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ARTICLE

Water Quality Evaluation of the Main Drain in Dhi-Qar Governorate, South Iraq

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Abstract

The Main Drain is one of the largest irrigation projects which is used to collect drainage water from the lands extended on both sides of the water channel and diverts it to Shatt Al−Arab and from there to the Arabian Gulf. The Main Drain passed in Dhi-Qar Governorate to the northeast of Nasiriyah oil field in the Kati'a area, which is about 38 km from the center of the city of Nasiriyah. The objective of the present research is to evaluate the water quality, and its temporal change of the Main Drain, and if there is an impact of the Nasiriyah oil field on the water quality of this Drain. The hydrochemical analysis of the collected water samples showed high TDS, and high concentration of major ions, that exceeded the permissible limits of the approved standards (WHO and IQS), which is due to the salinity of the soil around the channel, industrial wastes, and wastes by human activities. The water of the Main Drain is also polluted with high concentrations of cadmium and zinc, whereas, the concentrations of lead and copper are within the permissible limits. The low concentrations of lead indicates a low possibility of contamination of the Main Drain water with the Nasiriyah oil field oprations, where lead represents the most important wastes of oil extraction. The results of comparing the quality of the current water with its quality during the year 2013, showed an increase in its salinity, with higher ionic concentrations. This proved the shortages of water releases from the upstream countries in addition to the effect of climate changes.

Keywords: Water pollution, The main drain, Heavy metals, Nasiriyah oil field, Climate change

1. Introduction

A small fraction of the freshwater supply is available for human needs, however, most of which is used for agriculture. The agricultural chemicals such as fertilizers and pesticides are carried off by the drain water, which empties into streams and rivers and then finally flows to the ocean, there if concentration are high, the chemicals can kill fish and other marine life [1].

The Iraqi Main Outfall Drain is one of the biggest project which was designed to carry the agricultural wastes and salty drain water of the areas irrigated by Tigris and Euphrates Rivers to the Arabian Gulf through regular drainage networks [2].

The main drain or what is also named the third estuary and locally called the salty river pass in Dhi Qar Governorate, 10 km to the northeast of Nasiriyah oil field in the Kati'a area, which is about 38 km from the center of the Nasiriyah city. The area surrounded the Main Drain suffers from a pollution problem resulting from the emission of toxic gases, solid waste and liquid from the Nasiriyah oil field (Fig. 1).

The Main Drain shows a general decreasing in discharge for the last years, which is due to the decrease in the quantities of water entering the main Tigris and Euphrates Rivers as a result of the lack of water releases from the upstream countries [3], in addition to the main global and regional climatic changes [4].

Accordingly, water salinity shows a remarkable increase in the Main Drain in addition to the nearby rivers (Euphrates and Gharraf), which may affect its suitability for different life uses [5−10].

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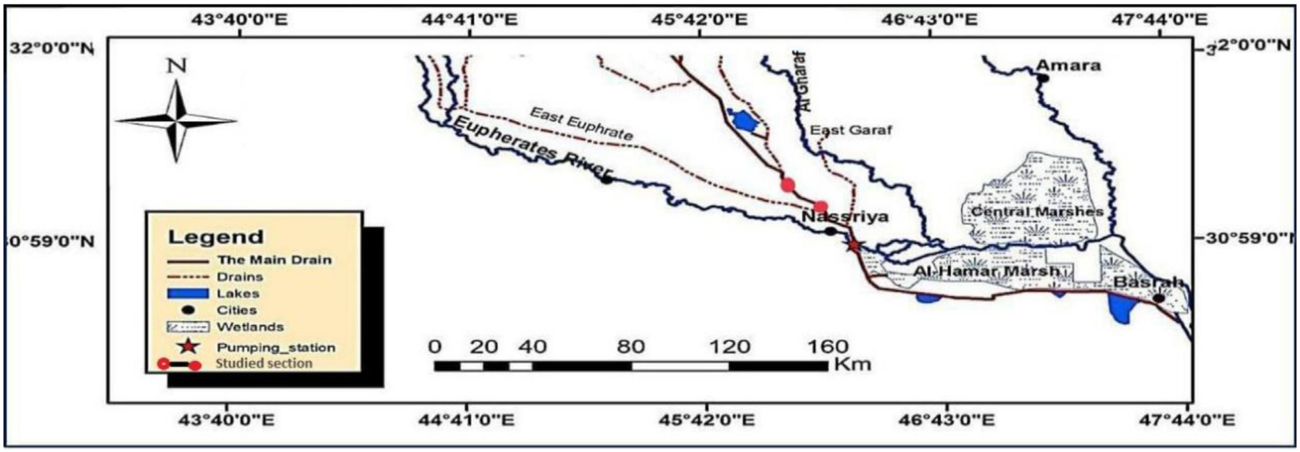

Fig. 1. Location map of the Main Drain studied section (Modified after Al-Mallah, 2014).

2. Materials and methods

The field work includes water sampling on December 30, 2021.The water samples were collected from the main drain (Plate −1). Seven water samples were collected from different sites along the channel (Fig. 2), these sites were marked on the map using (GIS) software.Water quality samples were obtained by using (500 ml) plastic bottles with two bottles for each sample, one for measuring the major ions and the second for the heavy metals. The analysis of major ions and heavy metals in water samples were carried out in the laboratories of U-Science Scientific, whereas, the physical parameters of water samples (pH, T,TH, Ec and TDS) were measured in situ.

The accuracy of the results was checked by using the following equations [11]:

$$R.D\% = \left| \frac{r\,\Sigma\text{Cations} - r\Sigma\text{Anions}}{r\,\Sigma\text{Cations} + r\Sigma\text{Anions}} \right| \times 100 \quad (1)$$

$$A\% = 100 - U \quad (2)$$

where:
U = Uncertainty or reaction error.
rΣCations = Summation of positive ions concentrations in epm unit.
rΣ Anions = Summation of negative ions concentrations in epm unit.
r =(epm) equivalent per million.
A = Accuracy or certainty.

3. Results and discussion

1. By applying the accuracy equations (equations (1) and (2)), it was found that all the water samples are acceptable for hydrochemical interpretations except sample No. 2 (Table 1).

2. The physical parameters of the water samples (Table 2) showed that the measurements of the temperature ranged between (14C° - 16C°) in the study area with a mean (15 .33C°), the values of pH are ranged from (7.44−8.45) with a mean (7.72), and the measurements of turbidity are ranged from (2.5 NTU - 4.2 NTU) with a mean (3.41 NTU), all these values are within the permissible limits of (WHO, 2008) [12]. The results of TDS in water samples are ranged from (7890 ppm−9090 ppm) with a mean (8360 ppm), which are exceeded the permissible limits of (WHO, 2008) and (IQS, 2009) [4], whereas, the results of EC are ranged from (12,140 μs/cm to 13990 μs/cm), with a mean (12,866 μs/cm), which are exceeded the permissible limits of (WHO,2008).

3. The chemical analysis of water samples (Table 3) showed that the concentration of potassium in the water samples are ranged from (32 ppm−92 ppm), with a mean value (65.16 ppm), which are higher than the permissible limits of (WHO, 2008), while the concentration of sodium are ranged from (506 ppm−664 ppm) with a mean (608.66 ppm) which is higher than the permissible limits of both (WHO, 2008) and (IQS, 2009). The analysis showed also that the concentration of calcium in the water samples are ranged between (1436 ppm−1660 ppm) with a mean (1514 ppm), and the concentrations of magnesium are ranged between (533 ppm−670 ppm) with a mean (617.5 ppm). The concentrations of both calcium and magnesium are higher than the permissible limits of (WHO, 2008) and (IQS, 2009).

The anions analysis showed that the concentration of chloride in the water samples are ranged (582 ppm−732 ppm)with a mean (629.33 ppm) (Table 3), which are higher than the permissible limits of (WHO, 2008) and (IQS, 2009), and the concentration of sulfate are ranged (5541 ppm -

Plate -1 The **Main** Drain

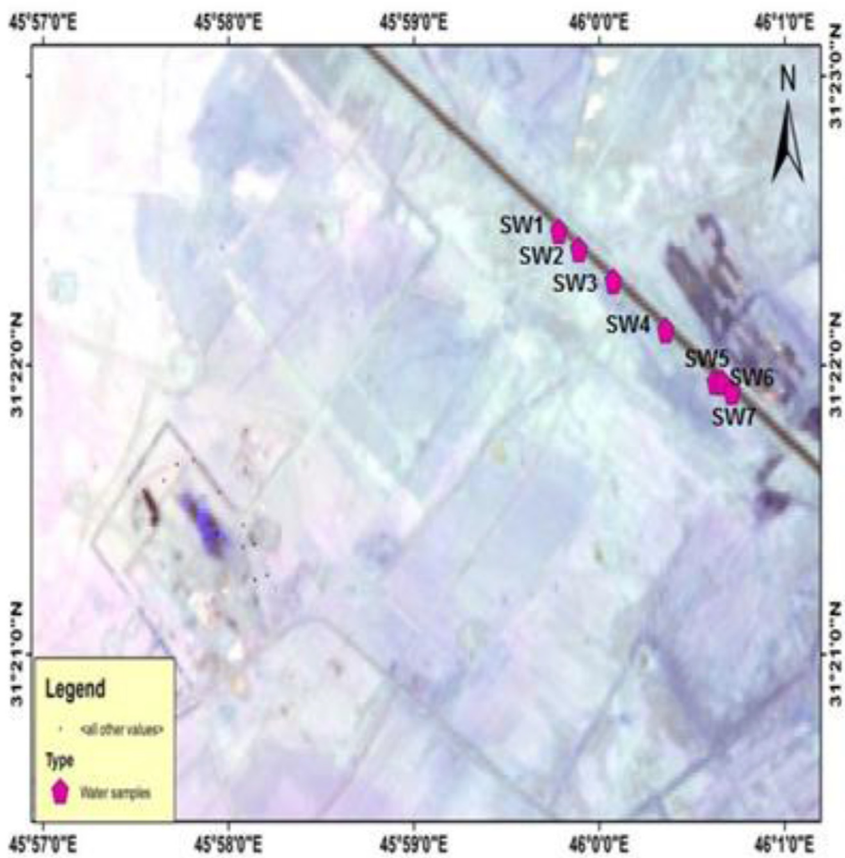

Fig. 2. Location map of the water samples sites within the study section of the Main Drain.

6672 ppm) with a mean (6060 ppm), which are higher than the permissible limits of (WHO, 2008) and (IQS, 2009) as well. The concentration of bicarbonate in the water samples are ranged (63 ppm−137 ppm) with a mean (93.66 ppm) and it is within the permissible limits of (IQS, 2009).

4. As for heavy metals, the analysis showed an increase in the concentration of cadmium and zinc in the water samples, which exceeds the permissible limits when compare it with the World Health Organization (WHO, 2008) and Iraqi standards (IQS, 2009) (Table 4). The concentration of copper and lead

Table 1. Accuracy of water samples analysis.

Sample No.	U%	A%
SW1	1	99
SW2	35	65
SW3	3	97
SW4	4	96
SW5	3	97
SW6	4	96
SW7	2	98

Table 2. Physical properties for water samples in the study area and comparing them with (WHO,2008) and (IQS, 2009).

Sample	T (°C)	pH	Turbidity (NTU)	EC µs/cm))	TDS (ppm)
SW1	14	8.45	3.1	12,970	8430
SW3	16	7.67	3.3	13,990	9090
SW4	15	7.69	2.5	12,730	8270
SW5	16	7.57	4.1	12,960	8420
SW6	16	7.54	3.3	12,410	8060
SW7	15	7.44	4.2	12,140	7890
mean	**15.33**	**7.72**	**3.4**	**12,866**	**8360**
WHO,2008	**–**	**6.5−8.5**	**5.0**	**250**	**1000**
IQS, 2009	**–**	**6.5−8.5**	**-**	**-**	**1000**

Table 3. The concentrations of major ions in the water samples.

Sample No.	Na^+	Ca^{+2}	Mg^{+2}	K^+	Cl^-	SO_4^{-2}	HCO_3^-
SW1	506	1480	661	81	590	6292	75
SW3	663	1660	641	92	582	6672	80
SW4	593	1550	533	42	661	5541	121
SW5	664	1460	670	32	732	5998	137
SW6	662	1500	565	71	627	5804	63
SW7	564	1436	635	73	584	6052	86
Mean	**608.7**	**1514**	**617.5**	**65.2**	**629.3**	**6060**	**93.7**
WHO,2008	**200**	**100**	**125**	**12**	**250**	**250**	**-**
IQS, 2009	**200**	**150**	**100**	**-**	**350**	**400**	**170**

are within the permissible limits (WHO, 2008) and (IQS, 2009). The spatial variations due to sampling site locations showed that the heavy metals concentrations increase in the direction of water flow (Fig. 3).

5. Comparing the analysis results of March 2013 [12] with the current analysis (December, 2021) (Table 5), it is clear that there a remarkable increase in the values of the chemical and physical parameters of the water in the Main outfall Drain. This confirm the fact of reducing the water releases from the riparian countries after the construction of many hydraulic projects [12], and the effect of climate change on the lack of precipitation and high evaporation which increases the salinity concentrations in the Main Drain [13].

Table 4. The concentrations of heavy metals in the water samples.

Location	Pb (ppm)	Cu (ppm)	Cd (ppm)	Zn (ppm)
SW1	N.D	0.382	0.443	N.D
SW3	N.D	N.D	0.300	0.978
SW4	N.D	0.534	0.411	N.D
SW5	N.D	0.305	0.255	1.642
SW6	N.D	0.311	0.126	2.056
SW7	N.D	0.191	0.237	3.186
Mean(ppm)	**N.D**	**0.280**	**0.290**	**1.310**
WHO,2008(ppm)	**0.01**	**2**	**0.003**	**3**
IQS,2009 (ppm)	**0.01**	**1**	**0.003**	**3**

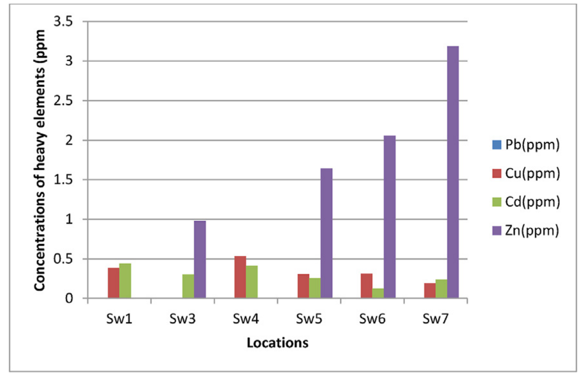

Fig. 3. The spatial distribution of heavy metals in water samples of the river.

Table 5. Comparison of the Main Drain water analysis for the current study (December 2021) with the results of March 2013.

Parameters	March 2013 (Al- Mallah,2014)	December 2021 (Current study)
TDS (ppm)	4853	8360
Ec (µs/cm)	7260	12,866
Turbidity (NTU)	18	3.4
Ca^{+2} (ppm)	228	1514
Mg^{+2} (ppm)	262	617.5
Na^+ (ppm)	1312	608.7
K^+ (ppm)	26	65.2
Cl^- (ppm)	1860	629.3
SO_4^{-2} (ppm)	1449	6060
HCO_3^- (ppm)	219	93.7

4. Conclusion

The hydrochemical analysis of the water samples in the main drain showed an increase in the value of Ec and TDS, which gives a good indicator that the salinity of water is high. The concentrations of the cations in all the samples are higher than the permissible limit of (WHO, 2008) and (IQS, 2009), which is believed to be due to the high salinity of the water. There is an increase in the concentration of (SO_4^{-2}) in all the samples due to the increase of soil salinity and the increasing of SO_2 gas in the atmosphere [14]. There is an increase in (Cl^{-1}) concentration in all the samples due to the salinity of the soil around the channel, industrial wastes, and wastes by human activities [15].

The river water is contaminated with (Cd and Zn) in which their concentrations exceeds the permissible limits of (WHO, 2008) and (IQS) as a result of industrial wastes, where the concentration of (Cu and Pb) in the water samples are within the permissible limits (WHO, 2008) and (IQS, 2009), hence no dangerous effects from copper and lead is expected.

The comparison between the current study results of the water analysis with those of March 2013 [12], showed an increase in most of the parameters which is attributed to the decrease in the water releases from the riparian countries and the climate change with decrease of rain and increase in temperatures and evaporation as well. In addition, another reason for the high salinity of the water, is due to the fact that the Main Outfall Drain is considered a drain channel for collecting excess irrigation water and land wash water from the agricultural lands that extends along the course of the channel [16].

It could be concluded also that the Nasiriyah oil field has no direct effect on the quality of the water in the main drain, where if it has, the lead which represent the most important component of the oil operations wastes should be high in the water [17,18]. Cadimium and zinc concentrations in the main drain water, is maybe due to industrial and domestic activities in areas located along the channel path [19].

References

[1] Erickson J, Moore PD. Environmental geology: facing the challenges of our changing earth: facts on file.Incorporated. 2014.

[2] Abdullah M, Al-Ansari N, Laue J. Water resources projects in Iraq, main drains. J Earth Sci Geotech Eng 2019;9(4): 275−81.

[3] Al-Mallah IA. Assessment of the environmental, hydrological and hydrogeological changes of the Main Drain. Iraq: Unpub. Ph.D. thesis, Univ. of Basrah, 2014. p. 229p.

[4] Muhammed M, Al-Dabbas M. Impact of climatic change and shortage of water flow on the Euphrates River water salinity between Al-Hindyia and Al-Nasiriya, Souther Iraq. Iraqi Geological journal 2022;55(2A):139−52.

[5] Al-Mallah I, Al-Suhail Q. Assessment of the water quality index of the Main Drain. Iraq 2017;50(No.2):36−46.

[6] Shahadha S, Salih R. Assessment of water suitability of the main outfall drain river for irrigation purposes in Iraq: case study. Iraqi Journal of Soil Science 2021;21(1):146−53.

[7] Al-Dabbas M, Jassim W, Kadhim W. Hydrochemical evaluation of the main drain and hor dalamj, Central Iraq. Iraqi Geological Journal 2016;39−49(No. 1):36−48.

[8] Turki S, Maktoof A. Assessment of water quality for Euphrates River in Al-Nasiriyah city by using organic pollution index,Journal of Education for Pure Science. Univ. of Thi-Qar 2019;9(2):58−68.

[9] Nomas H, Hashim A. The qualitative changes of the Euphrates River between Nasiriyah and Qurnah and their implications for development and the environment. Basra studies journal 2017;26(1994):123−54 [in Arabic)].

[10] Al-Dabbas M, Al-Shamma'a A, Al-Matawaki K. Evaluation of Gharraf river water for different uses, South Iraq. Iraqi J Sci 2018;59(3C):1697−709.

[11] Hem JD. Study and interpretation of the chemical characteristics of natural water U.S. Geological Survey. Water supply paper 2254; 1989. p. 246p.

[12] WHO (Guidelines for Drinking Water Quality). 3 rd 2008. p. 516p. recommendation , Geneva.

[13] IQS(Iraqi standards). Iraqi standard of drinking water No. 2009. 417modification NO.1.

[14] Ma O, Xing Ch, Sun H, Zhang X, Xu L. Distribution characteristics and source analysis of sulfate in the main rivers of Heze city, China. Water Sci Technol 2021;84(10−11).

[15] Kincaid D, Findlay S. Sources of elevated Chloride in local streams: groundwater and soils as potential reservoirs. Water and soil pollution 2009;203(1):335−42.

[16] Naff Th. The third river project: Iraq's main drain. 1992. https://www.washingtonpost.com/archive/opinions/1992/09/04/the-third-river-project-iraqs-main-drain/ce4d90c3-b6c4-4edb-921a-f15df51b2e1c/.

[17] Asim N, Sopian K. Wastes from the petroleum industries as sustainable source materials in construction sectors: opportunities, limitations, and directions. J Clean Prod 2021;284.

[18] Al-Shamma'a A, Hassan R. Pollution assessment of surface and drainage water by heavy elements in Al-Ahrar District, Wasit Governorate , Iraq. Iraqi J Sci 2018;59(No. 2B):886−91.

[19] Abed MF. Environmental risk assessment of industrial district, Baiji area. Unpub. Ph.D. thesis, University of Baghdad; 2015. p. 226p.