Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Evaluation of Drainage Water Quality of El Hoks Drain at North Nile Delta, Kafr El-Sheihk Governorate, Egypt

El-Saka, M. S.*

Environ. Res. Dept., Soils, Water and Environ. Res. Instit. (SWERI), Agric. Res. Center (ARC), Giza, Egypt.

Cross Mark

ABSTRACT

There is a severe shortage in irrigation water supply in North Delta area, especially Kafr El-Sheikh Governorate, Egypt. The shortage in fresh water supply in farmlands located on the tail end of irrigation canals has to be replenished by the available drainage water. So, the current work focused on assessing water quality of El-Hoks Drain for irrigation with respect to its contents of ammonium- N (NH_4-N), nitrate-N (NO_3-N), salts, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), boron (B) and some heavy metals. Sixty water samples were collected from ten branch drains' discharge in El-Hoks Drain during winter (2017/018) and summer (2018) seasons. According to FAO (1985) and Egyptian standards (Law 48/1982), results showed that BOD, COD and NO_3-N are the main pollutants, which BOD and COD values are classified between bad to slight and moderate, whereas, NH_4-N and NO_3-N values fall within the normal range for irrigation, but it is in the abnormal range based on the Egyptian standards. DO Values are in the normal range for irrigation according to Egyptian standards. Also, values of heavy metals Cu, Mn, Pb and Cd exceed the allowable limits for irrigation except Ni which falls within the normal range. B values in water samples fall between bad and good. Meanwhile, pH values ranged from 7.37 to 7.95, EC values ranged from 1.16 to 2.71 dSm^{-1}, while SAR values varied from 5.74 to 8.64 which are suitable for irrigation and their values were higher in winter than in summer.

Keywords: BOD, COD, heavy metals, nitrate and water quality.

INTRODUCTION

Water scarcity is one of the common problems in many parts of the world with increasing population and industrial growth (Motoshita *et al.*, 2018). Therefore, drainage water and other low-quality water such as wastewater have to be used for irrigation (Ali *et al.*, 2011). In Egypt, using low-quality water in the agricultural sector at the North Nile Delta is common, especially in Kafr El Sheikh Gov, which is located at the end of irrigation networks, where the farmers receive inadequate fresh water. They have to pump the drainage water directly to irrigate their fields. The local irrigation districts of Kafr El-Sheikh Governorate constructed a number of emergency feeders to feed the end of some irrigation canals which have water supply shortage from the nearby drains (Allam and Negm, 2013 and Gabr, 2018). The main drains in Kafr El Sheikh Gov., are West El-Burullus, Gharbia, El-Khashaah, Tirrah, No. 7, No. 8, No. 9, and El-Hoks, and Brinbal (EMI, 2012; Nassar and Gharib, 2014) and Abukila, 2015).

The long-time reuse of low-quality water such as drainage water and wastewater for irrigation could impair soil functions and cause environmental pollution due to salinization, increase of sodium ions relative to other cations, and accumulation of heavy metals (Kabata-Pendias and Mukherjee, 2007; Abegunrin *et al.*, 2016; Balkhair and Mohammad, 2016; Saliba *et al.*, 2018; Cao *et al.*, 2018; Ganjegunte *et al.*, 2018; Abd-Elwahed, 2018 and Barber *et al.*, 2019). There is a number of water quality guidelines related to irrigation according to FAO (Ayers and Westcot, 1985), but none of them is entirely satisfactory because of the wide variability in the environmental conditions, because they concerned about the effect of water quality on soil and crops. Therefore, five categories are defined related to problems of water quality in irrigated agriculture: (a) salinity hazards (EC and total dissolved solids, TDS), (b) infiltration and permeability hazards (EC and SAR), (c) specific ion toxicity (SAR, boron and chloride), (d) trace element toxicity, and (e) miscellaneous impacts on sensitive crops (pH, NO_3 and $CaCo_3$). In the Egyptian standards (Law 48/1982), chemical water quality parameters (pH, TDS, dissolved oxygen, DO, biochemical oxygen demand, BOD, nitrates, NO_3-N, phosphate and heavy metals) are used to classify the suitability of agricultural drainage water (ADW) for irrigation. The expected water quality level may be different depending on the type of irrigation (Bouwer and Idelovitch, 1987).

There are several studies that have discussed the assessment of drainage water quality in Kafr El Sheikh Governorate. El-Shahawy and Ragab (2005) determined the concentration of some heavy metals in the El-Gharbia main drain and they found that the concentration of Pb, Cd, Ni and B were less than the permissible limits for irrigation. Taha *et al.* (2012) found that the water quality of El Gharbia, No.11 and No.10 drains in Kafr EL-Shiekh for irrigation purposes was classified as none and slight to moderate degree of impairment according to FAO (1985), but NO_3-N concentrations in some locations on EL-Gharbia main drain during September and December were over the permissible limit. The quality evaluation of drainage water of Nashart Drain indicated that its quality doesn't meet the local standards for the direct use for irrigation based on the Egyptian standards (Allam and Negm 2013). The contamination factor of water in most locations on

* **Corresponding author.**
E-mail address: elsaka3@yahoo.com
DOI: 10.21608/jssae.2020.109532

El-Hoks No. 7 and No. 8 drains indicated that their water quality had moderate suitability for irrigation (El-Amier *et al.*, 2015). El-Batrawy *et al.* (2018) showed that the average concentrations of Mn, Zn, Fe, Ni, Cu, Pb in Burullus Lake water at the front of Hoksa Drain were 2.58, 12.44, 14.94, 2.94, 0.78 and N.D. μg/L, respectively during winter and 0.10, 2.68, 13.96, 10.26, 1.04 and 8.10 μg/L, respectively during summer 2014. Jahin *et al.* (2020) showed that the water of some canals and drains in Kafr El-Sheikh Gov., North Nile Delta, Egypt was classified as low to good water quality. Therefore, this study aimed to assess water quality of El-Hoks Drain, North Nile Delta, Kafr El-Sheik Gov., Egypt for irrigation.

MATERIALS AND METHODS

Study area: Ten branch drains discharge in El-Hoks Drain at Kafr El-Sheik Governorate, North Nile Delta, Egypt were chosen (Fig.1) to assess the quality of their water for irrigation. The length of El-Hoks Drain is about 18.3 km, which received drainage water as well as sewage water from the adjacent villages.

Water sample collection: Sixty water samples were collected from the outlets of the ten branch drains (Table 1) during winter 2017/18 (November, January and March) and summer 2018 (May, July and September).

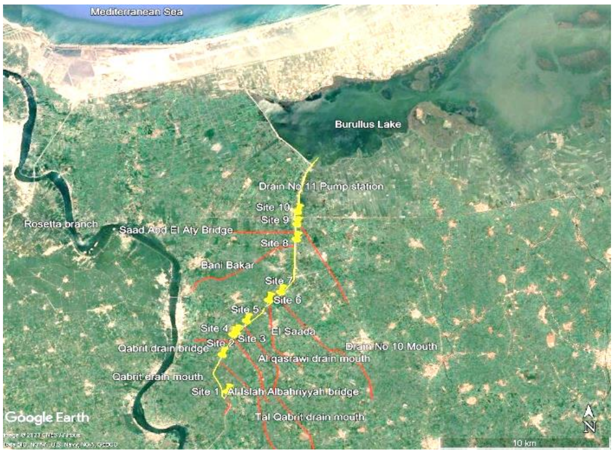

Fig. 1. Study area and sampling locations of drainage water.

Table 1. Locations of water sampling under the present study

Location	Name of the drain	Latitude	Longitude
Site 1	Al-Islah Albahriyyah bridge	31° 14' 46.40"N	30° 33' 4.23"E
Site 2	Qabrit drain mouth	31° 16' 4.92"N	30° 32' 51.76"E
Site 3	Qabrit drain bridge	31° 16' 47.07"N	30° 33' 17.39"E
Site 4	Al qasrawi drain mouth	31° 16' 52.94"N	30° 33' 22.29"E
Site 5	Tal Qabrit drain mouth	31° 17' 16.94"N	30° 33' 45.43"E
Site 6	El Saada	31° 18' 5.89"N	30° 34' 42.50"E
Site 7	No 10 Mouth	31° 18' 18.01"N	30° 35' 0.91"E
Site 8	Bani Bakar	31° 20' 10.32"N	30° 35' 37.72"E
Site 9	Saad Abd El Aty Bridge	31° 20' 40.22"N	30° 35' 38.22"E
Site 10	No 11 Pump station	31° 21' 9.93"N	30° 35' 39.44"E

Water samples analysis: The water samples were drawn at a depth of 0.5 meter below the water surface and stored in acid-washed high dens polypropylene vials (1 L). Water samples were stored in another set of 0.5 L polypropylene vials washed with 50% HNO_3 and double deionized water and acidified by 5 ml HNO_3 and transported in iceboxes to the lab for analysis within 24 h for trace element analysis.

The chemical analysis of water was carried out as follows:

- EC (dSm^{-1}), pH, soluble cations and anions (meq/L) were determined according to Jackson (1973).
- Sodium adsorption ratio (SAR) was calculated according to Richards (1954).
- NH_4-N was measured using Kjeldahl methods and NO_3-N concentration was determined calorimetrically using a spectrophotometer (Jackson, 1973).
- Boron was determined calorimetrically using a spectrophotometer with Azomethine-H method according to Bingham (1982).
- Heavy metals (Cu, Mn, Ni, Pb and Cd) were determined using atomic absorption spectrophotometry (GBC Σ Aventavir 1.3) as described in standard methods-302 A (APHA, 1985).
- Dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD) were measured according to Ademoroti (1996).

Quality indices: Water quality classes according to USDA (1954) were; C_1, C_2, C_3 and C_4, representing low, medium, high and very high salinity, respectively and S_1, S_2, S_3 and S_4 representing low, medium, high and very high sodicity, respectively.

Sodium: Calcium activity ratio (SCAR) was calculated as follow:

$$\mathbf{SCAR = Na^2\ meq/L \div \sqrt{Ca}\ \ meq/L}$$

Residual sodium carbonate (RSC): was calculated as follow:

$$\mathbf{RSC = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})}$$

Soluble sodium percentage (SSP) was calculated according the following:

$$\boldsymbol{SSP = \frac{Na}{\sum Cations} * 100}$$

The permeability index PI was calculated according to Doneen (1964):

$$\boldsymbol{PI = \frac{Na + \sqrt{HCO3}}{Na + Ca + Mg} \times 10}$$

The other measurements were made by Irrigation Water Assessment Model (IWA-Mod), which is a computer model that can be used to assess the quality of irrigation water through some indicators such as salinity, SAR, Adj. SAR, SSP, RSC, SCAR, MAR and PI.

Statistical analysis: The data of water analysis for all variables were statistically analyzed for significant differences among seasons and locations using a one-way ANOVA. Also, the relationships between the studied variables with that for Nile River water were calculated using the Pearson correlation index.

RESULTS AND DISCUSSION

Water salinity (EC) and alkalinity (SAR):

The salinity and alkalinity of the drainage water might be affected by some factors such as land use, crop pattern, soil management, drain location, sampling location and drainage efficiency. Results in Table (2) indicate that the average values of EC in drainage water in both seasons ranged from 1.16 to 2.71 dSm^{-1} and SAR varied from 5.74 to 8.64. The salinity and alkalinity values of water in the studied drains are mostly classified as slight to moderate according to the international guideline of FAO/RNEA (1993) with EC_w limits of ≤ 0.7 dS/m (slight) and 0.7-3.0 dS/m (moderate), while SAR limits are ≤ 3.0 (slight) and 3.0-9.0 (moderate). The increases in salinity and alkalinity in the drainage water of this area are mainly ascribed to the inflow of saline water due to sea water intrusion, so salinity and alkalinity values of drainage water increased towards the sea. Also, salinity and alkalinity of water of these drains were higher in winter (November, January and March) than in summer (May, July and September), may due to the high amounts of irrigation water with rice crops which led to dilution of drainage waters. Data also revealed that salinity and alkalinity of water in drain No 11 pump station in January recorded the highest values compared to other drains. The EC values (≤ 1 dSm^{-1}) were in the normal range for irrigation water according to FAO (1985), but they exceed the allowable limits of EC according to the Egyptian standards (Law 48/1982). Therefore, using water of these resources for irrigation required special management such as the selection of salt tolerant crops and effective drainage systems for salinity control.

Soil reaction (pH):

Water samples showed alkaline pH values (7.37-7.95) and its values were increased in July and September. The highest pH values were obtained in the outlet of Tal Qabrit Drain in July. The pH values fall within the normal range for irrigation according to the guidelines given by FAO (1985) and the Egyptian standards (Law 48/1982). These results may be due to the high influx of $CO_3^{=}$ and HCO_3^- to the agricultural drainage water (El-Gamal, 2017). $CO_3^{=}$ and HCO_3^- anions change the Ca^{2+} and Mg^{2+} to be insoluble salts leaving Na^+ as the predominant ion in water (Mandal *et al.,* 2019).

Table 2. Average pH, EC and SAR values in drainage water in different locations

Location	pH		EC (dSm^{-1})		SAR	
	Winter	Summer	Winter	Summer	Winter	Summer
Al-Islah Albahriyyah bridge	7.38	7.76	1.77	1.64	6.96	6.93
Qabrit drain outlet	7.43	7.77	1.81	1.50	7.05	6.59
Qabrit drain bridge	7.42	7.74	2.22	1.51	7.80	6.61
Al qasrawi drain outlet	7.45	7.84	2.13	1.27	7.66	6.04
Tal Qabrit drain outlet	7.54	7.87	2.09	1.16	7.58	5.74
El Saada outlet	7.43	7.86	1.78	1.40	6.99	6.39
Drain No 10 outlet	7.57	7.86	2.34	1.53	8.01	6.66
Bani Bakar outlet	7.42	7.95	2.40	1.50	8.12	6.58
Saad Abd El Aty Bridge	7.37	7.83	2.18	1.47	7.74	6.48
Drain No 11 Pump station	7.45	7.89	2.71	1.60	8.64	6.77
C.V.(standard deviation)	0.12	0.10	0.33	0.19	0.58	0.45

Organic matter indicators (DO, BOD and COD):

Dissolved oxygen (DO) is one of the important parameters for water quality assessment. The values of DO in drainage water of the investigated drains ranged from 10 to 13 mgL^{-1} in both seasons (Table 3). Also, the data revealed that the highest DO value was recorded in the Tal Qabrit Drain outlet in September, while the lowest value was obtained in the El Saada Outlet in January. However, DO values fall within the normal range for irrigation based on the guidelines given by the Egyptian standards (Law 48/1982).

Biochemical oxygen demand (BOD) is also an important pollution indicator that reflects the load of organic waste in water. The average values of BOD in drainage water of the investigated drains ranged from 18.33 to 32.67 mgl^{-1} for both seasons, and the higher values were recorded at the Al Qasrawi Drain outlet in the winter season. The majority of BOD values recorded in the winter season were higher than that in the summer season. These results are similar to that observed by Safaa *et al*. (2012), who recorded that BOD varied from 7 to 120 mgL^{-1} in water of some drains in the Nile Delta.

Chemical oxygen demand (COD) concentration gives a reliable parameter for judging the extent of organic pollution in water. COD is the oxygen required for chemical oxidation of organic matter. The results indicated that the average values of COD in drainage water of the studied drains ranged from 46 to 63 mgL^{-1} for both seasons, and its values in the winter season were higher than that in the summer season. The values of BOD and COD in water of the studied drains were classified as slight to moderate and bad according to the guidelines given by FAO (1985) and the Egyptian standards (Law 48/1982). The higher BOD and COD values reflect higher load of organic matter in water due to the increased level of pollution from the adjacent drains, which adversely affects the water quality. This indicates that a high percentage of organic matter in water samples might be resistant to microbial degradation (Badr *et al.,* 2013).

Table 3. Average of DO, BOD and COD in water of different locations

Location	DO		BOD		COD	
	Winter	Summer	Winter	Summer	Winter	Summer
Al-Islah Albahriyyah bridge	11.33	11.67	31.67	23.33	53.67	46.33
Qabrit drain outlet	13.00	11.33	30.33	21.67	55.67	46.00
Qabrit drain bridge	11.67	11.33	29.33	26.00	49.00	50.33
Al qasrawi drain outlet	12.67	11.33	32.67	27.33	57.33	55.00
Tal Qabrit drain outlet	11.67	12.33	32.33	29.67	58.00	55.67
El Saada outlet	10.00	10.67	28.33	29.00	61.67	49.00
Drain No 10 outlet	12.00	11.00	28.67	30.33	58.67	50.00
Bani Bakar outlet	11.67	11.67	28.33	32.67	63.00	49.33
Saad Abd El Aty Bridge	11.67	11.67	26.33	26.33	58.67	48.33
Drain No 11 Pump station	12.00	11.00	26.00	18.33	51.67	46.67
C.V(standard deviation)	0.80	0.47	2.34	4.35	4.33	3.35

Boron concentrations:

Data in Table (4) showed that the average values of boron concentrations in drainage water in drains under study for both seasons varied from 0.50 to 0.87 mgL^{-1}, and the highest values in both seasons were recorded in water of Drain No 11 Pump Station. The B concentration values were evaluated as good to bad according to guidelines given by FAO (1985) and the Egyptian standards (Law 48/1982), so the water can be used for irrigating the tolerant and semi-tolerant crops.

Nitrate and ammonium forms:

Nitrogen in drainage water is mainly in the form of nitrate (NO_3-N), but may also be in the form of ammonium (NH_4-N), although NH_4-N is readily adsorbed by the colloids and rapidly oxidized into NO_3-N. Also, nitrate is the final stable form of oxidation/decaying of organic matter from domestic, industrial and agricultural sources. Data in Table (4) shows that the average values of NH_4-N concentration in water of the studied drains for both seasons ranged from 1.23 to 3.60 mgL^{-1}, while the NO^-_3-N concentration varied from 2.67 to 18.00 mgL^{-1}. These results are similar to Antar *et al*. (2012) who reported that the concentration of NH^+_4-N is less than the NO^-_3-N in drainage water. The concentration of NO_3-N in drainage water increased towards the sea. Also, concentration of NO_3-N was higher in the summer months than in the winter months and varied from one drain to another and from one month to another. This may be ascribed to several factors including soil properties, amount of irrigation water, temperature, drainage system and forms of applied fertilizers (Dinnes *et al*., 2002). In general, the majority of NO_3-N concentrations in drains exceed the maximum contaminant level for drinking water (10 mgL^{-1}) according to U. S. Environmental Protection Agency (1991). Moreover, NH_4-N concentrations were higher in winter months than that in summer months, may be due to lower amounts of water discharged to the drains during winter. Also, NH_4-N is mostly produced by decomposition of organic matter and by hydrolysis of urea (El-Sheltawy *et al.*, 2007). Generally, NH_4-N values fall within the normal range for irrigation according to the evaluation given by FAO (1985), but it is in the abnormal range based on the Egyptian standards (Law 48/1982). On the contrary, NO_3-N values may not fall in the normal range for irrigation according to FAO (1985), but they fall within the normal range of the Egyptian Standards (Law 48/1982). Therefore, with using of drainage water of these drains with these concentrations of NH_4-N and NO_3-N, the application rates of N-fertilizers can be decreased.

Table 4. B, NH_4-N and NO_3-N concentrations in drainage water in different locations

Site	B		NH4-N		NO3-N	
	Winter	Summer	Winter	Summer	Winter	Summer
Al-Islah Albahriyyah bridge	0.70	0.50	2.63	2.33	6.67	4.33
Qabrit drain outlet	0.73	0.61	2.93	2.60	4.00	2.67
Qabrit drain bridge	0.78	0.63	3.60	2.20	8.00	11.33
Al qasrawi drain outlet	0.75	0.67	2.57	2.87	7.33	14.00
Tal Qabrit drain outlet	0.79	0.68	3.30	2.83	9.33	15.33
El Saada outlet	0.79	0.61	3.27	2.97	10.33	17.00
Drain No 10 outlet	0.73	0.61	3.27	2.07	12.33	16.33
Bani Bakar outlet	0.73	0.66	3.20	1.70	11.00	16.67
Saad Abd El Aty Bridge	0.78	0.76	3.20	1.51	13.00	15.33
Drain No 11 Pump station	0.87	0.86	2.43	1.23	10.67	18.00
C.V (standard deviation)	0.05	0.10	0.38	0.60	2.77	5.40

Heavy Metals:

The concentrations of heavy metals (Ni, Mn, Cu, Cd and Pb) in water of the studied drains varied from one metal to another and from one drain to another (Fig 2). Heavy metals concentrations (mgL^{-1}) of water in all drains and months ranged from 0.009 to 0.17 for Ni, 0.12 to 0.52 for Mn, 0.20 to 0.41 for Cu, 0.03 to 0.09 for Cd and 0.036 to 0.092 for Pb. These results indicated that Ni concentration in all drains fall within the normal range for irrigation (0.2 mg/l) according to FAO (1985) and the Egyptian standards (Law 48/1982), while the concentrations of Mn, Cu, Cd and Pb exceed the allowable limits (0.2 , 0.2, 0.01 and 0.05 mgL^{-1}, respectively). The results showed lower levels of Cu and Pb in drainage water in the summer months in different locations than in winter months might be due to the high amounts of irrigation water with rice fields which led to dilution of drainage waters. While, the high level of Mn in summer may due to the water current speedily in summer faster than in winter and the rate of evaporation was relatively high. Similar findings were obtained by Antar *et al.* (2012) and El-Batrawy *et al.* (2018). Also, the data showed that Cd concentrations in drainage water recorded approximately the same values in both summer and winter. Generally, drainage waters were highly contaminated by heavy metals in both winter and summer seasons at all sampling locations. Therefore, the use of these waters without good treatment lead to increases in the concentrations of heavy metals in soils and plants and consequently enter the food chain causing dangerous complications to man and other biota. These toxic metals may cause kidney and liver failure, anemia and cancer in addition to chromosomal aberrations (El-Sanafawy *et al.*, 2010).

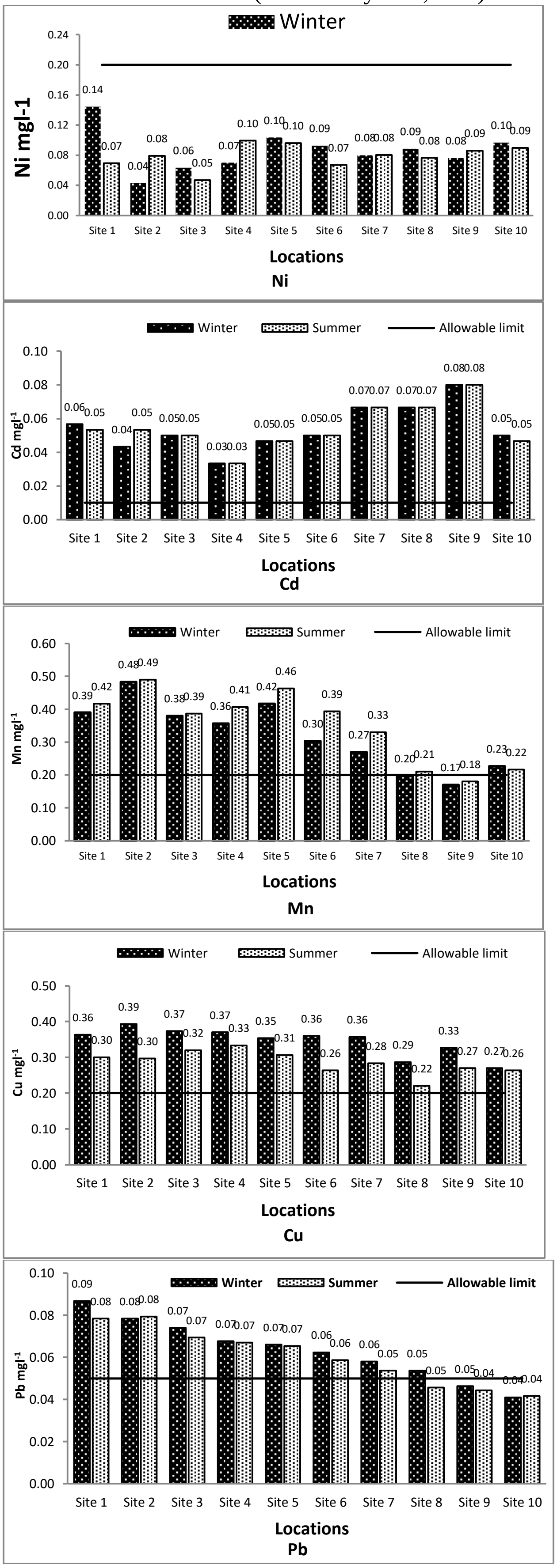

Fig. 2. heavy metals concentration in different sites alonge el hoksa drain

Water quality Assessment by IWA-Mod:

According to the diagram of USDL (1954), the studied water samples in all sites (Table 5 and Fig 3) are in class C_3S_2 , except the sites No. 7, 8 and 9 and 10 in winter are in class C_4S_2. According to this classification, the water in the C_3S_2 class is high saline and medium alkalinity. Therefore, this water is considered slightly dangerous for irrigation purposes and can be used with adequate drainage, special management for salinity control and salt tolerant plants must be selected. On the other hand, C_4S_2 class indicates that the water is very high in saline with medium alkalinity. This water is not suitable for irrigation under ordinary conditions but may be used occasionally under very special circumstances, such as permeable soils, adequate drainage, high salt tolerant crops and excess irrigation water to provide considerable leaching of salts. Sodium ions in this water are present in appreciable high level and can cause hazardous effects in fine textured soils having high cation exchange capacity, especially under low leaching without gypsum application. So, this water can be used in course textured or organic soil with good permeability. The reductions in water infiltration can occur when irrigation water contains high sodium relative to the calcium and magnesium and when the residual sodium carbonate (RSC) was appreciably high in drainage water; they cause an appreciable sodicity hazard. The concept of RSC appears to relate better to sodicity problems in the field (FAO, 1988). The soil permeability is affected by long term use of irrigation water with high levels of sodium relative to calcium and magnesium. Doneen (1964) gave a criterion for assessing the suitability of drainage water for irrigation based on the permeability index classified as class 1 (>75%), class 2 (25-75 %) and class 3 (<25 %). Class 1 and 2 water is categorized as good for irrigation with a 75 % or more permeability index. Class 3 water is unsuitable with a 25 % permeability index as shown in Tables 5.

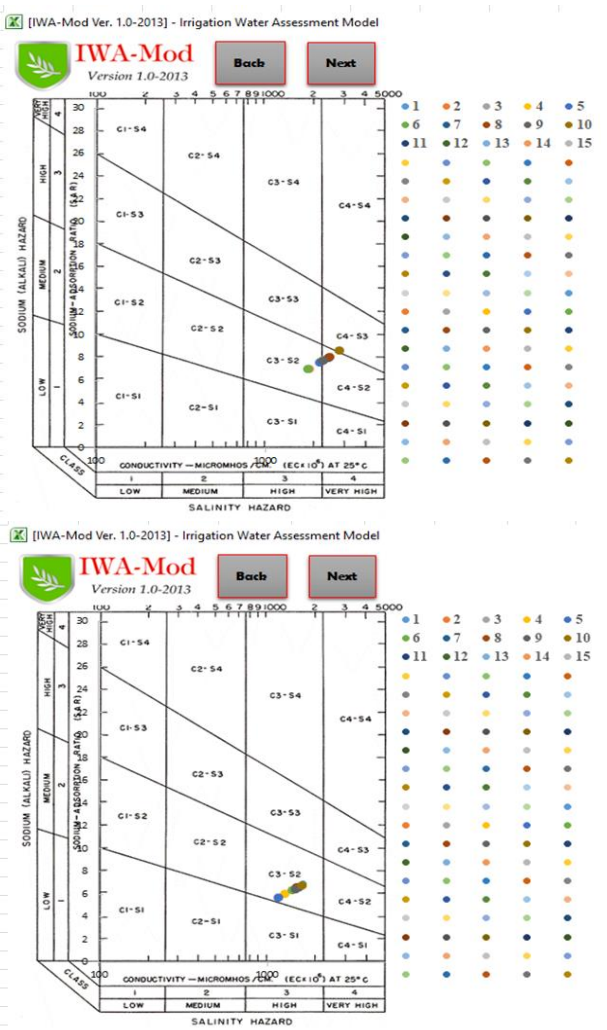

Fig. 3. Classification of drainage water in winter (a) and summer (b) seasons on USDA Diagram (1954)

Table 5. Assessment of drainage water quality

No.	SSP	SAR	Adj. SAR	RSC	SCAR	PI	MAR	Salinity hazard	Alkalinity hazard	USSL Index	USSL class
						Winter months					
Site 1	65.33	6.97	11.59	-3.56	5.94	75.77	31.27	C3	S2	C3S2	Acceptable
Site 2	65.79	7.05	11.69	-3.75	6.02	75.48	31.26	C3	S2	C3S2	Acceptable
Site 3	65.83	7.80	13.33	-5.06	6.65	73.98	31.27	C3	S2	C3S2	Acceptable
Site 4	65.77	7.66	12.77	-4.92	6.53	74.04	31.23	C3	S2	C3S2	Acceptable
Site 5	65.91	7.58	12.58	-4.8	6.46	74.14	31.24	C3	S2	C3S2	Acceptable
Site 6	65.59	6.99	10.34	-4.34	5.96	74.09	31.23	C3	S2	C3S2	Acceptable
Site 7	65.77	8.00	13.46	-5.63	6.83	73.34	31.24	C4	S2	C4S2	Poor
Site 8	65.83	8.12	14.13	-5.58	6.92	73.59	31.25	C4	S2	C4S2	Poor
Site 9	65.8	7.73	13.2	-4.93	6.6	74.11	31.23	C4	S2	C4S2	Poor
Site 10	66.21	8.64	15.3	-6.57	7.37	72.91	31.26	C4	S3	C4S3	Very poor
						Summer months					
Site 1	65.59	6.93	11.83	-3.44	5.8	75.84	28.57	C3	S2	C3S2	Acceptable
Site 2	65.32	6.59	10.57	-3.35	5.52	75.7	28.57	C3	S2	C3S2	Acceptable
Site 3	65.19	6.61	10.53	-3.44	5.53	75.5	28.54	C3	S2	C3S2	Acceptable
Site 4	64.84	6.03	9.68	-2.35	5.05	77.69	28.54	C3	S2	C3S2	Acceptable
Site 5	64.46	5.74	9.2	-1.86	4.8	78.95	28.57	C3	S2	C3S2	Acceptable
Site 6	65.02	6.39	10.4	-2.8	5.35	76.84	28.57	C3	S2	C3S2	Acceptable
Site 7	64.71	6.65	10.7	-3.46	5.56	75.5	28.54	C3	S2	C3S2	Acceptable
Site 8	64.75	6.59	10.4	-3.45	5.51	75.45	28.57	C3	S2	C3S2	Acceptable
Site 9	64.98	6.47	10.17	-3.37	5.42	75.45	28.54	C3	S2	C3S2	Acceptable
Site 10	65.08	6.77	10.97	-3.7	5.67	75.06	28.57	C3	S2	C3S2	Acceptable

CONCLUSION

Water is fundamental in agriculture, different source of pollution such as sewage and industrial wastewater which discharge onto the drains. So, the present study illustrates the water quality of El-Hoksa Drain. The water in this drain has very low quality, which in turn may cause hazards to soil and grown crops. It could be concluded that El-Hoks Drain may be used for irrigation purposes under controlled precautions with good soil management e.g, good tillage, deep plowing, land leveling, applying soil and water amendments, and finally suitable cropping system.

REFERENCES

Abd-Elwahed, M.S., (2018). Influence of long-term wastewater irrigation on soil quality and its spatial distribution. Annals of Agricultural Sciences 63 (2), 191–199.

Abegunrin, T., G. Awe, D. Idowu and M. Adejumobi (2016). Impact of wastewater irrigation on soil physicochemical properties, growth and water use pattern of two indigenous vegetables in southwest Nigeria.Catena, 139, 167–178.

Abukila, A. F. (2015). Assessing the drain estuaries' water quality in response to pollution abatement. Water Science 29: 1–18.

Ademoroti, C.M.A., (1996). Standard method for water and effluents analysis, Foludex Press Ltd, Ibadan, pp. 22-23, 44-54,111-112.

Ali, H.M.; EL-Mahrouk, E.M.; Hassan, F.A.; EL-Tarawy, M.A (2011). Usage of sewage effluent in irrigation of some woody tree seedlings. Part 3: Swieteniamahagoni (L.) Jacq. Saudi J. Biol. Sci. 18, 201–207.

Allam A. E. and A. M. Negm (2013). Agricultural drainage water quality analysis and its suitability for direct reuse in irrigation: case study: kafr el-sheikh governorate, Egypt. Seventeenth International Water Technology Conference, IWTC17, Istanbul, 5-7 November 2013.

APHA (American Public Health Association) (1985). Standard Methods For the Examination of Water and Waste water 15th(ed), Washington, D.C.; U.S.A. P, 525-535

Antar, A. S., A.A. S. Gendy and G. M. A. El-Sanat (2012). Study on some agrochemical pollutants in drains water at North Delta, Egypt. J, of Soil Sciences and Agricultural Engineering. Mansoura Univ. Vol. 3 (2): 237-247.

Public Health Association, Washington DC

Ayers, R.S., and D.W. Westcot. (1985). Water Quality for Agriculture. Irrigation and Drainage Paper 29 (rev.1). FAO, Rome, Italy.

Badr, E.A. M. A. El-Sonbati and H. M. Nassef (2013). Water Quality Assessment in the Nile River, Damietta Branch, Egypt. CATRINA (2013), 8 (1): 41-50.

Balkhair, K.S. and Muhammad, A.A. (2016). Field accumulation risks of heavy metals in soil and vegetable crop irrigated with sewage water in western region of Saudi Arabia. *Saudi Journal of Biological Sciences*, 23, pp.S33-S44.

Barber, L.B., Rapp, J.L., Kandel, C., Keefe, S.H., Rice, J., Westerhoff, P., Bertolatus, D.W., Vajda, A.M., (2019). Integrated assessment of wastewater reuse, exposure risk, and fish endocrine disruption in the Shenandoah River watershed. Environmental science & technology 53 (7), 3429–3440.

Bingham,F.T. (1982). Boron. InA. L. Page. R. H. Miller and D.R. Keeny (eds) method of soil analysis, part 2,Agron.Monogr.9,A.M.Soc. Agron.,Madison, WI.P. 431-446ion. Rome.

Bouwer, H.; Idelovitch, E. (1987). Quality requirements for irrigation with sewage water. J. Irrig. Drain. Eng., 113, 516–535.

Cao, C., Q. Zhang, Z. –B. Ma, X. –M. Wang, H. Chen, and J. –J. Wang, (2018). Fractionation and mobility risks of heavy metals and metalloids in wastewater irrigated agricultural soils from greenhouses and fields in Gansu, China. Geoderma 328, 1–9.

Dinnes, D. L.; D. L. Karten; D. B. Jaynes; T. C. Kaspr; J. L. Hatfield; T. S. Colvin and C. A. Cambardella (2002). Nitrogen management strategies to reduce nitrate leaching in tile drained Midwestern soils. Agronomy J. 94 (1): 153- 171.

Doneen, L,D. (1964). Notes on water quality in Agriculture. Water Science and Engineering paper No.4001.Dept. of water Csii. And Eng., Calif. Univ., USA.

El-Amier Y.A., Zahran M.A., Al-Mamory S.H. 2015, *J. Water Res. Prot.* (7) 1075-1086

El-Batrawy Omnya A., Maie I. El-Gammal, Lamiaa I. Mohamadein, Dina H. Darwish and Khalid M. El-Moselhy (2018). Impact assessment of some heavy metals on tilapia fish, Oreochromis niloticus, in Burullus Lake, Egypt. The Journal of Basic and Applied Zoology 79 (13): 1-12.

El-Gamal, A.A., (2017). Sediment and water quality of the Nile Delta Estuaries. In: Negm, A.M. (Ed.), The Nile Delta. Springer International Publishing, Cham, pp. 347–378.

El-Sanafawy Hameda M.A.; Nour El-Din, M. and N. I. Talha (2010). Monitoring of some chemical and biological pollutants in wastewater drains of Middle Delta region. Egyptian Soil Science Society (ESSS) 9th National Conference on Oct. 18-20, 2010, Cairo, P3-3.

El-Shahawy, M.I. and M. M. Ragab (2005). Demonstration of sustainable safe reuse of drainage water in agriculture at North Delta. Annual report Agricultural Research Center, Regional Council for agricultural Research and Extension, pp. 20-25.

El-Sheltawy, H. M., A. S. Morsy, A. S. El-Lithy, M. A. Labib, S. H. Maree, D. F. Ahmed, E. A. Mohamed, R. M. Saleh, K. H. Korany, AND M. A. Abo El-Azm. (2007). Environmental Monitoring of Water Quality of River Nile 2005-2006; Second International Conference on Environmental Engineering. Cairo, Egypt, Ain Shams University. 2007. Ref Type: Conference Proceeding.

EMI (2012). Egyptian Ministry of Irrigation, the amount of agricultural drainage water which entered the Lake Burullus during 2010. Organization of Mechanic and Electricity, Central Administration of the Central Delta stations, Kafr El-Sheikh, Egypt.

FAO, (1985) Food and Agriculture Organization. Water quality for agriculture. FAO Irrigation and drainage Paper No. 29 Rev. Sed. FAO, Rome.

FAO/RNEA, (1993). Considerations of wastewater reuse system for irrigation. Tech. Bull. No. 7, P. 18.

Gabr, M. (2018). Evaluation of Irrigation Water, Drainage Water, Soil Salinity, and Groundwater for Sustainable Cultivation. Irrigat Drainage Sys Eng 7 (3); 224:1-10.

Ganjegunte, G., Ulery, A., Niu, G., Wu, Y., (2018). Organic carbon, nutrient, and salt dynamics in saline soil and switchgrass (Panicum virgatum L.) irrigated with treated municipal wastewater. Land Degrad. Dev. 29 (1), 80–90.

Jahin H.S., A.S. Abuzaid and A.D. Abdellatif (2020). Using multivariate analysis to develop irrigation water quality index for surface water in Kafr El-Sheikh Governorate, Egypt. Environmental Technology & Innovation 17,100532: 1-11.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentic Hall of India private limited, New

Kabata-Pendias, A., and Mukherjee, A.B., (2007). Trace elements of group 12 (Previously group IIb). Trace elements from soil to human, 283-319.

Mandal, S.K., Dutta, S.K., Pramanik, S., Kole, R.K., (2019). Assessment of river water quality for agricultural irrigation. Int. J. Environ. Sci. Tech. 16: 451–462.

Motoshita, M.; Ono, Y.; Pfister, S.; Boulay, A.M.; Berger, M.; Nansai, K.; Tahara, K.; Itsubo, N.; Inaba, A. (2018). Consistent characterization factors at midpoint and endpoint relevant to agricultural water scarcity arising from freshwater consumption. Int. J. Life Cycle Assess. 23, 2276–2287.

Nassar MZ, Gharib SM. (2014). Spatial and temporal patterns of phytoplankton composition in Burullus Lagoon, Southern Mediterranean coast, Egypt. Egypt. J. Aquat. Res., 40 (2): 133-142.

Richards, L. A. (1954). "Diagnosis and Improvement of Saline and Alkaline Soil". USDA. Handbook No. 60.

Safaa, M. E.; Hesham M. M.; Mervat A. A.; Essam H. A. and Mostafa A. E. Water Quality Assessment of River Nile at Rosetta Branch: Impact of Drains Discharge, Middle-East Journal of Scientific Research 12 (4): 413-423 (2012).

Saliba, R., Callieris, R., D'Agostino, D., Roma, R., Scardigno, A., (2018). Stakeholders' attitude towards the reuse of treated wastewater for irrigation in Mediterranean agriculture. Agric. Water Manag. 204, 60–68.

Taha, A. A.; M. E. El-Shehawy; A. A. Mosa and M. N. EL-Komy (2012). Suitability of drainage water for irrigation and its impact on wheat and clover crops at northern delta, Egypt. *J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 3 (6): 655 - 668.*

U. S. Environmental Protection Agency (1991). National primary drinking water regulations, final rule. Fed. Regist. 56(20): 3526-3594.

USDA (1954) "Diagnosis and Improvement of Saline and Alkali Soils". Agriculture Handbook 60, US Gov. Printing Office, Washington, DC, USA.

Yasser A. El-Amier, Abdelhamid A. Elnaggar and Muhammad A. El-Alfy (2017). Evaluation and mapping spatial distribution of bottom sediment heavy metal contamination in Burullus Lake, Egypt. Egyptian Journal of Basic and Applied Sciences 4 (2017) 55–66.

تقييم جودة مياه الصرف لمصرف الهوكس شمال دلتا النيل ،محافظة كفر الشيخ ، مصر

محمد سامي السقا*

قسم بحوث البيئه- معهد بحوث الاراضي والمياه والبيئه. مركز البحوث الزراعية. الجيزة. مصر

نظرا للنقص الحاد في كميات مياه الري بمنطقة شمال الدلتا ، خاصة محافظة كفر الشيخ بمصر. لذا يجب تعويض النقص في كميات المياه العذبة للأراضي الزراعية الواقعة على في نهايات الترع. ولذلك ،تم تقييم جودة مياه مصرف الهوكس للري فيما يتعلق بمحتوياته من الأمونيوم- N (NH4-N) ، النترات- N (NO3-N) ، الأملاح ، الأكسجين المذاب (DO) ، الاكسجين الحيوي الممتص (BOD) ، الاكسجين الكيميائي المستهلك (COD) ، والبورون (B) وبعض العناصر الثقيلة. حيث تم جمع ستين عينة مياه من عشرة مصارف فرعية لمصرف الهوكس خلال فصل الشتاء (2018/2017) وموسم الصيف (2018).- ووفقا لمنظمة الأغذية والزراعة (1985) والمعايير المصرية (قانون 1982/48) أظهرت النتائج أن الاكسجين الحيوي الممتص و الاكسجين الكيميائي المستهلك و النترات هي الملوثات الرئيسية ، حيث تم تصنيف قيم الأكسجين الحيوي الممتص و الأكسجين الكيميائي المستهلك بين سيئة إلى طفيفة ومتوسطة كما وجد أن قيم الامونيا و النترات تقع ضمن الحدود المسموح بها للري وفقًا لمنظمة الأغذية والزراعة (1985) ، لكنها تقع في خارج الحدود المسموح بها بناءً على المعايير المصرية (قانون 1982/48). إن قيم الاكسجين الذائب في النطاق الطبيعي للري وفقًا للمعايير المصرية (القانون 1982/48). أيضا ، تجاوزت العناصرالثقيلة (النحاس ، المنجنيز ، الرصاص والكادميوم) الحدود المسموح بها للري وفقًا لمنظمة الأغذية والزراعة (1985) والمعايير المصرية (قانون 1982/48) ، باستثناء Ni النيكل الذي يقع ضمن المعدل الطبيعي (0.2 mg / لتر). كما وجد ان تركيز البورون في عينات المياه بين السيئ والجيد. بينما تراوحت قيم الأس الهيدروجيني من 7.37 إلى 7.95 ، وتراوحت قيم EC من 1.16 إلى 2.71 dSm^{-1} ، بينما تراوحت قيم SAR من 5.74 إلى 8.64 وهي مناسبة للري وكانت قيمها أعلى في فصل الشتاء منها في الصيف.

الكلمات الدالة: الاكسجين الحيوي الممتص والاكسجين الكيميائي المستهلك، المعادن الثقيلة، النترات وجودة المياه.