisons between Cover % of Vegetation and Soil Map Unit

Soil Map Unit	A	D	E
B	8.634 (p=0.003)	11.165 (p=0.001)	11.551 (p=0.001)
C	5.366 (p=0.021)	7.340 (p=0.007)	6.337 (p=0.012)

Vegetation Cover vs. EC

There was a negative relationship between EC and cover percentage of vegetation, when among of EC increased, cover percentage of vegetation will be decreased cover percentage of vegetation (Fig. 8), but this relationship was not significant (Kruskal-Whallis taste α=0.05, p>0.05).

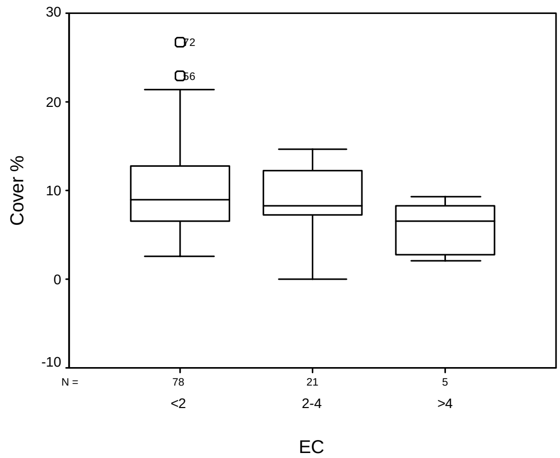

Fig. 8. Box-Whisker Plot of Vegetation Cover % Again EC

Vegetation Cover vs. Soil Texture

There was not difference for vegetation cover between different soil texture (Fig. 9).

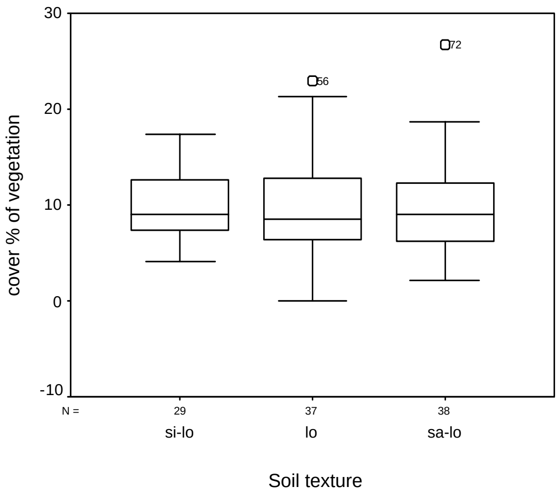

Fig. 9. Box-Whisker Plot of Canopy Cover % in Various Soil Texture

Browsing Damage vs. Vegetation

Browsing damage influences the percentage of vegetation cover. Therefore, relationship between browsing damage and vegetation cover was assessed in different geopolitical map units, slope classes, altitude. There was a negative relationship between cover percentage and browsing damage in landscapes Hill, Piedmont and Valley (Fig. 10). Lowest vegetation cover occurs in valley, whereas it has the highest browsing damage. There was no clear relationship between vegetation cover and browsing damage in different altitude classes. There was a negative relationship between browsing and cover in different slopes, it means that when slope steepness increases, vegetation cover will be increased and browsing damage decreased (Fig. 11).

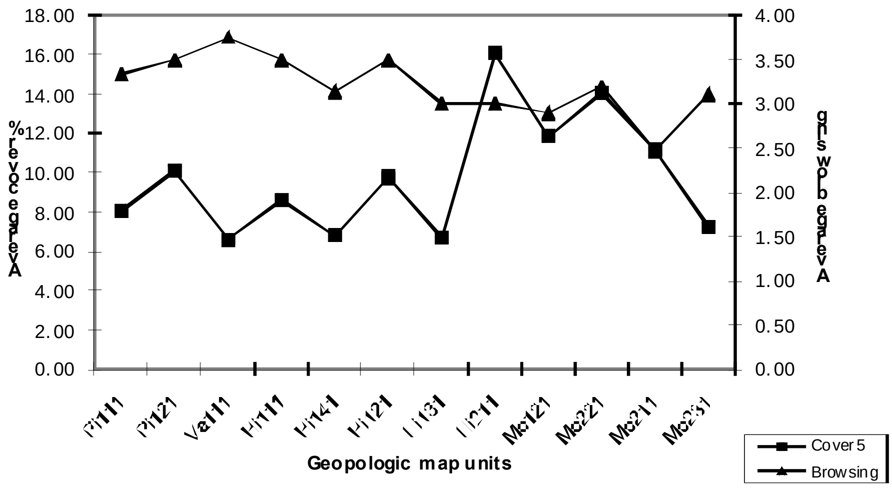

Fig. 10. Average Cover %and Browsing Damage in Different Geopdologic Map Units

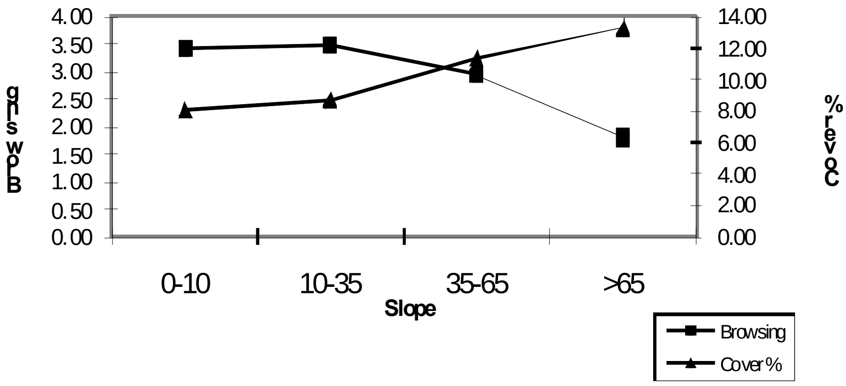

Fig. 11. Average Cover % and Browsing Damage in Different Slope

Discussion

There was a significant difference in canopy cover in different geopedological map units. The highest canopy vegetation cover occurs in hill with glacis relief-type. In this unit natural condition for vegetation was good, soil is deep, and slope percent was low, with moderate elevation. Lowest vegetation cover percentage occurs in the valley. Although this unit had good natural condition for vegetation growth the cover was scares probably because of high human activity such as overgrazing and cutting vegetation cover. Due to the impact of human on the ecology, balance is disturbed in such a way that unpalatable species such as Acantholimon spp. becomes dominant. Generally, canopy cover percentage in the landscape mountain is higher than other landscapes because the study area is located in arid zone, where the important factor influencing vegetation is moisture. In the "Mountain" with calcareous lithology, moisture is available more than other landscapes. The result was the same as under desert conditions, where cliffs and rocky outcrops often enjoy conditions more favourable to plant life than other stony habitats (Zohary 1973). This was so, because in rock crevices fine soil material was accumulated and most of rain water that runs into these clefts is well preserved and protected against evaporation. In addition, rocks are favourable habitat for a number of shade demanding plants. Rocks are also inhabited by true lithophytes, whose roots are able to break the solid rock into pieces.

There was low positive correlation between altitude and canopy cover percentage($r=0.22$, $p<=0.02$). Vegetation cover percentage in the high elevation was significantly more than low elevation (Kruskal-Wallis test). Many studies confirm this result, so there is a significant relationship between altitude and vegetation because of high correlation between precipitation and elevation has been observed in semiarid landscapes Smith *et al.* (1990).

There was a low positive correlation between slope and vegetation cover percentage ($r=0.35$, $p<=0.00$) and based on the Kruskal-Wallis test there was a significant difference between high and low slopes for vegetation cover. When slope increased, vegetation cover percentage will be also increased, because human activity such as cutting and browsing damage in low slope is more than high slope and there is inverse relationship between vegetation cover and browsing in the low and high slopes.

Generally, north facing slopes are cooler and more humid, whereas south facing slopes are warmer and more arid (Robert and Whittler 1975). But in the study area because of high temperature, low rainfall, and shallow soil depth on the hillsides, there was no considerable impact of different aspects on increasing the soil moisture and consequently vegetation cover. Therefore, although box plot shows difference in vegetation cover between different aspects, this difference is not significant.

Conclusion

Based on this study, it was concluded that there was a low and positive correlation between elevation and vegetation cover, also between slope steepness and vegetation cover. There was significant difference in vegetation cover for high and low slope steepness. Generally, vegetation cover percentage in present study was low, less than 15% and in the mountain with calcareous lithology vegetation cover was more than other cases.

In general, other than elevation and slope, which control climate, but on the other hand controlled by lithology, no significant relationships were found between vegetation cover and soil properties, such as PH, EC, and texture. In the case of EC, there was a low negative relationship between EC and vegetation cover. Other soil properties, such as soil depth and gravel percentage affect vegetation cover, as mentioned above.

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