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IMPACT STUDY OF SLOPE ASPECT IN THE BOILOGICAL CRUST PROPERTIES OF SOME GYPSIFEROUS SOILS USING REMOTE SENSING AND GIS

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Abstract

This study conducted on gypsiferous to investigate the effect of the slope aspect in the biological crust of some gypsiferous soils using remote sensing. The field work involves selection of two Hills (top, middle, under slope) both from south and north aspect. A three replicates of soil sample from biological and under biological crust were taken, and photo vertically at 1 meter height by a digital camera. laboratory analysis of the samples involve the biological and chemical soil properties such as (bacterial number, fungi, algae, mycorrihza, pH, EC, $CaCO_3$, $CaSO_4.2H_2O$, available N, available P, O.M. and soluble ionic (Ca^{++}, Mg^{++}, Na^+, K^+, CO_3^{--}, HCO_3^-, CL^-, SO_4^{--}). Office work, include digital processing of the satellite image by ERDAS program, calculation spectral reflectance and other indicators (CI, BSCI, BCDI, BI, WI, CNI, B/(G+R), B2/B7, B4/B7, B5/B7) which explain biological crust status and degradation degree (slightly, moderate, sever). The results refer to clear effect of slope aspect in the optical, chemical and biological properties. The number of bacteria, fungi, algae, available N, available P and organic matter were increased in the hills top and North aspect, while the EC, $CaSO_4.2H_2O$ were increase in south aspect. In addition, the spectral indices (B/(R+G), B2/B7, B4/B7) were decreased in north aspect. Whereas BCDI, R/(G+B) indicators were increased in the south aspect and through indices maps showed a biological crust suffer from sever degradation.

Key word: Biological crust, gypsiferous soils, Remote sensing.

Introduction

Many arid and semi-arid regions worldwide suffer from scarcity of vegetation and large areas are free of trees, shrubs and other plant coverings. In contrast, they are rich in other living organisms which are playing an important role in the formation of the biological crust. The Biological crust is highly resistant to extreme temperature, drought, solar radiation, salinity and soil reaction and erosion. Although it is sensitive to natural disturbances such as climatic changes and human activities. The biologic crust form between 70-80% approximately of the biosphere, and contributes to the protection of the desert ecosystem through the formation and development of soil and the maintenance of fertility, reduce the water erosion, wind erosion, grazing and the movement of sand dunes. On the other hand, they are subject to change and disturbances such as climatic variations, degree and aspect of slope, unfair human use and fires, and in addition the rate of biologic creation is slow which will be requires years and sometimes decades to be formed (Belnap and Eldridge, 2001; Johansen *et al.,* 1993).

Biolophytes are vital groups of lichens, symbiotic organisms, mycobiont, photobiont, lichens, fungi, other types of bacteria, free living algae, other algae, eukaryotic and prokaryotic microscopy. They form part of a complex mixture associated with the grains, voids, cracks and deposits of sedimentary rocks which are formed during sediment deposition or metal crystallization. Therefore, the composition and density of soil biota depend on several factors including solar radiation, precipitation, temperature, topography, texture and parent material.

Slope is one of the soil formation factors which are reflect the activity of various pedogenetic processes and contribution in the soil formation and development. An addition, it is influence in soil degradation and desertification in arid and semi-arid regions through its effect on local climate, vegetation cover, activity and presence of microorganisms and soil properties.

Wet climate have biologic diversity dense compare

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to dry climate, but some types of soils in dry environments such as gypsum soil have a high and dense variety of lichens, algae and mosses compared to other desert soils. Therefore, the properties of gypsifereous soil in the Moyev desert have high diversity in the biological crust compared to the other soil. gypsifereous soil have a fragile structure and low fertility content. Therefore, the management of the biologic crust on the surface of the gypsum soil will protect the soil surface and increase its ability to moisture retain and reduce evaporation rate. Biologic crust reduces the erosion water and wind depending on the degree of hazard. Many studies have confirmed that cyanobacteria are related with soil particle and are mainly stable in warm desert soils.

Remote sensing are one of the most important modern technologies that can monitor a wide area with extreme accuracy. The most important of these techniques are the spectral reflective properties that help us evaluate the biologic crust in gypsum soils through the analysis and interpretation of satellite image and the calculation of spectral indices (Karnieli *et al.,* 2001). In the past two decades there has been an interest in the study of the biologic crust in the desert areas, as a number of research has focused on the spectral properties of the biologic species and their components (Ager and Milton, 1987; Jacobberger, 1989; Karnieli and Sarafis, 1996; Karnieli and Tsoar, 1995; Karnieli *et al.,* (Karnieli *et al.,* 1996; Karnieli *et al.,* 1996; O'Neill, 1994; Pinker and Karnieli, 1995; Rollin *et al.,* 1994; Tsoar and Karnieli, 1996). Therefore, the study was used to evaluate the effect slope aspect some of the physico-chemical and optical properties of the biologic crust of some the gypsiferous soil using Remote Sensing and GIS.

Materials and Methods

study Area: An area of 11740 km^2 was selected. Two different slope sites were identified: the first slope (HILL 1) is located within longitude (43' 30.7165) east and the Latitude (35' 36.3081) north (Fig. 1). In order to increase accuracy in achieving the best results, the second slope (HILL-2) with a different slope according to the aspect was selected and is located within the coordinates of the longitude (43°14' 35.414") east and Latitude (35°27' 0.607"). The area of the study is an extension of the Makhul Hills series, which is bordered from the south, to the east by the Tigris River and 2.5 km to the west by the Sharqat-Tikrit street, which is grazing land. It is suffering from overgrazing and it has been exploited for years. The method increased the risk of wind and water erosion and led to deterioration of the biologic crust, which was reflected in the deterioration of gypsum soils (Fig. 2).

Geology and Soils of the Area: According to Geological and Topographic maps, the area of study is a undulating area with deep and large valleys and the predominance of gypsum and calcareous rocks. The soils is classified as gypsiorthids according to Altei (1968) and Muhamiad *et al.,* (2015) and so classified as badland and brown, shallow and medium-sized brown, covering a layer of gypsum and sandstone, according to the Buringh (1960), with semi-tropical subtropical semi-tropical brown plains Low mountains by Russian classification, (1982).

There is a large area of the Shurqat region within Al-Jazerah areas, which were used for wheat agricultureand and rangeland because these areas are not rain guaranteed, in dry and semi-arid conditions with belt between 100-300 mm in which the high temperature is summer and low in winter (Fig. 3). Lagonychium farctum, Alhagi mauronum, *Tribulus terrestris* L., Peganum harmala, Artemisia herba- alba, Gendelia tournefortii, and other annual plants are among the most dominant plants in the region.

Soil samples: Samples of the Biological crust were selected, which is the different in thickness according to slope aspect. And also samples from the layer under the Biological crust were selected, and at the rate of three replicates (Hill top, Centre Slope, Under Slope).

Digital Camera: Sony 16-megapixel camera was used to calculate the color system (RGB) and reflectance and acquiring the images at a height of 1 m as indicated in previous studies.

Laboratory work: The sample was divided into three different parts. The first part was carried out by drying, grinding and sieve with a 2 mm. EC and pH were measured with soil extract (1:1) (Page *et al.,* (1982)). Gypsum was estimated by precipitation by acetone, according to Richards (1954). Calcium carbonate was estimated by Bascomb (1961). The organic matter is estimated according to Tandon (1998). Determination of dissolved ions (positive and negative) (Richard (1954)), as well as the estimation of Total nitrogen prepared by the Kaldal method, as shown by Bremner (1965) in Black (1965) and phosphorus prepared according to the Olsen method. The second part was used for the purpose of Biologic analysis, using the method of blasting and counting of dishes using Nutrient Agar medium to estimate the total number of bacteria and using the method of blasting and counting of dishes using a PDA to estimate the total number of fungus (Black, 1965), while estimated the number of ALGAE NOSTOC by method (Kantz and Bold, 1969) and estimated the incidence of mycobacterium fungi (Vierheilig *et al.,* 1998). The

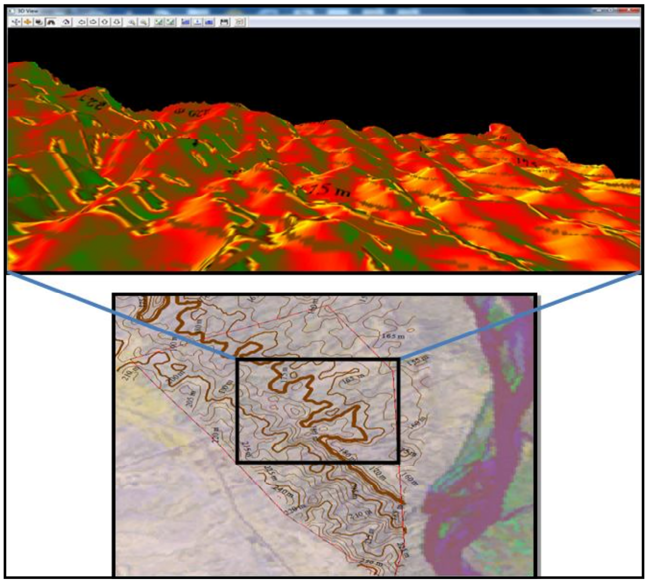

Fig. 1: The Digital Elevation Model (DEM) shows the degree and slope inter face.

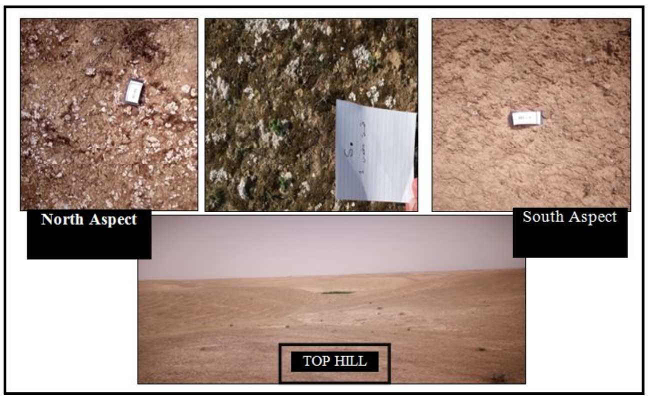

Fig. 2: Some scenes and images taken to the study area.

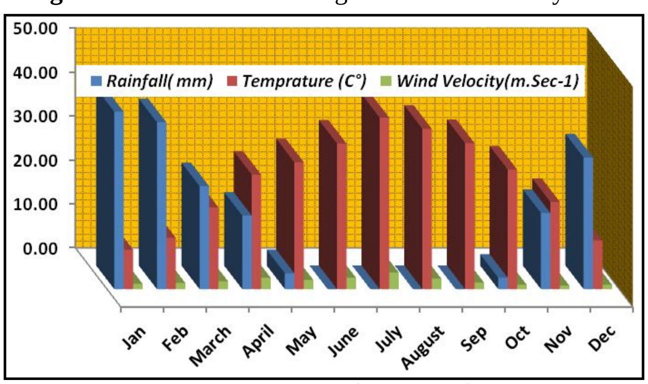

Fig. 3: Some climate data and information for the study area for the period 1999-2009.

isolating of the mycorrihza Fungi was used by Wet Sieving and Decanting method (Gerdmen, 1963), while the third part, was also used For grinding, sieving and drying and was placed in regular dishes similar to Petri dishes of a known diameter and was scientifically prepared, in a manner that combines the dry and wet soil and the standard $BaSO_4$ and then took a number of images and at a height of 1 m using a digital camera type SONY to express soil color and soil Reflectance(CMYK, RGB, HSB).

Office work

Satellite Images: We have adopted the satellite image acquired by Landsat satellite, which is within the range of path 170 and row 35, and date 25-2-2011. The study area was cut by the Erdas program and then calculate RGB,H,S, reflectance% and spectral indices.

Software used in the study:

The study included the use of a number of important programs that help us in the interpretation and analysis of the satellite image, including ERDAS IMAGING *Ver.* 9.1, which was used in the account various indicators which have a direct and indirect relationship with the biologic crust composites, based on the calculation of spectral reflectivity values expressed as DN.

The images acquired by the digital camera were calculated by calculating the components of the basic colors and the spectral reflectivity. The working mechanism included putting the model in a petri dish and acquiring images at a height of 1 meter. The Global Mapper Ver.11 helped us to create Digital Elevation Model map. Whereas, ArcGIS *Ver.* 9.3 was based on the calculation of spectral indices and the mapping of the spectral indices.

Spectral Indices: There are many indices and plant indicators that can be used to monitor the impact of the slope aspect in vegetation intensity and diversity. Indicators that can be adopted as follows.

Brightness Index: Refers to degraded soils and suffers from scarcity of vegetation cover and erosion activity.

$$BI = 0.2909\times BI + 0.24\times B2 + 0.48\times B3 + 0.55\times B4 + 0.44\times B5 + 0.17\times B7$$

Wetness Index: Humidity is one of the most important indicators that are affected by the slope aspect and are closely related to the vegetation cover and some soil characteristics such as clay and organic matter.

$$Wetness\ Index - WI = \left(\frac{1}{BI}\right)\times 100$$

Karnieli's Cyanobacteria index: Used to monitoring the thin layer formed on the soil surface, and which is rich by herbs, lichens, mosses, fungi and bacteria (Karnieli *et al.*, 1997).

$$Crust\ Index - CL = 1 - \left(\frac{(B3 - B1)}{(B3 + B1)}\right)$$

Biologic Soil Crust Index:

$$BSCI = \frac{1 - L \times \left| Rred - Rgreen \right|^{mean}_{GRNIR}}{R}$$

Rr: Reflective red color which represents the band 3 in Landsat + ETM.

Rg: Reflective green color which represents the band 2 in Landsat + ETM.

RMEAN: red, green and near infrared

L: ranges from 2 to 4 and takes value 2 as adopted by previous studies.

Biological Crust Degradation Index: The areas with degraded crust, which are inversely proportional to the thickness of the crust as follows:

BCDI = 1-BSCI

CRUST NOSTOC Index-CNI: The high value of the band 1 indicates a layer that is rich in algae and has relatively high moisture content. In contrast, the band 7 indicates that the bare soil. And found that the value ranges from (zero and one and one.

CNI = (B1-B7) / (B1 + B7)

Miscellaneous spectral ratios: It is known that the visual space consists of a number of spectral beams and with the help of specialized scientific programs we have been able to perform a number of combinations and spectral ratios, the result of the division of spectral package on another. After this method we statistically reach the most spectral ratios as follows:

B/(G+R)R/(G+B)B1/B7 B2/B7 B4/B7 B5/B7

Expression of soil color and spectral reflectivity using digital camera:

ERDAS V.9.2 was used to express the values of the RGB system, representing R: red, G: green, B: blue, and the sum of these colors gives the reflection color 100%. Therefore, (3) replicates were selected for each model and its average was extracted to ensure that there is a real representation of each model, including as follows:

1. Reflectivity: The primary color of the model is divided by the value of the reference material, which gives (255, 255, 255) red, green and blue. When squared and root values we get 441.67 (George *et al.*, 1998).

R% = $\sqrt{R^2 + G^2 + B^2}$ /441.67) × 100

2. Using spectral evidence to express the soil of the study sites (Ray et al., 2004), which include:

2.9.Brightness Index-BI:

BI = ((R2 + G2 + B2) /3.0)) ^ 0.5

Saturation index (SI): which reflects Spectra Slope and color saturation (light red and dark red).

SI = (R-B) / (R + B)

Results and Discussion

The Effect of the slope aspect on biological properties

Results of Table 1 indicated a differences in the biologic properties of gypsum soils. It has been observed that the total number of bacteria ranged between (12-22)×10^{-4} in the biologic crust, reaching the highest of value in the R3 at the slope top of the HILL-1. (22×10^{-4}). Also, results showed an increasing in total bacterial numbers at the northern aspect, which reached (18-20)×10^{-4} compare to the southern aspect (12-15)×10^{-4}. Total bacteria numbers in subsoil at the under biological crust were relatively less ranged (13-15), (11-14) (9-11) at the top of the slope, the northern and the southern aspect, respectively. Mycorrhiza, is an important fungus, and important role play in the supply of the plant's nutrients, the following arrangement were taken according to the slope aspect: slope top > the northern aspect> the southern aspect (83-86), (75-80) and (51-54), respectively. While it decreased under of the biological crust and taking the following order: The northern aspect> the top of the slope> the southern aspect, which recorded the following values (65-67), (51-54) (35-38) respectively.

Results of Table 1 shows that the Algae were very high in the biologic crust at the slope top which ranged between (299-321) and there was a superiority in the northern aspect where it ranged from (198-205) compared to the southern aspect (112-122) and may be to the effect impact of solar radiation on the surface of the crust. Contrast, Notes that Algae were relatively decreased in the layer under the crust where it reached (178-189), (186-193) and (112-119) for both the top of the slope and the north and south aspect, respectively. Results Table 1 show that Fungi were affected by the slope which decreased in the southern aspect (20-25)×10^{-3}, may be due to high temperatures, low moisture content, low organic matter, seldom vegetation and erosion, while range between (26-29)×10^{-3} at the northern aspect and taken relative decrease in the layer under the crust. Addition, notes that Hill-2, the same arrangement were obtain, but there was a difference in values due to the effect of the site and the degree of slope. It was found that the numbers of fungi, bacteria and algae were relatively less varied between the northern and southern aspect, may be that the relatively longer period from solar radiation were exposure, while it was noted that the southern aspect was a steep slope of 45 degrees while in the hill-1 (25 degrees) of the northern aspect and (35 degrees) of the southern aspect.

Results of Fig. 4 show that the numbers of the Mycorrhizae Fungi has taken the following order: the top of the slope> the northern aspect> the southern aspect (84.67, 77.33, 59.67), (73.67, 62.00, 34) for the hill 1 and hill 2, respectively. It was also found that the number of bacteria, algae and fungi increased in the northern aspect, where they reached (19, 14, 201.33, 145.33, 27.33 and 36.67) compared to the southern aspect (13.67, 8.00, 117.67, 128.67, 22.67 and 10.33) both sites. While its numbers were found to be relatively low in the layer which is below the biologic crust. Their numbers were higher in the northern aspect. This may be due to the

Table 1: Effect of the slope interface on the properties of the biologic crust of gypsum soil in the study sites.

LOC	Layer	Mycorrhizas por/10g Soil			Bacteria $\times10^{-4}$			Algae			Fungi $\times10^{-3}$		
		Replication											
		r1	r2	r3	r1	r2	r3	r1	r2	r3	r1	r2	r3
		Hill-1											
North Aspect	A	80	75	77	20	19	18	205	198	201	26	27	29
	B	67	66	65	12	11	14	193	186	186	10	15	16
Top Hill	A	85	83	86	20	21	22	321	302	299	51	45	55
	B	53	51	54	15	14	13	189	178	181	17	16	14
South Aspect	A	60	58	61	14	12	15	122	112	119	20	23	25
	B	36	38	35	11	10	9	93	90	78	8	6	9
		Hill-2											
North Aspect	A	62	63	61	16	14	13	147	141	148	37	34	39
	B	42	40	43	9	8	9	42	38	45	16	14	13
Top Hill	A	76	73	72	20	23	25	185	178	183	22	21	26
	B	41	40	42	11	9	12	63	66	61	15	13	17
South Aspect	A	38	37	38	8	7	9	133	124	129	11	9	11
	B	34	33	35	6	5	7	39	36	31	6	5	8

A: Crust , B: Sub Crust

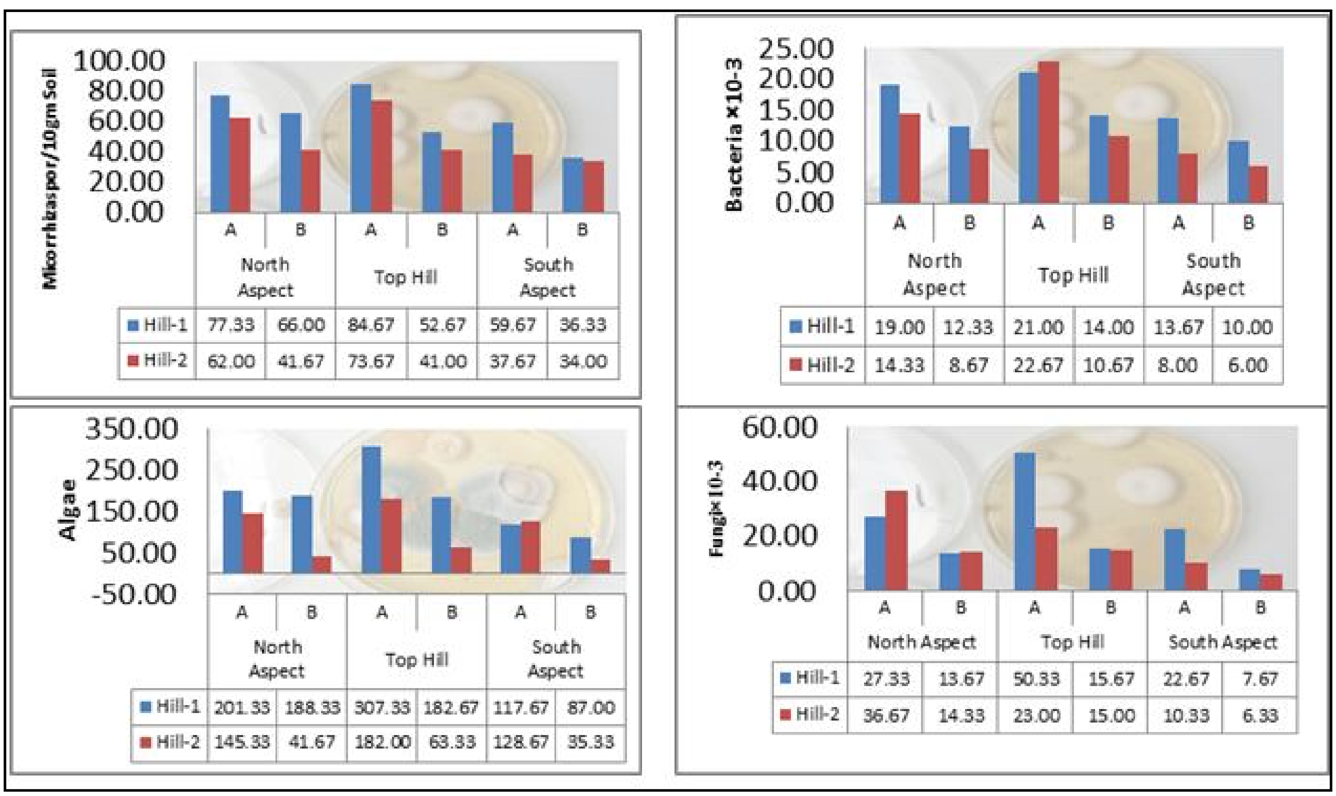

Fig. 4: Properties of biological properties under the effect of the regression interface in gypsum soils.

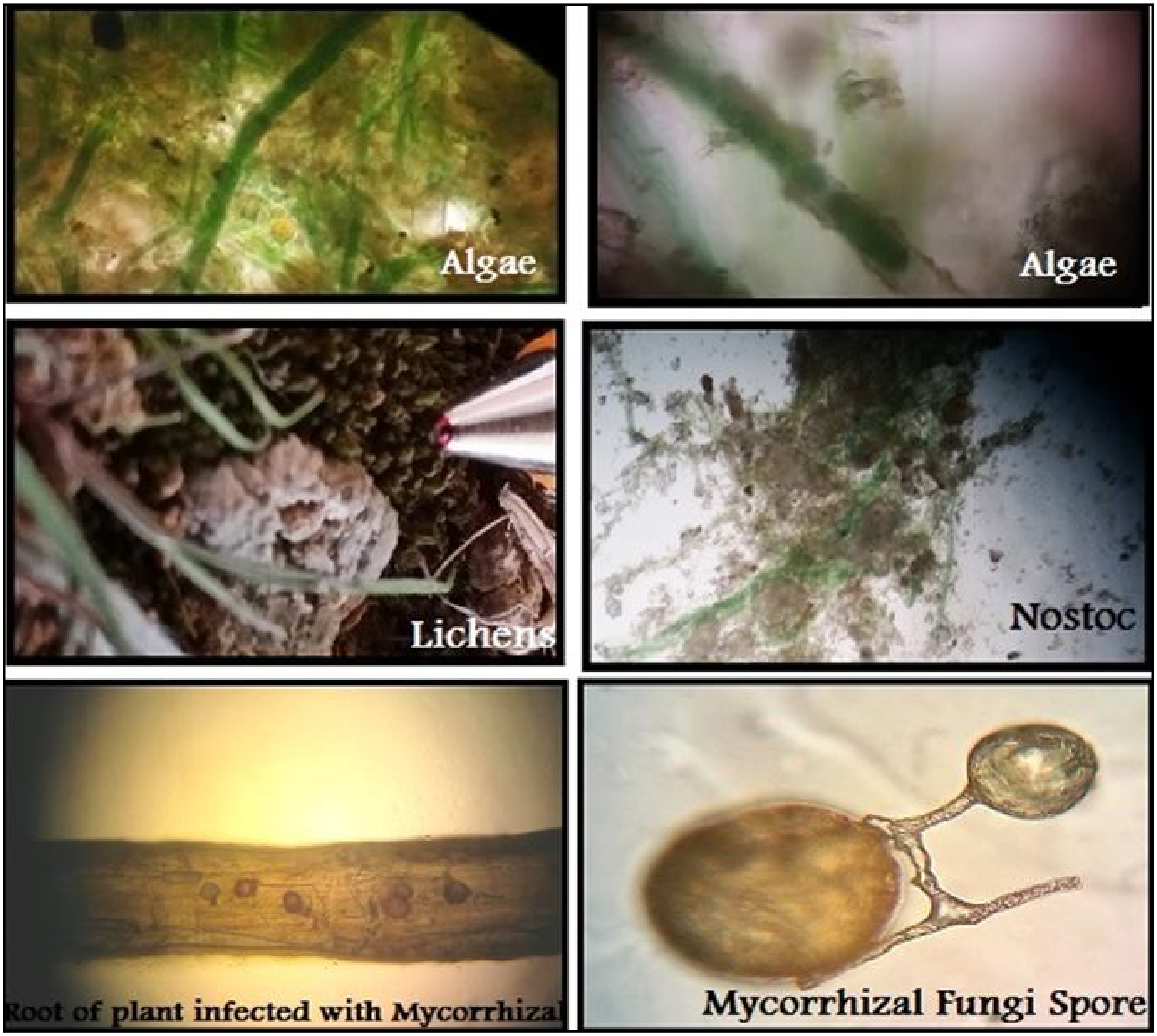

Fig. 5: Some scenes acquired after being imaged using the Microscope.

appropriate conditions that help the presence and activity of microorganisms, especially the temperature and moisture content. While the crust is very thin and weak at the southern aspect, which is exposed to intense sunlight (Fig. 5).

Chemical properties in gypsifereous soils

Results of Table 2 demonstration a difference in the chemical properties of the soil of the study sites. The values of pH ranged between 7.73-8.20 in the HILL-1 and between 7.41-8.10 in the HILL-2 and according to the slope aspect, the following order was taken: Slope top < Northern aspect < Southern aspect (7.70, 7.73, 7.81) in the surface layer respectively. It was noted that the EC reached the highest level in the southern aspect (3.42 and 2.50) and (3.51 and 2.58) dS. L^{-1}, followed by the top of the slope (2.50 and 2.40) and (2.59 and 2.36) dS. L^{-1} and reached the lowest level in the northern aspect (1.80 and 0.99) and (1.70 and 0.93) dS. L^{-1} for Hill-1 and Hill-2 and for both crust and subcrust respectively, so the rise in the southern aspect may be due to the salinity of the surface layer by capillarity property and high evaporation rate in the surface layer due to high temperatures effectively contributes to the dryness of the layer Surface and salts. Results show that the organic matter content in the biologic crust was higher than that at the top of the slope (14.21 and 13.00) gm.kg^{-1} for both the Hill 1 and Hill-2, respectively, compared to the layer under the biologic crust. Gypsum content in the biologic crust of the southern aspect, reaching 32.00, 32.00 and 43.00 gm. Kg^{-1} were highest than northern aspect which reached (18.50, 16.00 and 20.00) gm. Kg^{-1}. In the layer below the biologic crust, there was a dominance of the top of the slope (176.00, 201.00 and 250.00)gm. Kg^{-1} and at the south aspect (180.00, 180.00 and 175.00) gm. Kg^{-1}. It was also observed that the results HILL2 showed superiority of the southern aspect, reaching (152.00, 165.00 and 165.00) gm. Kg^{-1} consistently compared to the north and the top of the slope which reached (10.50, 10.00 and 8.500) and (13.00, 25.00 and 25.00) gm. Kg^{-1}, respectively. Calcium carbonate content was relatively high in the biologic crust compared to the sub-crust. This is probably associated with its low solubility ratio compared with the gypsum salts, generally ranging between (125.60 - 148.90) gm. Kg^{-1} in the biologic layer of the Hill 1 and relatively less in the subcrust layer. Nitrogen content was higher to the biologic crust of the slope, reaching 41.00, 39.00 and 35.00 mg. Kg^{-1}. If we compare between the northern and southern aspect we

Table 2: Chemical properties of the Biological Crust in the gypsiferous soils.

LOC	Layer	pH	EC dS.m^{-1} at 25°C	O.M. g.m. kg^{-1}	Gypsum gm.kg^{-1} r1	r2	r3	$CaCo_3$ gm.kg^{-1} r1	r2	r3	Available N ppm r1	r2	r3	Available P ppm r1	r2	r3
	Hill-1															
North Aspect	A	7.73	1.98	12.00	18.50	16.00	20.00	144.20	144.50	125.60	32.00	26.00	25.00	16.50	14.20	12.50
	B	8.20	0.78	8.40	130.70	146.00	182.00	130.00	110.20	102.30	12.00	15.00	15.00	3.70	3.20	3.00
Top Hill	A	7.70	2.50	14.20	26.00	26.90	15.20	145.00	145.00	148.90	41.00	39.00	35.00	14.30	14.60	13.50
	B	7.98	2.40	8.10	176.00	201.00	250.00	134.00	115.30	145.00	14.00	16.00	17.00	5.50	6.50	3.50
South Aspect	A	7.81	3.42	8.80	32.00	32.00	43.00	140.00	143.50	139.00	22.00	19.00	15.00	4.50	7.20	6.40
	B	7.83	2.50	8.20	180.00	180.00	175.00	141.00	135.60	103.20	12.00	11.00	12.00	6.50	3.20	3.20
	Hill-2															
North Aspect	A	7.63	1.70	13.20	10.50	10.00	8.50	142.00	149.80	140.00	31.00	32.00	37.00	10.80	19.60	11.00
	B	7.73	0.93	7.00	230.00	263.00	263.00	125.00	102.00	125.00	17.00	17.00	19.00	4.70	4.00	4.60
Top Hill	A	7.41	2.59	13.00	13.40	25.00	25.00	150.00	150.00	152.10	33.00	39.00	35.00	13.50	17.20	12.60
	B	7.70	2.36	8.00	300.00	350.00	350.00	113.20	135.00	110.00	19.00	21.00	18.00	4.60	3.40	3.50
South Aspect	A	8.10	3.51	9.10	152.00	165.00	165.00	145.00	146.00	143.20	17.00	18.00	21.00	4.50	6.50	6.00
	B	8.00	2.58	6.50	413.00	412.00	396.00	150.00	141.00	136.00	10.00	9.00	8.00	3.50	3.90	4.30

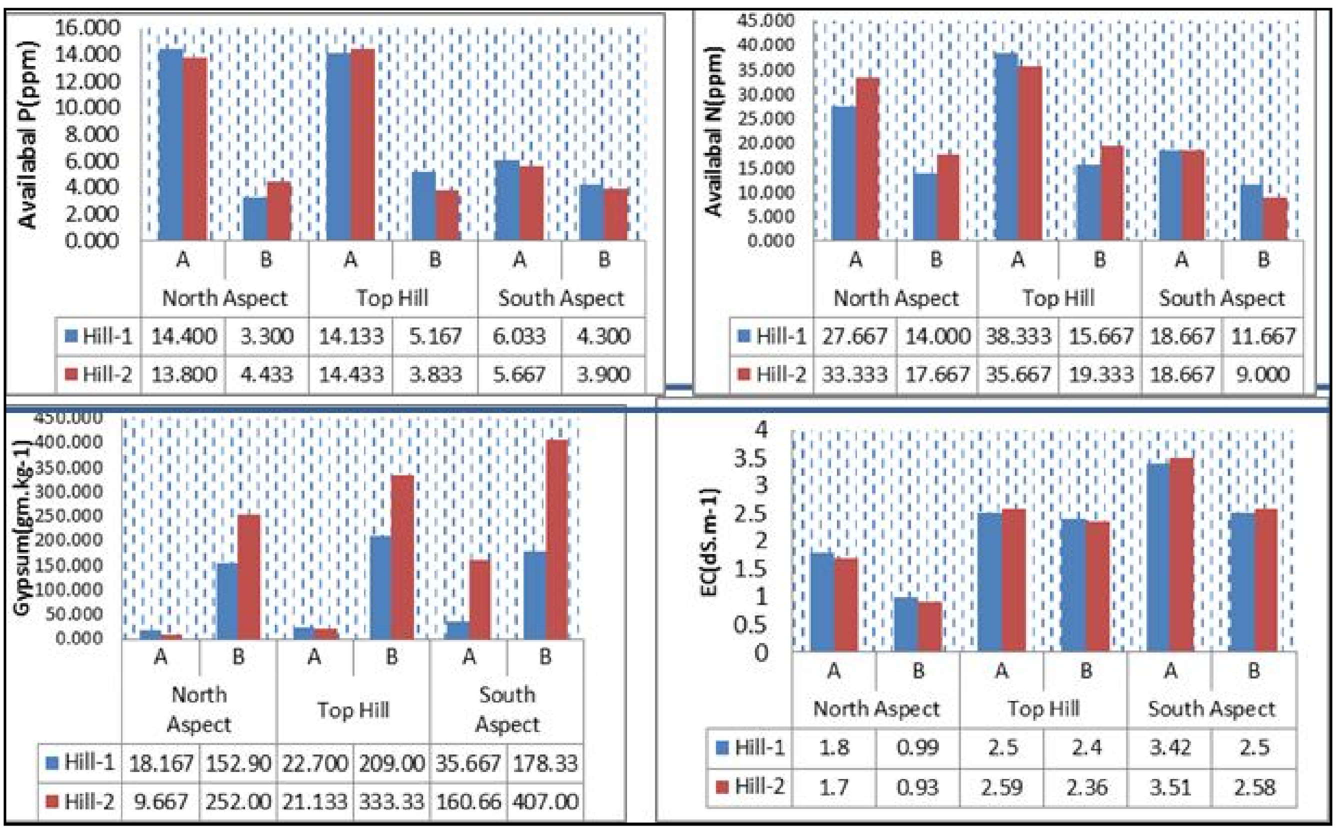

Fig. 6: Curves of some chemical properties of biologic crust in study sites.

will find that there is an increase in nitrogen content in the northern aspect (32, 26 and 25) mg. Kg^{-1} compared to the southern aspect, which reached (22.00, 19.00 and 15.00) mg. Kg^{-1} for both the crest of the slope and the north and south fronts, respectively.

Fig. 6 shows the chemical properties of the biologic crust in gypsum soils. Results of Table 3 indicate that the concentration of calcium ion was high in the study sites. This is due to the fact that gypsum soils are a major source of calcium ion. 35.60 and 35.00) and a relatively low slope in the southern aspect (31.96, 24.50 and 25.00) meq. L^{-1}. In the sub-crust, there was a significant decrease (29.36, 28.60, 29.50, 12.65, 9.25, 10.00), 14.66, 10.80 and 19.80 meq. L^{-1} for each of the top and the northern and southern aspect of the HILL-1 of the relay as observed results of the HILL-2 that there is an increase in the layer of crust compared to the layer under the crust came Their results are consistent with the results of the HILL-1. The results shows that the magnesium ion was different between the sites, taking the following order: the slope top > southern aspect > north aspect (14.32, 14.00, 14.25), (5.64, 6.20, 3.69), (3.57, 2.69 and 3.21 meq. L^{-1}, respectively. The results of the second slope took the same ranking. As observed in general there is a decrease in the layer under the crust and for the gradient sites. The results showed that the concentration of sodium ion was low in the soil of the study sites, ranging between 2.03-4.00 meq. L^{-1} was relatively superior in the crust layer compared to the next layer and this may be due to the cumulative effect of plants that grow on the surface and the layer of dead micro roots, which is a source of organic matter and nutrients and found that the top of the slope and the northern direction was superior to the southern trend and both the positions of the decline and Because of the dominance and activity of erosion, which works on the shelf of the rich layer of food needed by the plant. As well as with potassium ions.

Evaluation Biological crust status using spectral indices.

Results of Table 4 show a difference in the numerical values of spectral reflectivity (DN) and for all spectral bands. According to the B1 results will be the following order: the top of the slope < the northern aspect > the southern aspect (144.33, 154.00 and 154.33). This is probably due to the presence of blue green algae, moisture content and organic matter which increase the color dark. The second Channel B2 ranged from 144.33 to 154.33 and this may be due to the type and composition of organic matter, lichens, cyanobacteria and blue green algae. While the red wavelength B3 ranged between 118.33-141.67 and 111.67-131.33 which showed a clear rise in the

Table 3: Effect of the regression interface in the concentration of dissolved Ions to Soil the study sites.

Location	Layer	Negative Soluble Icons									Positive Soluble Icons											
		Ca^{++}			Mg^{++}			Na^{+}			K^{+}			CL^{-1}			HCO_3^{-}			SO_4^{--}		
		Meq.L^{-1}																				
		HILL-1																				
		r1	r2	r3	r1	r2	r3	r1	r2	r3	r1	r2	r3	r1	r2	r3	r1	r2	r3	r1	r2	r3
North Aspect	A	36.63	32.40	28.50	3.57	2.69	3.21	2.97	3.20	2.99	0.22	0.32	0.20	5.3	5.50	6.00	2.21	2.66	3.24	35.88	30.45	25.66
	B	12.65	9.25	10.00	0.67	0.52	0.36	2.24	2.30	2.00	0.11	0.10	0.09	3.2	3.50	2.60	2.00	1.90	1.20	10.47	6.77	8.65
Top Hill	A	39.96	35.60	35.00	14.32	14.00	14.25	2.92	3.50	3.10	0.23	0.29	0.41	6.2	5.50	5.50	5.50	5.40	4.90	45.73	42.49	42.36
	B	29.36	28.60	29.50	0.33	0.45	0.56	2.69	2.40	2.30	0.14	0.11	0.13	3.6	2.00	1.90	2.59	3.20	2.10	26.33	26.36	28.49
South Aspect	A	31.96	24.50	25.00	5.64	6.20	3.69	2.03	1.88	1.66	0.30	0.32	0.30	3.8	4.00	4.00	2.59	1.20	0.90	33.54	27.7	25.75
	B	14.66	10.80	19.80	3.00	2.90	3.50	2.58	2.53	2.50	0.17	0.12	0.16	5.5	3.50	3.50	0.80	1.59	1.39	14.11	11.26	21.07
		HILL-2																				
North Aspect	A	33.30	32.20	33.10	9.99	10.32	8.50	2.90	3.10	3.00	0.15	0.11	0.13	5.0	6.2	6.3	3.22	4.2	4.50	38.12	35.33	33.93
	B	29.97	31.60	30.60	3.33	4.23	3.65	2.65	2.30	2.40	0.24	0.29	0.22	2.5	2.5	2.0	1.39	1.50	1.60	32.3	34.42	33.27
Top Hill	A	33.3	32.50	32.40	11.65	13.20	10.00	3.57	4.00	4.00	0.25	0.28	0.23	6.5	6.5	6.5	2.79	3.60	3.40	39.48	39.88	36.73
	B	26.64	27.00	29.30	2.33	3.21	3.12	2.88	2.66	2.75	0.19	0.16	0.19	5.0	4.5	4.0	1.66	1.00	1.00	25.38	27.53	30.36
South Aspect	A	32.66	24.50	26.00	23.31	12.00	11.50	2.40	2.00	1.99	0.25	0.25	0.26	3.4	3.0	3.0	2.59	1.96	2.30	52.63	33.79	34.45
	B	14.99	15.00	15.00	4.10	3.66	3.99	2.35	1.56	1.00	0.26	0.23	0.21	6	2.4	2.9	2.59	2.01	2.20	13.11	16.04	15.1

southern aspect. The fifth channel (B5), which was relatively higher among the other spectral bands, took the following sequence: 192.67 < 194.00 = 194.00. There was no apparent difference between the northern and southern aspect of this spectral band while the seventh spectral band took the same sequence with the spectral bands from B1 to B4. The results of spectral bands were therefore significant in the expression of the biologic crust under the influence of the slope aspect.

Spectral indices are very important in expressing variations in the characteristics and components of biologic crust of gypsum soils using simulating spectral ratios Table 5. CI is the most important indicator which is calculate through the third band (red wavelength) and the first band (blue wavelength). Notes that value highest was in the top of the slope (1.10) and the lowest in the south aspect (1.04) may be due to cyanobacteria, algae and fungi. Results BSCI showed a clear effect of the slope aspect in the characteristics of the biologic crust and show positive relationship between the index values and crust thickness and their density. Thus, it reached (0.33) in the northern aspect and relatively less in the southern aspect (0.21). BCDI was high in the south aspect of the slope (0.79) and relatively low at the top of the slope and the northern aspect (0.50 and 0.67). We suggest a new index called the algae index calculated using the first and seventh bands. The following sequence was taken: the top of the slope > the northern aspect > the southern aspect reached (0.17, 0.12 and 0.06) respectively. It was noted that the brightness index-BI was the highest in the southern aspect (317.48) and lower at the top of the slope and the northern aspect where it reached (283.18 and 306.31) respectively. WI index takes the following arrangement: the top of the slope > the northern aspect > the southern aspect (0.31, 0.33 and 0.35), respectively. It was also observed that the other spectral ratios took the same behavior: the top of the slope > the northern aspect > the southern aspect except the spectral ratio (R/G + B).

Results of the proposed indicators CNI, CSDI, CI, BSCI and spectral ratios, they were very important in monitoring changes in the biological crust. Figure 7 show images of the most important indices for the expression of the biologic crust. Karnieli's Cyanobacteria index ranged between 1-1.2 and through the GPS and DEM showed that the relatively higher values were in the northern directions (Northern, Western North and Eastern North), Eastern and flatland, and lower in southern directions (Eastern South, Western South and Southern). The CI ranged from 0.11 to 0.8, where the higher the density of the biologic crust. The brightness index ranged from 230 to 360, where it is inversely proportional to the presence of the biologic crust. Other evidence (0.014-0.26), (0.28-0.43) and (0.20-0.89) for the BCNI, WI, and BSDI indices, respectively.

Evaluation the degradation status of the Biological crust

The phenomenon of deterioration and desertification in recent times is one of the most

Table 4: Spectral Reflectance as (DN) which calculated by landsat images.

Loc.	Riplication	b1	b2	b3	b4	b5	b7
North Aspect	1	155.00	98.00	136.00	123.00	193.00	122.00
	2	155.00	96.00	139.00	125.00	194.00	121.00
	3	152.00	94.00	131.00	120.00	195.00	122.00
	Average	154.00	96.00	135.33	122.67	194.00	121.67
Top Hill	1	142.00	85.00	118.00	109.00	192.00	103.00
	2	147.00	87.00	119.00	109.00	193.00	103.00
	3	144.00	86.00	118.00	117.00	193.00	104.00
	Average	144.33	86.00	118.33	111.67	192.67	103.33
South Aspect	1	155.00	101.00	147.00	134.00	194.00	138.00
	2	154.00	98.00	139.00	130.00	194.00	136.00
	3	154.00	98.00	139.00	130.00	194.00	136.00
	Average	154.33	99.00	141.67	131.33	194.00	136.67

Table 5: Some of the spectral indices which calculated by using Landsat images.

Loc.	RIP.	CI	BSCI	BCDI	CNI	BI	WI	B/(G+R)	R/(G+B)	B1/B7	B4/B7	B5/B7
North Aspect	1	1.07	0.33	0.67	0.12	307.2	0.33	0.66	0.54	0.79	1.01	1.58
	2	1.05	0.28	0.73	0.12	309.53	0.32	0.66	0.55	1.28	1.03	1.60
	3	1.07	0.37	0.63	0.11	302.2	0.33	0.68	0.53	1.25	0.98	1.60
	Aver.	1.06	0.33	0.67	0.12	306.31	0.33	0.67	0.54	1.10	1.01	1.59
Top Hill	1	1.09	0.47	0.53	0.16	280.29	0.36	0.70	0.52	1.38	1.06	1.86
	2	1.11	0.54	0.46	0.18	283.14	0.35	0.71	0.51	1.43	1.06	1.87
	3	1.10	0.50	0.50	0.16	286.12	0.35	0.71	0.51	1.38	1.13	1.86
	Aver.	1.10	0.50	0.50	0.17	283.18	0.35	0.71	0.51	1.40	1.08	1.86
South Aspect	1	1.03	0.13	0.87	0.06	322.41	0.31	0.63	0.57	1.12	0.97	1.41
	2	1.05	0.25	0.75	0.06	315.02	0.32	0.65	0.55	1.13	0.96	1.43
	3	1.05	0.25	0.75	0.06	315.02	0.32	0.65	0.55	1.13	0.96	1.43
	Aver.	1.04	0.21	0.79	0.06	317.48	0.31	0.64	0.56	1.13	0.96	1.42

problems that lead to the imbalance of the environment in arid and semi-arid regions due to the impact of human activities and the impact of harsh climatic conditions (drought) on the very large areas are difficult to monitor and study the state, Which helped us to calculate a number of indicators.

Results of Table 6 indicate the degradation degree of the biologic crust calculated using spectral indices. According to the CI, ranged between (1.16 - 1.05). The higher the value of the index, the lower the rate of deterioration (52.16, 39.43 and 8.41) for each of the degrees of severe deterioration, moderate and slightly. BSCI ranged from 0.80 to 0.28. The degree of deterioration were (8.70, 39.49 and 51.81%), while the degree of deterioration (CNI) were 7.16, 38.28 and 54.57%. As for the BI index were (11.56, 39.86 and 48.59%). The results of the indices show that the study area suffers from severe deterioration and this may be due to plow method with high gypsum content and overgrazing actions.

Optical properties which calculated by using the digital camera

Table 7 shows clear differences in primary colors system (red, green and blue). Notes that Red colour range between (114.72) in the dry state of the biological crust layer at the slope top as the lowest numerical value and 161.50 in the biological crust layer of the southern aspect. This may be due to the high thickness of the pylogenous crust of the green algae and the trees which, when decomposed, produce a relatively high organic matter resulting from the phenomenon of absorption of irradiation on the surface of the soil and if we take the infiltration sites, we will note the following order: the top of the slope < North aspect > South aspect (114.72, 133.36 and 161.50) respectively, Either, the layer which is Below the biologic crust, the following order was taken: the top of the slope > the southern aspect > the northern aspect (177.22, 176.52 and 143.31) respectively, which may be due to the relatively higher gypsum content at the top of the slope and the southern aspect compared to the

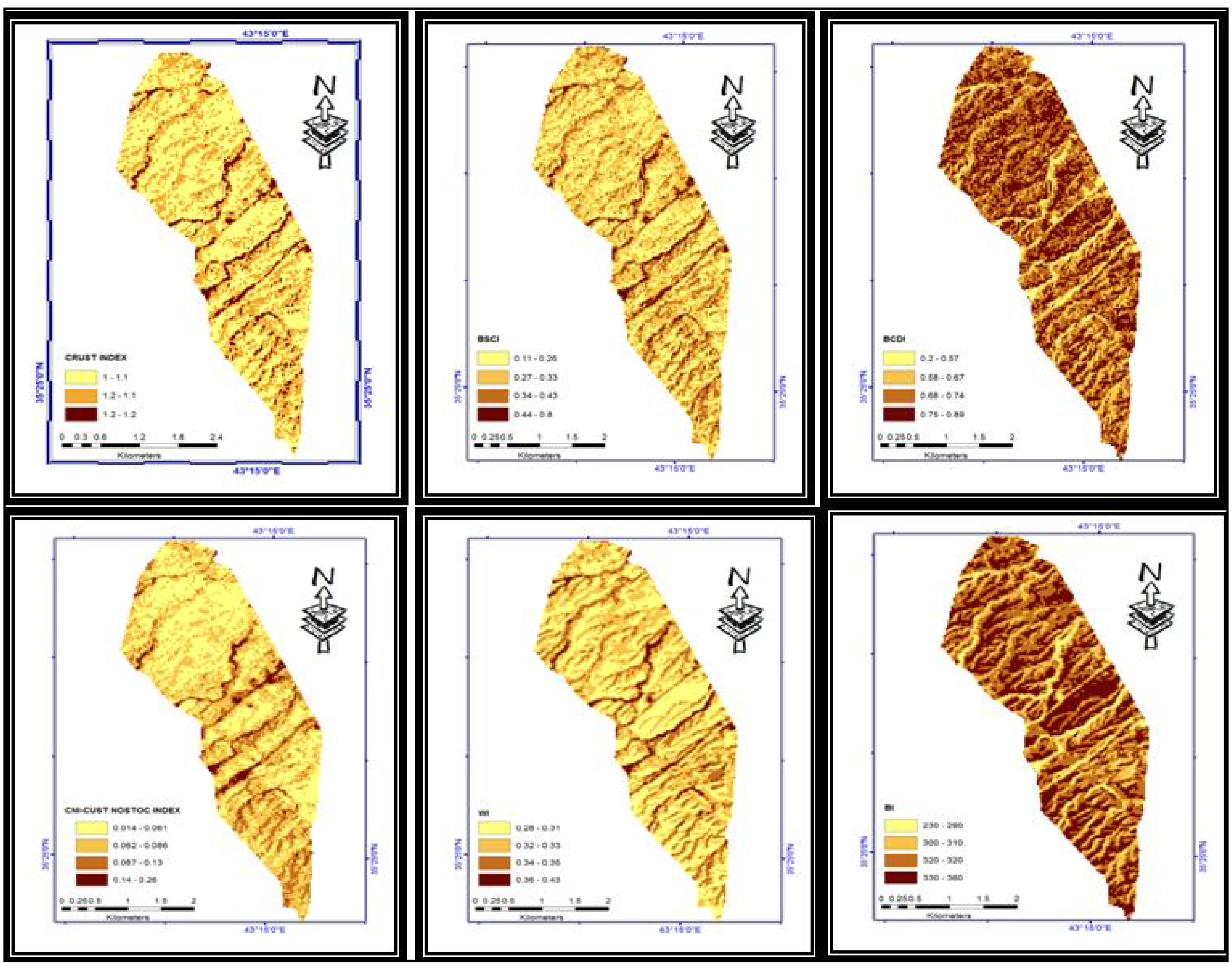

Fig. 7: Maps of indices evidence in the study area.

northern aspect. The Green wavelength ranged between 65.61 to 122.50 in the dry state. The increase in the thickness of the blue green algae has reduced the chromatic depth of the green wavelength from light to dark, while in the subterranean layer it ranged from 103.26 to 137.52. Either the Blue wavelength is took the following order: the top of the slope < north aspect > the southern aspect (45.75, 66.36 and 106.50) of the biologic layer respectively. Spectral reflectivity is an important indicator that reflects the interrelated effect of various soil, which are the result of the different components of the soil, both chemical, physical or biological properties, etc. It was observed that the difference in the spectral reflectivity values (%) was clear between the slope directions in the biologic crust layer and the following order was taken: the top of the slope < north aspect > south aspect (31.66, 39.68 and 51.84) respectively. SI-saturation index is an important indication of the difference in the biologic crust, ranging between 0.43-0.21 and 0.26-0.18 and 0.43-0.21 and 0.26-0.19 for the surface and subsurface layers of the biologic crust at the HILL-1 and HILL-2 respectively. It was observed that it was high in the biologic crust of the top of the slope and the northern aspect, as well as in the surface layer above the subterranean layer. This may be due to the effect of the biologic diversity, which increases the thickness of the wavelength and saturation of the color. While it is observed that the brightness index was took the following arrangement: the southern aspect > the northern aspect > the top of the slope.

Table 6: Evaluation of degradation status of the biological crust by spectral indicator.

Index	Degradation Grade	RANGE	%
CI	Slightly Degradation	1.16	8.41
	Moderate Degradation	1.07- 1.16	39.43
	Sever degradation	1.05-1.07	52.16
BSCI	Slightly Degradation	0.38- 0.80	8.70
	Moderate Degradation	0.28- 0.39	39.49
	Sever degradation	0.28>	51.81
CNI	Slightly Degradation	0.11-0.26	7.16
	Moderate Degradation	0.06-0.11	38.28
	Sever degradation	0.06	54.57
BCDI	Slightly Degradation	0.71-0.88	8.07
	Moderate Degradation	0.61-0.71	36.63
	Sever degradation	0.61	55.30
BI	Slightly Degradation	297	11.56
	Moderate Degradation	297- 318	39.86
	Sever degradation	318-361	48.59

Table 7: Optical properties which calculated by Digital Camera.

Layer	Colour System			R %	SI	BI
	R	G	B			
	HILL-1					
	Northern Aspect					
A	133.36	92.36	66.36	39.68	0.34	101.19
B	143.31	103.26	84.28	44.31	0.26	112.99
	Top HILL					
A	114.72	65.61	45.75	31.66	0.43	80.74
B	177.22	134.29	118.10	57.00	0.20	145.36
	Southern Aspect					
A	161.50	122.50	106.50	51.84	0.21	132.20
B	176.52	137.52	121.52	57.65	0.18	147.01
	HILL-2					
	North Aspect					
A	130.33	89.33	63.33	38.54	0.35	98.28
B	140.33	100.78	81.56	43.26	0.26	110.30
	Top HILL					
A	116.33	67.78	46.67	32.26	0.43	82.27
B	171.67	128.78	112.44	54.85	0.21	139.88
	South Aspect					
A	160.00	121.00	105.00	51.26	0.21	130.72
B	175.22	136.22	120.22	57.15	0.19	145.73

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