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DEGRADATED SALINE SOIL MANAGEMENT IN AL - KAHLAA AREA - SOUTH OF IRAQ WITH SOME IMPLICATIONS FOR THE LONG TERM LAND USE PLANNING

H.K. Al-Nussaiari[1] and K.A. Hassan[2*]

[1]State University of Land Management, Moscow 105 064, Russia.
[2*]College of Agriculture and Forestry, Duhok University, Duhok 42001, Kurdistan Region, Iraq.

Abstract

Today there is consent regarding the necessity of nature protection due to the threats of rapidly expanding human population, global climate change and human misuse of the natural resources. Many lands are being lost through degradation. Case study of Al-Kahlaa, south of Maysan province has been selected as salt affected degradated area. The cost of reclamation of such region is very expensive, so the spatial analysis was used in this study. The use of spatial analysis techniques in evaluating the land capability, allow producing multi – thematic maps and outlining the limiting factors, accordingly suitable suggestions could be attained to understanding how to deal with these soils for sustainable agricultural use. In order to generate improved knowledge this work will involve a survey of the past and present situation of the land and land use of Al-Kahlaa area. Two procedures will be followed, through direct observation and measurement, and through an interpretation of environmental factors which influence land degradation.

Key words: Degradation, soil management, salinity, spatial analysis, GIS.

Introduction

Agriculture is one of the important economic sectors that contribute directly to national income. Increase in agricultural production is possible through modern methods, but these methods will be useless unless there is enough good land for farming. The destruction of the natural resources can reduce soil productivity (Emadi *et al.,* 2008). A lot of lands lost through degradation. Salinity is a major soil degradeation increasing problem in arid and semi-arid regions where annual precipitation is insufficient to meet the evapotranspiration needs of plants. An example is the center-south irrigation zone of Iraq.

Al kahlaa in Maysan south of Iraq is a productive area suffer from sever salinity worth to maintain. The cost of reclamation of such region is very expensive, so the spatial analysis was used in this study, it can be defined as the analytical techniques associated with the study of locations of geographic phenomena together with their spatial dimensions and their associated attributes (ESRI, 2001).

Al-Kahlaa region lies 23 km south-east of the center of Maysan province. It situated between longitudes (47°20'32.60"-47°19'23.10") east and latitudes (31°43'33.80"-31°34'36.70") north, Al-Kahlaa covers an area of (800 km^2) and accounting for (4.9%) of the total area of Maysan province (Hussain, 1995). About (120, 450) donum which is 37% of Al-Kahlaa area is used in agriculture (Agriculture directorate in Maysan, department of planning).

The study area is part of the alluvial plain created by rivers; the surface is described by slight slope from the north-west towards south-east in Al-Hawaiza marsh. The soils are formed as a result of irrigation water deposits and sedimentation has been longley determined by the subsequent irrigation systems. Levee and flood plain soil are found. A striking feature is the very high content of calcium carbonate 25-30% is quite common and less than 20% is rare. As may be expected under prevailing climatic conditions, the organic content is low to very low and the texture is clay loam. The study area includes river levees soil and flood plain soil.

The most characteristic feature of the climate in the study area is long dry summer, from April to October, with very high temperature. The average annual rainfall

****Author for correspondence :*** E-mail : husamkalf@yahoo.com

is low, with high evaporation rate resulted from high temperatures, strong winds, relative humidity and lack of vegetation.

Few studies has been done about the area, most of these were geographical studies (Al Salaim, 1989; Ramadan, 1989; Al Assadi, 1989; Hussain, 1995; Al-Khaier, 2003; Salih, 2009), so the main objective of this study is to have an idea on the status of salinity distribution in Al-Kahlaa area as well as shows the future threats on agricultural lands in the city, defined more basic knowledge on salinity problem , its relation to soil condition, drainage and irrigation, and cultivation practices. Since, anything known about the soil under Iraqi conditions and all

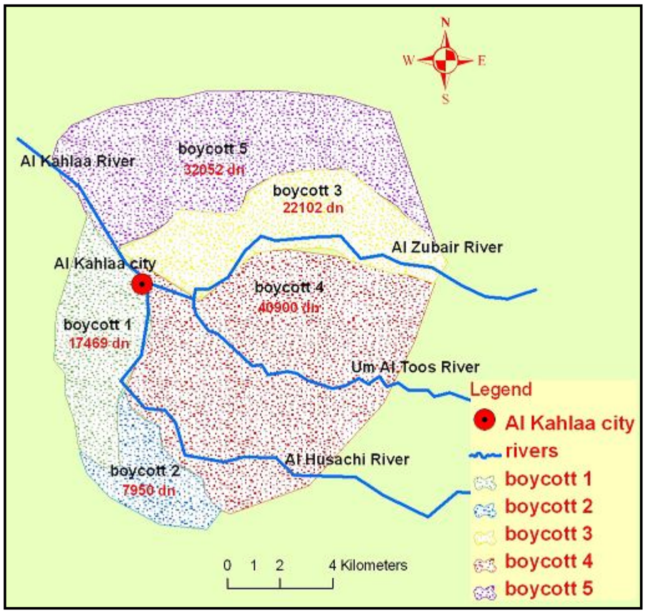

Fig. 1: Areas of boycotts for study area.

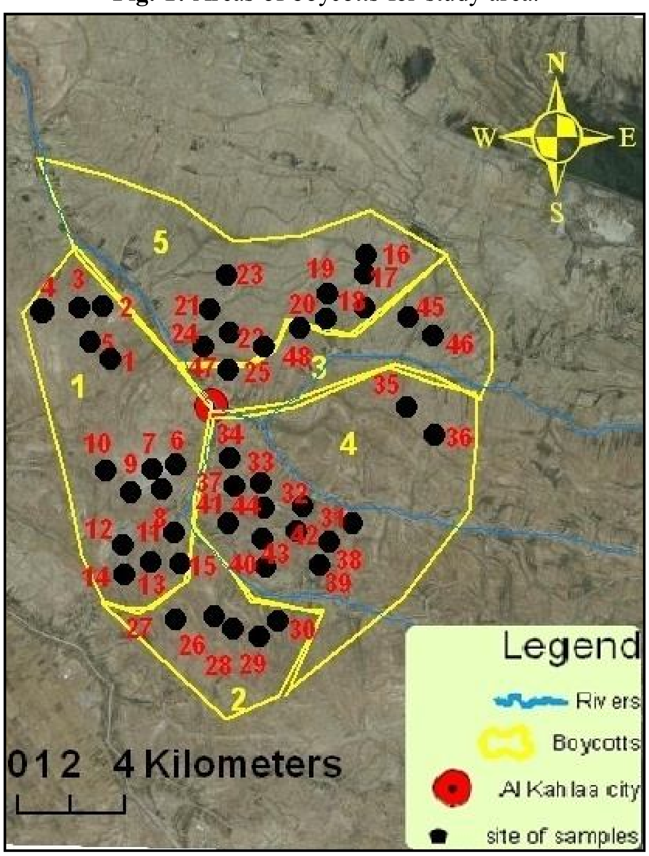

Fig. 2: Locations of soil samples in study area.

Table 1: Area and number of soil samples collected.

No. of site	Area /dn	No. of Sub-sample	No. of composite for each depth
Boycott (1) 1 - 15	533	214	53
Boycott (5) 16-25	206	99	25
Boycott (2) 26-30	62	44	11
Boycott (4) 31-44	531	219	51
Boycott (3) 45-48	150	76	17
Total	1482	652	157

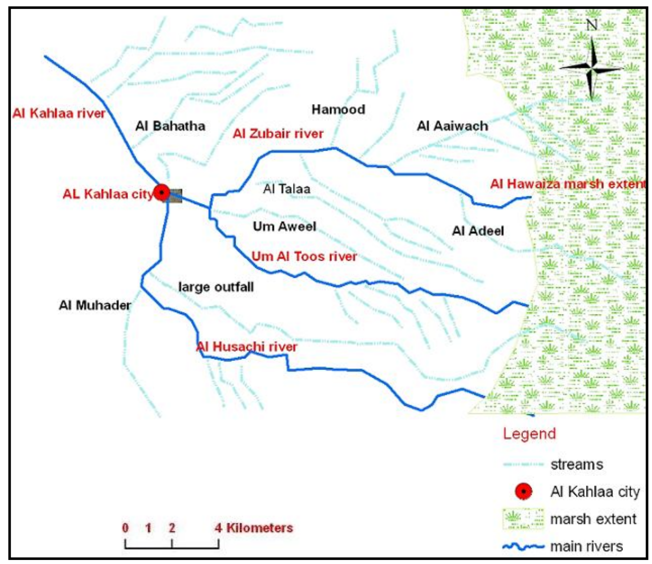

Fig. 3: Main rivers and sub-rivers, done by researcher.

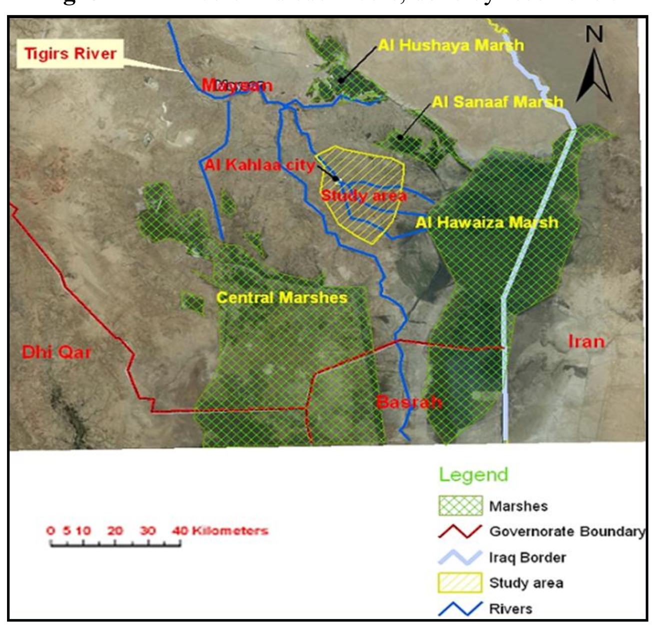

Fig. 4: The marshes in south of Iraq, done researcher.

information collected will be new and may help in formulating provisional concepts and criteria.

Therefore this study will be proposed to achieve the following objectives:

1. Initiating a scientific data which could serve as a basic for future work by researchers and can provide local policy makers and farmers with important information for land use planning, strategic planning and investment.
2. Evaluation of actual threats and problems by focusing on the area affected by salinity and monitoring changes through the last 5- 10 years.
3. Public awareness for protection of these soils and delineating the main factors which caused salinization.
4. To present some recommendations based on the results gained by the research.

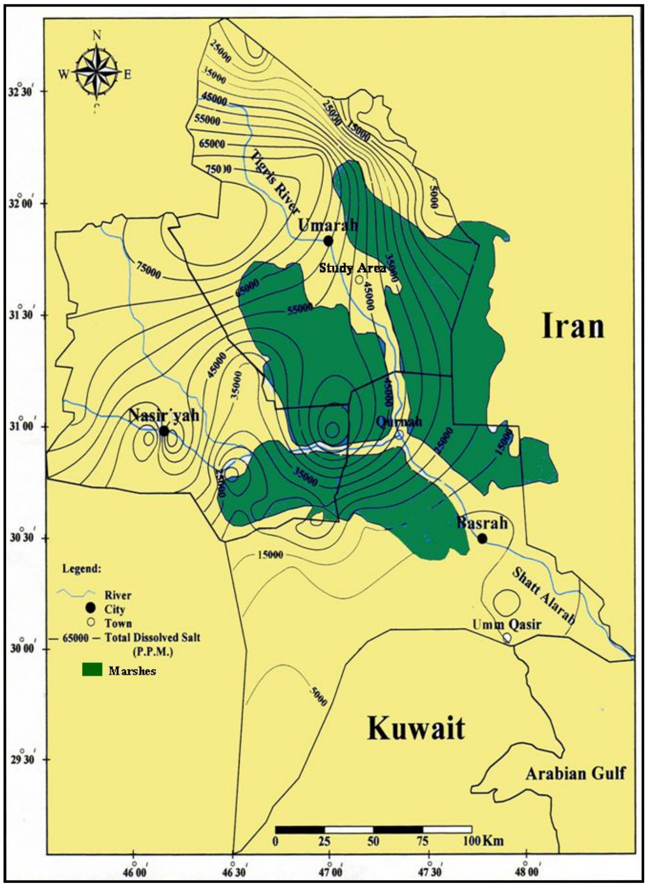

Fig. 5: Map for concentration of total dissolved salts in ground water in marshes regions, (cited from General Commission of ground water).

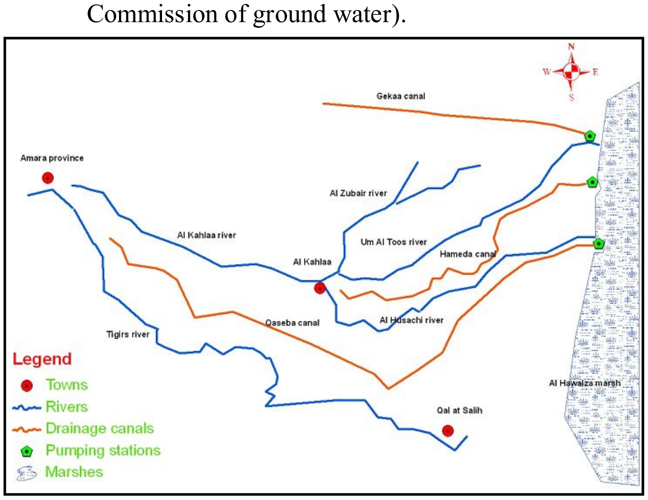

Fig. 6: Network of drainage canals in study area and adjacent area, done by researcher.

Materials and Methods

To accomplish the objects of this study the researcher visited some fields, made interview with farmers, specialists, authorities and direct-orates related to this study. He also collected data and studies that are related to this research, in combination with a field study include collecting surface (0-5 and 5-20 cm) and sub-surface (20-40 cm) soil samples from selected locations within the study area for determination of PH, EC, organic matter and soluble ions.

The total study area covers 120, 450 donum of Al-kahlaa district, divided into five boycotts of varying areas

Table 2: Yearly average soil temperature for the period (2004-2009) in Maysan.

year	Soil temp. C^o						
	Sur.	5 cm	10 cm	20 cm	30 cm	50 cm	100 cm
2004	27.0	26.9	26.8	26.9	-	27.5	27.4
2005	26.1	26.1	26.0	26.9	23.8	26.5	26.2
2006	26.1	26.5	26.3	26.3	25.4	26.4	25.8
2007	26.4	26.4	26.2	26.2	22.3	26.4	25.9
2008	25.8	25.8	25.8	25.9	22.8	25.9	24.6
2009	26.5	25.9	25.7	25.6	25.1	26.0	26.2
AVE.	26.3	26.2	26.1	26.3	23.8	26.4	26

Source: the state board of meteorological and seismology.

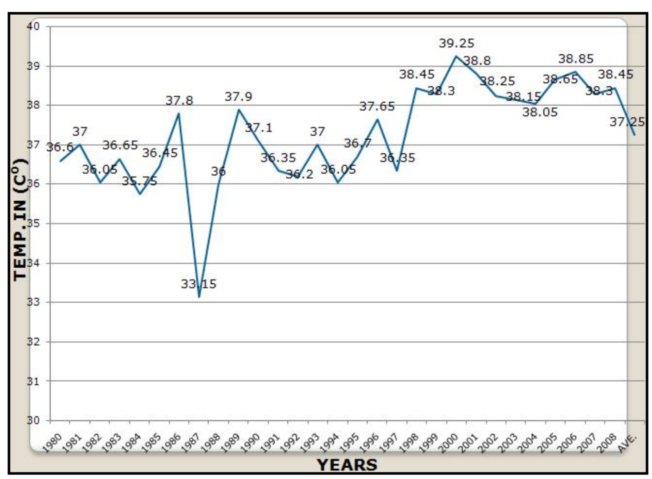

Fig. 7: Yearly air temperature (average for July and August) for the period (1980-2008) in Maysan.

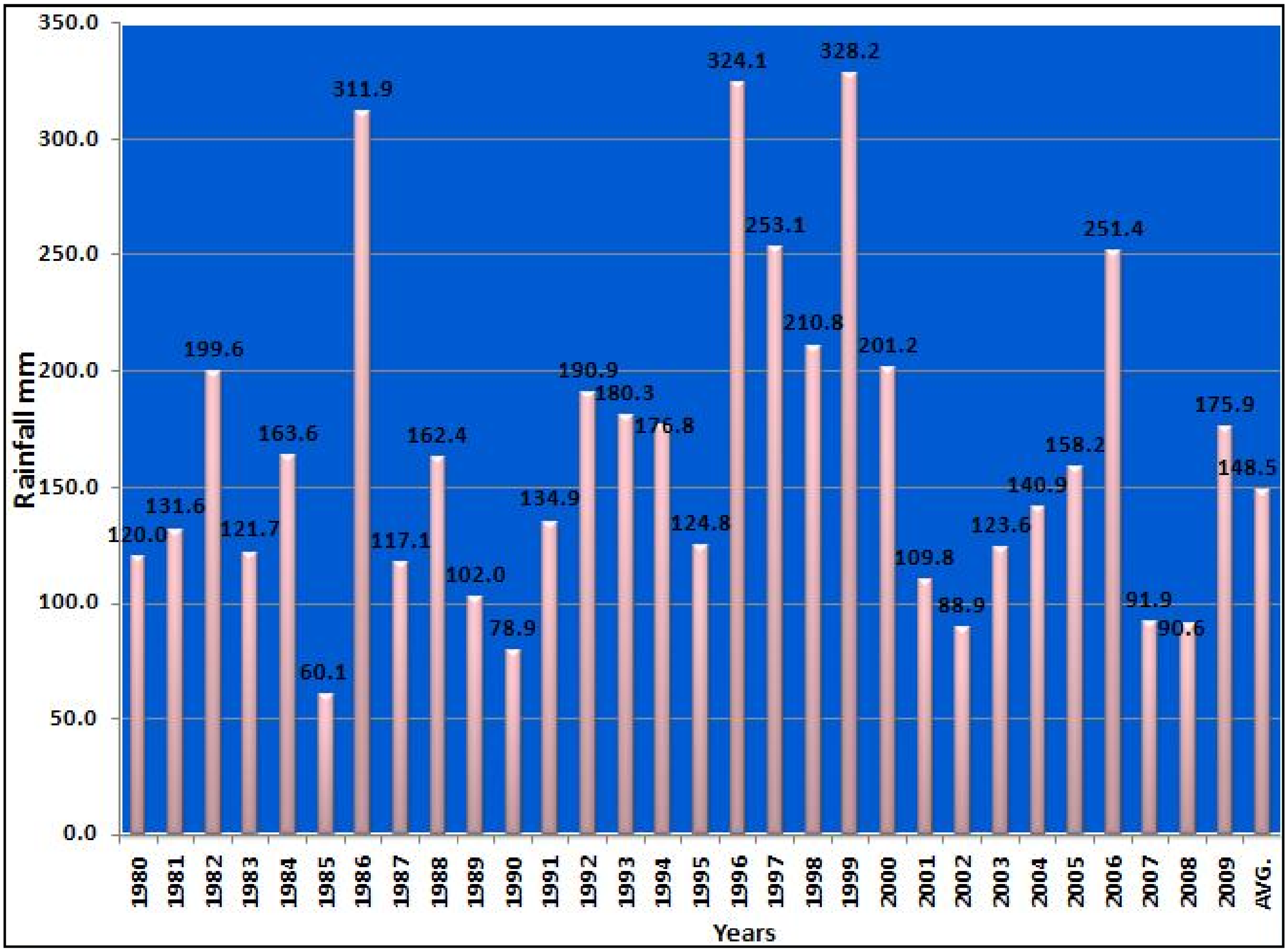

Fig. 8: Total yearly rainfall for the period (1980-2009) in Maysan.

(Cited from Maysan agriculture directorate), as shown in (Fig. 1).

Various forms of collected and derived data were used in this study. The researcher adopted the principle of the questionnaire, visiting, direct observation as a tool for gathering information and data about the study area, because of the lack in obtaining accurate data from related offices which is relevant to the problem of the area. The researcher has following steps to conduct this study:

1. Collect as possible as, the previous studies and publication which contain background of this area from the governmental sources. Conduct site visits to about (50) fields, meet the local farmers and following topics have been discussed.

• Productivity and planted areas of winter and summer crops for the last 15 years and current production, the quality of the crops for the last 15 years, dominated crops in study area and quantity and method used for fertilizer and pesticides.

• Soil salinity, irrigation methods used, drainage canals of cultivated lands, water flowing rate for those canals, water resources in study area as well as qualities and levels of irrigation water in the prior and current periods.

2. Verbal discussion with leader of agricultural offices and environmentalists, gathering their comments and suggestion which where helpful to overcome on this problem.
3. Using geographic position system (GPS) and (Surfer 8 program) to create an attribute data base.
4. Gathering as much as possible local data for rainfall, temperature, evaporation, relative humidity, wind speed and soil temperature, for the period from 1980-2009.
5. Collecting data for water resources (Main Al-Kahlaa River and its streams) and the levels and discharges for the period from 1979- 2010.
6. Identify agricultural patterns, cultivated areas and productivity of winter and summer crops for the period from 1995 - 2010.
7. Construction of maps from satellite imagery and other

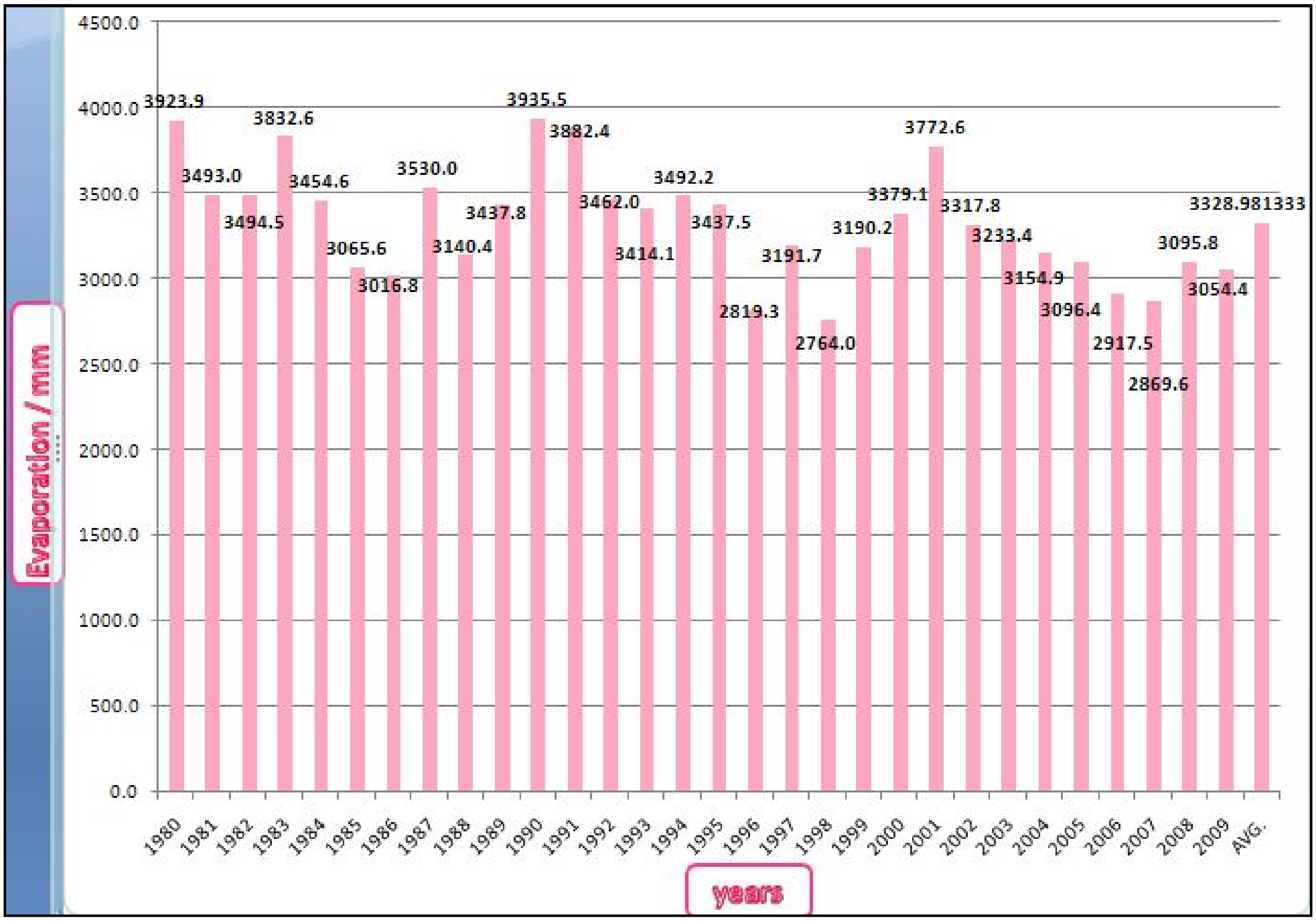

Fig. 9: Total yearly evaporation for the period (1980-2009) in Maysan.

sources for the application of GIS technology.

8. Collecting composite random soil samples (Each composed of individual samples) in July 2010 from 48 locations (Table 1). The soil samples were taken from three depths, (0-5), (5-20) and (20-40) cm. These samples are being the best and most meaningful of the study area. Several factors have been taken into account in choosing the location of the soil samples. These are: the salinity level, cultivated or fallow area, river flood plain, levees and terraces (Fig. 2).

Fig. 10: Discharges for Al Kahlaa river through the period from (1979 – 2009), done by the researcher.

Soil samples were brought back to the laboratory for soil chemical analysis, according to (Jakson, 1973; Richard, 1954), the analysis includes EC, PH, O.M and soluble

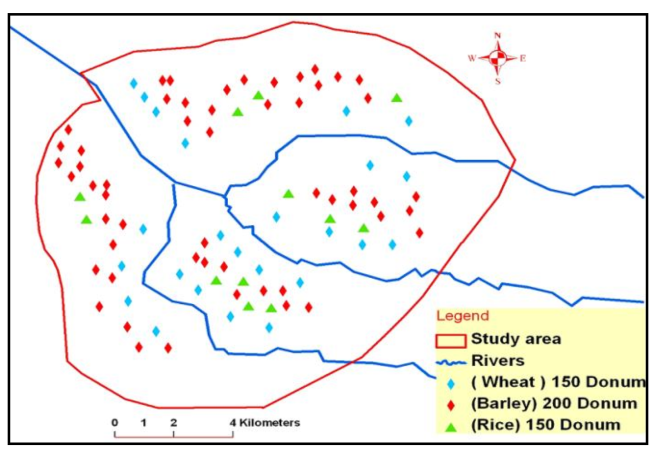

Fig. 11: Areas of field crops cultivation in the study area, done by the researcher.

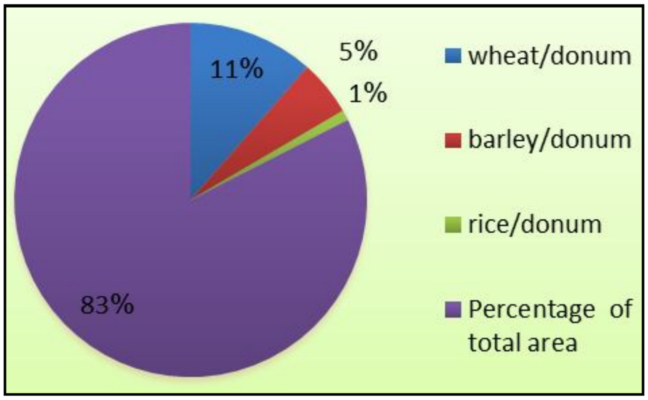

Fig. 12: The average area cultivated by wheat, barley and rice crops for the period (1995-2002) in the study area.

Table 3: Area and production of wheat and barley for the period (1995-2010).

year	wheat			Barley		
	Area /dn	Produc-tion/Ton	Yield (kg/dn)	Area /dn	Produc-tion/Ton	Yield (kg/dn)
1995/1996	18340	4313	235.16	8427	1324	175.11
1996/1997	19000	2007	105.63	8000	1204	150.5
1997/1998	11000	3201	291	7500	1132	150.93
1998/1999	12000	3144	262	7500	1327	176.93
1999/2000	12460	2188	175.60	5500	1078	196
2000/2001	12000	4212	351	5000	1355	271
2001/2002	12000	4044	337	5000	935	187
2002/2003	12000	4020	335	2000	370	185
2003/2004	3395	1293	380.85	9715	2108	216.98
2004/2005	12000	4510	375.83	12000	2763	230.25
2005/2006	13000	4554	350.30	13000	3055	235
2006/2007	12850	2947	229.33	13000	2400	184.61
2007/2008	10000	1394	139.4	16474	2166	131.47
2008/2009	5000	3000	600	10000	5560	556
2009/2010	3600	949	263.61	11000	2884	262.18

Source: Agriculture directorate in Maysan, department of planning.

ions.

Results and Discussion

1. Water resources in the study area:

Water resources include (rainwater, ground water and surface water); the surface water represents by the main river Al-Kahlaa and its tributaries which is the only source of irrigation water for the area (Fig. 3). The average annual rain rate is 0.6 mm / day for the last (30) years according to (the state board of meteorological and seismology), it cannot be relied on for cultivation. The groundwater does not have any importance in agricultural and non-agricultural exploitation, because of the high salinity which reach 18 ds.m^{-1} last year (2009) in some places.

Marshes and swamps occupies under normal circumstances, an area of 2800 km^2 , about 19.85% of Maysan province area (Mohammed Ramadan, 1989), it extend to the east and west sides of the province and separated by Tigris River (Fig. 4). Generally the local aquifers were open to all the marshland, as a result the water flow from high pressures hydraulic area to low pressures areas, depending on the topography the water move from Paleozoic deposition in the north-east of Maysan province, (where is the presence of Hamrin mountains series) towards the marshes (General Commission of ground water Ministry of planning.) . The water also moves from wet to dry area, therefore the study area also affected by such movement.

Because of the long distance and the movement of groundwater toward the discharge area and the lack of natural recharge from rainfall, the salt concentrations in water is expected to be high and not suitable for agricultural, human, animal and even industrial purposes. (Fig. 5) represents a map for the concentration of dissolved salts in the groundwater. The general concentration was very high and reached (65000) ppm in the Central Marshes, and for Al-kahlaa region (study area) it is limited of between (45000-55000) ppm.

In general there were some main drainage canals which are out of use because of lack in pumping stations, uncompleted drainage net for sub canals in the area, and the drainage net cover only 25000 donum of the total area (120450) donum that formed only 20% (Fig. 6).

2. Climate conditions in the study area:

The annual average temperature for the period (1980 -2008) was (25.022) Co (Fig. 7). There were large differences in the yearly total amounts of rainfall for the period (1980-2009), (Fig. 8) and the average annual rate of evaporation for the same

Table 4: Areas of winter and summer vegetables in study area for the period (1995-2009).

year	Area of winter vegetables /donum	Area of summer vegetables /donum
1995	1385	822
1996	2330	2380
1997	2330	2630
1998	1325	3800
1999	1405	1605
2000	1360	989
2001	6000	3829
2002	2700	3529
2003	2513	2734
2004	3940	2160
2005	4470	4132
2006	5170	3000
2007	6708	2900
2008	920	6257
2009	2751	4399

Source: agriculture directorate in Maysan, department of planning.

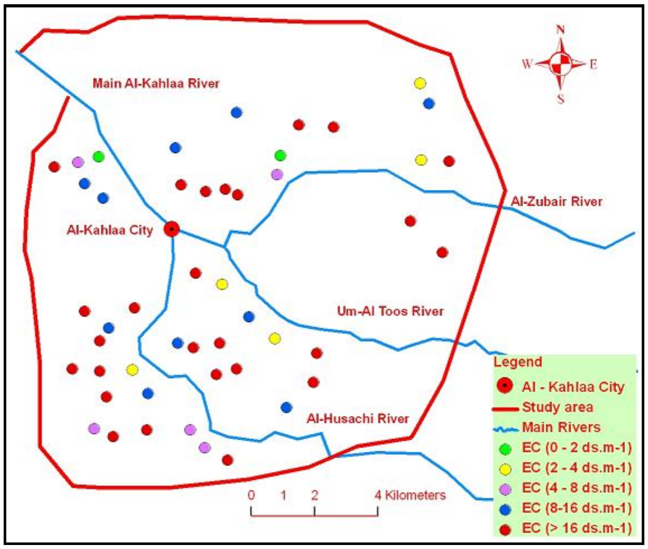

Fig. 13: Concentrations of soil salinity in study area, done by the researcher.

period was (277.4 mm) (Fig. 9).

Soil temperature is changed through the seasons and days, soil surface exposed to this change more than the sub-soil (Table. 2).

Table 5: Range of Electrical conductivity for different depths of studied soils.

	No. of composite samples	EC ds.m^{-1} Depth/cm		
		0-5	5-20	20-40
Boycott (1) 1 – 15	159	1.6-154.0	2.2-80.8	2.5-97.3
Boycott (5) 16-25	75	2.0-204.5	1.2-73.7	2.0-42.0
Boycott (2) 26-30	33	4.4-69.0	3.0-36.5	6.6-39.7
Boycott (4) 31-44	153	2.4-153.0	2.0-78.6	2.0-51.8
Boycott (3) 45-48	51	2.0-55.7	2.0-53.1	1.5-23.8

Fig. 10 showed the mean discharge of Al-Kahlaa River, the discharges decreased from (178 m^3/sec) in 1979 to (16 m^3/sec) in 2009 with a level of (3.64 m). In august 2010, the discharge decreases to (13 m^3/sec) with a level of (3.60 m) according to directorate of water resources and center of marshes recovery in Maysan.

3. Cropping patterns and crop productivity:

It has been shown from various collected information and statistical data and as a result of the interaction of natural and human factors there were two main patterns of cropping, the first is field crops and the other is horticultural crops. Depending on agricultural boycotts areas and natural phenomena, there was a clear picture of the spatial distribution of field crops. The crop pattern concentrated in river basins and decreased largely towards river levees (Fig. 11). There was very clear reduction in cultivated area of strategic crops compared to the area in the previous years and to the total area of Al-Kahlaa region (Fig. 12), which reflect the extent of degradation of these soils over recent decades gradually.

Productivity and areas of the crops were varying in recent decades. (Table. 3) showed that area cultivated by wheat crop began to decline in the midnineties (1996-1997) from 19000 dn to 3600 dn in (2009-2010), thus had a negative impact on production

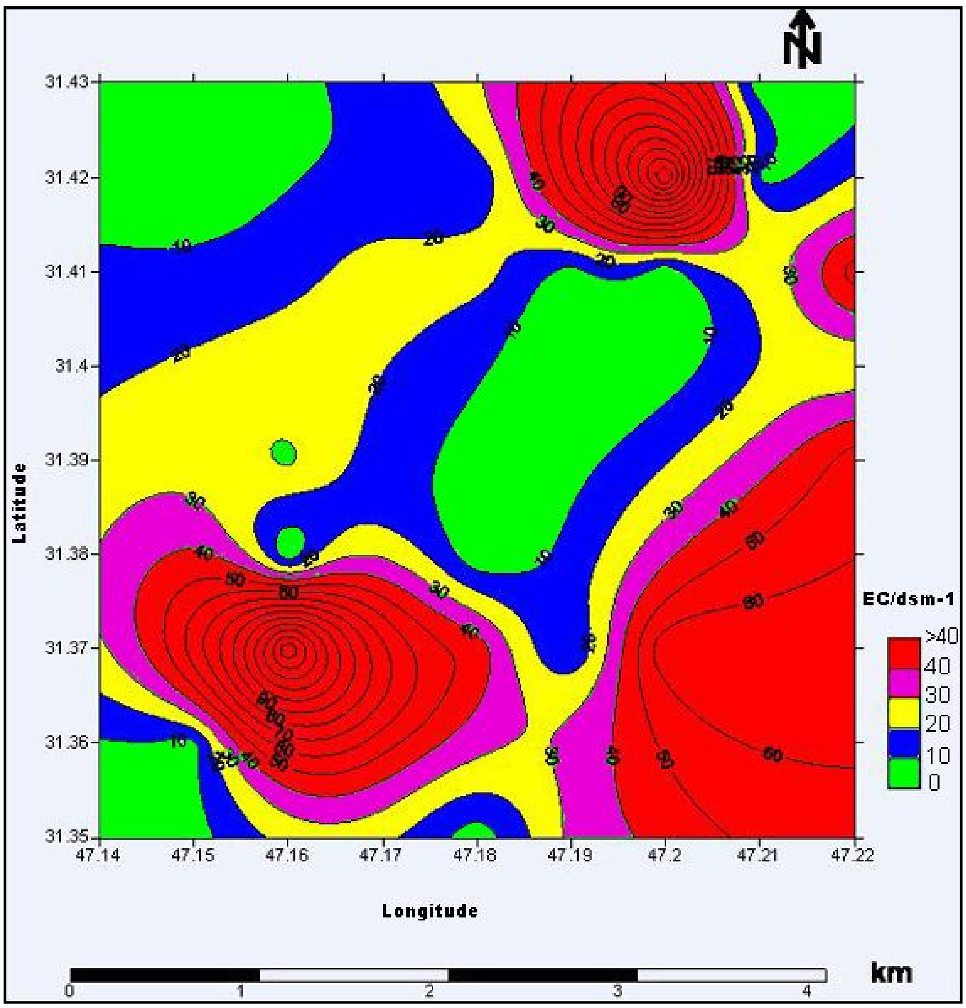

Fig. 14: Saline map for (0-5 cm) in the study area, done by the researcher.

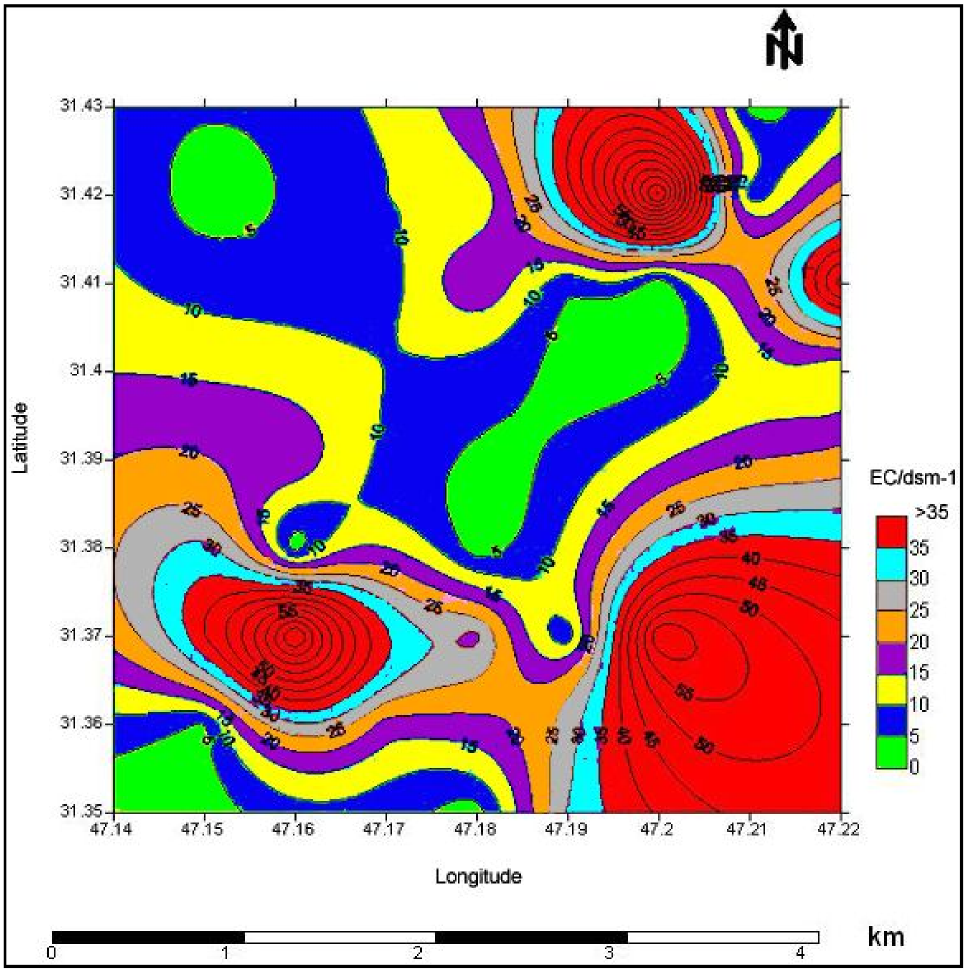

Fig. 15: Saline map for (5-20 cm) depth in the study area, done by the researcher.

rate, it decline from (4313) to (949) tons in (2009-2010).

Generally the pattern of horticultural crops concentrated in the rivers levee only, because of the good drainage loamy soil. For winter and summer vegetables crops, the area did not reach 7000 dn (Table. 4), it is equivalent to 5% of the total area in some seasons and decrease to 0.7% in other seasons because it was only cultivated in river levees and not expanded to river flood plain due to the high salinity and poor drainage soils.

4. Chemical Soil characteristic:

Data presented in (Table 5) showed the EC values and some descriptions for the studied soils. The highest soils EC were obtained from uncultivated soils which have been left unplanted for 10-20 years. In general, the EC was between (1-8 $ds.m^{-1}$) in river levee soils and increased to (8-16 $ds.m^{-1}$) towards the flood plain soils (Fig. 13). This is due to the different soil characteristics of the two soils. River levee soils characterize with good drainage and deeper ground water compared with clay poor drainage soils in flood plain. From data presented in (Table 5), saline maps for three depths were made as shown in (Fig. 14, 15, 16).

There were small differences in soil PH values between depths and samples. The PH values range from (7.5-8.4) with an average of (7.8).

In general, data indicate that the concentrations of Ca, Mg, Na and Cl were highest in cases of uncultivated soils compared with cultivated ones, in flood plain compared to river levee and in 0-5 cm depth compared to the other depths. This distribution reflected on soil salinity (Table 6).

There were some differences in organic matter between locations and depths depending on whether the soil was cultivated or uncultivated. Organic matter percentage ranged from (0.23) for some depths to (1.95%). Overall the percentage was low because of high temperature, lack of vegetation and lack of rainfall.

The most important conclusions of the study were:

1. The salinity levels varies from (1-8 $ds.m^{-1}$) in river levee to (8-16 $ds.m^{-1}$) in flood plain. Some location reached 203 $ds.m^{-1}$.
2. A large part of the area is not now under cultivation, mostly because of soil salinity.

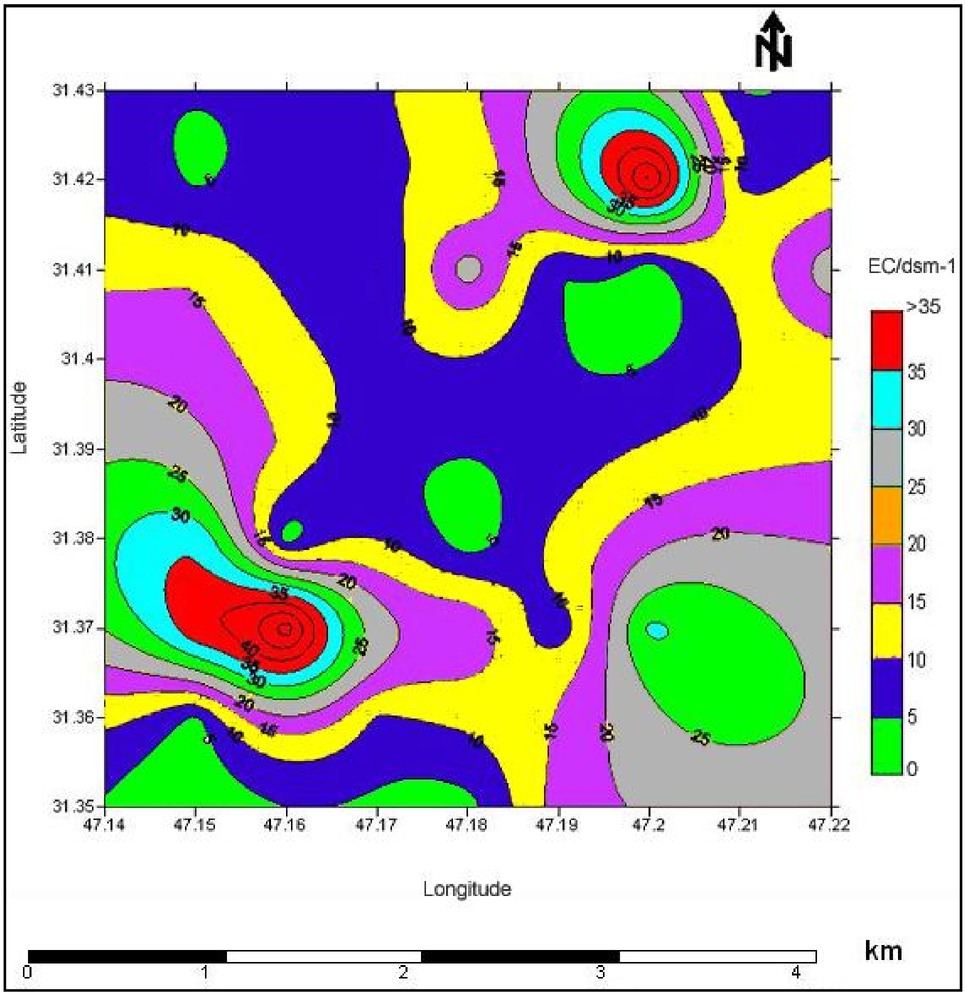

Fig. 16: Saline map for (20-40 cm) depth in study area, done by the researcher.

3. There were different agriculture patterns and low to very low crops productivity as a result of soil salinization.
4. There are serious problems in quantity and quality of irrigation water, drainage network and absence of natural outlets.

Recommendations

In light of the facts which we have in the above study, the researcher suggests the following recommendations to perhaps help in solving or alleviating the problem of soil degradation in Al- Kahlaa region:

1. Maintain the irrigation and drainage systems already existed, and follow appropriate water management to prevent canal seepage and subsurface drainage.
2. The researcher suggest, establishing a third drainage canal between AL-Zubair and Um Al Toos rivers, in addition to the two canals proposed by (directorate of water resources in Maysan) in the boycotts (3, 4 and 5), and internal drainage canals within boycotts (1, 2 and 4) link with Qaseba and Hameda canals.
3. There is also need for establishing relief wells for discharging drainage water connected to suitable outlets instead of marshes and rivers, to avoid pollution in Al Hawaiza marsh and Tigris River.
4. Due to the lack of discharges and low levels of Al-Kahlaa River and its branches, the researcher recommend active collaboration between water resources and agriculture directorates and farmers in the region to work on appropriate water management.
5. Adaption of farming methods to the specific conditions of the region. The salinity maps obtained by the researcher (Fig. 14, 15, 16) can be used with information from table 5 to choose the suitable tolerant crop for each salinity level in the study area.
6. Using of subsurface drainage water for crop production may be an economic and environmentally acceptable means of disposal, but the effect of different salinity levels of irrigation water on crop yield must be evaluated for different agroclimatic region.
7. Raise the awareness of the farmers through intensification of agricultural workshops for farmers

and agricultural staff.

8. Government funds are needed for carrying out irrigation and drainage projects; provide fertilizers, agricultural machinery, pesticides, etc for farmers.
9. Better data may improve the salinity mapping accuracy. Image data from multiple consecutive growing seasons is required to discriminate between short-term causes of low productivity, and long-term causes of low productivity such as salinity to provide salinity control recommendations to farmers.
10. It is clear that there is a need for greater attention to developing sustainable land use practices in management of these soils. In addition, the development of agricultural research and extension service to develop and disseminate improved varieties and successful production practices are needed to restore agricultural productivity.

Can using the unmanned aerial vehicle (UAV) used in exploitation of mineral resources investigation, Detection of ecological environment information, Including land destroyed range, damage to vegetation, scope of scope of scope of dust pollution, water pollution, desertification and land reclamation.

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Offices

1. Agriculture directorate in Maysan, department of planning.
2. Agriculture directorate of Maysan, department of marshes recovery.
3. Directorate of water resources in Maysan.
4. General Commission of ground water in Maysan.
5. General Commission of ground water. Ministry of planning.
6. Marine science center in university of Basrah.
7. Marshes recovery center in Maysan.
8. Ministry of Water Resources.
9. The state board of meteorological and seismology in Maysan.