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Zian and Qalabshu, the Area of Future Development Dakahlyia Governorate, Egypt

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Abstract

Salinity is a major problem throughout the world. The present work was carried out on seventy samples collected from Zian and Qalabshu. Analysis carried out of selected ten drainage and four subsoil water samples represent the water resources of the study area. Aim of the present work was to suggest the best and scientific method of utilization and conservation of soil and water for the future development in the area. The results showed that, samples of El-Nil canal fall in high saline water class. Though such water is permissible for irrigation but may cause a harmful effect on crops. It may be suitable for plants of moderate tolerance. Samples of El-Sokar factory canal at the front of factory gate, rejection area of drain-2-station and suction area of drain-2-station, El-Gamaiat canal and subsoil-1 fall in very high saline class which is of doubtful quality for irrigation. Samples of El-Sokar factory canal 1km away from factory gate, immersed area by water, El-Moheet drain and subsoil samples fall in the excessive saline water class which is of unsuitable quality for irrigation. The depth to water in the area ranges between 75 cm and 175 cm. The closeness of the subsoil water to the ground surface is harmful to the crop yield in the agricultural areas. To avoid the serious problem of salinity, the subsoil water has to be lowered either horizontally by relatively deep surface drains or vertically dewatering from the wells.

Keywords: Anions, Cations, Drainage water, Salinity, Subsoil water

1. Introduction

Dakahlyia governorate is one of the most highly populated governorates in the Nile Delta. Damietta Nile branch crosses the governorate from Mit-ghamr to Shirbin (Fig.1). The total population of Dakahlyia governorate is about 5 million. Its area is about 825,000 feddans, where the total agricultural land is about 785,000 feddans. The increased rate of population, feeding, housing and employment entails increased demand for food from the existing agricultural areas, reclamation of new lands and intensified water use. More attention must be given for conserving soil and water resources. The study area Zian-Qalabshu (fifty thousand feddans), Bilqas district is located at the western north part of Dakahlyia governorate. Aim of the work is to suggest the best and scientific methods of utilization and conservation of soil and water for the future development in the area.

2. Hydrology of the Study Area

The subsoil section of the selected areas consists mainly of sand, silt and clay lenses. The depth of water in boreholes dug in the area ranges from 75 to 175cm, the variation in depth to water of the subsoil zone is possibly attributed to the surface relief, the misuse of irrigation water and the inadequate drainage system. Moreover, the piezometric surface of the groundwater in this zone is governed by the hydrostatic pressure, due to the presence or absence of the impervious hard sticky clays at the bottom of the subsoil section. Certainly, the relation between the subsoil water and the deep groundwater is very important for future studies.

3. Materials and Methods

3.1 Water sampling

The present work was carried out with the collection of seventy samples. Concerning the analysis of present study, ten drainage and four subsoil water samples were selected which represent the water resources of the selected areas (Table 1 and Fig 1). The water samples were subjected to chemical analysis. The analysis carried out includes the determination of TDS (Total Dissolved Solids), pH, EC (Electrical Conductivity), concentration of major ions namely K^+, Na^+, Mg^{++}, Ca^{++}, Cl^-, CO_3^{--}, HCO_3^{--} and SO_4^{--}. The minor component of the soil 'boron' was also estimated from the study area. The values of cations and anions were expressed in parts per million.

4. Results and Discussion

In relation with analysis of water samples, ten drainage and four subsoil representative water samples of the water resources in the study area were selected. Our results showed that the pH for drainage-subsoil samples ranges from 7.5 to 8.5; a slightly alkaline to alkaline. EC of the water samples ranged from 1590.32 µmhos/cm at 25 ^{0}C of sample 1 to 47135.456 µmhos/cm at 25 ^{0}C of sample 12. The higher EC is consequent to the high sodium and chloride ions content in the water.

4.1 Salinity and Total Dissolved Solids

In general salinity is high when Total Dissolved Salts (TDS) values are high. The TDS content of the water samples were found to range from 956.4 ppm (sample No 1) to 28564.48 ppm (sample No 12). Samples 1 and 2 reflect a fresh water type while other samples reflect a brackish to a brine water type. The brackish water reflects the impact of leaching and solubility of the marine aquifer sediments (Table 2).

4.2 Major Cations

The values obtained for major cations are represented in Table 2. Potassium content in water is generally lower than sodium content and represents the least dominant cations. It ranges between 5.60 ppm (sample 1) to 610 ppm (sample 5). Sodium is the most predominant ion in natural water. In our study, it ranges from 49 ppm (sample 1) to 5167.67 ppm (sample 5). However, the sodium content is very important in assessing water for domestic and irrigation purposes. Magnesium occurs mainly in the ionic form in water. It dissolves readily in water as bicarbonate. In the present investigation concentration of magnesium varied from 17.68 ppm (sample 10) to 2381.9 ppm (sample 12). Calcium is easily dissolved in water; however carbonate rocks are the principal source for Ca^{++}. In the present study, Ca^{++} values ranged between 45 ppm (sample 2) to 1082.2 ppm **(**sample 12).

4.3 *Major Anions*

The values obtained for major anions are represented in Table 2. Chlorides are generally the most common salts of the earth's crust. The occurrence of chlorides depends on the type of environment during deposition. The chloride content is very important in assessing water for domestic and irrigation purposes. In the present study, chlorides varied from 65.9 ppm (samples o 1 and 2) and 21027 ppm (sample 12). Sulphate (SO_4^{--}) is considered the second predominant anion after chloride; it varies in content from 78 ppm (sample 1) and 2600 ppm (sample 13). Carbonates and bicarbonates are the less dominant anions in natural waters. Solubility of carbonate increases markedly in the presence of CO_2 in water, forming the highly soluble bicarbonate. In this study, bicarbonates were found to range between 465 ppm (sample 10) and 2376.45ppm (sample 3).

Table 1: Sampling Location in Zian - Qalabshu area, Bilqas district

Sr. No.	Name of the Sampling Site	Number of Samples
1)	El-Nil canal at the front of el-Adala canal	1
2)	El-Nil canal at the convergence of el-Gamaiat canal	1
3)	El-Sokar canal (1 Km of factory gate**)**	1
4)	El-Sokar canal at the front of factory gate	1
5)	Drain-2-station (Rejection area)	1
6)	Drain-2-station (Suction area)	1
7)	El-Gamiat canal (1 Km from the high way)	1
8)	El-Gamiat Canal at the convergence of el-Nil canal	1
9)	El-Moheet drain	1
10)	Area immersed by water (9 Km from the high way)	1
11)	Subsoil-1 3.5 Km from the high way (1.25 m deep)	1
12)	Subsoil-2 7.75Km from the high way (0.75 m deep)	1
13)	Subsoil-3 15Km from the high way (1.5 m deep)	1
14)	Subsoil-4 8 Km from the international road (1.5 m deep)	1

First ten samples were of Drainage water while remaining four samples were collected from Sub-soil area

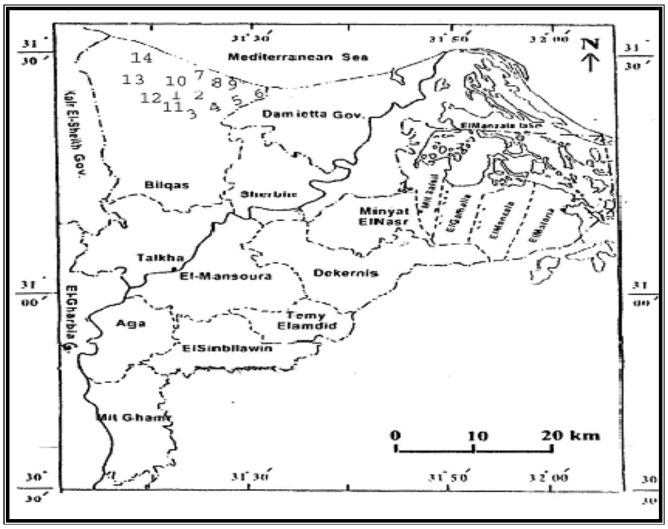

Fig. 1: Sampling Locations for the Drainage Subsoil Water Samples in the Study Area of Dakahlyia Governorate

Table 2: Chemical Analysis of the Study Samples expressed in ppm

Sr. No	TDS (ppm)	K^+	Na^+	Mg^{++}	Ca^{++}	Cl^-	SO_4^{--}	HCO_3^-
1	956.4	5.60	49.0	57.6	56.0	65.9	78.0	644.3
2	983.54	6.0	50.0	60.12	45.0	65.9	89.0	667.52
3	9320.65	107.5	820.0	1895.8	480.9	1640	2000.0	2376.45
4	2105.8	12.5	315.56	102.1	72.14	567.4	100.0	936.1
5	12738.56	610	5167.67	1895.79	801.6	1242.50	2000.0	1021.0
6	2707.28	12.0	440.0	247.9	72.14	937.0	215.0	783.24
7	2981.25	12.0	390.0	297.2	80.1	760.0	225.0	1216.95
8	2731.11	13.0	586.73	121.5	80.16	914.125	270.0	745.6
9	3040.16	20.0	667.69	177.43	68.14	1331.25	266.0	509.65
10	5517.04	80.0	1607.93	17.68	220.44	2025.99	1100.0	465.0
11	3217.01	18.0	680.34	150.7	112.22	1153.75	322.0	7800.0
12	28564.48	150.0	2013.74	2381.9	1082.2	21027	1200.0	710.0
13	8830.7	50.0	1756.97	315.97	681.36	2662.5	2600.0	763.9
14	6631.07	230.0	1702.0	167.64	64.13	1773.0	1000.0	1604.3

5. Evaluation and suitability of Drainage-Subsoil Water for Irrigation:

The relation between some ions in water affects to great extent, its quality and the physical properties of the irrigated soil. The increase in salinity of irrigation water leads to increase in its percentage in the soil, which damage growth and yield of plants. The quality requirements of irrigation water vary with the crops, types and drain ability of soils and climate (Bower, 1978). The depth of water in the selected areas ranges between 75 cm and 175 cm. The closeness of the subsoil water to the ground surface is harmful to the crops yield in the cultivated areas. To avoid this serious problem, the subsoil water has to be lowered either horizontally by relatively deep surface drains or vertically by dewatering from wells. Certainly, the relationship of the subsoil water to the deep groundwater is very important for future development of this area. Such type of study needs not only shallow to moderate drilling, but also deep boring to penetrate subsurface zones in the surrounding localities. More detailed classification and strict standards will help for the evaluation water quality. Examination carried out of drainage-subsoil water samples is shown in Table 3, 4 and 5. Samples 1 and 2 fall in high saline water class, which is permissible for irrigation but due to high value of electrical conductivity, it may cause a harmful effect. Such water may be suitable for plants of moderate tolerance to salinity. Samples 4, 6, 7, 8 and 9 fall in very high saline class, which is of doubtful quality for irrigation. Samples 3, 5, 10, 11, 12, 13 and 14 fall in the excessive saline water class, which is totally unsuitable for irrigation. The classification of the United States salinity laboratory (1954) is based on the Sodium Adsorption Ratio (SAR) and the specific conductivity (EC) in µmhos/cm. The ratio between Na and Mg^{++} + Ca^{++} contents from the following equation, affects greatly to the physical properties and use of soil. It is interested to follow the distribution of SAR as indicative of the probable extent to which the soil adsorbs ions from water. SAR is important for the assessment of the suitability of groundwater for irrigation purpose. Generally, irrigation water with low SAR is much desirable.

$$\mathrm{SAR} = [\mathrm{Na}^{+}] / \{([\mathrm{Ca}^{++}] + [\mathrm{Mg}^{++}]) / 2\}^{1/2}$$

In comparison with the standard guidelines suggested by United States Salinity Laboratory Staff (1954), All subsoil samples show high EC and is an indication that water content of these areas is not satisfactory for irrigation purposes, although SAR is 7.8 and 12.76 for subsoil samples 11 and 13.

Table 3: United States Salinity Laboratory Classification as per Salt Concentration

Sr. No.	Water class quality	TDS (ppm)	E.C. µ mhos/cm at 25 °C	No of sample
1)	Low saline water	<160	0-250	-
2)	Medium saline water	160 – 480	250- 750	-
3)	High saline water	480 – 1440	750 – 2250	1, 2
4)	Very high saline water	1440 – 3200	2250 – 5000	4, 6, 7, 8, 9
5)	Excessive saline water	>3200	>5000	3, 5, 10, 11, 12, 13, 14

Table 4: Electrical Conductivity Classification According to Hammad, 1985

Sr. No.	E.C (µmohs/cm at 25 °C	No. of samples	Water class
1)	Less than 250	-	Excellent
2)	250 – 750	-	Good
3)	750 – 2000	1, 2	Permissible
4)	2000 – 3000	4	Doubtful
5)	More than 3000	3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	Unsuitable

Table 5: SAR and EC for Subsoil Samples

Sr. No.	No of sample	EC µmhos/cm	SAR
1)	11	5343.97	7.80
2)	12	47135.46	11.38
3)	13	14586.99	12.76
4)	14	10987.56	21.98

6. Distribution of Boron

The natural sources of boron in water are igneous and volcanic rocks. Sallouma *et al.* (1998) were observed the boron concentration in groundwater samples with less than 1 mg/l. Traces of boron are needed for all plants but many plants species suffers a negative effect at the concentration of more than 1ppm (Wilber, 1969). Sodium tetra borate is widely used in detergent formulations for bleaching and cleaning. As a consequence, boron is commonly found in domestic sewage and natural waters.

Boron is an essential plant food, but it is toxic at higher concentrations. For this reason, irrigation water should not contain more than 2ppm of boron depending on crops and soil. In the present study the drainage-subsoil samples showed the concentration of boron within permissible limit. According to National Academy of Science (NAS) and the National Academy of Engineering (NAE, 1972) the favorable concentration for crops ranges between 0.145 to 0.398 ppm (Table 6).

Table 6: Boron Concentration of Some Drainage-Subsoil Samples

Sr. No.	Name of Sample	B (ppm)	NAS and NAE for concentration of Boron, 1972	
1)	El-Nil canal	0.154	0.75 ppm	Sensitive crops
2)	El-Nil canal	0.145		
3)	El-Gamaiat canal	0.265	1 ppm	Semi-tolerant crops
4)	El-Gamaiat canal	0.343		
5)	Subsoil 1	0.398	2 ppm	Tolerant crops

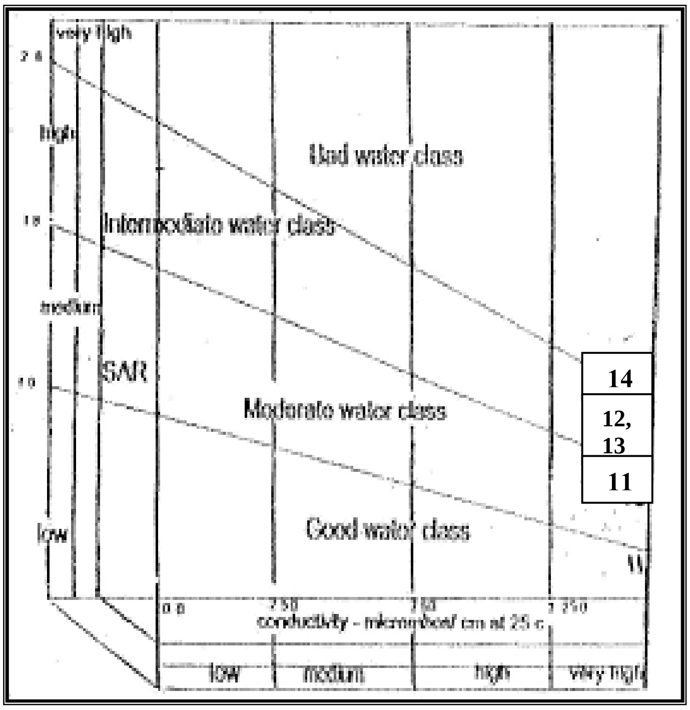

Fig. 2: United Salinity Diagram for Classifying Irrigation Water of Zian- Qalabshu District

6. Conclusion

Samples collected from El-Nil canal fall under high saline water class but within permissible limit for irrigation. It may also cause slight harmful effect on the agricultural crops. It may be suitable for plants of moderate tolerance. Samples of El-Sokar canal at the front of factory gate, rejection area of drain-2-station, and suction area of drain-2-station, El-Gamaiat canal, and subsoil-1 comes under very high saline class, which is of doubtful quality for irrigation as per the standards. Samples of El-Sokar canal 1km away from factory gate, an immersed area by water, El-Moheet drain and subsoil samples fall in the category of excessive saline water class, which is of unsuitable quality for irrigation.

7. Recommendations

Based on the results obtained it is recommended that:

1) Drilling operations should be carried to further assess the quality of the water; for the same PVC observation wells with 2 inch in diameter should be dug to a depth of 20 m to determine: a) Level, direction and velocity of water movement b) Type of water and c) Efficiency of using drainage system.
2) There is need to prepare detailed topographic map of the area to determine high, low and plain lands for agricultural management.
3) Modern irrigation techniques specially sprinkling and drop-by-drop irrigation systems should be promoted to save water and to reduce percolation hazard in the area.

4) Excessive groundwater use and lowering of table by withdrawal should be checked and needs controlled, pre-estimated management to reduce damage due to salinity in the cultivated lands.
5) Salt tolerant crop species should be used in salt affected soils.

8. Acknowledgement

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