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EVALUATE THE WATER SUITABILITY FOR IRRIGATION OF DIFFERENT STREAMS USING NUMERICAL MODELS

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ABSTRACT: Water quality of the main streams in Sharia Governorate were evaluated using the water quality index (WQI) technique and Piper diagram. A water quality index provides a single number that expresses the overall water quality at a certain location and time based on several water quality parameters. Several essential parameters were investigated such as pH; electrical conductivity (EC), main cation, anions, Iron (Fe), Cobalt (Co), Nicle (Ni), and Cadmium (Cd) were taken for the calculation of WQI and the Piper diagram. The results of the water quality index in the spring season at El-Wadi Canal, Abu El-Akhdar Canal and Bahar El-Baqar drain were 164.5, 159.38 and 303.6 that classified the water suitability for irrigation as unfit for irrigation, unfit for irrigation and unfit for irrigation, respectively. While the WQI for the same locations in the autumn seasons were 72.3, 8.7, and 96 that classified the water suitability for irrigation as fair, excellent and poor for irrigation, for El-Wadi Canal, Abu Elakhdar canal and Bahar El-Baqar drain respectively. The impact of various anthropogenic activities was evident on some parameters such as the EC, alkalinity and hardness. The Piper diagram enables us to determine the ionic composition of the water samples and their classifications. It is suggested that monitoring of the drain is necessary for proper management. Application of the WQI is also suggested as a very helpful tool that enables the public and decision-makers to evaluate water quality of Egypt Lakes.

Key words: Water quality index, piper diagram, water suitability, irrigation, streams, drain.

INTRODUCTION

Water is an essential requirement of human and industrial developments and it is one the most delicate part of the environment **(Hendy *et al.,* 2023)**. Tremendous increase in the demand for freshwater due to rapid growth of population and the accelerated pace of industrialization **(El-Bastamy *et al.,* 2021)**. Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and unsanitary conditions **(Ibrahim *et al.,* 2022)**. The availability of water in shows a great deal with spatial and temporal variability. The increase in population and expansion of economic activities undoubtedly leads to increasing demand for water use for various purposes. Water quality index (WQI) is commonly used tool for the detection and evaluation of water quality and may be defined as a reflection of composite influence of different quality parameters on the overall quality of water **(Horton, 1965)**. It is based on physical, chemical, and biological factors that are combined into a single value ranges from 0 to 100 and involves 4 processes: (1) parameter selection, (2) transformation of the raw data into common scale, (3) providing weights and (4) aggregation of sub-index values.

Water is the vital natural resource with social and economic values for human beings **(Zelenakova *et al.,* 2018; Ibrahim *et al.,* 2022)**.

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The optimal quantity and acceptable quality of water is one of the essential needs to survive as mentioned earlier, but the maintenance of an acceptable quality of water is a challenge in the sector of water resources management **(Das and Acharya, 2003; Zelenakova *et al.*, 2018)**. Accordingly, the water quality of water bodies can be tested through changes in physical, chemical and biological characteristics related to anthropogenic or natural phenomena **(Ramakrishnaiah *et al.*, 2009; Abd-Elaty *et al.*, 2019**). Therefore, water quality of any specific water body can be tested using physical, chemical and biological parameters also called variables, by collecting samples and obtaining data at specific locations (**Abd-Elaty *et al.*, 2019; Hendy *et al.*, 2023)**. Thus, the suitability of water sources for human consumption has been described in terms of Water Quality Index (WQI), which is one of the most effective ways to describe the quality of water, by reducing the bulk of information into a single value ranging between 0 and 100 **(Tyagi *et al.*, 2013)**.

With a growing population and intensified industrial and agricultural activities, large amounts of untreated urban municipal, industrial wastewater, and rural domestic wastes discharge into the river Nile, canals, or agricultural drains which become an easy dumping site for all kinds of wastes. According to **Ibrahim *et al.* (2022)** the main industrial sectors are oil and soap, starch yeast glucose, pulp and paper, metal industry, plastic and rubber, and textile and dyeing. In the irrigated areas, the level of applied water is generally higher than necessary to prevent salt accumulation in the root zone of the soil. In a system of drainages (~18000 km length) the excess water carrying salts and chemical residues is collected and either pumped into irrigation canals for reuse or pumped into the river Nile or the northern lakes or the Mediterranean. Using the water twice or even three times increases the salinity, especially in drains near the lakes bordering the Mediterranean Sea. In Egypt about 0.9 million ha of irrigated land were damaged by salt, corresponding to about 33% of the total irrigated land **(Okeke and Igboanua, 2003)**. The mixing of drain water with clean water diffuses all kinds of constituents that still have negative environmental and health impacts. Without seasonal flushing floods, the former delta plain surface is now incapable of recycling and or removing agricultural, municipal, and industrial waste generated by Egypt's rapidly expanding population. The necessary expansion of the water supply services is not always fitting to the conjugate development of the sewerage system. This results in an increasing pollution load to canals and drains the Bahr El-Baqar drain system is a typical example **(Rahi and Halihan, 2010)**.

MATERIAL AND METHODS

The water quality of the Bahr El-Baqar Drain system in Egypt was studied in 2022–2023. The section of the drain system called Bilbeis Drain starts in the eastern zone of Greater Cairo, where all sewage and industrial wastewater, treated or untreated, is dumped into this drain. Near Zagazig, the Bilbeis and Qalubeya Drains flow together to form the Bahr El-Baqar Drain. Along its way from Cairo down to Lake Manzala, there are a lot of discharges, like agricultural run-offs, in the northeastern cultivated areas. Large amounts of untreated urban municipal water are discharged into the drain in larger cities or villages. At 3 different sites along the Abou-Lakhder, El-Wady, and Bahr El-Baqar Drains water samples were taken and analysed for some parameters (pH, EC, Ca, Mg, Fe, Mn, Zn and Cu), salts and heavy metals (Table 1).

The research provides solutions to environmental problems by developing and promoting techniques that help to protect and improve the environment by advancing scientific information to support regulatory and policy decisions, providing technical support, and transferring information to ensure the implementation of environmental regulations and strategies at the national, state and community levels.

Study Area

Bahr El-Baqr drain (BBD) is the largest and most polluted drain **(Jones *et al.*, 2008)** of the seven drains discharging in Lake Manzala (5.5 billion m^3/day). The drain originates from Cairo, collecting agricultural, industrial, and sewage water for three other governorates before reaching Lake Manzala with a total length of

Table 1. Some water analysis of strains water used in the study

Parameters	PH	Ec	Ca	Mg	Fe	Mn	Zn	Cu
				Spring				
El- Wadi Canal	7.68	1.16	1.17	4.21	1.44	0.66	0.25	0.046
Abu Elakhdar Canal	7.60	0.92	2.30	1.64	1.83	0.63	0.26	0.053
Bahr El- Baqar drain	7.94	1.33	2.66	3.60	1.85	1.23	0.54	0.077
				Autumn				
El- Wadi Canal	8.22	1.12	2.18	3.91	2.14	0.051	0.004	0.007
Abu Elakhdar Canal	7.89	0.96	1.03	2.44	0.63	0.002	0.001	0.001
Bahr El- Baqar drain	8.26	1.54	3.68	4.86	2.88	0.075	0.006	0.009

more than 200 km. Wastewater in the drain is composed of particulate, nutrients, heavy metals, hydrocarbons, and residues of toxic compounds such as herbicides and pesticides **(Sargaonkar and Deshpande, 2003).** Although Bahr El-Baqr is the largest drain in the Eastern Delta, it was excluded from supplying the El-Alam Canal delivering mixed drainage and fresh water to Sinai due to the high level of pollution. This condition results in the loss of large amounts of water that could have been reused for irrigation (Fig. 1).

Collection of Water Samples

All samples were examined according to water and wastewater examination standards **(Shultz, 2001)**. Water samples collected were in clean and sterile polyethylene plastic bottles from the canals. All samples were stored using an ice box and were immediately sent to the laboratory for analysis. All analyses were carried out at the Soil and Water Research Institute, Cairo, Egypt.

Water samples analysis

All analyses were done according to Water and Waste Water Examination Standards **(APHA, 1998).**

Physico-chemical analysis

All field parameters including pH, Temperature, electric conductivity (EC), and total dissolved solids (TDS) were carried out in the field by utilizing the multi-probe system. Then the water samples were rechecked in the laboratory to ensure data accuracy. As soon as the samples were received in the lab, they were mixed by shaking and examined for different cations and anionsby the method of **APHA (1998)** as follow: calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and Cloride (Cl), Carbonate and Dicarbonate, and sulfate (SO_4). Also, the certain heavy metals such as Lead (Fe), Cobalt (Co), Nicle (Ni), and Cadmium (Cd) were examined by the same method.

Water Quality Index (WQI)

The water quality index is a 100-point scale that was used to summarize results from a total of eight measurements by using Microsoft Excel Version, 2013 according to National Sanitation Foundation, USA. The used parameters are: pH, EC, Ca, Mg, Fe, Mn, Zn and Cu. The WQI makes the reduction of large amounts of data, thus ranking water into one of five categories. The steps for Water quality index (WQI) are:

The quality rating scale for each parameter qi was calculated by using this expression:

$$qi = (Ci / Si) \times 100$$

A quality rating scale (qi) for each parameter is assigned by dividing its concentration (Ci) in each water sample by its respective standard (Si) and the result multiplied by 100.

Unit weight (Wi) was calculated by a value inversely proportional to the recommended standard (Si) of the corresponding parameter:

$$Wi = 1 / Si$$

The overall WQI was calculated by aggregating the quality rating (Qi) with unit weight (Wi) linearly:

$$WQI = \left(\sum_{I=1}^{i=n} wi\ qi\right)$$

Overall WQI = Σ qi wi / Σ wi

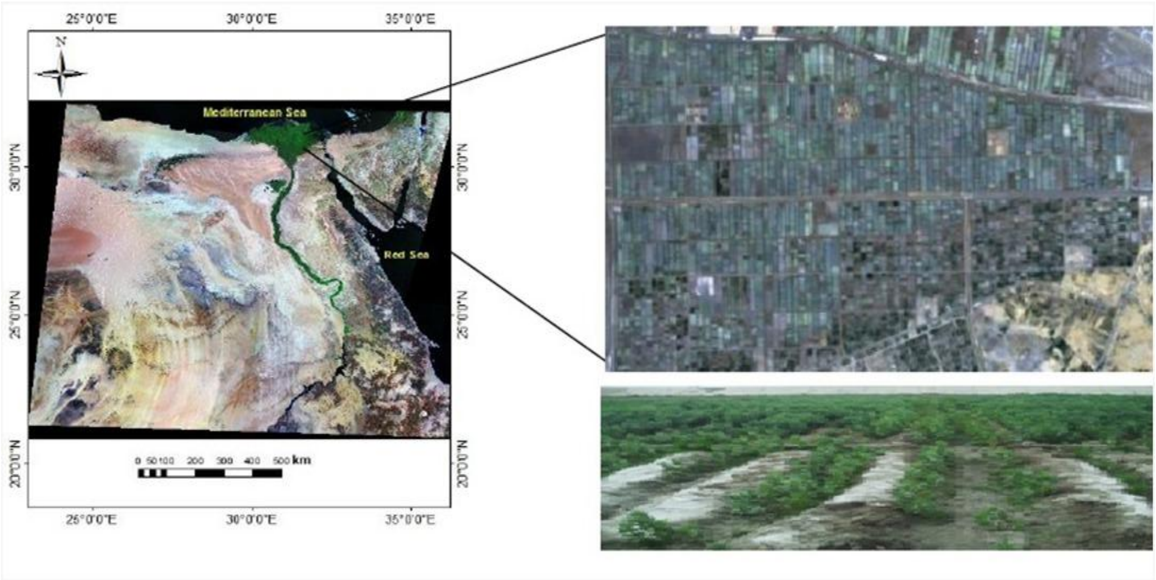


Fig. 1. Water sample location in Sharkia governorate, Egypt

Table 2. Water quality classification based on WQI value (C.R. Ramakrishnaiahet al. 2009 & FAO, 2004).

S.No	WQI	Status	Possible usages
1	**0-25**	Excellent	Drinking,Irrigation and Industrial
2	**25-50**	Good	Domestic, Irrigation and Industrial
3	**51-75**	Fair	Irrigation and Industrial
4	**76-100**	Poor	Irrigation
5	**101-150**	Very poor	Restricted use for Irrigation
6	**Above 150**	Unfit for irrigation	Proper treatment required before use

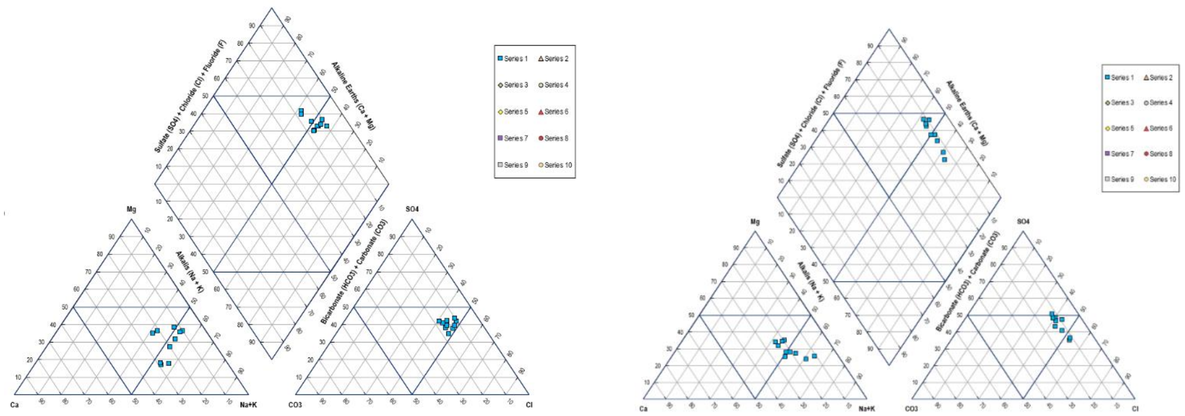
RESULTS AND DISCUSSIONS

Hydrogeochemical Water Types

To identify the chemical facies of the waters of the investigated sites showed that in the spring the major ions were plotted on a Piper diagram (Fig. 2a). The Piper diagram enables us to determine the ionic composition of the water samples and their classifications. The waters of the investigated streams in the spring season show three types of facies: 50% of the water samples have Na–Ca–Cl–HCO_3 facies, 23% of the water samples show a type facies Na–Ca–Cl–SO_4, and 27% of the water samples present Na–Cl facies. While the waters of the investigated streams in the spring season show three types of facies: 70% of the water samples have Na–Ca–Cl–HCO_3 facies, 10% of the water samples show a type facies Na–Ca–Cl–SO_4, and 20% of the water samples present Na–Cl facies (Fig. 2b).

Water Quality Index

Water quality index in the historical and the present study is established from important various physicochemical parameters in different seasons. Season water quality index calculations are depicted in Tables 3, 4, 5, 6, 7 and 8. Among all the physicochemical parameters selected for the water quality index calculation, the importance of Electrical Conductivity (EC) is due to its measure of cations which greatly affects the taste and thus has significant impact on the user acceptance of the water for irrigation



(A) (B)

Fig. 2. Hydrogeochemical water types using Piper diagram in the Spring season (a) and the Autum season (b)

Table 3. Calculation of the water quality index in the spring season at El-Wadi Canal

Parameters	Sn	$1/sn$	$\sum 1/sn$	K=$\frac{1}{\sum 1/sn}$	Wn=$\frac{k}{sn}$	Vo	Vn	$\frac{Vn}{Sn}$	Qn= $\frac{Vn}{Sn}\times 100$	Wn× Qn
pH	8.5	0.117647	10.8676	0.092017	0.010826	7	7.68	0.9035	90.35	0.97816
EC	300	0.003333	10.8676	0.092017	0.000307	0	1.16	0.00387	0.387	0.000119
Ca	75	0.013333	10.8676	0.092017	0.001227	0	1.17	0.0156	1.56	0.001914
Mg	30	0.033333	10.8676	0.092017	0.003067	0	4.21	0.1403	14.03	0.04304
Fe	5	0.2	10.8676	0.092017	0.018403	0	1.44	0.288	28.8	0.530
Mn	0.2	5	10.8676	0.092017	0.460085	0	0.66	3.3	330	151.83
Zn	2	0.5	10.8676	0.092017	0.0460085	0	0.25	0.125	12.5	0.575
Cu	0.2	5	10.8676	0.092017	0.460085	0	0.046	0.23	23	10.582
$\sum$					1.0000085					164.54

WQI= $\frac{\sum wnQn}{\sum Wn}$= $\frac{164.54}{1.0000085}$= 164.5 water classified as unfit for irrigation

Table 4. Calculation of the water quality index in the spring season at Abu El- Akhdar Canal

Parameters	Sn	$1/sn$	$\sum 1/sn$	K=$\frac{1}{\sum 1/sn}$	Wn=$\frac{k}{sn}$	Vo	Vn	$\frac{Vn}{Sn}$	Qn= $\frac{Vn}{Sn}\times 100$	Wn×Qn
pH	8.5	0.117647	10.8676	0.092017	0.010826	7	7.60	0.8941	89. 41	0.96797
EC	300	0.003333	10.8676	0.092017	0.000307	0	0.92	0.00307	0.307	0.0000941
Ca	75	0.013333	10.8676	0.092017	0.001227	0	2.30	0.031	3.1	0.00376
Mg	30	0.033333	10.8676	0.092017	0.003067	0	1.64	0.05467	5.467	0.01677
Fe	5	0.2	10.8676	0.092017	0.018403	0	1.83	0.366	36.6	0.6735
Mn	0.2	5	10.8676	0.092017	0.460085	0	0.63	3.15	315	144.93
Zn	2	0.5	10.8676	0.092017	0.0460085	0	0.26	0.13	13	0.5981
Cu	0.2	5	10.8676	0.092017	0.460085	0	0.053	0.265	26.5	12.192
$\sum$					1.0000085					159.382

WQI= $\frac{\sum wnQn}{\sum Wn}$= $\frac{159.382}{1.0000085}$= 159.38 Water classified as unfit for irrigation

Table 5. Calculation of the water quality index in the spring season at Bahar El- Baqar Drain

Parameters	Sn	$1/_{sn}$	$\sum 1/_{sn}$	K=$\frac{1}{\sum 1/sn}$	Wn=$\frac{k}{sn}$	Vo	Vn	$\frac{Vn}{Sn}$	Qn= $\frac{Vn}{Sn}$×100	Wn×Qn
pH	8.5	0.117647	10.8676	0.092017	0.010826	7	7.94	0.9341	93.41	1.01128
EC	300	0.003333	10.8676	0.092017	0.000307	0	1.33	0.00443	0.443	0.000136
Ca	75	0.013333	10.8676	0.092017	0.001227	0	2.66	0.0355	3.55	0.00435
Mg	30	0.033333	10.8676	0.092017	0.003067	0	3.60	0.12	12	0.0368
Fe	5	0.2	10.8676	0.092017	0.018403	0	1.85	0.37	37	0.6809
Mn	0.2	5	10.8676	0.092017	0.460085	0	1.23	6.15	615	282.9523
Zn	2	0.5	10.8676	0.092017	0.0460085	0	0.54	0.27	27	1.2422
Cu	0.2	5	10.8676	0.092017	0.460085	0	0.077	0.385	38.5	17.713
$\sum$					1.0000085					303.6409

WQI= $\frac{\sum wnQn}{\sum Wn}$= $\frac{303.6409}{1.0000085}$= 303.6 Water classified as unfit for irrigation

Table 6. Calculation of the Water quality index in the Autumn season at El-Wadi Canal

Parameters	Sn	$1/_{sn}$	$\sum 1/_{sn}$	K=$\frac{1}{\sum 1/sn}$	Wn=$\frac{k}{sn}$	Vo	Vn	$\frac{Vn}{Sn}$	Qn= $\frac{Vn}{Sn}$×100	Wn×Qn
pH	8.5	0.117647	125,349464	0.00797769	0.0009385	7	8.22	0.9671	96.71	0.091
EC	300	0.003333	125,349464	0.00797769	0.00002659	0	1.12	0.0037	0.37	0.0000099
Ca	75	0.013333	125,349464	0.00797769	0.00010636	0	2.18	0.0291	2.91	0.00031
Mg	30	0.033333	125,349464	0.00797769	0.0002659	0	3.91	0.1303	13.03	0.0035
Fe	5.0	0.181818	125,349464	0.00797769	0.0015955	0	2.14	0.428	42.8	0.068
Mn	0.05	20	125,349464	0.00797769	0.15955	0	0.051	1.02	102	16.27
Zn	0.2	5	125,349464	0.00797769	0.039888	0	0.004	0.02	2	0.0798
Cu	0.01	100	125,349464	0.00797769	0.797769	0	0.007	0.7	70	55.84
$\sum$					1.00014					72.36

WQI = $\frac{\sum wnQn}{\sum Wn}$= $\frac{72.36}{1.00014}$= 72.3 water classified as Fair for Irrigation

Table 7. Calculation of the Water quality index in the autumn season at Abu El- Akhdar Canal

Parameters	Sn	$1/_{sn}$	$\sum 1/_{sn}$	K=$\frac{1}{\sum 1/sn}$	Wn=$\frac{k}{sn}$	Vo	Vn	$\frac{Vn}{Sn}$	Qn= $\frac{Vn}{Sn}$×100	Wn×Qn
pH	8.5	0.117647	125.349464	0.00797769	0.0009385	7	7.89	1.1635	116.35	0.1092
EC	300	0.003333	125.349464	0.00797769	0.00002659	0	0.96	0.0032	0.32	0.0000085
Ca	75	0.013333	125.349464	0.00797769	0.00010636	0	1.03	0.0137	1.37	0.00015
Mg	30	0.033333	125.349464	0.00797769	0.0002659	0	2.44	0.0813	8.13	0.0022
Fe	5	0.181818	125.349464	0.00797769	0.0015955	0	0.63	0.126	12.6	0.020
Mn	0.05	20	125.349464	0.00797769	0.15955	0	0.002	0.04	4	0.638
Zn	0.2	5	125.349464	0.00797769	0.039888	0	0.001	0.005	0.5	0.019
Cu	0.01	100	125.349464	0.00797769	0.797769	0	0.001	0.1	10	7.978
$\sum$					1.00014					8.767

WQI= $\frac{\sum wnQn}{\sum Wn}$= $\frac{8.767}{1.00014}$= 8.7 Water classified as Excellent for irrigation

Table 8. Calculation of the Water quality index in the autumn season at Bahar El-Baqar Drain

Parameters	Sn	$1/sn$	$\sum 1/sn$	K=$\frac{1}{\sum 1/sn}$	Wn=$\frac{k}{sn}$	Vo	Vn	$\frac{Vn}{Sn}$	Qn= $\frac{Vn}{Sn}\times 100$	Wn×Qn
pH	8.5	0.117647	125.349464	0.00797769	0.0009385	7	8.26	0.97	97.18	0.094
EC	300	0.003333	125.349464	0.00797769	0.00002659	0	1.54	0.00513	0.513	0.000014
Ca	75	0.013333	125.349464	0.00797769	0.00010636	0	3.68	0.0491	4.91	0.00052
Mg	30	0.033333	125.349464	0.00797769	0.0002659	0	4.86	0.162	16.2	0.0043
Fe	5	0.181818	125.349464	0.00797769	0.0015955	0	2.88	0.576	57.6	0.092
Mn	0.05	20	125.349464	0.00797769	0.15955	0	0.075	1.5	150	23.93
Zn	0.2	5	125.349464	0.00797769	0.039888	0	0.006	0.03	3	0.12
Cu	0.01	100	125.349464	0.00797769	0.797769	0	0.009	0.9	90	71.79
$\sum$					1.00014					96.04

WQI= $\frac{\sum wnQn}{\sum Wn}=\frac{96.04}{1.00014}$= 96 water classified as poor for irrigation

(FAO, 2004; Pradeep, 1998). It is an indirect measure of total dissolved salts. High conductivity may arise through natural weathering of certain sedimentary rocks or may have an anthropogenic source, e.g. industrial and sewage effluent **(WHO, 2004)**. The results showed that EC values were slightly higher than the permissible level recommended by the **WHO (2004)** for drinking water. The pH of the aquatic systems is an important indicator of the water quality and the extent pollution in the watershed areas. Results obtained for pH varied between 7.60 and 8.10. However, the pH concentration in the study area is within allowable limits for surface water. However, the values come also in accordance with the known values of Egypt inland waters **(J. Rozoska, 1980).**

The Water Quality Index

The computed overall WQI for the analyzed water streams in the two seasons were presented.

The results of the water quality index in the spring season at El-Wadi Canal was 164.5 which reveals that the water suitability for irrigation is classified as unfit for irrigation (Table 3). While the the water quality index in the spring season at Abu El- Akhdar Canal was 159.38 (Table 4), and this WQI reveals that the water suitability for irrigation is unfit for irrigation. Water quality index in the spring season at Bahar El-Baqar drain high WQI with 303.6 and the the water suitability for irrigation is classified as unfit for irrigation (Table 5) and these results are relevant with the findings of **Wilcock *et al.* (1995), Pradeep (1998) and Alam and Pathak (2010)**.

The obtained results for the same locations in the autumn seasons were obtained. The results of the water quality index in the autumn season at El-Wadi canal was 72.3 which reveals that the water suitability for irrigation is classified as fair for irrigation (Table 6). While the the water quality index in the autumn season at Abu El-Akhdar canal was 8.7 (Table 7), and this WQI reveals that the water suitability for irrigation is excellent. Water quality index in the autumn season at Bahar El-Baqar drain high WQI with 96 and the the water suitability for irrigation is classified as poor (table 8) and these results are convenient with the findings of **Pradeep (1998), Mohamed (2005) and Alam and Pathak (2010)**.

The high values of WQI have been found mainly in the spring seasons for the whole selected water streams higher than the values of WQI in the same locations in the autumn streams. In addition, the WQI values for the Bahar El-Baqar drain are higher than the WQI values for the El-Wadi Canal and Abu El-Akhdar canal in both the summer and the winter seasons. This could be attributed to improper disposal of wastes, cottage activities, and large quantity of agricultural and urban run-off, sewage, over application of inorganic fertilizer, improper operation and maintenance of septic system in Bahar El-Baqar drain **(WHO, 2004)**. During the last decade, Bahar El-Baqar drain has been subjected to a rapid decline in water quality status which is possibly due to the increase in the population and human activities.

It is clear that the domestic discharge and agricultural activities in addition to the drought impact are the major threats to Bahar El-Baqar drain water quality and these results are convenient with the findings of **Tepe (2005), Mohamed (2005) and Alam and Pathak (2010)**.

Conclusion

The results obtained from the study reveals that Bahar El-Baqar drain is polluted and this could be attributed to anthropogenic activities such as agricultural activities, cottage industries. Application of Water Quality Index (WQI) in this study has been found useful in assessing the overall quality of water and to get rid of judgment on the quality of the water. This method appears to be more systematic and gives a comparative evaluation of the water quality of sampling stations. It is also helpful for the public to understand the quality of water as well as being a useful tool in many ways in the field of water quality management. In addition, the Piper diagram enables us to determine the ionic composition of the water samples and their classifications.

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تقييم صلاحية المياة للرى من مصادر مختلفة بإستخدام النماذج الرقمية

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تم تقييم جودة المياه للمصارف المائية الرئيسية في محافظة الشرقية باستخدام تقنية مؤشر جودة المياه (WQI) ومخطط بايبر. يوفر مؤشر جودة المياه رقمًا واحدًا يعبر عن جودة المياه الإجمالية في موقع ووقت معينين بناءً على العديد من معايير جودة المياه. تم التحقيق في العديد من المعايير الأساسية مثل الرقم الهيدروجيني والتوصيل الكهربائي (EC) والكاتيون الرئيسي والأنيونات والحديد (Fe) والكوبالت (Co) والنيكل (Ni) والكادميوم (Cd) لحساب مؤشر جودة المياه ومخطط بايبر. كانت نتائج مؤشر جودة المياه في موسم الربيع في ترعة الوادي ،ترعة أبو الأخضر ومصرف بحر البقر 164,5، 159,38، 303,6 والتي صنفت ملاءمة المياه للري على أنها غير صالحه للرى، غير صالحه للرى و غير صالحه للرى على التوالي. بينما كان مؤشر جودة المياه لنفس المواقع في مواسم الخريف 72,3 ، 8,7 ، 96والتي صنفت ملاءمة المياه للري على أنها متوسطة ،ممتازة وفقيرة للري لترعة الوادي ، ترعة أبو الأخضر ومصرف بحر البقر على التوالي. كان تأثير الأنشطة البشرية المختلفة واضحًا على بعض المعلمات مثل EC والقلوية والصلابة. يمكّننا مخطط بايبر من تحديد التركيب الأيوني لعينات المياه وتصنيفاتها. يُقترح أن مراقبة الصرف ضرورية للإدارة السليمة، تطبيق مؤشر جودة المياه أيضًا كأداة مفيدة للغاية تمكن الجمهور وصناع القرار من تقييم جودة المياه في مصر.

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