

# RELATIONSHIP OF SPECTRAL REFLECTANCE AND NDVI TO SOME SOIL PROPERTIES OF BRICKS FACTORIES SOILS IN NAHRAWAN AREA,BAGHDAD IRAQ

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## **ABSTRACT**

A study was conducted to investigate the effect of the brick industry on the environmental system of these project soils of the brick factories in Alnahrawan district. Remote sensing techniques was used to study the relationship between the spectral reflectivity and the vegetative index on the one hand and some surface soil characters of the project and to determine the variation in vegetation cover for the same area and for two different periods.Ten sites were selected to study spectral reflectivity under similar geomorphological conditions near the brickworks project in the Anahrawan district with an area of 10,000 hectares. Soil samples were taken from the surface and at a depth of 0-30 cm. Some chemical and physical characters of research soil were analyzed in the soil department laboratories, college of Agriculture, Baghdad University.Several satellite images taken from the satellite Land sat (ETM) 2013 and another from same satellite in 1990 T.M to determining the change between the two periods. After obtaining remote sensing data (reflectivity and vegetation index).the correlation analysis was carried out between these data. It was observed that the soil salinity values were decreased due to the drainage that the area was confined between the Tigris River and the Diyala tributary which leads to good natural drainage.The attached tables indicate that the digital numbers of the soil sampling sites in 2013 are highly significant correlated, While some of the characters did not show the use of this region industrially. After calculating the difference between the two images to determine the change. A 100% change was observed and the vegetation cover was sharply reduced between the two images. as well as the extension of the land of empty land, although these lands are still suitable for agriculture.

**Keywords:** remote sensing GIS, NDVI, soil properties, vegetative index

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مجلة العلوم الزراعية العراقية - 2019: 799-793: 50(3)

علاقة الانعكاسية الطيفية ودليل اختلاف توزيع الغطاء الخضري NDVI بعض صفات تربه مصانع الطابوق في قضاء

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## **المستخلص**

أجريت دراسة لمعرفة أثر صناعة الطابوق على النظام البيئي لترب مشروع معامل الطابوق في قضاء النهروان وباستخدام تقنيات التحسس الثاني بدراسة العلاقة بين صفات الانعكاسية الطيفية ودليل الخضري من جهة وبعض صفات التربة السطحية للمشروع وتحديد التغير في اختلاف الغطاء الخضري لنفس المنطقة ولفترتين مختلفتين. فقد اختيرت عشرة مواقع لدراسة الانعكاسية الطيفية ضمن ظروف جيومورفولوجية متشابهة قرب مشروع معامل الطابوق في قضاء النهروان وبمساحة 10000 هكتار . وقد اخذت عينات للتربة من السطح وبعمق 0-30 سم . وتم تحليل بعض الصفات الكيميائية والفيزيائية لترب منطقة الدراسة في مختبرات كلية الزراعة جامعة بغداد المتخصصة.أخذت مرئيات فضائية للقمر LandSat ETM + 2013 + وبمشهد أخرى لنفس القمر الصناعي 1990T.M بهدف تحديد التغير بين الفترتين وبعد الحصول على بيانات الاستشعار عن بعد (الانعكاسية ودليل الغطاء الخضري). تم اجراء تحليل الارتباط بين تلك البيانات ولوحظ انخفاض قيم ملوحة التربة بسبب البزل كون المنطقة محصورة بين نهر دجلة ورافدي ديالى المؤدي الى بزل طبيعي جيد. كما تشير قيم الاعداد الرقمية لموقع عينات ترب في 2013 ومن خلال الجداول المرفقة وجود علاقة عالية المعنوية مع قيم الانعكاسية ، في حين ان بعض الصفات لم يظهر أي علاقة معنوية معها. وبين دليل الغطاء الخضري بين العامين 1990 و 2013 ان هناك اختلاف كبير حيث يظهر نقصان شديد في الغطاء الخضري بسبب استخدام هذه المنطقة صناعيا. وبعد حساب القيم احصائيا بين الصورتين لتحديد التغير لوحظ تغير 100 % ونقصان الغطاء الخضري وبشكل حاد بين الصورتين.

كلمات مفتاحية: التحسس الثاني، جيومورفولوجيا، الصفات الكيميائية والفيزيائية.

\*Received:21/1/2019, Accepted:20/5/2019

## INTRODUCTION

The physical basis of remote sensing are the electromagnetic rays whether it is natural or artificial living or dead bodies react with electromagnetic energy, and this reaction depend on the frequency , radiation intensity, energy absorption or its revival as electromagnetic waves depends on body characters that fall upon. Based on that, soil and its contents of water and vegetation cover react with the plopped and absorbedbeams, revive and reflect this radiance in varying degree according to the characters of soil, water and vegetation cover. When the amount of energy is determined, it is possible to know some soil characters, which mainly affect some portions of the reflected beam incident (9). Incidenceof sun rays on the ground sufferfromreflection, absorption and dispersion, parts of these rays will be reflected through the air and its plankton, others will be reflected from earth surface and ground covers, taking in consideration water bodies which have the greatest percentage of reflections of falling rays ,in particular pure water which reflectpart of the reflected rays in spectroscopic packages (0.45 – 0.69 M), beyond this wavelength, water will become fullyabsorbentfor sunrays and so it seems dim (24). The infrared absorption by water regarded as the best factor helping to distinguish water areas from the rest of ground phenomena's(14).Hammad (12)confirmed the statements of Buringh (8) that soil properties reflectivity depends on several characteristics such as mineral composition of metals, chemical and texture the proportion of particles volumes, surface roughness,the ratios of organic matter, moisture contents and all these factors are complex,variableand correlated.Obukov and Orlov (17) found in their studies on the relation of deposited particles diameter in the soil and its relationship with the spectral reflectivity,it was found that the change reflectivity linked with their shape and diameter and not with chemical and mineral composition. Obukov and orlov (17)and Gunsauliset al (11)stated that the small diameter of particles increase its reflectivity and have an impact on soil moisture. Soany increase in particles decrease the diameter will cause decrease of spectrum

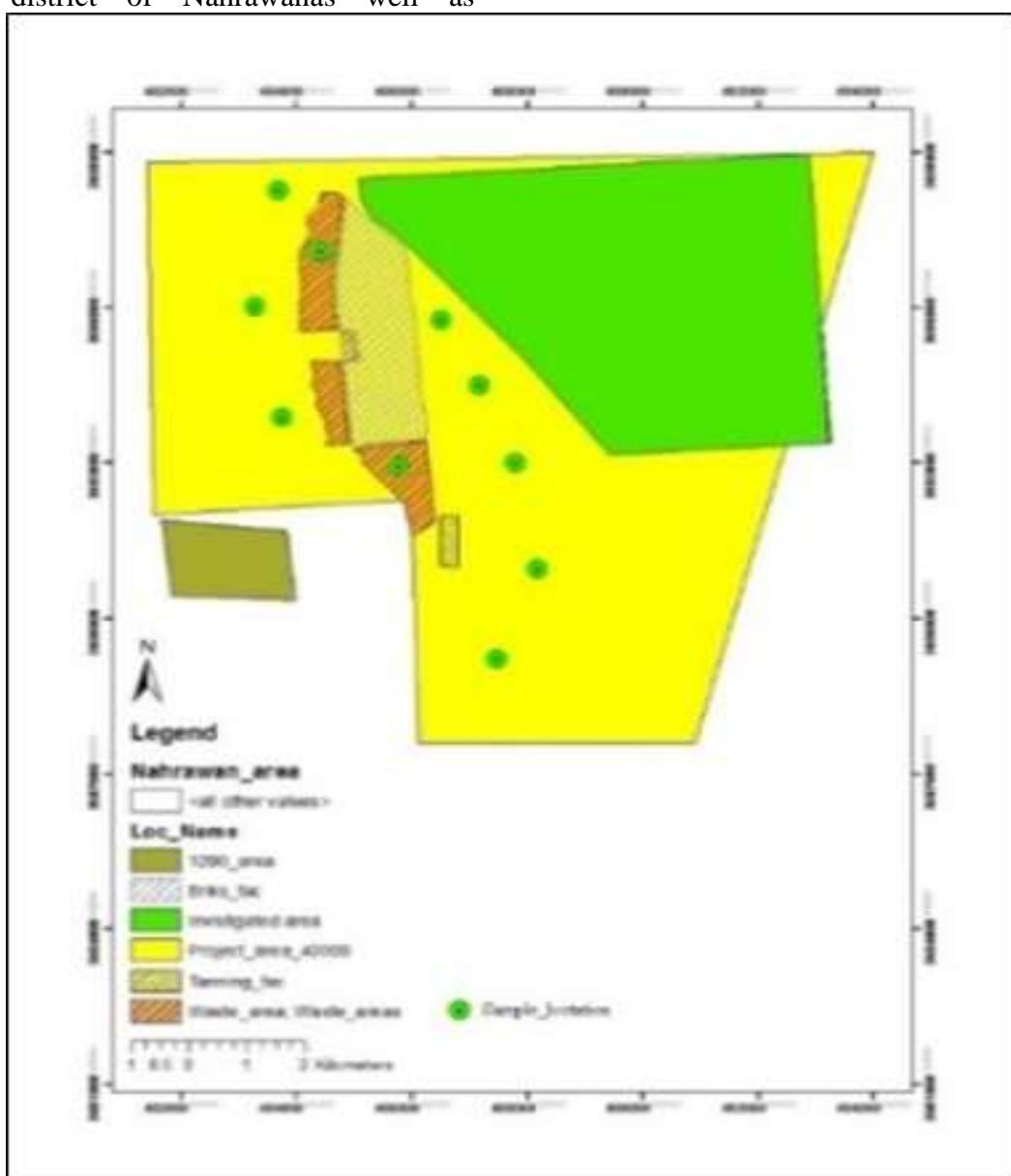
reflectivity and vice versa. Oriove(19) and Swain and Davis (23) mentioned that smooth texture soils are more refractive than rough textures because of the smooth surface of particles. Zhang et.al(25) stated the importance of status spectral of soil properties to improve particles volume prediction when using infrared ( $0.76 - 0.9$   $\mu\text{m}$ , Bowers and Hanks (7), SaliburyandAria(21) used infrared with wave length ranging between  $8-114$   $\mu\text{m}$  to determine soil particles diameter which proposed with the dry state of sand particles volume with low moisture contents and vegetation, Ristori et. Al, (20) studied the properties of organic matter and its impact with particle diameter of vertisol soil using the embodiment of the infrared ,which showed that the organic matter concentrated in communities, the size of silt are identified the mature of regularity Alvertsol soils . Ben-Dor and Banin (5) noted that spectral reflectivity for most soils showed lack capabilities to absorb radiates with wavelengths  $2.1 \mu\text{m}$ , but to some extent, the clay minerals have shown its ability to short radiation with wavelengths  $2.2 \mu\text{m}$  and this linked with the ability of the crystal lattice of clay minerals. Alkubaisy (2) and Ali and Muhaimeed (3) used the average intensity values for each package and connect them with soil characteristics including deposition rates and the adoption of a linear, quadratic and cubic wallasey and quadraple and engineering in the statistic analysis of the date and the way that multi-phased linear regressionfound a significant relationship of soil separates of horizon A;Scull et. al. (22) and Muhaimeed et al (15) said that remote sensing can give information on the texture of soil surface and its importance to draw maps of soil invocation. Okin and Painter (18) found significant relation between particles diameters of sand and the spectral reflectivity of short infrared waves which is affected by particles size where  $0.06 \text{ ml}$  diameter reflect rays with  $1.7 \text{ Mm}$  waves length while  $2.2 \text{ Mm}$  for  $0.08 \text{ ml}$  in diameter, with correlation  $R^2=0.89$  and  $0.93$  respectively. Bogrekci and Suklee (6) stated the impact of sand soil particles on spectral reflectivity using ultra violet and infrared rays with a range ( $200 - 2500 \text{ Mm}$ ) and developed a design to show the impact of particles diameter using multiple linear

regression equations adding that the spectral reflectivity vary depending on the diameter of particles and their distribution which often interferes with moisture contents, organic matter and soil class. Karavanova et al (13) and Muhaimeed and Gatea(16) noted that the sandy soil and gypsum showed higher values of spectral reflectivity comparing with other soils in Iraqi desert. The aim of this paper was to study the relationship between the characteristics of reflectivity and spectral index of vegetation on one hand and some soil surface characteristics of brick factory project in the district of Nahrawanas well as

determination of the difference in vegetation cover index between the two different periods and to know the impact of bricks industry on the whole ecosystem of the region.

#### MATERIALS AND METHODS

Ten sites were selected for the study of spectral reflectivity within similar geomorphological conditions to represent soils project brick factories in the district of Nahrawan area of about 1000 hectares (Fig 1) Soil samples were taken from the surface to about 30 cm depth. Some soil properties were analyzed as shown in Table 1.



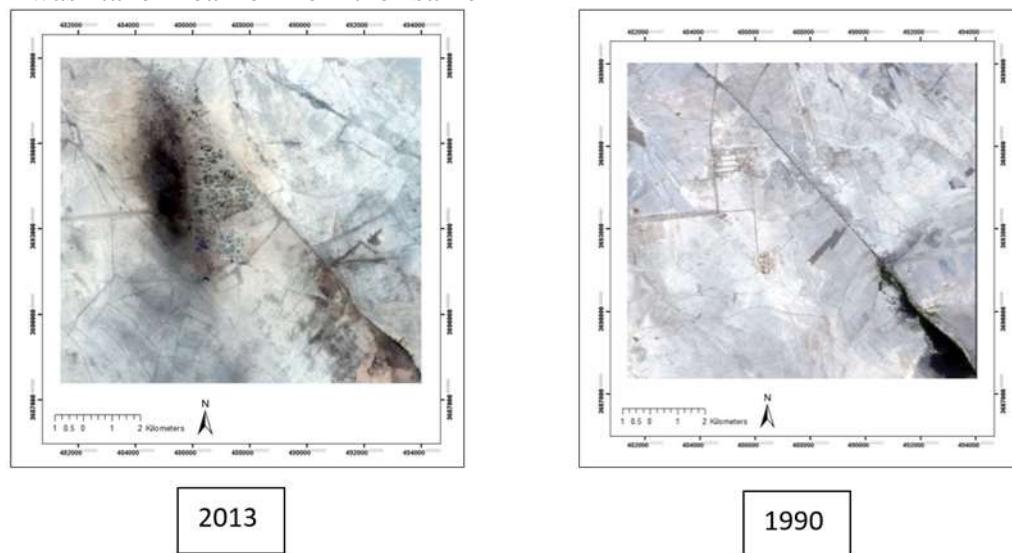
**Fig 1.**Map of brick Factory sites at Al Nahrawan district

**Table 1.**Some chemical and physical characteristics of the study soils

No	Longitude	Latitude	EC	pH	CaCO <sub>3</sub>	CaSO <sub>4</sub>	OM	%clay	%sand	%silt
1	483285.7188	3696031.1094	5.70	6.37	28.00	0.17	1.40	18.10	14.20	67.70
2	483746.0947	3693887.9801	5.70	6.37	30.30	0.05	1.07	21.10	15.80	63.10
3	485793.9738	3692935.4782	15.80	6.60	23.10	3.20	0.84	32.50	14.80	52.70
4	486508.3502	3695761.2338	7.30	6.10	21.10	0.56	1.20	15.60	19.60	64.80
5	487175.1015	3694507.1063	6.30	8.12	28.00	0.34	1.25	24.60	25.60	49.80
6	487794.2278	3693014.8533	3.40	8.10	30.30	0.34	1.50	26.80	21.00	52.20
7	488191.1036	3690951.0992	5.60	7.55	26.30	0.90	1.62	21.50	18.90	59.60
8	483698.4696	3698269.4888	5.80	6.10	32.60	0.01	1.07	22.80	17.60	59.60
9	484428.7211	3697094.7365	10.10	6.50	24.50	1.87	1.30	23.50	11.80	64.70
10	487476.7272	3689220.7207	6.30	6.57	25.70	0.61	1.30	19.80	16.10	64.10

**Satellite images**

Satellite images were selected from the satellite Land Sat ETM + from the year 2003 and other was taken earlier for the same

**Fig 2.Satellite images of the study area in 1990 and 2013**

Soil samples were located using UTM coordinate system,using the GPS to locate soil samplesand for extracting the reflectivity values for each location using Arc Map 10.1 and ERDAS 11.0.2, theNormalized Difference Vegetation Indexwas also calculated according to (10) and (1).

$$\text{NDVI} = \frac{\text{B4} - \text{B3}}{\text{B4} + \text{B3}}$$

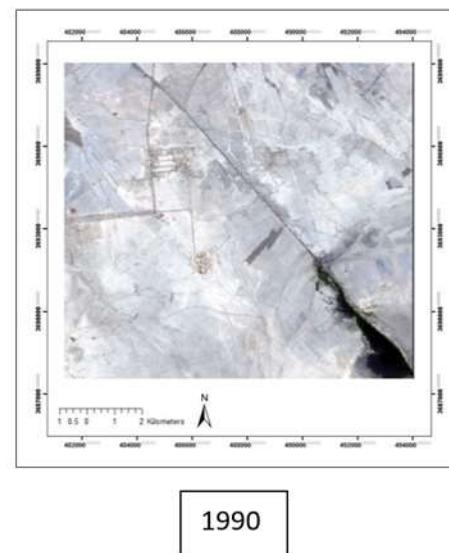
**Statistical analysis**

After obtaining remote sensing data for the reflectivity and guide vegetation, correlation analysis was done between those environments and some characters of measured soil using the statistical packages for social science SPSS IBM 12.

**RESULTS AND DISCUSSIONS**

Table 1 illustrates some chemical and physical characters of the study soil. These soils are characterized by low salinity values as it

satellite in 1990 to determine the changes between the two periods. The following (Figure 2) illustrate the two visual images.



reached the highest value in the debris and industrial waste of brick areas, while salinity values ranged from low rates in the rest sites are of sedimentary origin located geographically between the Tigris River and its tributary of Diyala River which improve soil characters especially salinity because of the natural drainage by these two rivers which encourage the establishment of brick factory in this region as well as its proximity to the capital Baghdad which lowers the transport costs of bricks from factories to the place of use. This Table also shows other characteristics such as soil interaction values of limestone (Gypsy) soil as mentioned before by Al Zubaidi et al (4). Calcium carbonates values were so high ranging from 21.1 – 32.6 % and that is not surprising as the materials that soil originated from are of gypsum origin,

besides the climate which helps to precipitate this compound and accumulate it in high quantities. High organic matter was also observed ranging from 0.84 to 1.62 % despite the low vegetation in that area as industrial but the history of this region has shown intensive use of agriculture in the past because of the soil validity for agriculture. It was noted during the site visit of the study area that there are some areas heavily used for agriculture as confirmed by the results of changes determination which reveal the heavy vegetation cover in 1990 as compared with that of 2013. It was also noticed from the result of this study that the soil contents of gypsum was low due to the same reasons that led to lower salt contents in the soil. The study area also characterized by adequate contents of soft tab-delimited, clay and silt where the

sovereign in most soils in this study due to the separated silt followed by clay and sand, which encourage the presence of many quarries for the fine separations for brick industry in the same area.

#### Spectral reflectance

Table 2 indicates the digital values of the study soil samples, 2013. It can be seen that the values of those digital numbers which refer to some extent to the reflection values of grounded coverings that have characterized as low in most study areas which was free of water flats and salt accumulations on the ground surface, in addition to a large number of urban facilities since this area is industrial and agricultural reigns mainly sued in brick industry and the key factor in these regions is mud quarries which makes the bricks.

**Table2. Digital number of sample sites on the satellite image 2013**

Id	DN_1	DN_2	DN_3	DN_4	DN_5	DN_61	DN_62	DN_7	DN_8
1.00	99.00	97.00	118.00	82.00	84.00	156.00	194.00	75.00	98.00
2.00	104.00	106.00	130.00	94.00	103.00	152.00	188.00	94.00	110.00
3.00	79.00	71.00	80.00	55.00	58.00	135.00	157.00	53.00	66.00
4.00	81.00	75.00	83.00	57.00	59.00	139.00	165.00	53.00	71.00
5.00	91.00	87.00	106.00	74.00	74.00	148.00	185.00	66.00	91.00
6.00	103.00	97.00	123.00	86.00	89.00	156.00	195.00	66.00	100.00
7.00	103.00	107.00	136.00	98.00	105.00	153.00	184.00	96.00	114.00
9.00	104.00	106.00	134.00	96.00	103.00	154.00	190.00	94.00	110.00
0.00	90.00	87.00	102.00	73.00	79.00	149.00	182.00	71.00	89.00
10.00	99.00	102.00	130.00	95.00	113.00	145.00	176.00	105.00	108.00

Correlation between those values and the measured soil characters was studied and Table 3 illustrates the correlation coefficient

between soil characteristics and the values of the digital numbers of pixels in each site.

**Table 3. The values of correlation coefficient between the measured soil characters and digital numbers of sampling sites on the satellite image 2013\**

	EC	pH	CaCO <sub>3</sub>	CaSO <sub>4</sub>	OM	clay	sand	silt
DN_1	-.774**	.190	.833**	-.684*	.491	-.220	.047	.138
DN_2	-.722*	.086	.751*	-.656*	.458	-.304	-.013	.239
DN_3	-.726*	.161	.759*	-.639*	.481	-.246	.043	.159
DN_4	-.696*	.131	.729*	-.611	.457	-.249	.012	.182
DN_5	-.606	.030	.621	-.528	.383	-.262	-.087	.254
DN_61	-.773**	.274	.800**	-.674*	.610	-.228	.066	.131
DN_62	-.793**	.315	.827**	-.721*	.559	-.218	.146	.073
DN_7	-.475	-.122	.505	-.453	.261	-.321	-.169	.351
DN_8	-.726*	.157	.732*	-.644*	.495	-.286	.036	.194

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

From the above table it can be noticed that some of the traits showed highly significant relationship with the reflectivity values while

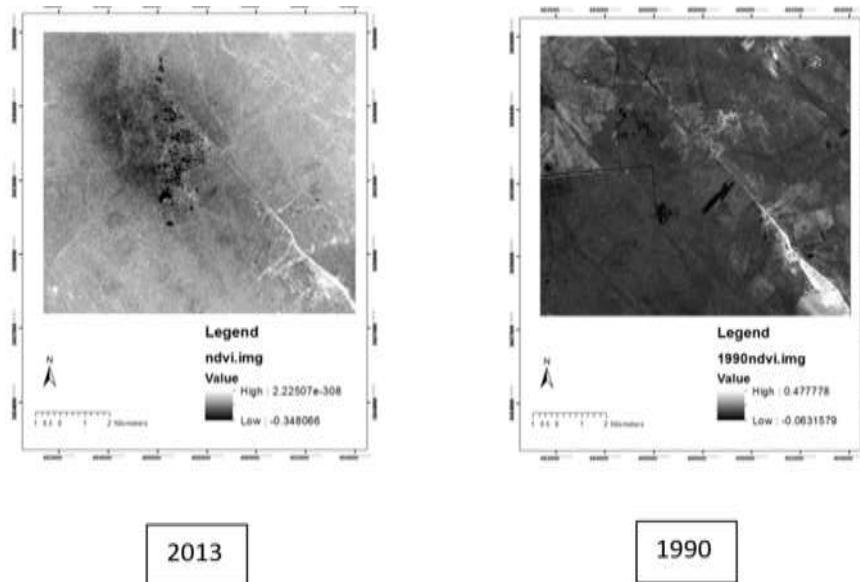
not with others. The relationship between soil salinity and the high significant digital numbers of spectral package (1, 2, 3, 4, 6 And

8) despite the fact that most of the salinity values was low except for two locations which eternally high values of salinity (Note table 1). Soil reaction values did not show any significant relation with the satellite image reflections due to the fact these convergent values and within a tight range. The contents of calcium carbonate showed a high significant relation with the reflectivity for the same mentioned spectral packages despite its lower contents. Gypsum showed significant relationship perhaps because of its association with soil salinity where he showed the same trend in the reflectivity relation with soil characters. Organic matter didn't seem to have any relation with spectral reflectivity probably due to its lower contents in all study sites, and also the same for soil separates contents because of the prevalence of moderate softness texture type in the study area and the rule of

unbroken silt which reduce the heterogeneity of soil texture.

#### **Index of normalized differences of vegetation index (NDVI) and changes determination**

It notes the considerable difference between the two periods ranging from 0.063 – 0.48 in 1990, while 0-0.35 in 2013 due to many probable factors including the use of this area for industrial purposes at the expense of agricultural use as well as changes in the ecosystem conditions. Calculation of the differences between the two images shows that 100 % of the study area have been changed in terms of the values of vegetative variance index from higher to lower i.e. the patch of green vegetative cover decreased dramatically in the two mentioned years because of the use of those lands for brick industry as well as the prevalence of wide land areas as ruins places of these factories.



**Figure 3.**shows the map of different vegetation cover index of the study area during 1990 and 2013

Soil texture was ranging from moderately fine to fine in the study area with low values of electrical conductivity, which emphasize the need to exploit these areas for agriculture instead of using them for industrial purposes. They are suitable for the production of many crops with no objection for using them for both industrial and agricultural uses, taking in consideration the contamination of soil occurs under the industrial use. Result of variance vegetative cover variance index revealed a severe deterioration in the vegetation cover of the study area. Satellite images

showed great back cloud resulting from the exhausts of brick factories and this draw attention to stop such air pollution in the green belt areas of Baghdad province.

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