Universal Journal of Environmental Research and Technology
All Rights Reserved Euresian Publication © 2013 **eISSN 2249 0256**
Available Online at: **www.environmentaljournal.org**
Volume 3, Issue 2: 242-254

Open Access **Research Article**

Effect of Spatial Variation on Plant Community Structure in South Sinai, Egypt

Om-Mohamed A. Khafagi [1,] El-Bialy E. Hatab[2] and Ahmed A. Mohamed[2]

[1] Botany and Microbiology Dept. Faculty of Science, Al-Azhar Univ. Cairo, Egypt.
[2] Nature Conservation Sector (NCS), Egyptian Environmental Affairs Agency (EEAA).
[2] Nature Conservation Sector (NCS), Egyptian Environmental Affairs Agency (EEAA).

Corresponding author: ahmed.tpa@gmail.com

Abstract:

The effect of spatial variation on plant community structure was studied through the comprehension to eco-geographical and climatic variables. The present study was carried out on four wadis at different elevation (Wadi Gebal at 1722-1916 m above sea level, Wadi Gharaba at 1110-1217 m a.s.l., Wadi Hodra at 600-700 m a.s.l. and Wadi Khoshbi 20-120 m a.s.l.) in Saint Katherine Protectorate, south Sinai, Egypt between March and September 2011. In this study, we used a multivariate analysis, GIS and descriptive analysis to ensure the best using and orientation for the information. As a result for the available data and analysis, we get good outputs that can help in support any conservation actions for the ecosystem. The indices of Simpson, Shannon-Weiner and Birllouin were used to estimate the floral diversity on 4 locations. Estimates showed that Wadi Gebal is the most value of diversity index (4.19) according to Shannon-Weiner Index, while the lowest value (2.7) recorded in W. Khoshbi, and the others two wadis showed, Wadi Gharaba (3.61), Wadi Hodra (3.135). The total vegetation cover over the study area was determined about 30 % of the total area studied (5000 m^2). The maximum cover percentage was record in W. Gebal (38%), while the lowest value was 19% recorded in W. Gharaba. Physical and Chemical prosperities of soil showed great variation among the different elevation ranks. Results found that soil pH, and organic matter values decreased with elevation while HCO3 increased with elevation. T.D.S and EC increased with elevation without Location Wadi Hodra between 599-697m was decreased. The most stands at Wadi Gebal and Wadi Hodra finds in Northeast aspect, while most stands in Wadi Gharaba finds in NW aspect and Wadi Khoshbi in South aspect. The climatic results could explain by two words "altitudinal gradient"; because W. Gebal is the highest elevated point it received cool temperature and high rain W. Khoshbi is the lowest one in this area it receive high temperature and low rains; however, for each 1,000-foot rise in altitude there is a 4°F drop in temperature. It discerned that great variation in vegetation distribution and plant community structure, this variation may result from the variation of elevation, aspect, and slope ranks between different locations. Result for the available data was found that spatial variation play a great role in the variation of plant community structure from variation in altitudinal and latitudinal variation that leads to variation in climatic conditions and consequently, makes changes in all ecosystem components.

Keywords: Eco-geographical, Elevation, GIS analysis, Plant community structure, South Sinai, Spatial variation.

1.0 Introduction:

The unique formation of the south Sinai Mountain, lead to greater variation in the climate and the vegetation than elsewhere. The clearest characteristics of the desert vegetation are scarcity of plant growth and near lack of trees; many plant species have become endangered due to increasing aridity and human activities. The continuous overgrazing, overcutting and uprooting are leading to the disappearance of the pastoral plant communities, a reduction of plant cover and soil erosion **(Hatab, 2003)**.

The Saint Katherine Protectorate (SKP) contains a wide range of micro-habitats and landscapes that is a consequence of varying microclimatic conditions, a wide range of altitudes, and variable topography. The landscape ranges from rugged mountains, which includes Mount Katherine (2642 m), Egypt's highest peak, whose slopes are incised by Wadi Rivers. The Wadi Rivers generally slope toward the east, in the direction of the Gulf of Aqaba, or westwards towards the Gulf of Suez **(El-Alqamy, 2002)**. It is currently recognized as one of the central regions for flora diversity in the Middle East by the IUCN the World

Conservation Union and Worldwide Fund for Nature **(Davis *et al*., 1994)**. However, it is a very fragile system because of the aridity and scarcity of water and overgrazing.

The high mountains of southern Sinai support mainly Irano-Turanian steppe vegetation. Smooth faced rock outcrops supply sufficient runoff water to permit the survival of the unique flora. SKP is one of the most floristically diverse region in Egypt, as containing 44% of Egypt's endemic plant species. To date, around 472 plant species have been recorded as surviving and still occurring in SKP **(Fayed & Shaltout, 2004)** of these 19 species of the surviving flora are endemic, and more than115 are with known medicinal properties used in traditional therapy and remedies.

Spatial variation is the variation across the landscape that is normally associated with populations. Factors causing geographic variation to include geologic differences that affect soil type, and thus habitat, and weather patterns, e.g., differences in rainfall across the landscape (**Ruggiero *et al.* 1994)**. So that subpopulations that are depleted because of local conditions, high spatial variation can lead to higher persistence. This is because the probability of all the subpopulations of a population being affected simultaneously by some catastrophe is low when high spatial variation exists. In contrast, with low spatial variation, the likelihood of a bad year affecting the entire population is high.

Spatial pattern plays a central role in plant community dynamics, such as succession, adaptation, maintenance of species diversity, and competition **(Legendre and Fortin, 1989; Purves and Law, 2002)**. The study of plant spatial pattern is therefore, useful for ecological theory and for restoration management. **Perry *et al.* (2006)** reviewed a range of plants spatial pattern methods, mainly local and global autocorrelation. They concluded that local analyses provide a potentially useful means of taking the 'plants-eye view' **(Purves and Law, 2002)** and thereby link spatial pattern with ecological theory.

Understanding the spatial distribution of data from phenomena that occur in space constitute today a great challenge to the elucidation of central questions in many areas of knowledge, be it in health, in environment, in geology, in agronomy, among many others. Such studies are becoming more and more common, due to the availability of low cost Geographic Information System (GIS) with user-friendly interfaces. These systems allow the spatial visualization of variables such as individual populations, quality of life indexes or company sales in a region using maps. To achieve that it is enough to have a database and a geographic base (like a map of the municipalities), and the GIS is capable of presenting a colored map that allows the visualization of the spatial pattern of the phenomenon **(Câmara *et al*., 2004)**.

Spatial patterns of plants in natural communities hold an enduring interest for plant ecologists **(Watt 1947; Pielou 1968; Greig Smith 1983).** They carry information about the processes which operated for the past, and they form the template on which processes will take place in the future. There are, however, some special difficulties in extracting and drawing inferences from this information. For instance, there are no strong grounds for assuming that past processes leave their own unique, identifiable footprint in a spatial pattern. Given that environmental factors do not necessarily operate independently, or at distinct spatial scales, studying plant community structure using a single analytical scale cannot provide a complete understanding of community dynamics. Multi-scale comparisons, in which patterns are analyzed at several different spatial scales, may be more useful when trying to identify the factors that control community development. Conclusions about the plant communities, the effect of disturbance, or the roles of various limiting factors are likely to differ at different spatial scales **(Wiens *et al.,* 1986)**.

Conservationists need to evaluate multiple factors when considering how to invest scarce resources to conserve biological diversity. In recent years, international conservation organizations have conducted a variety of planning exercises to target their investments based upon a combination of biological and socioeconomic criteria **(O'Connor, Marvier, & Kareiva, 2003; Wilson, McBride, Bode, & Possingham, 2006)**.

.

2.0 Material and Methods:

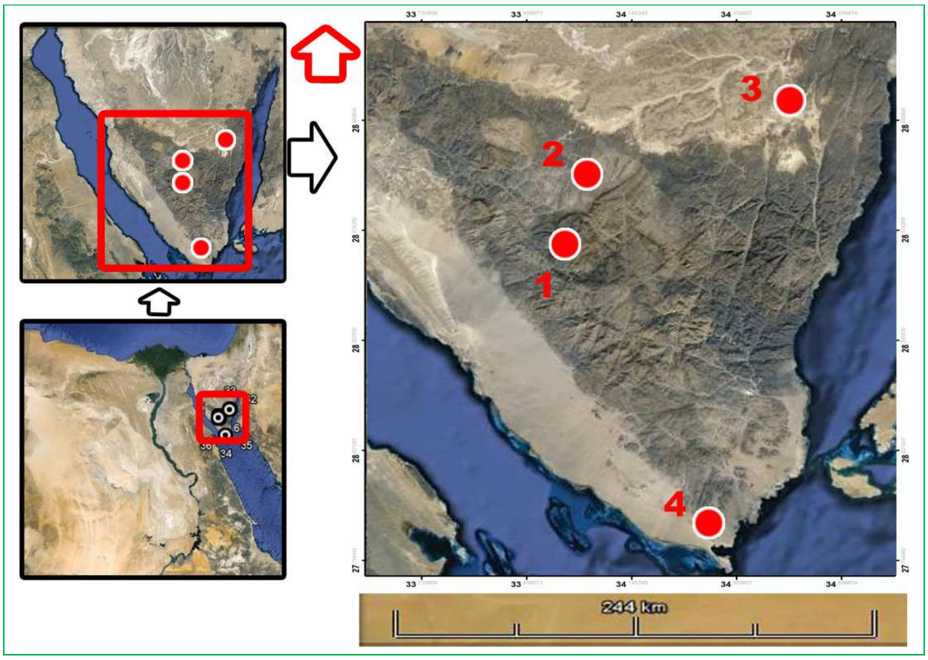
2.1 Study Area:

Sinai Peninsula has the geographical importance and uniqueness of being the meeting place of Asia and Africa. For this reason, its flora combines elements from these two continents Saharo-Arabian, Irano-Turanian, Mediterranean and Sudanian elements **(McGinnies *et al*., 1968)**.

SKP region is situated in the southern part of Sinai and is a part of the upper Sinai massif. It is located between 33˚ 55' to 34˚ 30' East and 28° 30' to 28° 35' North. The study area (map, 1) involves wadi systems. Four wadis were selected for the spatial variation, especially height. The first is wadi Gebal on the west which include some branch located between 1700m to 2000m altitude. The second is wadi

Gharaba on the west which include two branches located between 1100m to 2300m altitude. The third is wadi Hodra on the north which include two branches located between 500m to 700m altitude. The fourth is wadi khoshbi on the south which located between 1m to 200m altitude.

Forty stands within four main locations inside SKP were surveyed ranging to cover different microhabitats. The diversity of both landforms and geologic structures of SKP leads to the differentiation of a number of microhabitats. Each of them has its peculiar environmental conditions and unique flora, which are rich in medicinal, rare and endemic plants. The diversity in geomorphological and geological structures of SKP resulted in a unique landscape. Six landform types are identified in this landscape namely: Wadis (valleys), Oasis, Terraces, Slopes, Gorges and Farsh (basins) **(Khedr, 2007)**. Air temperature in Sinai is subjected to large variations; minimum winter temperature ranges from 19°C at Sharm El-Sheikh to -4ºC at Saint Katherine. Maximum summer temperature also shows a large variation, and ranges from 20ºC in Saint Katherine with its high elevation the coolest in the peninsula, to more than 45ºC in Sharm El Sheikh. The amount of the rainfall in Sinai decreases from the Northeast to the Southwest. But then increase in the southern mountain region to about 62mm/year in Saint Katherine where precipitation may occur as snow that may last about four weeks **(Migahid *et Al.*, 1959)**.These locations are illustrated in the map of the study areas (Map. 1).



Map 1. Location map for study area, 1- Wadi Gebal, 2- Wadi Gharaba, 3- Wadi Hudra and Wadi khoshbi.

2.2 Methods:

2.2.1 Vegetation analysis.

The present study was carried out in the period between March to September, 2011. Quadrate Transect techniques were used to study vegetation within the four wadis inside SKP. A sampling site was selected every equal distance to cover such locations. 40 stands were studied within 4 wadis; Number of sampling sites (stand) for each wadi depended upon the length of this wadis. In each stand 5 quadrates with size 5X5 m for each quadrate according to location size was studied. Sample was done encompassing the whole microhabitat types for each stand to represent the variability of the sample sites and to assure the comprehensiveness of sampling and reduce the bias induced by spatial patterns, and variable habitat types. Microhabitat types were designated as following: wadi beds, slopes, terraces, gorges and runnels **(Omar *et al.*, 2012)**.

At each site, a GPS fix was recorded in decimal degrees and datum WGS84 using Garmin 12 XL receiver. The fix was recorded to the fifth decimal digit. Arc View GIS 9.2 was used to plot the study sites. Wadi boundaries were digitized from 1:50,000 topographic maps with Egyptian Transverse Mercator projection (Blue belt). According to "Braun – Blanquet (1964)" "Mueller-Dombois and

Ellenberg 1974" and "Shukla, and Chandel, (1989)" in each of the 40 stands, 200 quadrates to have been set up to determine the following vegetation parameters namely: Abundance, Relative Abundance of, Density, Relative Density, Frequency, Relative Frequency, Cover, Relative Cover, Importance Value Index and Floral diversity. The indices of Simpson, Shannon-Weiner and Birllouin were used to estimate the floral diversity on 4 locations micro-habitat These parameters were used to assess the general conditions of vegetation cover and to determine the community structure quantitatively.

2.2.2 Soil Analysis.

Soil samples were collected during the work, from all the forty stands for the determination of their physical (texture and Water content%) and chemical characteristics (ph, Organic Carbon, EC, TDS, CO_3, HCO_3, Na, K, Cl, Mg, SO_4, Ca, $CaCO_3$) according to **Piper, (1950), Richard, (1954), Black, (1965), Jackson, (1967) and Allen *et al.,* (1976).**

2.2.3 Spatial analysis.

Eco-geographical analysis can be divided to two divisions; geographical and climatic attribute's analysis. Elevation, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas **(Titshall *et al.,* 2000)**. In a Geographic Information System (GIS), digital elevation, models (DEM) are commonly used to represent the surface (topography) of a place, through a raster (grid) dataset of elevations, aspect and slope. Digital terrain models are another way to represent terrain in GIS.

DIVA-GIS is a free computer program for mapping and geographic data analysis a geographic information system (GIS), BIOCLIM is a bioclimatic prediction system which uses surrogate terms (bioclimatic parameters) derived from mean monthly climate estimates, to approximate energy and water balances at a given location **(Nelson *et al.,* 1997).** GPS points recorded for each stand, will be imported as a shape file into DIVA GIS software, using a climate point tools, we will obtain all bioclimatic parameters. Vegetation traits (characteristics) and related environmental factors were analyzed using ordination techniques, ordination (**Pavlůet et aL., 2003**) are two possible means to obtain results from multivariate data analysis. We preferred a direct ordination method to enable us to test environmental variables collected for each relevé (statement). All ordinations were performed on the Canoco program (Version 4.5) **(Hejcmanovā-Neźerková & Hejcman, 2006)**.

3.0 Results and Discussion:

3.1 Vegetation analysis:

The highest Density was recorded at W. Gebal (0.13) and the lowest was at W. Hodra (0.04) while W.Gharaba and W.Khoshbi were similar (0.06). The highest Frequency was recorded at W. Hodra (48.79) and the lowest was at W. Gharaba (38.93) while W.Khoshbi (45.48) and W.Gebal (43.7) were so close. The highest Abundance was recorded at W. Gebal (5.65) and the lowest was at W. Hodra (2.05) while W.Gharaba (3.01) and W. Khoshbi (2.55) were also so close. Important Value Index also showed variation ranged from 64.68 in Wadi Hodra to 14.5 in Wadi Gebal, while Wadi Khoshbi (45.99) and Wadi Gharaba (27.69) (Table 1).

Table 1. Average of vegetation characteristics values among the four Wadis

Wadi Name	D.	R. D.	F.	R. F.	A.	R. A.	I.V.I.
W.Gebal	0.13	4.83	43.70	4.83	5.65	4.83	14.50
W.Gharaba	0.06	9.23	38.93	9.23	3.01	9.23	27.69
W. Hodra	0.04	21.56	48.79	21.56	2.05	21.56	64.68
W.Khoshbi	0.06	15.33	45.48	15.33	2.55	15.33	45.99

A total of 104 species were recorded in total within the 40 studied stands. However, species number gives an indication of the diversity of any community. Great variation in species diversity among different locations was detected in this study confirming.

In this study Wadi Gebal showed the highest species richness as 64 while Wadi Khoshbi showed lowest species richness as 16, Wadi Gharaba and Wadi Hodra has recorded 38 and 24 species richness value as presented in Table 2. Also, Wadi Gebal showed the highest No of Families as 26 while Wadi Khoshbi showed lowest No of Families as 9, Wadi Gharaba and Wadi Hodra has recorded 21 and 17 families.

Table 2: Species richness and family number within each wadi

Location Number	Location Name	Family Number	Species richness
1	Wadi Gebal	26	64
2	Wadi Gharaba	21	38
3	Wadi Hodra	17	24
4	Wadi Khoshbi	9	16

Species number gives an indication of the diversity of any community. Great variation in species diversity among different locations was detected in this study confirming. There is a considerable difference between the four Shannon estimates but the trend is conserved. In other words, estimates showed that Wadi Gebal, is the most value of diversity index compared to the others. As it was showed that Wadi Khoshbi presents the lowest value in this issue while the two other wadis placed between the two Wadis (Table 3).

Table 3. Diversity estimates for the sampled Wadis computed in different ways

	Wadi Name			
Diversity Index	**W.Gebal**	**W.Gharaba**	**W. Hodra**	**W.Khoshbi**
Sp. richness	64	38	24	16
Simpson_1-D	0.9848	0.973	0.9565	0.9333
Shannon_H	4.19	3.611	3.135	2.708
Brillouin	3.235	2.685	2.244	1.86

In this study; results showed that *Achillea fragrantissima* (Forssk.) Sch. Bip, & *Zilla spinosa* (L.) Prrantl in Engl. Prantl., were the most frequently recorded species in Wadi Gebal. *Zilla spinosa* (L.) Prrantl in Engl, were the most frequently recorded species in Wadi Gharaba. *Haloxylon salicornicum* (Moq.) Bunge ex Boiss, and *Retama raetam* (Forssk.) Webb. & Berthel were the most frequently recorded species in Wadi Hodra. Fagonia *scabra Forssk*, and *Crotalaria thebaica* (Delile) DC., were the most frequently recorded species in Wadi Khoshbi. Species cover is an important factor that reflects the status of this species within its habitat. *Achillea fragrantissima* (Forssk.) Sch. Bip, it represented the highest cover in Wadi Gebal, *Artemisia judaica* L, the highest in Wadi Gharaba, *Retama raetam* (Forssk.) Webb. & Berthel the highest in Wadi Hodra and *Acacia tortilis* subsp. raddiana (Savi) Brenan the highest in Wadi Khoshbi.

The total vegetation cover over the study area was determined as 1505.6 m2, which represent only about 30 % of the total area studied (5000 m2). The maximum cover percentage for a sampling site was recorded in Wadi Gebal (38%), while the lowest value was 19% recorded in Wadi Gharaba. Results showed that 14 species recorded as dominant species within studied locations. *Achillea fragrantissima* (Forssk.) Sch. Bip recorded as the highest Important value index, especially in Wadi Gebal with average I.V.I. 41.1, also *Haloxylon salicornicum* (Moq.) Bunge ex Boiss, represent the most frequently dominant species within Wadi Hodra with average I.V.I. 89.3. *Fagonia mollis* Delile, recorded as dominant species in 7 stands between 3 wadis (Wadi Gebal, Wadi Gharaba and Wadi Hodra). Only *Fagonia mollis* Delile, present in more than one wadi and this reflect the great variation in community structure (Table 4).

3.2 Soil Analysis

Soil moisture content show great variation among different elevation ranks among the selected four Wadis (0.69%, 0.73%, 1.05% and 0.96%). Chemical properties of soil showed great variation among the different elevation ranks. Results found that soil pH (7.99, 8.47, 8.84 and 9.11), and organic matter values (3.67, 6.65, 7.62 and 8.28) decreased with elevation while HCO3 increased with elevation (10.9, 7.8, 7.3 and 6.4). T.D.S and EC increased with elevation without Location Wadi Hodra between 599-697m.

Table 4: Main Plant Communities of the study area

location Name	Dominant Species	Dominant stands	No. of Stands	I.V.I
Wadi Gebal	*Achillea fragrantissima* (Forssk.) Sch. Bip.	1-2-3-7-8-9-10-11-13-16	10	41.17
	Euphorbia obovata	12,14	2	23.50
	Fagonia mollis Delile.	4	1	8.68
	Hypericum sinaicum Boiss.	5	1	496
	Veronica rubrifolia Boiss.	6	1	7.66
	Astragalus sieberi DC.	15	1	17.39
Wadi Gharaba	*Fagonia mollis* Delile.	17-18-19-22	4	38.89
	Fagonia arabica L.	20	1	14.09
	Leysera leyseroides (Desf.) Maire.	21	1	11.66
	Artemisia judaica L.	23	1	17.92
Wadi Hodra	*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.	24-26-28-31-32-33	6	89.31
	Fagonia mollis Delile.	27-29	2	45.08
	Artemisia judaica L.	25	1	14.08
	Phoenix dactylifera L.	30	1	12.54
Wadi Khoshbi	*Zygophyllum coccineum L.*	35-38-39-40	4	361.36
	Crotalaria thebaica (Delile) DC.	34-36-37	3	51.47

From statistical analysis for chemical and physical properties of the soil among different wadis, we found that there are significant differences in some chemical and physical variable of soil. Results showed significant and high significant differences in moisture content, sand, silt, clay, pH, T.D.S, EC, Organic matter ,CaCO3 and HCO3, While it showed non-significant differences to Ca++, Mg++,Na+, K+, Cl and SO4 between four studied wadis; W.Gebal, W.Gharaba, W. Hodra and W. Khoshbi (Table 5).

Table 5: One-way analysis of variance (ANOVA) of Chemical and Physical properties of soil among different wadis; significantly different according to LSD = significant at $P < 0.01$ and non-significant at $P > 0.05$

Location Names	W.Gebal 1722-1916m a.s.l.	W.Gharaba 1110-1217m a.s.l.	W.Hodra 600-700m a.s.l.	W.Khoshbi 20-120m a.s.l.	F	Sig.
W. content%	0.69	0.73	1.05	0.97	33.344	0.000
Sand%	76.58	71.82	71.1	76.63	20.566	0.000
Silt%	10.85	13.07	24.47	19.02	16.853	0.000
Clay%	12.56	15.11	4.43	4.35	7.8	0.001
pH	7.99	8.47	8.84	9.11	20.827	0.000
T.D.S PPm	106.07	50.14	173.64	36.46	2.409	0.006
EC µs/ cm	220.63	104.29	356.4	70.57	13.477	0.000
Org.matter %	3.67	6.65	7.62	8.28	4.437	0.011

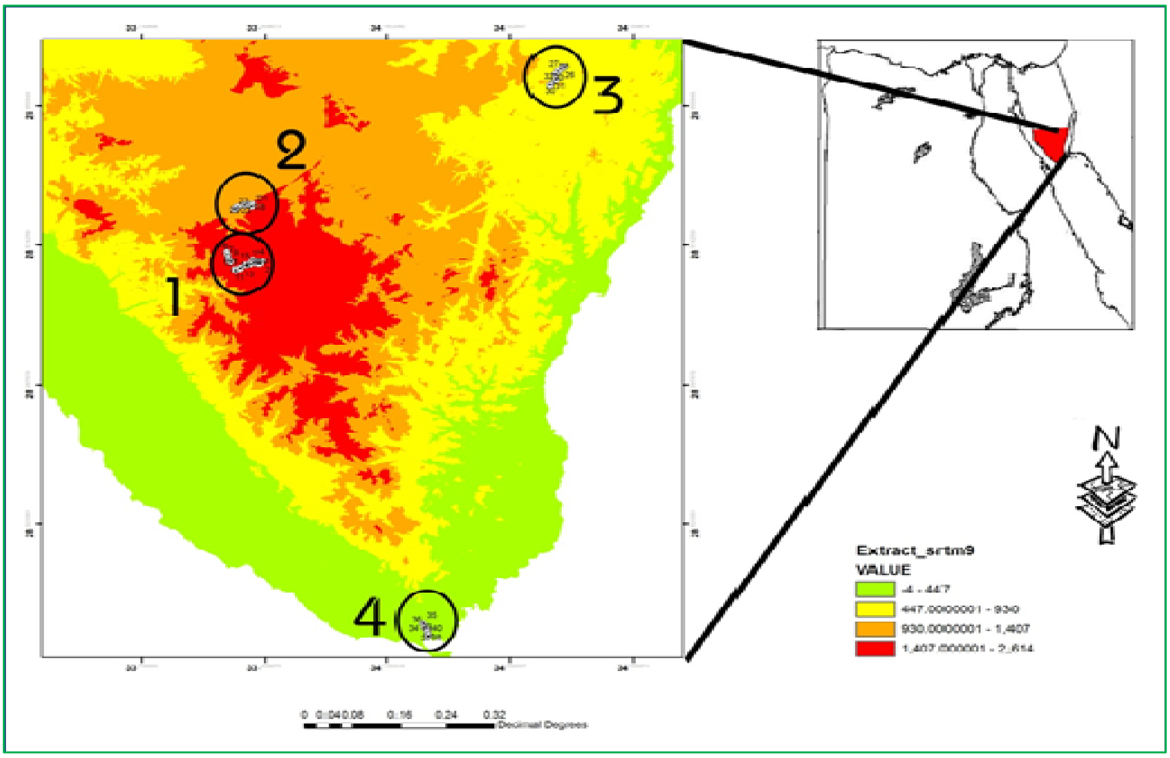
CaCO3 %	29.09	31.43	24.3	40.79	15.096	0.000
Ca++ meq/L	21.5	9.5	24.2	12.36	2.082	0.124
Mg++ meq/L	7.41	11.21	7.05	11.57	0.444	0.723
Na+ ppm	26.92	27.3	26.05	26.48	2.145	0.115
K+ ppm	45.34	56.86	36.66	42.71	0.358	0.784
HCO3- meq/L	10.94	7.86	7.3	6.43	6.35	0.002
Cl-meq/L	9.94	8.21	11.95	9.79	0.743	0.535
SO4-- meq/l	75.47	51.43	70.75	55.36	1.931	0.146

3.3 Spatial analysis:

Spatial analysis can be divided into two divisions; geographical (Elevation) and climatic attributes analysis.

3.3.1 Elevation effect.

It was recorded that the lowest elevation point recorded at W. Khoshbi (34 m), and the highest recorded in Wadi Gebal (1916 m) and this make a huge range about 1882 m, Map 2. So present the great variation in elevation ranks between the four locations.



Map 2. Elevation map for study area Altitude showed different spatial elevation ranks.

Table 4. Plant Community and Vegetation Cover of among different Elevation ranks

location Name	Means Elevation	Plant Community	Vegetation Cover m2
Wadi Gebal	**1823**	*Achillea fragrantissima*	38%
Wadi Gharaba	**1154**	*Fagonia mollis*	19%
Wadi Hodra	**644**	*Haloxylon salicornicum*	26%
Wadi Khoshbi	**79**	*Zygophyllum coccineum*	28%

In this study, results showed that *Achillea fragrantissima* species is the major plant community in location Wadi Gebal at 1823m elevation. And *Fagonia mollis* species is the major plant community in location Wadi Gharaba at 1154m elevation. And *Haloxylon salicornicum* is the major plant community in location Wadi Hodra at 644m elevation. And *Zygophyllum coccineum* is the major plant community in location Wadi Khoshbi at 79m elevation.

Total vegetation cover over the study area had different value consequent on spatial variation in the elevation as we recorded Vegetation Cover 38 % m2 in Wadi Gebal at 1823m elevation, Vegetation Cover 19% m2 in Wadi Gharaba at 1154m, Vegetation Cover 26% m2 in Wadi Hodra at 644m and Vegetation Cover 28% m2 in Wadi Khoshbi at 79m elevation (Table 4 and Fig. 1).

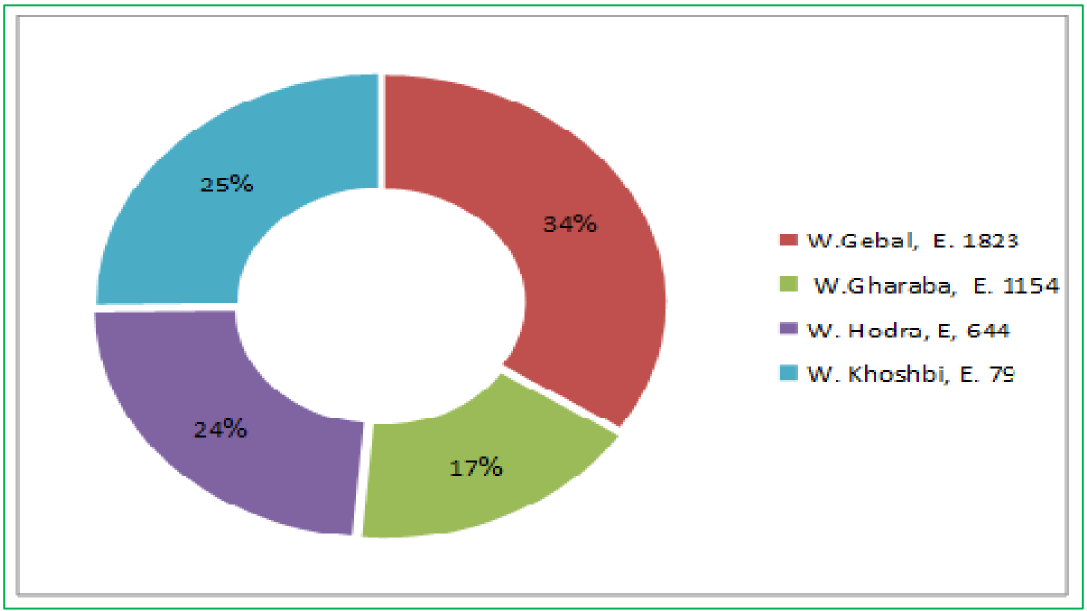
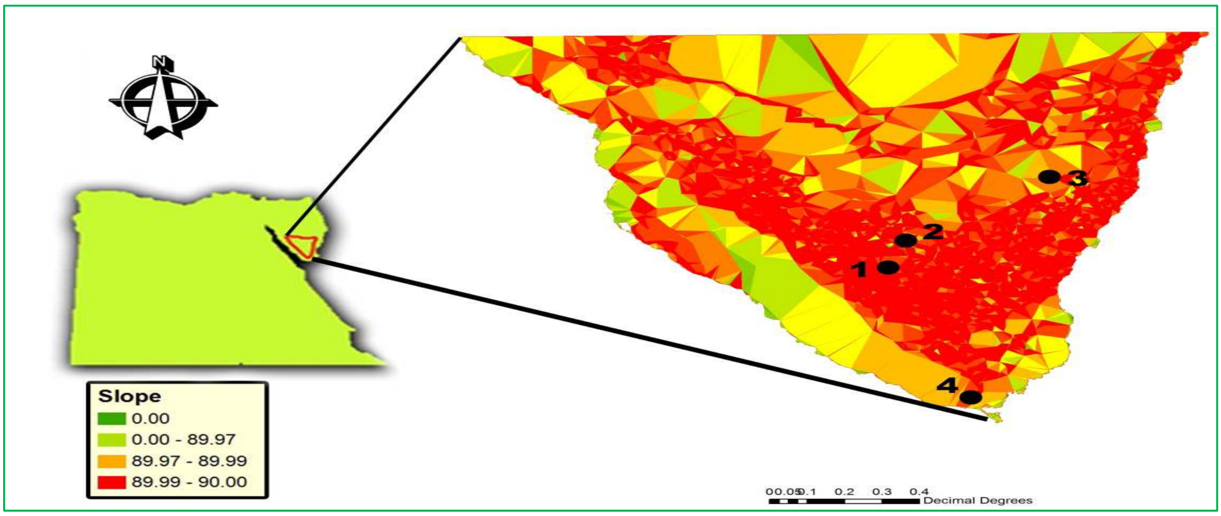


Figure 1. Vegetation Cover among different Elevation ranks.

Results showed that great variation in vegetation distribution and plant community structure, this variation in plant community structure output of different elevation ranks between different locations thus confirming the result's Elevation, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas **(Titshall *et al*. 2000).**

3.3.2 Slope effect.

The slope degree of the populated sites was high, as the species was found in slope aspect between 89.98 and 90 degree as shown in Map 3.

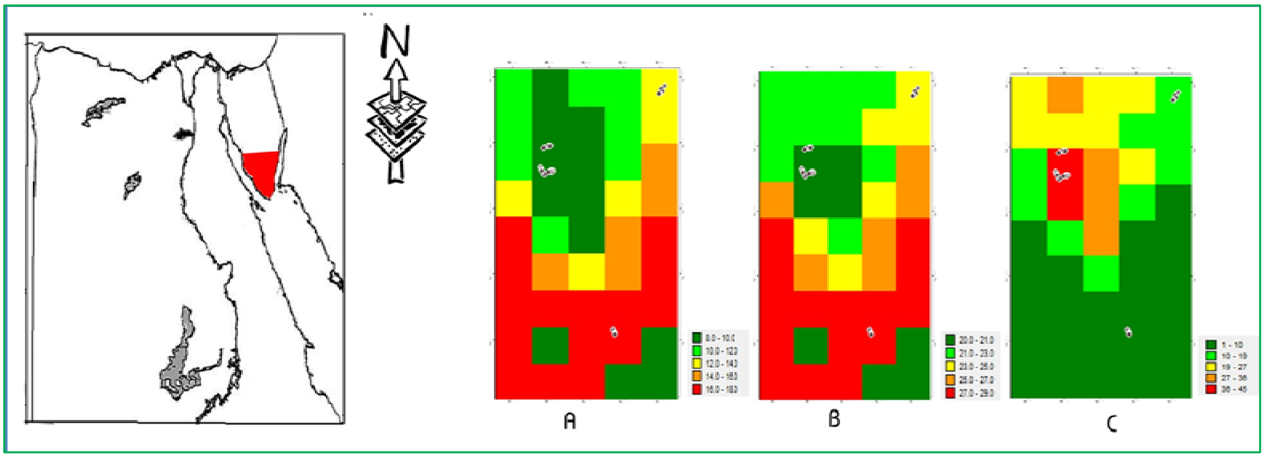


Map 3. Slope rate among different locations.

Results showed that topography is a principal controlling factor in vegetation growth. Elevation, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas **(Titshall *et aL.,* 2000).** Among these three factors, elevation is most important. Elevation along with aspect and slope in many respects determines the microclimate and thus large-scale spatial distribution and patterns of vegetation **(Allen and Peet 1990 and Busing *et aL.*, 1992).**

3.3.3 Climatic variables analysis.

Results extracted from DIVA GIS showed great variation between their four locations. The superimposed map (Map 4) of BIOCLIM annual Min-temperature, Max-Temperature and species distribution indicates that naturally occurs in the low-temperature zones range from 8.09 – 11.08 C at winter and from 19.4 - 22.28 C at summer season.



Map 4. Variation in Temperature between different Locations which under study, (A) Annual Precipitation, (B) Annual Maximum and (C)Annual Minimum Temperature in SKP.

Negative correlation was observed between Wadi Gebal (1722-1916 m a.s.l.) and Wadi Khoshbi (34-119 m a.s.l.); Annual precipitation recorded as the highest value in W. Gebal (150.00 mm) while in W. Khoshbi recorded the lowest value (6.00 mm). The previous status is reversed when we deal with temperature; the heist temperature (25 C°) were recorded in W. Khoshbi while the lowest temperature (14 C°) was recorded at W. Gebal. The previous results could explain by two words "altitudinal gradient"; because Wadi Gebal is the highest elevated point it receives cool temperature and high rain W. Khoshbi is the lowest one in this area it receives high temperature and low rains; however, for each 1,000-foot rise in altitude there is a 4°F drop in temperature (Table 5).

Table 5. Bioclimatic Conspectus for Locations under study

Bioclimatic factors	Wadi Gebal	Wadi Gharaba	Wadi Hodra	Wadi Khoshbi
Alt.	1790.00	1170.00	600.00	80.00
T. min.	8.40	9.90	14.80	20.40
T. max.	19.80	21.20	25.70	30.40
T.mean	14.10	15.55	20.25	25.40
Rain	105.00	68.00	20.00	6.00
Annual Mean Temperature	11.67	13.67	18.80	22.96
Mean Diurnal Range	11.96	11.86	11.58	10.61

It may be the highly elevation gradient and the dissected terrain in this area results in restricted gene flow over short distances led to isolation of small populations within the species, and the terrain and elevation gradient together lead to variable climatic patterns resulting in different selective regimes. Normally, climatic conditions become colder as altitude increases. "Life zones" on a high mountain reflect the changes; plants at the base are the same as those in surrounding countryside, but no trees at all can grow above the timberline. Snow crowns the highest elevations.

3.3.4 Multivariate statically analysis:

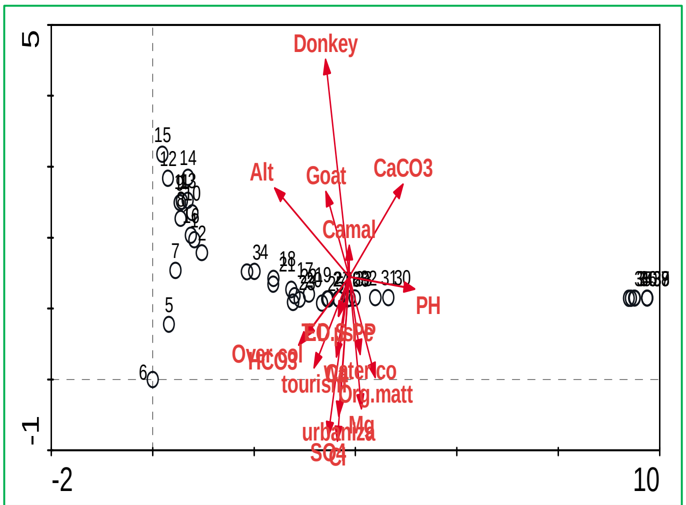


Figure 2. The samples-Environmental factors (circles and arrow, respectively) biplotof the DCA of the whole data set.

- <u>Detrended Correspondence Analysis (DCA)</u>

Was used to detect the length of the environmental gradient. The positions of arrows for environmental variables suggest that there are a group of variables that are mutually highly positively correlated (Altitude, HCO3, SO4, EC, T.D.S. and tourism) and negatively correlated with (CaCO3). Also it showed a great correlation with *Fagonia arabica, Fagonia mollis, Haloxylon salicornicum, Nicotiana rustica, Phoenix dactylifera, Seriphidium judaica and Zilla spinosa.* A closer inspection of the correlation matrix in the CANOCO Log View shows that variables are indeed correlated, but in some cases the correlation is not very great. The correlation matrix confirms that the correlation of all the measured variables with the second axis is rather weak Figure 2.

- <u>Modeling species response curves</u>

Regarding to important values index of each species, the species response curve for *Achillea fragrantissima, Fagonia mollis, Haloxylon salicornicum and Zygophyllum coccineum* reveals that there is different projection (negatively & positively correlated) with the Altitude gradients. The projection of *Achillea fragrantissima* important value index reveals that the optimum elevation range is from 1100 to 1950m a.s.l. While *Fagonia mollis* species reveals that the optimum elevation range is from 700 to 1500m a.s.l, *Haloxylon salicornicum* species reveals that the optimum elevation range is from 50 to 1200m a.s.l, And *Zygophyllum coccineum* species reveals that the optimum elevation range is from 50 to 150m a.s.l., (Fig. 3).

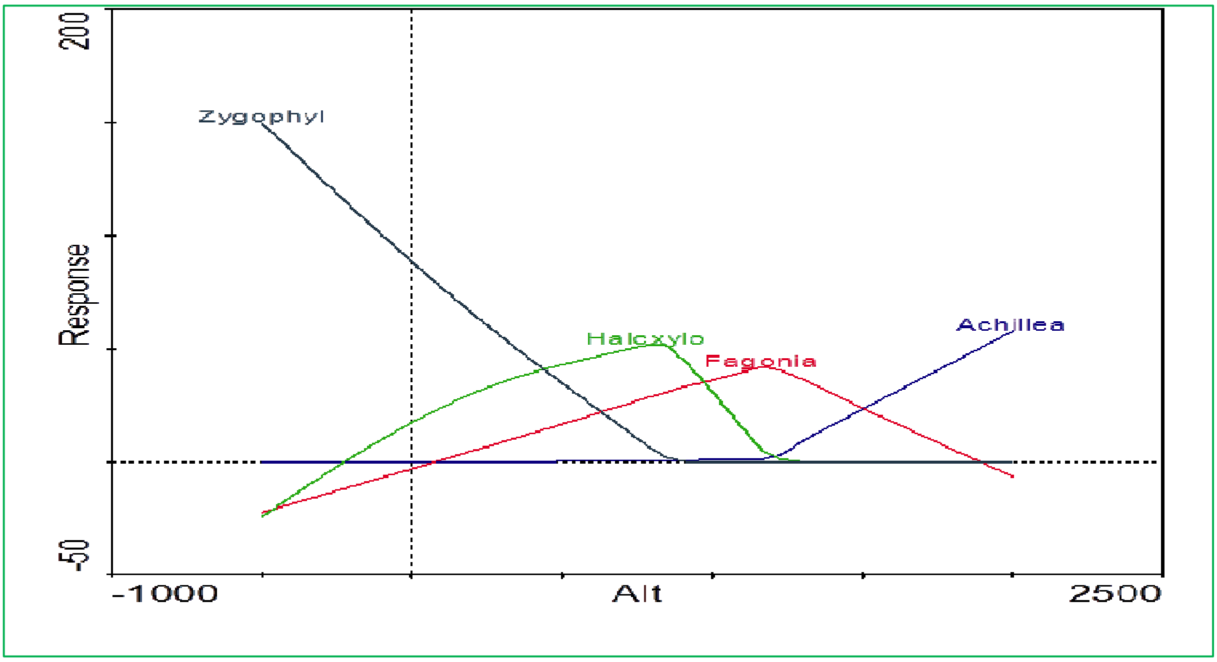


Figure 3. Important Value Index of four dominant species Achillea fragrantissima, Fagonia mollis, Haloxylon salicornicum and Zygophyllum coccineum plotted against important environmental gradient (Alt).

4.0 Conclusions:

The main conclusions regarding the previous results as follows:

- Spatial variation is crucial for determining the structure and dynamics of plant populations and communities.
- Floristic structure recorded great variation between sites. The main reason for this variability may be the variation in elevation, slope temperature, and small disparities in rainfall, as well as past differences in anthropogenic disturbance. Variation in altitudinal and latitudinal variation which leading to the variation in climatic conditions and consequently, make changes in all ecosystem components.
- Climatic variables (temperature, rainfall) play major role in plant community structure and plant distribution specially Mean Temperature where that plant species diversity and abundance of individual's increases as low temperature.
- Spatial variation can be used in economic issue, that we can help local communities to detect the time and place where they can collect their plants for commercial use or for grazing.
- GIS & DIVA GIS played an important role in analysis, management and extract of spatial variation for different habitats by using simple information collected from filed will give a great analysis just by using such programs.

5.0 Acknowledgement:

I would like to extend my thanks to **Dr. Karim Omar**, Environmental researcher/GIS specialist in Saint Katherine Protectorate who contributed time, suggestions and support during the planning, research. Also, we thank **Dr. Mohamed Salem**; General Manger of South Sinai protectorates for his work facilitation, fruitful advices and his support.

References:

1) Allen, S.E., Grimshaw, H.M., Parkinson, J.A., Quarmby, C., Roberts, J.D. (1976): Chemical Analysis of Ecological Materials. Edited by S.B. Chapman. Blackwell Science Publication, Oxford. Chapter 8: 166-411.
2) Allen, R.B. and Peet, R.K., (1990): Gradient analysis of forests of the Sangre de Cristo Range, Colorado. Canadian Journal of Botany, 68, 193-201.
3) Black, C. A. (1965): Methods of soil analysis. American Society of Agronomy. Vol. P 771-1572.
4) Boulos, L. (1995): Flora of Egypt: Checklist. Al-Hadara Publishing, Cairo, Egypt, pp. 283.

5) Braun-Blanquet, J. (1964): Plant Sociology. Translated by G.D. Fuller and H.S. Connard, McGraw-Hill Book Co., Inc. New York, London. 439 pp.
6) Busing, R. T., White, P. S. and MacKende, M. D. (1992): Gradient analysis of old spruce-fir forest of the Great Smokey Mountains circa 1935. Canadian Journal of Botany, 71: 951-958.
7) Câmara, G., Monteiro, A., Fucks, S. and Carvalho, M. (2004): Spatial Analysis and GIS: A Primer, www.obt.inpe.br/prodes
8) Davis, S. D. Heywood, V.H. and Hamilton, A.C. (1994): Centers of plant Diversity. A Guide and Strategy for their Conservation. Volume 1. Europe, Africa, South West Asia and the Middle East. WWF and IUCN, IUCN Publication Unit, Cambridge 293–308.
9) El-Alqamy, H. M. (2002): Developing and Assessing a Population Monitoring Program for Dorcas Gazelle (Gazella dorcas) Using Distance Sampling in Southern Sinai, Egypt. M.Sc. thesis, School of Biology, Division of Environmental and Evolutionary Biology, University of St. Andrews, Scotland. 118 pp.
10) Fayed, A. and Shaltout, K. (2004): Conservation and sustainable use of Medicinal plants in arid and semi-arid eco-systems project, Egypt (GEF, UNDP) (project no: 12347/12348), Flora of Saint Catherine protectorate, final report. And Floristic Survey of the Mountainous Southern Sinai: Saint Katherine Protectorate, final report.
11) Greig-Smith, P. (1983): Quantitative Plant Ecology, 3rd edn. Blackwell Scientific, Oxford.
12) Hatab, E. E. (2003): Establishing and Monitoring the Dynamic Population of Acacia in Saint Katharine Protectorate, South Sinai, and Egypt. M.Sc. Thesis, Botany Dep., Facu. Of Sci. Al-Azhar Univ., Egypt.205 pp.
13) Hejcmanovā-Neźerková, P. and Hejcman, M. (2006): A canonical correspondence analysis (CCA) of the vegetation–environment relationships in Sudanese savannah, Senegal. South African Journal of Botany 72: 256 – 262.
14) Jackson, M. L., (1967): Soil chemical analysis, Prentice-Hall of India private, New Delhi, India. 498 pp.
15) Kheder, A. (2007): Assessment, classification, and analysis of microhabitats supporting globally significant Plant species: Abdel-Hamid A. Khedr; May-September, 2007, 1-37.
16) Legendre, P. and Fortin, M. J. (1989): Spatial pattern and ecological analysis. – Vegetatio 80: 107–138.
17) McGinnies, W.G., Goldman, B.J. and Paylore, P. (1968): Deserts of the world an appraisal of research into their physical and biological environments, the university of Arizona press.569-645 pp.
18) Migahid, A.M., El-Shafei, A.M. and Abdel Rahman, A.A. (1959): Ecological observations in Western and Southern Sinai. Bull. Soc. Geogr. d'Egypte 32: 165-206.
19) Mueller-Dombois, D. and Ellenberg, H. (1974): Aims and Methods of Vegetation Ecology. New York, Wiley.
20) Nelson, A., LeClerc, G. and Grum, M. (1997): The development of an integrated Tcl/Tk and C interface to determine, visualize and interrogate infraspecifc biodiversity. Internal CIAT document. GIS Laboratory, CIAT, Cali, Colombia.
21) O'Connor, C. O., Marvier, M. and Kareiva, P. (2003): Biological vs. social, economic and political priority-setting in conservation. Ecology Letters, 6:706–711.
22) Omar, K., Khafagi, O. and Elkholy, M.A. (2012): Eco-geographical analysis on mountain plants: A case study of Nepeta septemcrenata in South Sinai, Egypt. Lambert Academic Publishing, 236 pp.
23) Pavlůet, V., Hejcman, M., Pavlů, L. and Gaisler, J. (2003): Effect of rotational and continuous grazing on vegetation of upland grassland in the Jizerske´ Hory Mts., Czech Republic. Folia Geobotanica 38: 21– 34.
24) Perry, G. L. W. et al. (2006): A comparison of methods for the statistical analysis of spatial point patterns in plant ecology. – Plant Ecol. 187: 59-82.
25) Pielou, E.C. (1968): An Introduction to Mathematical Ecology. Wiley, New York.
26) Piper, C. S. (1950): Soil and plant analysis, University of Adelaide press. Australia.
27) Purves, D.W. and Law, R. (2002): Fine-scale spatial structure in a grassland community: quantifying the plant's-eye view. Journal of Ecology 90: 121-129.
28) Richard, L. A. (1954): Diagnosis and Improvement of saline and Alkaline, Soils. U. S. Department Agr. Handbook, 66 pp.
29) Ruggiero, L.F., Hayward, G.D. and Squires, J.R. (1994):Viability analysis in biological evaluations: Concepts of population viability analysis, biological population, and ecological scale. Conservation Biology 8: 364–372.

30) Shukla, K. S. and Chandel, P. S. (1989): Plant Ecology and Soil Science. S. Chand and Co. New Delhi, India.
31) Titshall, L.W., O'Connor, T.G. and Morris, C.D. (2000): Effect of long-term exclusion of fire and herbivory on the soils and vegetation of sour grassland. African Journal of Range and Forage Science, 17: 70–80.
32) Watt, A.S. (1947): Pattern and process in the plant community. Journal of Ecology, 35:1–22.
33) Wiens, J.A., Addicott, J.F., Case, T.J. and Diamond, J. (1986): The importance of spatial and temporal scales in ecological investigations. In: Community Ecology (Diamond, J. and Case, T.J., Eds.), pp. 145-172. Harper and Row, New York.
34) Wilson, K. A., McBride, M. F., Bode, M. and Possingham, H. P. (2006): Prioritizing global conservation efforts. Nature, 440, 337–340.