EVALUATION OF CHEMICAL SOIL DEGRADATION IN THE MUSYAB PROJECT USING OF THE FUZZY LOGIC IN GEOGRAPHIC INFORMATION SYSTEM

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ABSTRACT

This study was aimed to use the fuzzy logic to employ complex and non-simple models to simple and understandable models that are concerned with no accuracy in the event or the concept itself in the GIS environmental to produce soil degradation maps of the chemical degradation for lands by spatial interpolation method (Inverse Distant Weight). The study area was selected in the province of Babil and within the large Musaaib project. Forty (40) surface samples and 12 profiles were drilled (soil profile). The chemical properties of the soil were then estimated. The results indicated that there were four types of chemical deterioration of the soil, which was characterized by a slight degradation of D1 with an area estimated at 1982.34ha, second class D2 represents the moderate degradation which occupies an area of 1074.71ha while the third class Severe degradation D3 area is estimated at 2403.18hectares, while the fourth class very severe degradation D4 area of 2830.56hectares.

Keyword: IDW, unsupervised classification, reclassification,soil profile.

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تقييم التدهور الكيميائي لترب مشروع المسيب باستعمال المنطق المضبب في نظم المعلومات الجغرافية

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المستخلص

اتجهت الدراسة لاستخدام المنطق المضبب لتوظيف النماذج المعقدة غير البسيطة إلى نماذج بسيطة ومفهومة تهتم باللادقة في الحدث أو المفهوم نفسه في بيئة نظم المعلومات الجغرافية لأنتاج خرائط صفات الترب الداخلة في التدهور الكيميائي للأراضي بطريقة الاستكمال. اختيرت منطقة الدراسة في محافظة بابل وضمن مشروع المسيب الكبير. تم اخذ العينات بواقع 40 عينة سطحية وتم حفر 12 بروفايل (مقد تربة) وبعدها قدرت الصفات الكيميائية لترب منطقة الدراسة. كما أشارت النتائج إلى وجود أربعة أصناف من التدهور الكيميائي للأراضي تمثلت بالصنف تدهورخفيفD1 بمساحة تقدر ب 1982.34هكتارأما الصنف الثاني D2 تمثل بالتدهور المتوسط الذي يشغل مساحة تقدر ب 1523.91 هكتار في حين شغل الصنف الثالث تدهور شديد D3مساحة تقدر ب 2403.18 هكتار في حين شغل الصنف الرابع تدهور شديد جدا D4مساحة تقدر ب 2830.56هكتار .

الكلمات المفتاحية: طريقة معكوس المسافة، التصنيف غير الموجه، إعادة التصنيف.

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INTRODUCTION

Our population in the world is steadily increasing to 9.5 billion in 2050, natural and human induced soil degradation, if not mitigated, will undoubtedly increase the potential for negative impacts such as disease and malnutrition (17). Land degradation is often caused by human activities, and exacerbated by natural processes such as climate change Some 25% of the global arable land surface is considered to be degraded; every year, approximately 12 million hectares are added to the total area of degraded land(20). Land degradation refers to the reduction of the biological or economic productivity and complexity of land (18). This means reduced food production, water storage, biodiversity and carbon sequestered in soils and vegetation (6). Dry land salinity is a major form of land degradation. The country suffers severely due to land degradation and desertification problems, especially in its central and southern parts of Iraq (9).Chemical soil degradation after erosion is the second most abundant form of soil degradation and as such poses a threat to our finite soil resource, as it tends to render it less usable. It is therefore necessary to understand the means by which soils are degraded chemically(14). (8) indicated that soil salinity increases with sodium adsorption rate and the Exchangeable sodium exchange, as their increase leads to saline degradation. Gypsiferous soils can readily be classified as highly sensitive to environmental conditions such as salts accumulation on the soil surface (1). The ecosystem in saline soils is not only affected by the concentration of soluble salts but by the content of soluble and exchangeable sodium(5). Cluster a dominated at the middle of iraq due to the deposition of the Tigris and the Euphrates river sediments in the direction normal to its flow path (2).GIS (geographic information system) is a special case of information systems that contains databases based on the study of the spatial distribution of events, activities and targets that can be identified in the spatial environment such as points, lines or spaces. The processes information related to these points, lines or spaces to make data Ready to be retrieved for analysis or query through data (7).(3) used Inverse distant weight to produce 3D mapping for the variables of some soil physical properties by using spatial statistic. (16) assessed the suitability of wheat, barley and maize crops in Iran using GIS to demonstrate crop suitability requirements as well as soil characteristics using maps to increase accuracy. (10) used one of the methods of spatial prediction by geographic information systems with some chemical and physical soil properties in the soil texture, salinity, calcium carbonate, gypsum and ESP, and produced it using a map system to serve the research and application work in southern Iraq, while (15) used one of the methods of spatial completion by geographic information systems to determine the spatial distribution pattern of soil isolates after numerical analysis numbering by Ward method (4) showed ability of spectral reflectance to detecting the Aridisols and Entisols orders and can be also detecting sub group at TypicHaplogypsids and TypicHaplosalids taxonomy units appeared to be distinguished andisolated. While there were difficult to detecting and identification between VerticTorrifluvents and TypicTorrifluvents in the lower of resent Mesopotamian plain of Euphrates river.Spatial logic is a mathematical process and a logical system depends on the generalization of traditional bivalent logic, in order to mysterious circumstances. In a narrow sense, the theories and techniques that use misty groups are infinite sets of boundariesThis logic is an easy way to describe and represent human experience,It also provides practical solutions to real problems, which are solutions at a cost effective and reasonable, compared to other solutions that offer other technologies and is converted from the classical logic expressed by mistake or right and the number one or zero to become a multi-value zero-to-one fuzzy logic and the transition from Classical Mathematics and numbers into Philosophical and Linguistic Mathematics This logic represents a way to describe and represent human experience and provides practical solutions to real problems (19). The land suitability for crop cultivation can be analyzed using multiple evaluation criteria in the GIS environment(13). While (11) used the fuzzy logic of producing suitable mapsfor land in southern Iraq.The type of cluster distribution pattern for some soil attributes may be due to the effect of pedogenic processes and to some extent to geomorphic processes, and landscape position(12).

MATERIALS AND METHODS

Location

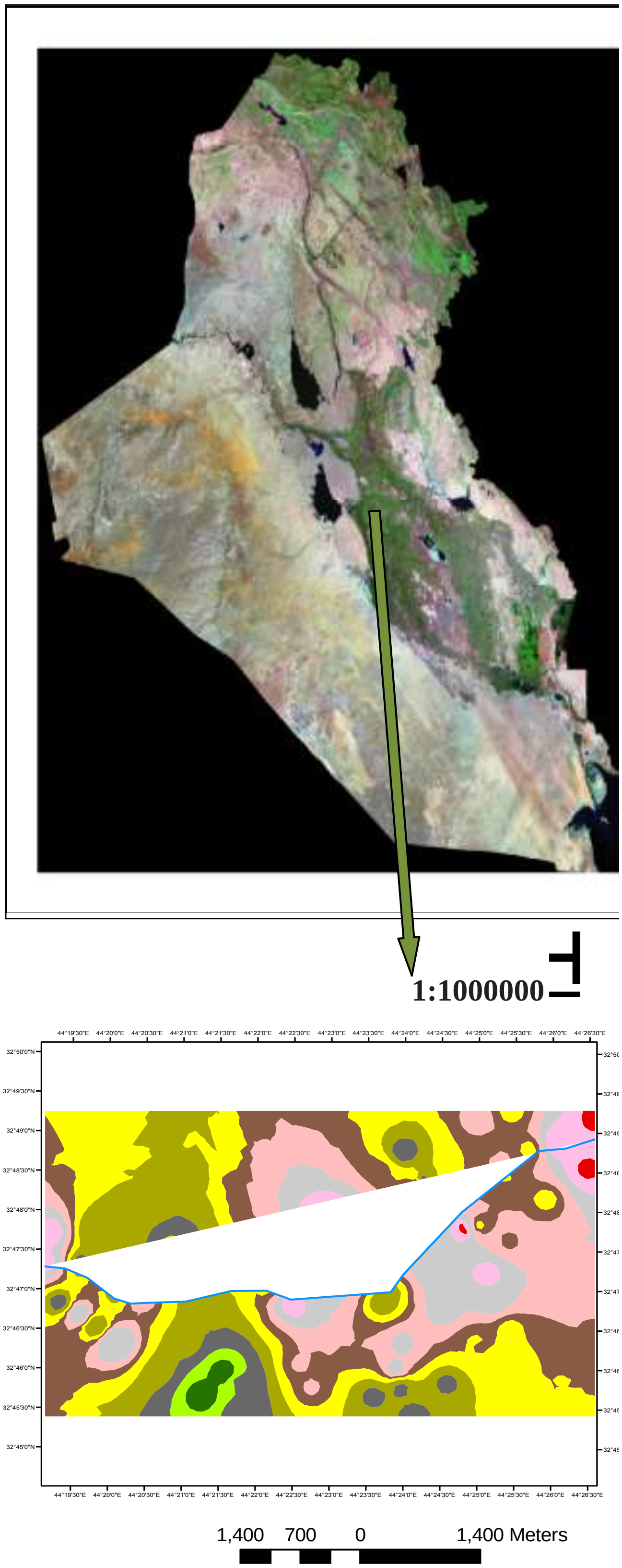

Figure1. study area

The study area is located in the North east of Babil province and within the large Al-Musaaib project, with an area of 8290.8306 ha, which is limited between the longitude E 44 ° 19'7.801 ", 44 ° 26'16.59"andlatitude 32 ° 48'47.465 ", 32 ° 45'39.795" N (figure1). The area of the study is bordered on the north by Latifiya, Elssaouira and Al-Qusayba. On the east side, its borders are the Shomali region, Al- Musaaib to the west, and from the south it is bordered by Mahaweel. The project lands are part of the sedimentary plain, which is the result of sediments in the Tigris and Euphrates.

Land use

The cultivation of many agricultural crops in the land of study area, as well as grain crops (wheat and barley) and natural plants, depending on the characteristics of the soil where it was observed in the soils with high salinity (Alhagimaurorum) and (Phragmitescommunis). The maps and data for the study area were collected to prepare for the implementation of the second stage of the implementation of the soil survey. Soil samples were taken in Octoberfrom several sites in the study area (Musyab project), which was determined in advance after obtainingunsupervised classification. 40 samples were identified, including 12 profiles and 28 samples distributed in two vertical and horizontal directions for the study area. the samples were determined by global positioning system (GPS). Some physical and chemical properties.particle size distribution (Texture)and electrical conductivity (EC),pH, Exchange Sodium percentage(ESP), Calcium Carbonate (CaCO3), Organic matter (OM) , Gypsum content ($CaSO_4 2H_2O$).After collecting information from laboratory analyzes and morphological description, soil maps were produced in IDW method depend on soil attributes ranges (table1). IDW relies mainly on the inverse of the distance raised to a mathematical power. The Powerparameter lets you control the significance of known points on the interpolated values based on their distance from the output point. It is a positive, real number, and its default value is two(21) then by map algebra applicant land degradation assessment equation (equation 1) and then reclassified according to the value of the extent of the soil character with the severity of the degradation. For example, the low salinity is suitable for a low degradation intensity, Organic matter and so on for other soil characteristics.

DI=((EC*Weight(0.50)+ESPWeight(0.20)+ CaCO3*
Weight(0.15)+Gypsum*Weight (0.15)…… …(1)
where DI= Degradation index,
ECe=Electric conductivity
ESP= Exchangeable sodium percentage,
$CaCO_3$= Calcium Carbonates,
Gypsum= Gypsum content

Arc map V.10.4 program was used to run all aboveprocesses.

Table 1. shows soil attributes ranges(Sys1980)

Ec	ESP	CaCO3	Gypsum
0-4	0-2	0-20	0-3
4-8	2-4	20-25	3-5
8-16	4-8	25-30	5-10
16-25	8-16	30-35	10-25
25-50	16-25	35-50	25-50
>50	>25	>50	>50

RESULTS AND DISCUSSION

Soil salinity

The results of the study indicate that the area of the study suffers from high salinity levels, with the lowest salinity value (0.59 dSm^{-1}), while the highest salinity value (130dSm^{-1}). The increase salinity trend was from west to east This is due to high temperature and high transportation . as well as the conditions of poor drainage, as well as the values of electrical conductivity affected by several factors, including the nature of parent materials , high temperature, high evaporation, topography and agricultural exploitation .InverseDistant Weight method (IDW) was used to predict salinity ranges. the range of (>50 dSm^{-1}) wasthe largest area in the study area is estimated at 2592.57 ha(31.72%) table 2and (Fig.2).

Table 2. shows soil attributes values estimated in IDW and areas (hectares)

Ranges (EC)	Area (ha)	Ranges (CaCO3)	Area (ha)	Ranges (Gypsum)	Area (ha)	Ranges (ESP)	Area (ha)
0-4	1396.04	0-20	130.629	0-3	5430.19	0-2	1307.94
4-8	645.166	20-25	1975.63	3-5	1363.54	2-4	2000.28
8-16	1107.95	25-30	5524.1859	5-10	1412.87	4-8	2658.21
16-25	558.645	30-35	627.486	10-25	84.2306	8-16	2233.5622
25-50	1990.4596	35-50	32.8997	25-50	0	16-25	90.8384
>50	2592.57	>50	0	>50	0	25-50	0
Sum	8290.8306		8290.8306		8290.8306		8290.8306

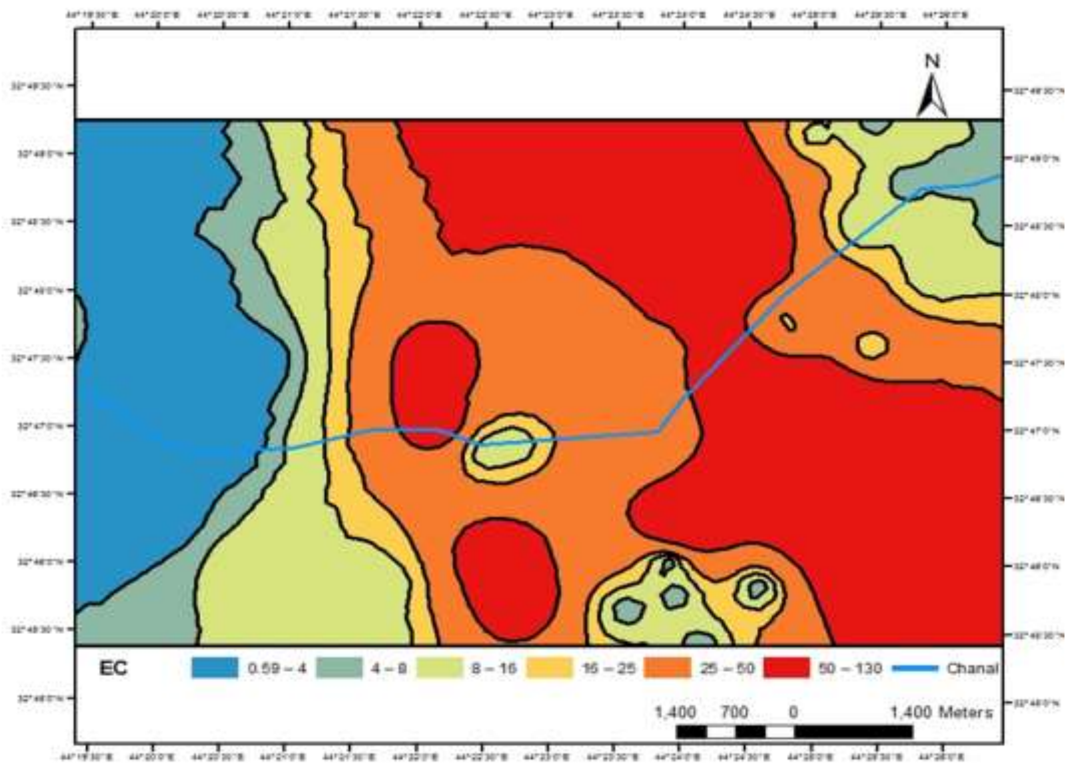

Figure 2. The prediction map by IDW of salinity

Calcium Carbonate minerals

The results referred that there were 5 levels of calcium carbonate minerals in the use of interpolation method (Table 2 and Figure 3). Calcium carbonate minerals were in the range of 25-30%, which occupied the largest area. Figure 3 shows that some places in the study area suffer from a high percentage of calcium carbonate mineralsin soil due to the lack of irrigation water. As well as high temperatures and low amounts of rainfall, which result in the stability of the soil content of calcium carbonate and non-transfer or washing to the lower horizons in the soil because of the relatively low solubility, especially that calcium carbonate minerals of minerals that are concentrated in the dry areas and semi-dry as deposited metal In the case of lack of rain and increase its deposition when evaporation is higher than the amount of rain. The results showed that the highest value of calcium carbonate was 35-30 % with an area of 5224.1859 hectares(66.63%). This is due to the high soil content of 25% carbonate, which will lead to low clay bonding with each other and turn into fragile, Winds can easily be moved and drifted while the lowest value is 35-50 % with an estimated area of 32.8997 ha(0.39%)Figure 3 and (table2).

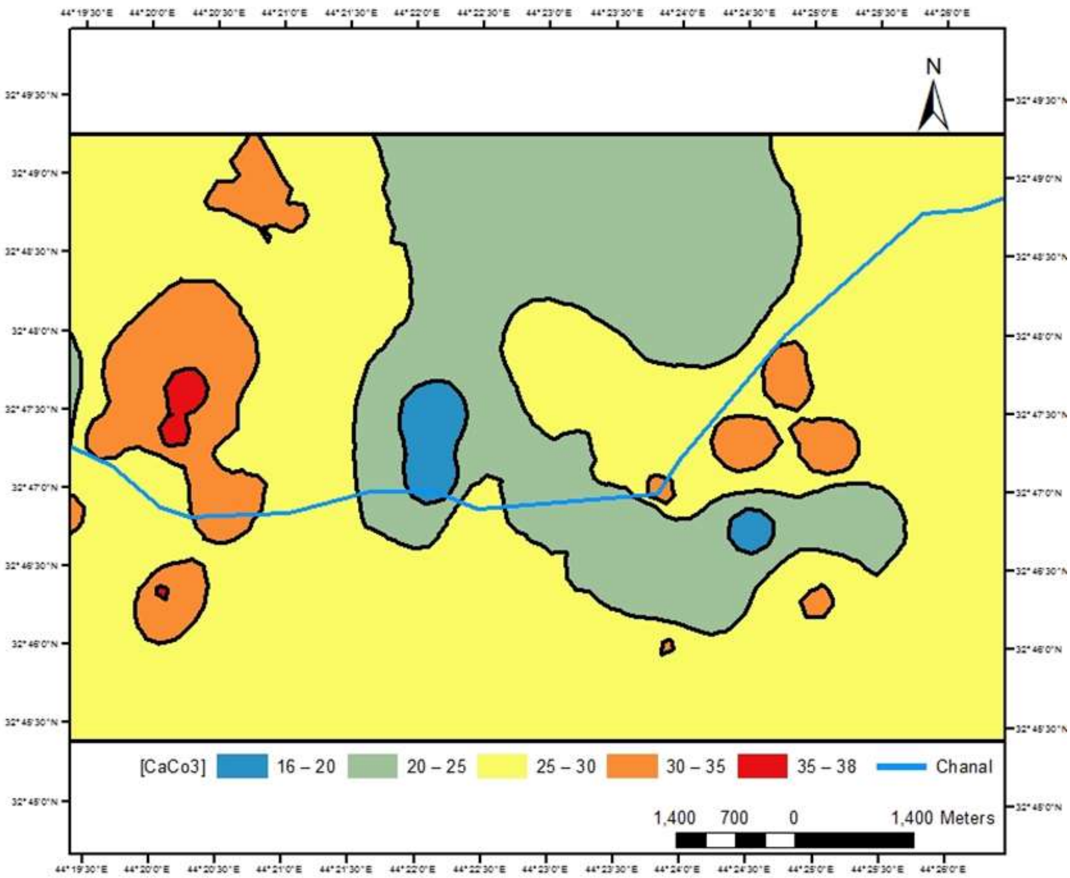

Figure 3. The prediction map by IDW of CaCO3

Gypsum

The high proportions of gypsum mainly affect the properties of physical and chemical soil by affecting the ionic balance of nutrients in the soil solution and thus affect the growth of plants. Gypsum is the most salts containing sulphate because of its high solubility compared to other sulphates. Table 2 and Figure 4 indicates that the gypsum content in the soil of the study area was in different ranges, with ranges from 0-3% occupying the largest area in the study area, which was 5430.19 ha (65.49%).High due to the presence of high quantities may be moved with water watering poorly and deposited in the horizons of the surface during the dry period. The lowest value of gypsum ranged between 10-25%, with an area of 48.2306 ha (1.01%),.

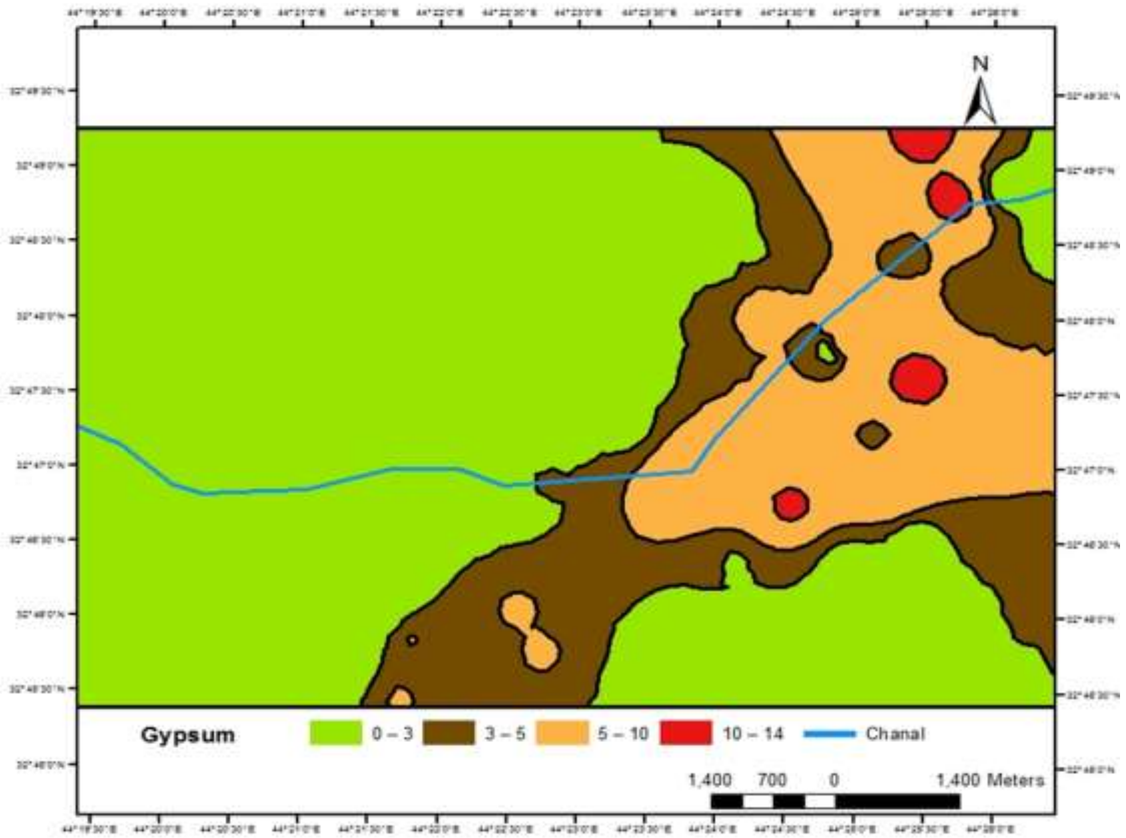

Figure 4. The prediction map by IDW of Gypsum

Exchangeable sodium percentage (ESP)

The results showed (figure5) that the percentage of sodium Exchangeable in the range of 8- 16% with , the largest area is estimated at 2233.5622 hectares (26.94%) in the study area, while occupancy range 16-25 % less area of about 90.8384 hectares(1.09%), The areas that occupied the study area are shown in Table (2).

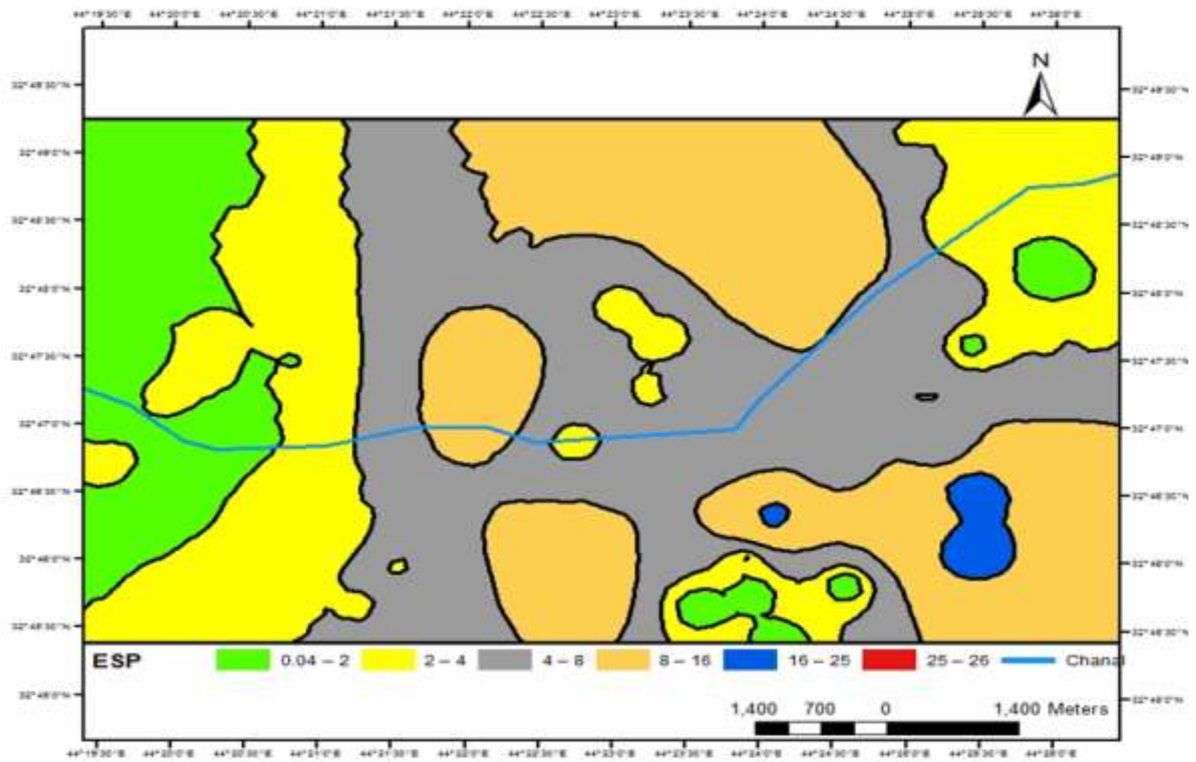

Figure 5. The prediction map by IDW of ESP

land degradation map

The results indicated that there were four classes of land degradation (figure 6) D1, with an area of 1492.349508ha. The second class of D2 represents the moderate degradationwhich occupies an area of 1906.891038ha, While the third class occupied a severe degradation D3 area of 4062.506994ha, while the fourth class was very severe degradation D4 area of 829.08306ha table (3). The results showed that the study area suffers from severe degradation of (49%) %, followed by a moderate degradation (23 %) , the third sequence slight degradation of the percentage occupied by the study area was (18%) of Study area. While the very severe degradation of was the lowest of area in the study area(10%). This indicates that more than half of the study area suffers from severe and very severedegradation, while the remaining two types of moderate degradation of and the moderate degradationoccupied more than the slightclassdegradation. the main cause of degradation in study area is Salinity which can occur when the groundwater levels is highand the temperature rises . The salts from the groundwater are raised by capillary action to the surface of the soil. This occurs when groundwater is saline.

Table 3. shows the degrees of degradation(Sys1980)

Degradation degrees	Area(ha)	%degradation
D1 (0-25)	1492.349508	18%
D2 (25-50)	1906.891038	23%
D3 (50-75)	4062.506994	49%
D4 (75-86)	829.08306	10%
Sum	8290.8306	100

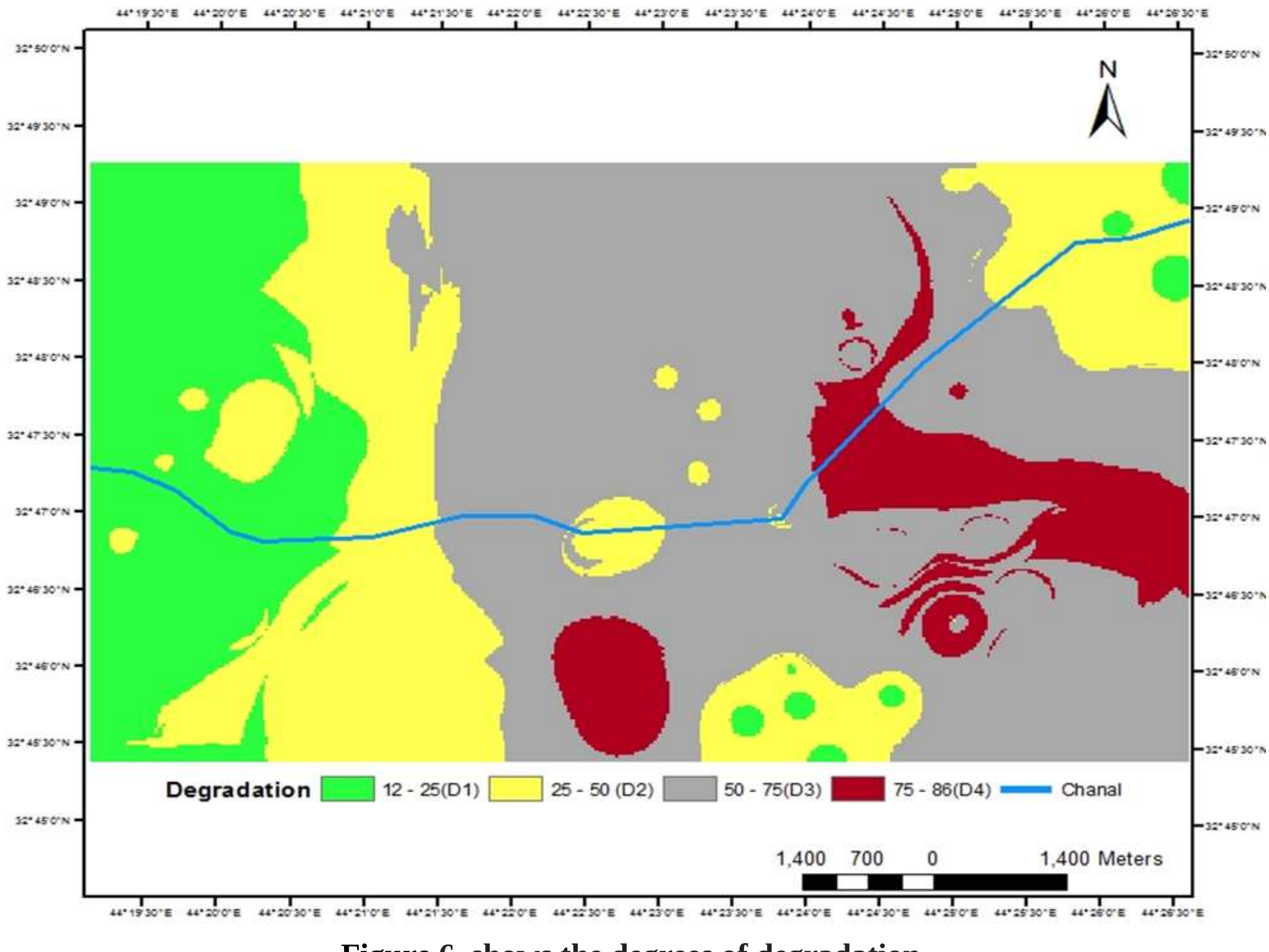

Figure 6. shows the degrees of degradation

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