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Full Length Research Paper

Utilization and conservation of soil and water samples from Zian and Qalabshu in Egypt

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The present work was carried out on fifty water samples collected from Zian and Qalabshu during May 2010. Analysis carried out on the selected ten drainage and four subsoil water samples represent the water resources of the study area. The aim of the present work is 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, it 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 the 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 (1 km away from the factory gate), immersed area of water, El-Moheet drain and subsoil samples, fall in the excessive saline water class which is of unsuitable quality for irrigation. To avoid the serious problem of salinity, the subsoil water was lowered either horizontally by relatively deep surface drains or vertically dewatering from the wells.

Key words: Drainage water samples, subsoil water samples, boron.

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 (Figure 1). The total population of Dakahlia governorate is about 5 million inhabitants. Its area is about 825,000 feddans, whereas the total agricultural land is about 785,000 feddans* (*Feddan is divided into 24 Kirats of 175 m^2).

The increased rate of population, feeding, housing and employment entails increased demand for 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. The aim of this work is to suggest the best and scientific method of utilization and conservation for soil and water of the future development area.

Hydrology of the study area

The subsoil section consists mainly of sands, silt and clay lenses. The depth to water in the boreholes dug in the area ranges from 75 to 175 cm, while the variation in depth to water of the subsoil zone is possibly attributed to the surface relief, the mis-use 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.

MATERIALS AND METHODS

Water sampling

The present work was done on fifty water samples collected during May 2010. Concerning the analyses, ten drainage and four subsoil water samples represented the water resources in the study area (Figure 1). The water samples were subjected to chemical analysis. The analysis includes the determination of TDS, pH, EC, and

- Wilber, C.G., (1969): The biological effect of water pollution. Springfield, Illinois, C.C., Thomas.

Figure (1) Location map for the drainage subsoil water samples

Figure 1. Location map for theindrainagethestudy areasubsoilofDakwaterhlyiasamplesGovernoratein the study area of Dakahlyia Governorate.

the concentration of major ions (K^+, Na^+, Mg^{++}, Ca^{++}, Cl^-, CO_3^{--}, HCO_3^{--} and $SO4^{--}$). The minor component of Boron was also required for studying the nature of this area. The obtained chemical data were expressed in parts per million (ppm), mill equivalent per million (epm), and percentage reacting values (%).

RESULTS

Concerning this study's analysis, ten drainage and four subsoil water samples represented the water resources in the study area. The pH for drainage-subsoil samples ranges from 7.5 to 8.5, and was slightly alkaline to alkaline.

Electrical conductivities (E.C) ranged from 1590.32 µm/cm at 25°C at Sample No. 1 to 47135.456 µm/cm at 25°C at Sample No. 12. The high E.C . value was as a result of the high sodium and chloride ions contents.

Salinity

Salinity or total dissolved salts (TDS) values obtained were found to range from 956.4 ppm (sample No. 1) to 28564.48 ppm (sample No. 12). Samples No. 1 and 2 reflect a fresh water type and 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 1).

Major cations

Potassium

It is generally lower than sodium content and it represents

Table 1. Results of chemical analysis of the study samples in ppm.

S/N	TDS mg/l	K^+	Na^+	Mg^{++}	Ca++	Cl^-	$SO4^{--}$	$HCO3^-$
1	956.4	5.60	49	57.6	56	65.9	78	644.3
2	983.54	6	50	60.12	45	65.9	89	667.52
3	9320.65	107.5	820	1895.8	480.9	1640	2000	2376.45
4	2105.8	12.5	315.56	102.1	72.14	567.4	100	936.1
5	12738.56	610	5167.67	1895.79	801.6	1242.50	2000	1021
6	2707.28	12	440	247.9	72.14	937	215	783.24
7	2981.25	12	390	297.2	80.1	760	225	1216.95
8	2731.11	13	586.73	121.5	80.16	914.125	270	745.6
9	3040.16	20	667.69	177.43	68.14	1331.25	266	509.65
10	5517.04	80	1607.93	17.68	220.44	2025.99	1100	465
11	3217.01	18	680.34	150.7	112.22	1153.75	322	780
12	28564.48	150	2013.74	2381.9	1082.2	21027	1200	710
13	8830.7	50	1756.97	315.97	681.36	2662.5	2600	763.9
14	6631.07	230	1702	167.64	64.13	1773	1000	1604.3

the least dominant cations. It ranges between 5.60 (sample No. 1) and 610 ppm (sample No. 5) (Table 1).

Sodium

Sodium is the most predominant ion in water samples. In this study, it ranges from 49 ppm (sample No. 1) to 5167.67 ppm (sample No. 5). However, the sodium content is very important in assessing water for domestic and irrigation purposes (Table 1).

Magnesium

It occurs mainly in the ionic form in water. In the studied samples, concentration of magnesium varies from 17.68 ppm (sample No. 10) to 2381.9 ppm (sample No. 12) (Table 1).

Calcium

It easily dissolves in water; however carbonate rocks are the principal source for Ca^{++}. In the present study, Ca^{++} is more common than other ions and detected in values ranging between 45 (sample No. 2) and 1082.2 ppm (sample No. 12) (Table 1).

Major anions

Chloride

Chlorides are generally the most common ions found in 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 vary from 65.9 ppm (samples No. 1 and 2) to 21027 ppm (sample No. 12) (Table 1).

Sulphate

It is considered as the second predominant anion after chloride; it varies in content from 78 ppm (sample No. 1) to 2600 ppm (sample No. 13) (Table 1).

Carbonates and Bicarbonates

They are the less dominant anions. Solubility of carbonate increases markedly in the presence of CO_2 in water, forming the highly soluble bicarbonate. In this study, bicarbonate is found to range between 465 ppm (sample No. 10) and 2376.45 ppm (sample No. 3) (Table 1).

DISCUSSION

The relation between some ions in water affects to a great extent, its quality and the physical properties of the irrigated soil. The increase of salinity in irrigation water may cause salinization of soil, which damage the growth and yield of plants. The quality requirements of irrigation water vary between the different crops, types and drain ability of soils and climate (Bower, 1978). The depth to water table is very important and ranges between 75 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. Classification and standards which help for the evaluation of the examined drainage - subsoil water samples are

Table 2. U.S. Salinity Laboratory classification according to salt concentration.

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

Table 3. Classification according to E.C. (Hammad, 1985).

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

Table 4. Results of SAR and EC for subsoil samples.

No of sample	EC µm/cm	SAR
11	5343.97	7.8
12	47135.456	11.38
13	14586.987	12.76
14	10987.563	21.98

shown in Tables 2, 3 and 4. Samples No. 1 and 2 fall in the high saline water class, which is permissible for irrigation limit (due to E.C) and which may cause a slight harmful effect. They may be suitable for plants of moderate tolerance. Samples No. 4, 6, 7, 8 and 9 all fall in the very high saline class, which is of doubtful quality for irrigation. Samples No. 3, 5, 10, 11, 12, 13 and 14 fall in the excessive saline water class, which is unsuitable for irrigation. The classification of the U.S Salinity Laboratory (1954), as shown in Figure 2, is based on the sodium adsorption ratio (SAR) and the specific conductivity (EC) in µ mhos /cm. The ratio between Na and (Mg^{++} + Ca^{++}) contents from the following equation affects greatly the physical properties and use of soil. It is interesting 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 purposes. Generally, irrigation water with low SAR is much desirable:

$$\text{SAR} = \text{Na} \Big/ \sqrt{\frac{(Ca^{++} + Mg^{++})}{2}}$$

epm

According to U.S. Salinity Laboratory Staff (1954), all subsoil samples show high E.C. which indicate that this water is not satisfactory for irrigation purposes, although SAR is 7.8 and 12.76 for subsoil Samples No. 11 and 13.

Distribution of boron

The natural sources of boron in water are igneous and volcanic rocks.

Boron in groundwater mostly occurred at concentration of less than 1 mg/l (Sallouma et al., 1998). Traces of boron are needed for all plants; many plants are harmed by the concentration of more than 1 ppm (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 nutrient, but it is toxic at higher concentrations. For this reason, irrigation water should not contain more than 2 ppm of boron depending on crops and soil. Here, in the drainage-subsoil samples, the concentration of boron within permissible limit (sensitive crops) according to NAS and NAE (1972) ranges between 0.145 and 0.398 ppm (Table 5).

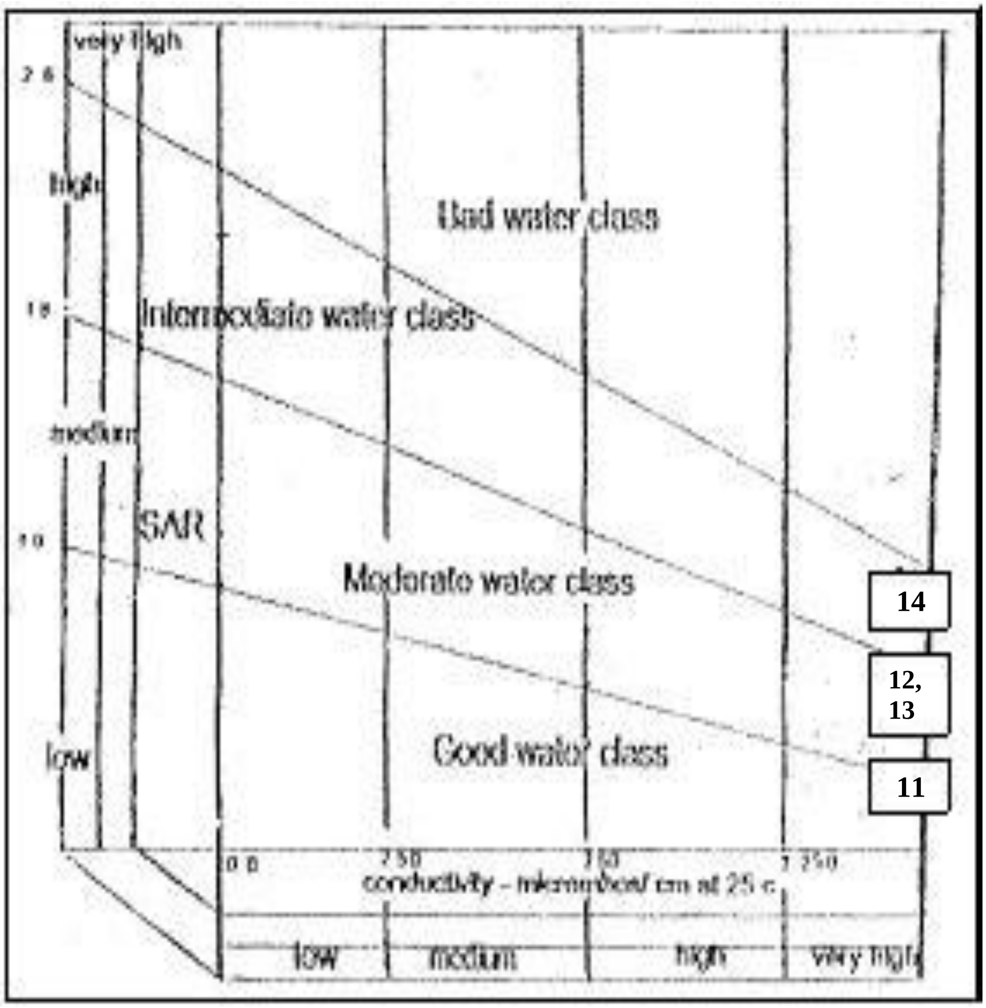

Figure 2. U.S. (2) Salinity U.S diagram. Salinity for diagram classifying for irrigation classifying water irrigation of Zian – Qalabshu water of district (U.S. Salinity Laboratory Stuffs, 1954).

Zian – Qalabshu district (U.S. salinity laboratory stuffs, 1954)

Table 5. Result of Boron (B) of some drainage-subsoil samples.

No./Sample name	B (ppm)	NAS and NAE (1972) concentration of Boron (ppm)	Type of crop
1 - El-Nil canal	0.154	0.75	Sensitive crops
2 - El-Nil canal	0.145	1	Semi-tolerant crops
8 - El-Gamaiat canal	0.265	2	Tolerant crops
9 - El-Gamaiat canal	0.343		
11 - Subsoil 1	0.398		

Conclusions

Samples of el-Nil canal fall in the high saline water class which is permissible for irrigation and may cause a slight harmful effect. 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, and samples of el-Gamaiat canal and subsoil-1 all fall in the very high saline class, which is of doubtful quality for irrigation, while samples of el-Sokar canal (1 km away from factory gate, with an immersed water area), el-Moheet drain and subsoil samples all fall in the excessive saline water class, which is of unsuitable quality for irrigation.

RECOMMENDATIONS

On the light of the results obtained through the study made on the area, the following recommendations are made:

1. Drilling and preparation of some observation wells should be done at a 20 m depth (PVC - 2 inches in diameter), and should be used to determine:

(A) Level, direction and velocity of water movement.
(B) Type of water.
(C) Efficiency of using drainage system.

2. Preparation of a topographic map for the area (to determine high, low and plain lands).

3. Using modern irrigation techniques (drip irrigation) for saving excess water, for example, sprinkling and drop by drop irrigation systems to reduce percolation hazard in the area.

4. Lowering of the groundwater table by excessive withdrawal under controlled and pre-estimated management to reduce salinity damage of the cultivated soil.

5. Selection of salt tolerant crops for the highly salt affected soils.

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