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MODELING THE IMPACT OF ENVIRONMENTAL VARIABLES ON TYPE AND DENSITY OF LAND COVER

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Abstract: Examination of relationships between plant communities with environmental factors is considered among the most important and complex issues related to natural resources and environmental management topics. In the present study, some of the most important environmental factors affecting growth and distribution of natural plant communities existed in Zanjanrood Watershed as well as their relations are discussed. For this purpose, the land use maps related to the years 1987, 1998, 2002 and 2009 were prepared using hybrid unsupervised method and the land cover density map was provided by means of NDVI. Subsequently, the diversity status of the plant species was determined in the area using alpha diversity indices. Information related to temperature and precipitation was obtained through statistics and meteorological data within a 60 year statistical period. Finally, using regression relationships and cluster analysis the role of each independent variable (environmental factors) on plant biodiversity was specified separately. The obtained results revealed a significant impressibility of plant communities by environmental factors during the years of the research. The highest correlation between environmental factors with tested vegetative characteristics is observed between elevation classes with vegetation types and density.

Key words: biodiversity; rangeland types, land cover density; environmental variables; conceptual model

1. INTRODUCTION

The issue of protection of plants and land cover has seriously been considered in many countries and extensive activities have been took placed to prevent their destruction (Le Buanec, 2006; Kiewiet, 2005; Thiele-Wittig & Claus, 2003; Tripp et al., 2007). Generally, biodiversity has a different, wide meaning so that the topic includes genetic diversity up to diversity of ecosystems (Nielsen et al., 2007; Haines-Young, 2009; Dirzo & Mendoza, 2008; Gugerli et al., 2008).

For example, to evaluate plant biodiversity in different habitats and compare them, some indicators are used in such a way that the simplest form of diversity is considered in form of preparation of plant species list along with their number (Barnes, 1998). In 2008, Gillet, by modeling vegetation dynamics concluded that major changes in plant species diversity in the form of deterioration of plant biodiversity in ecosystems such as pastures and grazing areas, in addition to being influenced by environmental factors, especially soil and physiographic is a function of the amount of pastures utilization by livestock in terms of type and number, time and duration of exploitation. In a way that, time and spatial changes of plant species diversity is in direct contact with the operation method, even if no changes occur in the characteristics of other factors affecting biodiversity. Two main components of biological diversity include plant species richness and relative dominance in a natural environment. The examination of relationship between plant communities with environmental factors has specific complexity whereas, firstly, the under study variables have lots of changes, secondly, there are complex interactions between environmental variables and plant communities (Jiang et al., 2007; Aparicio et al., 2008; Jeltsch et al., 2008). Understanding the relationship between environmental factors and the distribution of plant species plays an important role in environmental planning and management (Austin, 2002; Ferrier, 2002; Geneletti, 2008; Kampmann et al., 2008). Quantification of environmental factors is various. Plant communities comprised the main part of geographic distribution forecasting models, can present some information on land use changes impact assessment (Guisan & Zimmermann, 2000), recognition of previous climatic conditions (Arundel, 2005) and also ecosystem remediation objectives (Chunyan et al., 2005). Climatic factors such as temperature, precipitation and evapotranspiration can properly predict the spatial changes of the species richness (Sarr et al., 2005). Nowadays, in modern societies, due to increasing the number and availability of remote sensing products, there are lot of citable studies carried out on the basis of spatial data and remote sensing in a broad spatial scale (Du et al. 2010; Zhang & Zhu, 2011; Dewan & Yamaguchi, 2009; Waring et al., 2006). Also, using powerful statistical methods and geographic information systems (GIS), vegetation studies are rapidly developed in ecology (Salem, 2003; Powell et al., 2005, Skov & Svenning, 2003; Accad & Neil, 2006). Most of models produced by GIS predict geographic distribution of species and plant communities associated with environmental factors using statistical analysis (Cabeza et al., 2004). In this case, the ambiguous unknown aspect is the influence amount of factors and their participation and contribution in the field of creating and providing conditions for extinction of plant species or their threaten caused reduction and deterioration of plant biodiversity. Thus, by knowing the amount of participation and contribution of such factors, the possibility of achieving practical method or model for predicting plant biodiversity change is provided. Accordingly, the current study aims at achieving a model to present an appropriately the relationships between the variables the occurrence frequency of pasture types and extent of vegetation density classes with environmental factors including the characteristics of soil, climate, land use and land units in the years of study using multivariable regressions. Obviously, the variables considered in the study include some important environmental factors affecting the existence, survival and stability of plant communities. The factors were selected based on ecological requires of different plants, which their participation rate and role in stability, deterioration and change of plant biodiversity were specified using correlation analysis. Certainly, there are other effective factors like human factors, particularly; the cattle number and duration of grazing affected directly or indirectly the plant diversity which are not regarded in study ahead.

2. MATERIAL AND METHODS

2.1. The study area

Zanjanrood Basin is one of the sub-basins of SefidRood Watershed located on the northwest of Iran and the western part of Zanjan Province between latitudes 36°17′41″–37°13′27″ N and longitudes 49°04′55″–47° 47′23″ E (Fig. 1). The area extent is equal to 4670.27 km^2 in which the natural ecosystems including grasslands and grazing areas (rangeland), woodlands and widows cover 2369.71 km^2 (equivalent to 50.7 percent of the area). The watershed has a semi-arid to Mediterranean arid climate with average annual rainfall equal to 299 mm. The average rainfall varies between 216mm at downstream and 513mm at upstream of the region. Zanjanrood Basin is limited by Tarom Sofla Mountain Range from the north, Soltanie Mountain Range, heights of common border of Talkherood and Zajanrood from the south, common border between Abharrood and Zanjanrood from the east, to the continuance of Tarom Sofla Mountain Range as well as heights of common border of Talkherood and Zajanrood.

2.2. Methodology

As is apparent from figure 2, the current study was carried out through tree following stages:

2.2.1. Literature review stage

At this stage, all required data regarding the research subject and purposes were collected. Reports of studies conducted through the region consisted of environmental studies, natural resources investigations, and extraction of descriptive and quantitative statistics in the form of tables or maps, collection of statistics related to weather and climate, preparation of needed maps including topographic, geology, land resources, aerial photographs and satellite images of considered years are among the measures performed in this stage. Meanwhile, all required facilities and equipment of field studies such as quadrate to investigate the land cover characteristics, double cylinders Ogre, clinometer, stereoscope, as well as GIS software packages were supplied. Moreover, the places of field operations were identified on the base maps.

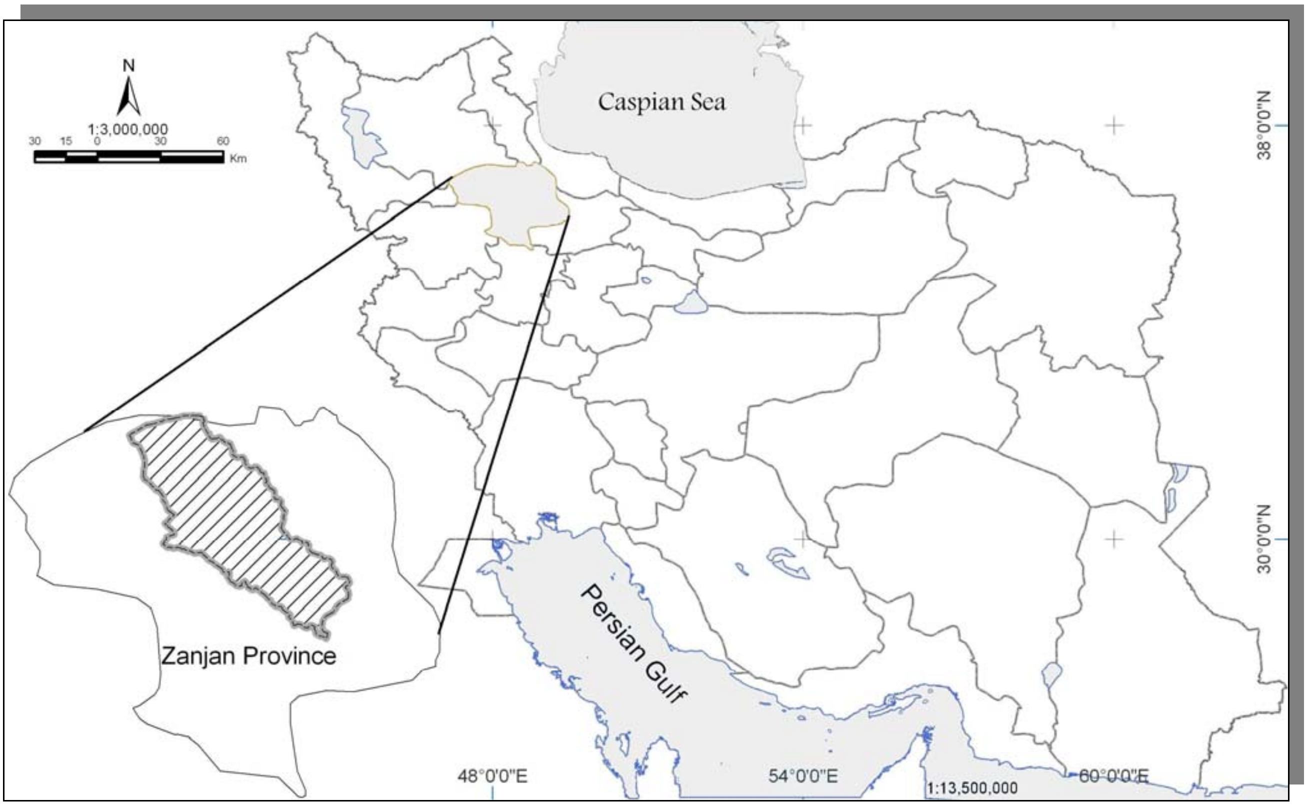


Figure 1. A view of the study area situation among the watershed divisions of the country

2.2.2. Field study stage

At this stage, in addition to completing and scrutinizing the characters of the study area and preparing maps related to environmental features and human activities, the sampling places were determined to investigate soil characteristics, plant diversity and land cover compound and density as well as performing field experiences including soil penetrate measurements, soil density rate caused by getting stampede by cattle, erosion profiles and so on. Accordingly, descriptive data, quantitative information and statistics were provided in the form of maps and tables.

2.2.3. Data analysis stage

At this stage, based on the research hypothesis and purposes, all qualitative and quantitative data were analyzed using relevant methods like correlation analysis between environmental factors with plant biodiversity and its features including density, composition, biodiversity and richness. The applied methods as well as the analyzing process of the research ahead are as follows:

- The collected statistics and basic information obtained from relevant reports and organizations were categorized based on the research hypothesis and purposes;

- In order to examination of land use, vegetative form, land cover density, soil properties, land form and water resources of the study area, the aerial photographs of the years 1956, 1967 (at scale of1:40000) and TM, ETM + ETM (at scale of 1:100000), IRS (at scale of 1:70000), satellite images for the years 1985, 1990, 1998, 2000, 2008 were prepared and interpreted;

- Periodic list of plant species in the study area was prepared by adaptation of the existing data and statistics with the time intervals of the aerial photographs and satellite images;

- The land cover map related to the determined time intervals was prepared using unsupervised hybrid method by means of satellite images; TM, ETM + ETM at scales of 1:100000 and 1:70000 respectively and aerial photographs (at scale of1:40000);

- Slope, aspect and elevation maps were extracted from Digital Elevation Map (DEM) which has a scale of 1:50000;

- Isothermal and isohyetal maps were obtained from statistics within a 60 year period at a scale of 1:50000;

- Geology, runoff, erosion, lithological units maps were prepared in the environment of GIS Software;

- By overlaying the maps; slope, elevation, lithological units and land cover, homogeneous units map was prepared in order to determination of training points so that 3 training points were specified through each homogeneous unit quite randomly. The reported characteristics related to each unit were recorded in the GIS environment;

- In order to complete and scrutinization of landform, slope, aspect and elevation maps, GPS and clinometer was applied within the training points beside the visual interpretation of aerial photographs and satellite images by means of stereoscope;

- Lithological units map were scrutinized at training points using comparative analysis of base maps with output derived from spectral interpretation of recent satellite images of the region;

- The land use map was scrutinized through field study to separate different land uses including shrubbery land, spinney land, grassland, irrigated, and non irrigated arable land and rocky outcrops;

- A list included different plant species; their number and composition in each unit of the land use map enjoyed natural grassland, shrubbery and spinney lands was prepared using quadrate/transect method. The dimension of quadrates was 1*1m. Considering the extent and length of each working unit some transects with dimensions between 10m to 20m were determined. In each quadrate, based on the standard measurement method for land cover characteristics, the bare soil percentage, plant canopy cover along with type, density and compound of the land cover as well as stampede appearance and the impact of soil stamped by cattle were recorded carefully;

- Classified land cover density map and its changing trend within the four periods were derived from Normalized Difference Vegetation Index (NDVI) and supervised classification method as follows:

$$NDVI = \frac{NIR - \mathrm{Re}\,d}{NIR + \mathrm{Re}\,d} \qquad (1)$$

Where:

NIR is near-infrared radiation;

Red is visible radiation.

- In order to specification of soil profile, a profile was drilled using the standard method at training points (the profile depth should be equal to 1 m). Afterward, soil was sampled from a depth of 40 cm (surface layer) using ogre. Soil permeability was measured using double cylinders and TDR (Time Domain Reflectometry) Device at training points. It should be noted that the TDR readout unit used in this project was a TRASE Model 6050X1 built by Soil moisture Equipment Corp. of Santa Barbara, CA;

- The study of erosion and land degradation at training points was carried out using Bureau of Land Management (BLM) Method;

- The type, composition, richness and density of the vegetation in the form of plant species diversity was mapped based on the results of sampling and measurement through the transect/quadrate method as a map of current plant biodiversity;

- The status of plant species diversity in each of the working unit was determined regarding alpha diversity indices as follows:

- alpha diversity indices

Shannon index (H')

$$H' = -\sum_{i}^{n} Pi \ln(Pi) \qquad (2)$$

Where;

ni is the number of individuals in species i; the abundance of species i.

N is the number of species, also called species richness.

N is the total number of all individuals.

Pi is the relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community:ni/N

Simpson's Reciprocal Index 1 / D

$$N_2 = (\sum_{i}^{n} P_i^2)^{-1} \qquad (3)$$

n = the total number of organisms of a particular species

i = the total number of organisms of all species

Hill's Index

$$N_1 = \exp[-\sum_{i}^{n} Pi \ln(Pi)] \qquad (4)$$

Pi' the proportion of the ith species in the community

-uniformity indices

Pielou's uniformity index

$$J' = [-\sum Pi \ln(Pi)] / \ln S$$
$$F = (N_2 - 1)(N_1 - 1) \qquad (5)$$
$$G = [(\arcsin F) / 90°]F$$

C. The studied variables in the form of a conceptual model:

In current research, independent variables include topography (slope, aspect and elevation classes), geomorphology and geology (land types, hillside status, lithological units and their related properties), soil (physicochemical properties), land uses (separation of natural ecosystems including shrubbery, spinney, natural grass lands, irrigated and rein-fed agricultures as well as other land uses such as urban and rural residential land, aquatic environments and so on), Weather and climate (including precipitation classes in the form of isohyetal contours, temperature classes in the form of isothermal contours, the evaporation classes in the form of iso-evaporation contours and vital climates boundaries using Emberger Method in the form of climate map of the region), while land cover (diversity, composition, richness and density of the land cover) was considered as depended variable.

- After preparation of required environmental variables maps, at the next stage, the relationship between changes in vegetation type and density with environmental variables was determined through the following multivariate regression relationships;

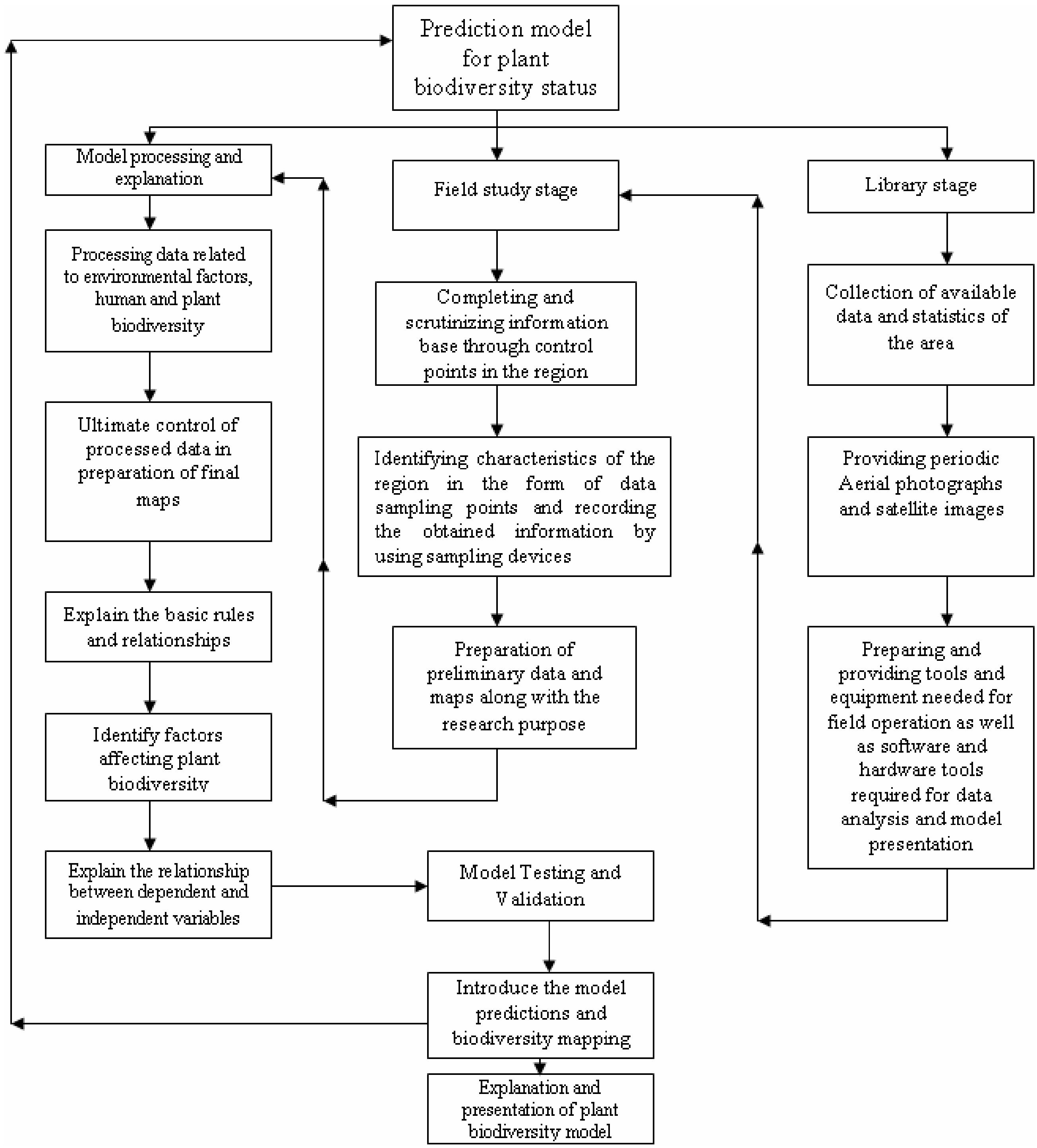


Figure 2. The implementation method of various stages of the research

-Spearman's rho

Spearman's rank correlation coefficient called Spearman's rho, is a non-parametric measure of statistical dependence between two variables. It evaluates how well the relationship between two variables can be depicted by means of a monotonic function. If there are no repeated data values, a perfect Spearman correlation of +1 or −1 will happen.

Assume that (y1 and x1)...(yn and xn) is a random sample of a two-dimensional distribution, if the rank of X_i is showed by R_i and the rank of y_j is represented by S_j then,

$$r = \frac{\sum_i \left(x_i - \bar{x}\right)\left(y_i - \bar{y}\right)}{\sqrt{\sum_i \left(x_i - \bar{x}\right)^2 \left(y_i - \bar{y}\right)^2}}$$

- Kendall's tau (τ) coefficient

The Kendall rank correlation coefficient, also called as Kendall's tau (τ) coefficient, is a statistic applied to measure the association between two measured quantities. A tau test is a non-parametric hypothesis test used the coefficient to test for statistical dependence.

-Tau-b

Tau-b statistic makes adjustments for ties and is suitable for square tables. Values of tau-b are ranged from −1 (100% negative association, or perfect inversion) to +1 (100% positive association, or perfect agreement). A value of zero indicates the absence of association. The Kendall tau-b coefficient is defined as;

$$T_B = \frac{n_c - n_d}{\sqrt{(n_0 - n_1)(n_0 - n_2)}}$$

Where,

$$n_0 = n(n-1)/2$$

$$n_1 = \sum_i t_i(t_i - 1)$$

t_i= number of tied values in the i^{th} group of ties for the first quantity;

u_j= number of tied values in the j^{th} group of ties for the first quantity.

- Cross-validation Method

Cross-validation or rotation estimation is used to estimate how accurately a predictive model will perform in practice.

3. RESULT AND DISCUSSION

According to the examination and evaluation of all layers as well as the basic information within the periods the trend of changes in each layer is described as below:

3.1. The changes trend of climatic factor*s*

Among the climatic factors, average periodic rainfall, monthly and annual rainfall average, average periodic temperature, monthly and annual temperature average in the considered years of the study were investigated

Based on investigations conducted in the first period of the study (1987), the average rainfall rate was equal to 351 mm which has upward and downward fluctuation till the final period. Table 1 shows changes in precipitation during the four periods).

Table 1. Average rainfall amounts through the studied periods

Period	Average rainfall (mm)
1987-1960	351
1998-1988	283
2002-1999	216
2009-2003	316

Based on the average annual rainfall within the considered years of the study, rainfall amounts in the years 1987, 1998, 2002 were calculated beyond the long-term average (299 mm), while, the annual average precipitation of the year 2009 was computed lower than the calculated long-term average. It should be noted that the average amounts of rainfall in the studied years (1987, 1988, 2002 and 2009) are equal to 328, 302, 305 and 286 respectively. The average monthly rainfall in the years of research is demonstrated in figure 3. The precipitation distribution through the different months, particularly, in the months associated with the plants water need for growing can be obviously observed in figures 3.

The average temperature in the first period was 12.44°C which were decreased to its lowest amount through the fourth period i.e. 10.72°C. So, the temperature has had a decreasing trend in the fourth period. Table 2 gives temperature changes during the considered periods.

Table 2. The average temperature during the study periods

Period	Average temperature (°C)
1987-1960	12.44
1998-1988	11.98
2002-1999	11.71
2009-2003	10.72

Based on the average annual temperature in the studies years, the calculated temperature in the years 1987, 1998, 2002 and 2009 were beyond the long term average (12.7°C), and the average temperature in 1998 has the highest level among the research years. The average temperature in the years of the study (1987, 1988, 2002 and 2009) is respectively equal to 13.2, 14.1, 13.2 and 13.3.

The changes trend of precipitation - temperature in the research years is illustrated in figures 4 and 5 using Ombrothermic Curve.

Ombrothermic Curve demonstrates the monthly trend of precipitation changes against temperature trends so that on one hand, reveals the start of the dry season and its duration on the other hand, shows the wet season beginning as well as the distribution of wet months during the year. Considering the curves, the changes trend is as follows:

- Duration of the dry seasons in the research years are observed equal to 5-6 months;

- The driest year within the research years is 2009, particularly, the distribution of rainfall at the beginning of the plant growth period (around March onwards) was inappropriate compared to the other years.

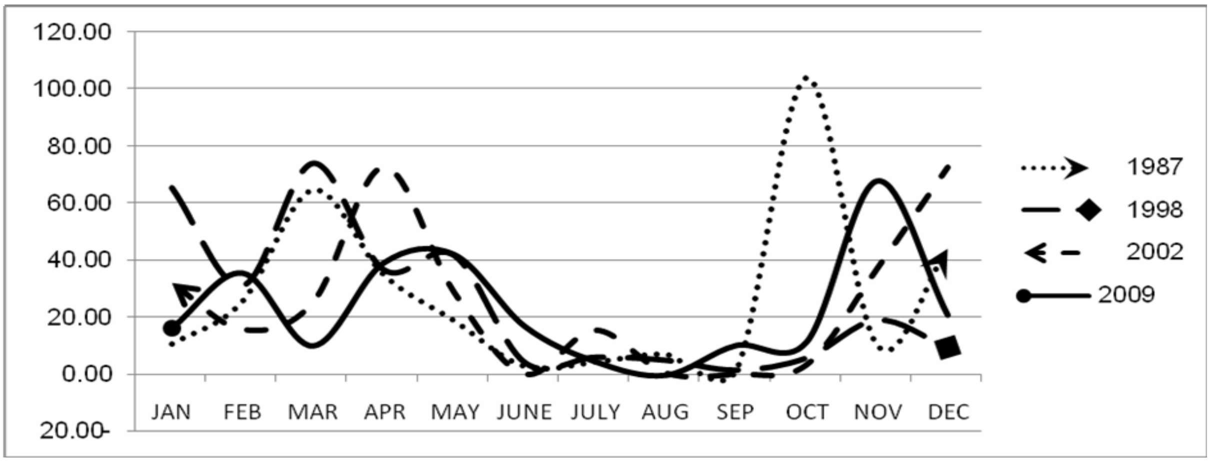
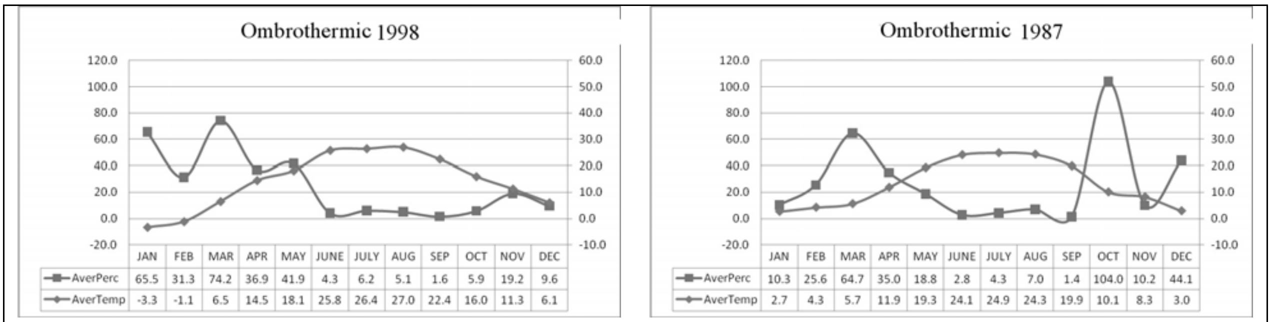


Figure 3. The average rainfall amounts within the months of the studied years



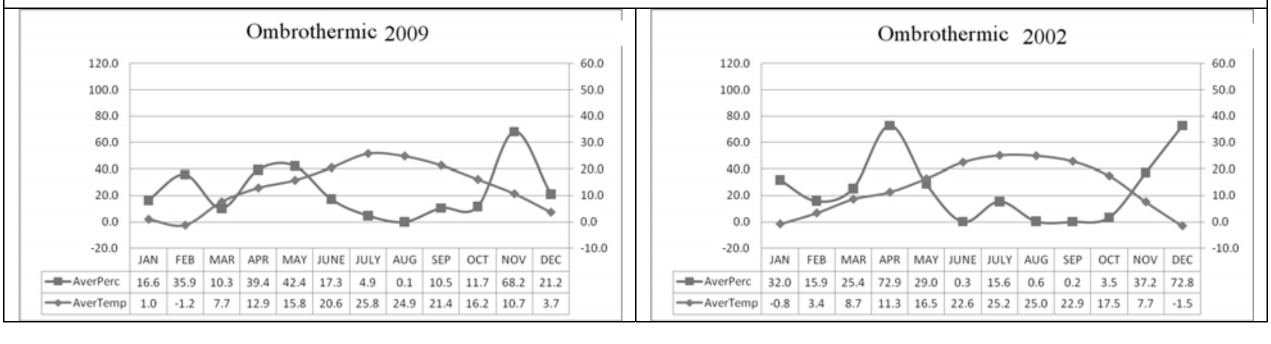
Ombrothermic 1998

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
AverPerc	65.5	31.3	74.2	36.9	41.9	4.3	6.2	5.1	1.6	5.9	19.2	9.6
AverTemp	-3.3	-1.1	6.5	14.5	18.1	25.8	26.4	27.0	22.4	16.0	11.3	6.1

Ombrothermic 1987

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
AverPerc	10.3	25.6	64.7	35.0	18.8	2.8	4.3	7.0	1.4	104.0	10.2	44.1
AverTemp	2.7	4.3	5.7	11.9	19.3	24.1	24.9	24.3	19.9	10.1	8.3	3.0

Figure 4. The trend of precipitation - temperature changes in the research years; 1987; 1998 using Ombrothermic Curve (part 1)



Ombrothermic 2009

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
AverPerc	16.6	35.9	10.3	39.4	42.4	17.3	4.9	0.1	10.5	11.7	68.2	21.2
AverTemp	1.0	-1.2	7.7	12.9	15.8	20.6	25.8	24.9	21.4	16.2	10.7	3.7

Ombrothermic 2002

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
AverPerc	32.0	15.9	25.4	72.9	29.0	0.3	15.6	0.6	0.2	3.5	37.2	72.8
AverTemp	-0.8	3.4	8.7	11.3	16.5	22.6	25.2	25.0	22.9	17.5	7.7	-1.5

Figure 5. The trend of precipitation - temperature changes in the research years; 2002 and 2009 using Ombrothermic Curve (part 2)

3.2. The changes trend of land use

According to table 3 land use changes trend is as follows:

- Rainfed agriculture has an increasing trend from the first period to the fourth and shows a growing rate tantamount to 10% reflected decreasing the extent of rangelands surrounding reinfed farmlands and their conversion into the farmlands;

- The extent of the rangelands has a declining trend within the four periods due to increasing the area of the other land uses specially, the reinfed farmlands so that the rangeland area was decreased 11.5% at the fourth period. The extent of the residential areas was increased 1.5% at this period which means population growth and consequently, incensement of agricultural lands. Total area of arable lands including gardens and farmlands has been almost constant.

3.3. The changes trend of the land cover density for rangelands

The changes trend of the land cover canopy within the four intervals was obtained by classification of information derived from NDVI (in 2009, some field studies were conducted at training points to ensure of applied information).

Table 3. The trend of changes of different land uses in research years

Land uses classes	the area percentage in 1987	the area percentage in 1998	the area percentage in 2002	the area percentage in 2009
Non irrigated Arable lands	24.5	27.3	32.0	34.2
Irrigated arable lands	7.3	6.9	4.0	6.2
Orchards and vineyards	1.9	1.8	2.1	2.8
Range lands	65.9	63.2	60.7	54.4
Built up areas	0.4	0.77	1.0	1.9
Airport	0.0	0.0	0.14	0.14
Water body	0.0	0.03	0.06	0.4

Table 4. the changes trend of various types of rangeland canopy density classes in the research years

Land cover density classes of rangelands	code	the area percentage in 1987	the area percentage in 1998	the area percentage in 2002	the area percentage in 2009
very low dense rangelands (less than 10% canopy)	R.L.1	1.2	1.8	2.4	3.8
low dense rangelands (less than 10-40% canopy)	R.L.2	23.6	26.4	29.1	31.6
Semi-dense rangelands (less than 40-60% canopy)	R.L.3	25.3	23.1	21.6	15.9
dense rangelands (more than 60% canopy)	R.L.4	15.8	11.9	7.6	3.1

Table 5. The trend of the most major rangeland types in the research years

Grazing suitability	The land cover types within the four periods	The type code	area (%) 1987	area (%) 1998	area (%) 2002	area (%) 2009
Palatable grasses	*Acantholimon-Agropyrun*	Aca.l.-Ag.	11.5	8.4	7.7	6.4
Highlands	*Acanthophyllum-Prennial grasses*	Aca.p.-Pre.	2.3	0.2	0.2	0.0
grazable at plain areas	*Artemisia sieberi-Astragalus*	Ar.si.-As.Spp.	2.1	9.7	6.1	7.7
grazable at plain areas	*Artemisia sieberi-Annual grasses*	Ar.si.-Ann.	21.3	18.2	15.5	12.2
protective	*Astragalus-Acantholimon*	As.spp.-Aca.l.	0.2	0.2	0.2	0.0
Palatable grasses	*Astragalus-Artemisia aucheri-Prennial grasses*	As.spp.-	28.4	24.2	22.5	16.0
unpalatable	*Astragalus-Hultemia*	As.spp.-Hu.	0.0	2.2	2.7	3.4
unpalatable	*Astragalus-Thymus*	As.spp.-Th.	0.0	0.0	2.7	3.3
Unpalatable grasses	*Rosa-Prennial grasses*	Ro.-Pre.	0.0	0.0	3.2	5.5

As can be observed in table 3, the area of dense rangelands (more than 60 percent density) and the extent of the semi-dense rangelands (40-60% canopy) have been declined around 13 and 10% respectively and some parts of the rangelands have been deteriorated to the lower classes or reinfed agriculture. Instead, the extent of the classes; 0-10 and 10-40 have been increased 2.6 and 8% respectively (it is worth noting that the proportions have been calculated regarding the total extent of the study area).

3.4. Trend of plant type changes

The most important changes include replacement of some types of dominant plant species by participant species which are mainly unpalatable or have low palatability, from the first period of the study until 2009 (Tables 3-5).

4. CONCLUSIONS

According to the investigation of changes trend for medium dense canopy classes as well as the correlation levels of the rangeland types with environmental factors (in 2009) it was concluded that factors including the average annual rainfall, the average annual temperature and elevation classes have the highest exponential correlation with the factor of the average canopy percentage in rangelands. Beside, change in the rangeland types (based on their dominant species) is significantly affected by the average precipitation changes as a linear function and the elevation changes as an exponential function while it doesn't have any significant correlation with annual temperature function. According to the field studies conducted in 2009 in order to evaluate the statistical correlation between two depended variables with independent ones in the form of multivariate correlation, the available information were processed using SPSS Software. Based on the results obtained from Kendall and Spearman's tests it was suggested that the average canopy density has a significant correlation equal to 99% with elevation (Tables 6 and 7).

The regression between rangeland canopy density with environmental variables revealed that the highest relationship belongs to the elevation classes (Table 8). It is revealed that to predict the canopy classes in the study area digital elevation model (DEM) can be used. As can be seen in the model, the constant coefficient is negative, which indicates underestimation of the canopy cover. In case of rangeland types association with the environmental factors based on two indices; Kendall and Spearman it was concluded that rangeland types have perfect (100%) correlation with elevation classes at confidence level of 99% (Table 8 and 9).

Table 6, Multivariate correlation test for canopy values with independent factors and its correlation formula

Methods	Land cover classes	Elevation classes	Rainfall classes	Temperature classes
Kendall's tau_b (Correlation Coefficient)	1	1.000**	1.000**	0.707
Spearman's rho (Correlation Coefficient)	1	1.000**	1.000**	0.775

a. *. Correlation is significant at the 0.05 level (2-tailed).
b. **. Correlation is significant at the 0.01 level (2-tailed).

Table 7, Model of multivariate correlation test for canopy values with independent factors and its correlation formula

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
(Constant)	-226.825	56.214	-	-4.035	.056
Elevation classifications	.139	.029	.958	4.746	.042

a. Dependent variable: canopy density classifications
b. Canopy density classifications for rangeland land cover= -226.825+.139*elevation classification

Table 8, Multivariate correlation test of rangeland types along with relevant correlation Formula

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.306	3.007	-	.767	.523
	Extent (m^2)	8.825E-9	.000	1.038	8.365	.014
	Precipitation classes	.010	.006	.411	1.553	.261
	Temperature classes	-.033	.199	-.021	-.166	.884
	Elevation classes	-.003	.002	-.460	-1.663	.238
2	(Constant)	1.840	.869	-	2.117	.125
	Extent (m^2)	8.887E-9	.000	1.046	10.967	.002
	Precipitation classes	.010	.005	.415	1.914	.151
	Elevation classes	-.003	.001	-.456	-2.013	.138
3	(Constant)	1.691	1.117	-	1.513	.205
	Extent (m^2)	8.450E-9	.000	.994	8.420	.001
	Elevation classes	.000	.001	-.059	-.503	.641
4	(Constant)	1.164	.361	-	3.227	.023
	Extent (m^2)	8.275E-9	.0001	.974	9.535	.000

a. Dependent Variable: the code of the rangeland type

Rangeland type=1.691+0.00084* the areas of the type+0.001*elevation classes

Table 9, Model Summary of Multivariate correlation test of rangeland types using independent factors

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.989[a]	.978	.935	.552	.978	22.466	4	2	.043	-
2	.989[b]	.978	.956	.454	.000	.027	1	2	.884	-
3	.975[c]	.951	.926	.586	-.027	3.665	1	3	.151	-
4	.974[d]	.948	.937	.540	-.003	.253	1	4	.641	2.222

a. Predictors: (Constant), Elevation classes (Extent in terms of m2), classes of precipitation, temperature classes,

b. Predictors: (Constant), Elevation classes (Extent in terms of m2), classes of precipitation

c. Predictors: (Constant), Elevation classes, Extent in terms of m2

d. Predictors: (Constant), Extent in terms of m2

e. Dependent Variable: the code of the rangeland type

Based on the regression between the rangeland type and environmental factors such as rainfall classes, temperature classes and the extent of the rangelands as well as the statistics four models were identified appropriate (Table 7). As can be observed from table 7, the models obtained by Stepwise Method show the regression rate between the rangeland types and the environmental variables. Sig=0.001 and R2=95% would be good criteria to choose between these four models.

The examination result of the models suggested that although the fourth model is suitable but, due to being limited just to the extent of the rangeland types factor it is better to use the third model which has tow factors; elevation classes and the extent of the rangeland types to estimate and predict the map of the vegetation type classes as follow:

Rangeland type=1.691+0.00084* the areas of the type+0.001*elevation classes

At the end, by performing the validation test, it was determined that the predicted amount of canopy percentage and plant type using the calculation models have an error equal to 7%.

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