STUDY OF THE WATER QUALITY IN THE SHATT AL-ARAB RIVER SOUTHERN OF IRAQ: A REVIEW

Zahraa Qadra Lateef

Graduate Student, Department of Environmental Engineering, College of Engineering, Mustansiriyah University, Baghdad, Iraq

Abstract: The Shatt Al-Arab River located at southern of Iraq is ranging 8,000 -30,000 km² in size. Freshwater delivery to such system has been influenced through the water control structures being constructed within neighboring countries and Iraq. Normally, lower than 10% of such marshes were of function. The current review try to summarize the available information on quality of water of such unique and vast ecosystem. These data come from numerous scientific articles. Quality of water variables under consideration including ionic composition, salinity, and various variables in respect to nutrients status. Such information illustrate that salinity has elevated by time, negatively influencing agriculture in the south. Generally, concentrations of dissolved O₂ are high, waters are normally slightly alkaline, and aquatic submerged vegetation extensively assist suspended solids settling. NO₃ are the major inorganic N where concentrations being low in comparison to other bodies of water. Experiments in limitation of nutrients mentioned that the phytoplankton were N limited.

Keywords: *water quality; Iraq; Shatt Al-Arab River; Mesopotamia; marshes; pollution.*

1. Introduction

Water quality is a major health and disease control factor for both human and animals.

Water quality in an area is affected by natural processes (weathering processes, precipitation rates, and sediment transportation) and anthropogenic inputs (effluents of municipal and industrial wastewater, urban development and farming) [1]. The anthropogenic waste is usually a constant pollutant source. Fluctuation in water quality is considered a seasonal phenomenon which is heavily affected by climate [2]. However, intensive investigations for the anthropogenic contamination of ecosystems are continuously carried out for areas which receive such contaminations [3]. Over the last decades, there was a need for increasing demand to observe the water standard of different rivers by frequent measurements using different water quality parameters [4]. The water quality for the water resources tends to be a topic of ongoing concern. The evaluation of changes in long-term water quality is a further problem that is challenging. Also, the uncontrolled wastewater releases are of perpetual and immediate impact when it comes to the users.

*Corresponding Author: zahraa.latif.14@gmail.com

As it is known, the rivers are utilized for various applications, for example, water system, residential and mechanical utilizations and it is the fundamental standard water supply for people. For water resources, regular water quality monitoring is required to evaluate the water quality for environmental hygiene and health along of its use for domestic, industrial use, and agricultural purposes[5].

Reported human activities by Niemi et al. (1990) [6] showed that a major determinant of water and groundwater quality is effluent discharges, use of agricultural chemicals, atmospheric pollution, soil erosion, and land use. Water pollution sources are now the main feature of public concern. Some countries, such as the under-developed countries, have been inflicted by pollution impacts that are attributed to the disordered economic growth relating to the natural resource exploitation.

Figure.1 shows that Shatt Al-Arab River involve the Mesopotamian Valley southeastern and south pieces (32.7557o N, 48.0128o E). Territory environment has blistering and short summers, more than winters being chilly; the predominant breezes as north-west impact the region [7]. This part is the most significant unit of topography in southe of Mesopotamia and manifests lacustrine as complex sedimentary situation [8]. Guideline of river flows from Euphrates and Tigris by Syria, Turkey and Iran, are essentially used for farming, however, it had contributed in diminishing these wetlands. Based by IUCN (2005) In Iraq, development of impoundments expanded water system for farming just as the wetlands depleting for agribusiness has likewise influenced the water conveyance timing and amount to such wetlands [9]. Application in compound variables causing anxieties that are numerous general in the quality of water [10]. The monitoring of water quality is needed to provide an overview of

water quality and to keep track of trends for long-range of the selected water quality parameters. The water quality monitoring is principally four primary approaches can be applied for water body water quality evaluation, such approaches are index of water quality, index of trophic status, statistical water quality data analysis and biological analysis with other different biological indices [10]. The water quality evaluation might be a difficult application in variable compounds leading to anxieties that are numerous general in the quality of water [11]. The monitoring of water quality is needed to provide an overview of water quality and to keep track of trends for long-range of the selected water quality parameters [12]. The water quality monitoring is used to detect actual or possible problems for water quality and to find specific causes and to determine the effect of any kind of convective activity. Nowadays, computer systems offer the opportunity of handling and manipulating databases in many ways that have not been formerly a practical option. Nevertheless, in recent decades, population growth, runoff of sewage from urban areas, and agricultural practices increase nutrient inputs to the level of their natural occurrence, causing accelerated eutrophication[13].

Figure.1. Map of Shatt Al-Arab River [7]

Shatt Al Arab water branches contains all immense pollution into main river. These branches have numerous origins of contamination of potential effects and water quality breaking down. In focal point of Basrah territory, there are many water treatment plants conveyed on Shatt Al-Arab River right bank which is the reason the wastewater that contains Aluminum, iron and the dangerous chemical is disposed of there. Notwithstanding waste removals leakage from septic tanks and the towns which circulated extremely near the stream course and the horticultural effluents, are the significant wellsprings of pollution. Furthermore, Hartha and Najabia electric force stations release its wastewater into the stream. At last, the contamination of the Shatt Al Arab River is might have alluded to the effluents of different modern squanders approaching at the waterway water. The contamination of the Shatt Al Arab River is likewise because of the expansion of water withdrawals and the wastewater releases, particularly in its branches into the waterway that compromised the sea-going existence of the stream. The review aims to summarize previous studies results on the quality of water in Shatt Al-Arab River southern of Iraq and to highlight factors as water quality key influencing the functions and structure of such ecosystem being unique.

2. Water Temperature (WT)

Among other things, temperature is a significant factor in the balance of the aquatic environment, and the change on temperature due to the remnants of industrial heat caused a thermal pollution, the temperature effects on viscosity of water, it is effect on the speed and effectiveness of microbial processes, effective analysis of organic matter will increasing, high temperature is also leads to killing of some species of aquatic organisms and decrease the amount of O₂ dissolved water, which effects on the

process of self-purification, and leads to emergence of a new types of plants and animals. All of this leads to emergence of non-environmental balance. The best temperature for drinking water is ranging from (9-12C⁰), the temperature in Iraq's river is ranging from (7-19 C⁰) in winter and from (23-30C⁰) in summer [14]. The studies that reported the WT in Shatt Al-Arab River are illustrated in Table 1.

3. Total Dissolved Solids (TDS), Salinity (Sal.) & (EC)

The gathering of each separated constituent in water is assessed "Salinity" is consistently used comparably with "complete broke down solids" regardless of the way that that expect that the aggregate of the deteriorated solids is saline. Saltiness is higher than an estimation of the total Na and Cl exist in water. Saltiness moreover consolidates anions, for instance, carbonates that have been changed over to oxides, bicarbonate and sulfate bromide and iodine displaced by Cl, and cations, for instance, Ca, Mg, and each and every characteristic issue have been oxidized [15].

The US-EPA excludes recommendations for TDS, anyway WHO (2011) reported that level of TDS not actually around 600 mg/l is usually seen as incredible, but levels around 1000 mg/l raises concerns of classiness. Based by APHA (2005), EC has been characterized as a proportion of the capacity of a fluid to mediate an electric flow, contingent upon the nearness particles, on their valence and concentration, portability, and on the temperature of measurement [16]. Generally, bases, salts and acids being inorganic compounds are conductors being acceptable, whereas salts and acids as organic mixtures are poor conductors moderately as a result of their most minimal water ionization [17]. The studies that reported the TDS, Sal. and EC in Shatt Al-Arab River Southern of Iraq are tabulated in Table 1.

Table 1. Summary of the studies reported the mean value of WT, TDS, Sal. and EC

Study area (All selected locations in Basra city)	Period of Study	WT (C°)	TDS (mg/l)	Sal. (%)	EC (mS/cm)	Ref.
Najibia power plant	2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 and 2012	27, 23, 28, 20, 29, 45.6, 23, 24, 24.5, 24.2 and 23.7	-	-	-	[18]
Al-Qurna, Paper factory, Al- Sindebad, Al-Ashar, Al-Sebah and Al-Fao	Aug/2008-Jul/2009	-	1679, 1848, 1586, 1662, 1945 and 1800	-	2.12, 2.53, 2.20, 2.53, 2.25 and 2.24	[19]
Sindibad, Ashar, Abu AL-Khaseeb and Fao	Winter 2009 - Summer 2010	18.7-33.7 15.9- 26 18.2-26.97 20.1-23.4	-	5.8-1.9 7.3-1.7 6.8-2.2 12.4-3.5	-	[20]
Basrah oil refinery (3 stations)	Oct/2009-July/2010	26.25	4330, 3562 and 3887	-	-	[21]
Staion-1 Staion-2 Staion-3 Staion-4 Staion-5 Staion-6 Staion-7 Staion-8 Staion-9 Staion-10	Oct/2009-Sep/2010	15.1–29.6 15.2–29.6 15.4–30.6 16.8–33.7 17.3–33.9 16.4–33.9 16.6–35.2 17.5–34.4 17.5–33.9 16.7–33.4	789-1956 586-3120 835-2508 1446-9982 1465-9774 1497-6069 1632-14811 1145-20615 870-35524 3190-42409	0.6-1.1 0.7-2.6 1.1-2.0 1.5-8.1 1.5-8.6 1.6-6.3 1.7-12.5 1.0-16.7 0.8-29.9 3.2-40.4	1.35-1.72 1.45-4.89 1.73-3.84 2.38-13.93 2.29-14.80 2.7-11.21 3.18-20.80 1.50-27.20 1.36-46.10 5.6-60.20	[22]
Shatt Al Arab River in Basrah city	Monthly from 2010 to 2012	-	1060.0	-	2.16	[23]
Garma I, Al-Muwahad, Twenty five and Jubaila	Mar, Apr, May and Octo/ 2011	-	1647.2, 1521.6, 1411.9 and 1348.1	-	-	[24]
St-1, St-2, St-3, St-4, St-5, St-6, St-7, St-8 and St-9	autumn season, October 2011	19, 19, 20.2, 21.10, 21.19, 22.33, 21.8, 20.75 and 21.4	2250, 2400, 1670, 6740, 2160, 3808, 4044, 3788 and 3139	-	1.6, 1.99, 1.3, 5.08, 20.82, 39.19, 41.92, 38.19 and 38.19	[25]
Baradia, Shatt Al- Arab , Al- Rabat, Al Jubiala, Garma 1, Garma 2, Twenty Five Millon, Basrah Mohad, Al Diar and Al Qurna	Mar/2011-Mar/2012	-	1946, 1821, 1648, 2331, 1435, 1770, 1061, 982.8, 1284 and 990	-	3.502, 2.990, 2.666, 2.289, 2.361, 2.925, 1.889, 1.918, 2.134 and 1.830	[26]
Qurna, Al- Sindebad, Abu Alkhaseeb, Al-Seba and Al-Fao	Oct/2011-Oct/2012	26.95, 29.95, 22.69, 29.07 and 23.36	-	-	2.38, 2.35, 4.52, 14.39 and 32.56	[27]
Garma, Sindbad, Ashar, Mohela, Abuflouse, Seba and Fao	Dec/2012-Nov/2013	24.02, 23.93, 23.28, 23.01, 22.7, 23.53 and 23.81	-	-	2.44, 3.88, 4.92, 5.39, 5.15, 7.44 and 24.15	[28]
Abo Al-Kaseeb, Al-Dear and Qurna	Dec/2012-Nov/2013	-	2326, 1946 and 1950	-	3.95, 2.81 and 2.51	[29]
Qurna, Basrah, Maqual,	Jan/2013-Apr/2013	-	1288, 1667,	-	1.93, 2.47, 5.83, 6.25,	[30]

Abo Al-Khasib, Sayba and Al-Fao			4352, 4448, 2844 and 9603		4.10 and 14.08	
Five sampling locations within the Shatt Al Arab River	winter 2014 - summer 2014	-	2592-10780	-	3.68-14.67	[31]
ALQurna, Paper factory, Al- Sindebad, Al- Ashare, AL-Sebah and Al- Fao	2015	26.5, 27.3, 30.4, 28.5, 29.1 and 29.4	1200, 1290, 2900, 2620, 5740 and 3710	-	1.88, 2.03, 3.14, 4.1, 8.94 and 55.6	[32]
The region between the confluence of Tigris and Euphrates Rivers	Dec/2016	-	١٩٥٦,٢٧	-	٣,٧٢	[33]
St-1, St-2, St-3, St-4, St-5 and St-6	during the dry season (August, 2016) and the wet season (January, 2017).	42 ± 3.7, 32 ± 3.2, 31 ± 3.3, 39 ± 3.9, 32 ± 3.2 and 38 ± 3.3	2065 ± 51.4, 1480 ± 53.7, 1980 ± 52.6, 2752 ± 54.6, 2377 ± 55.3 and 2441 ± 53.9	-	3.45 ± 0.85, 2.34 ± 0.84, 3.09 ± 0.87, 3.78 ± 0.83, 3.75 ± 0.86 and 3.88 ± 0.85	[34]
Shatt Al-Arab River in Basrah	2016–2017	25.4	٢٥٥٣,٥	-	٤,٠٨	[35]
The Canal of Shatt Al-Basrah	2017	-	١٦٦٧	-	٢,٢٥	[36]
Hartha, Garma, Ashar , Abu-Flus, Sihan, Mukhraq, Fao and Ras El-Bisha	during the year 2018	-	-	10.49, 13.81, 16.84, 20.86, 29.18, 37.48, 39.7 and 41.85	-	[37]

4. Total Hardness (TH), Calcium (Ca⁺²) and Magnesium (Mg⁺²) ions

Water that contains salts of Ca and Mg and, to lesser extent, other polyvalent metals, such as iron, aluminum, and manganese, and that requires large amounts of soap to lather, or that does not evaporate, forms a deposit on the container is referred to as hard water [38].

Hard water doesn't seem to deleteriously affect creatures, yet it frequently is accounted for as a feature of water quality inspection. Water with the highest of TDS or saltiness could conceivably be hard water. Water is arranged by Ca and Mg salt substance as follow: delicate water rang 0-60 ppm, moderate water ranges 61-120 ppm, hard water differs 121-180 ppm and hard water is >181 ppm [39,38].

There are two types of hardness: Carbonate hardness or temporary hardness which is equal to or less than the sum of the carbonate and bicarbonate alkalinities and precipitates at boiling temperature, and non-carbonate hardness or permanent hardness that exceeds the total alkalinities and does not precipitate at boiling temperature such as sulfate , Cl , and nitrate hardness [17,38].

Ca can be leached from practically all rocks but is much more prevalent in water from region with deposits of limestone, dolomite, and gypsum. Concentrations in water from limestone areas range from 30- 100 mg/l. Ca is import to the biological productivity of water, it is considered as a micronutrient for most algae.

Waters with concentration of 10 mg or less per liter are usually oligotrophic, while waters with 25 mg or more per liter are usually distinctly eutrophic [38].

The most essential component in Chlorophyll and red blood cells are Mg in common waters that originates from carbonate rocks. A few salts of Mg are harmful by ingestion or inward breath. Fluid concentrations which are more than 125 mg/l likewise can have a cleansing and diuretic impact [16]. Mg is frequently connected with Ca in a wide range of waters [40].

The studies that reported the TH, Ca^{+2} and Mg^{+2} in the River Southern of Iraq are tabulated in Table 2.

5. Turbidity (Turb.) and Total Suspended Solids (TSS)

Turbidity is the dispersion of light measurement in the water column due to colloidal and suspended matters. The highest the turbidity, the cloudiest the water appears. Too turbid water can't lose the ability to provide a majority of plants [41]. Virtually all effluents contain suspended solid matter TSS, but especially, stone and other mineral materials, engineering works, dredging and boat traffic commonly introduce particulate matter into suspension [42].

Furthermore, the runoff of surface water contributes to substantial loads. The blanketing effect and increased turbidity of the particulates constitutes an indirect effect if they settle eventually. Turbidity increase prevents or declines photosynthesis, leading to a decline in primary plants productivity or complete elimination [43]. The studies that reported the Turb. and TSS in the River are shown in Table 3.

6. Sulfate (SO_4^{-2}) ions

Sulfate is found in most of the natural water as compounded with cations at few milligrams concentrations to thousands of mg /L [17]. Sulfate considered as one of the least anions being toxic where WHO not recommend any value as guideline for it in drinking water. Nevertheless, dehydration, gastrointestinal and catharsis irritation have been noticed in drinking water at high concentrations and WHO thus proposes that authorities of health should be informed if concentrations exceed 500 mg/l at drinking water [44].

Sulfate is one of the anions that caused dominant hardness in water; also it causes bitter taste if it exceeds 200 mg/l [17]. Transient diarrhea is a result of elevated sulfates exposure in drinking water. Usually, animals acclimate to sulfate drinking water for 3–7 days where no longer exhibit diarrhea. Methemoglobin elevated by 50% in cattle drinking water with sulfates of 3493 mg/l [39].

The studies that reported the SO_4^{-2} in River Southern of Iraq are tabulated in Table 4.

Table 2. Summary of the studies that reported the TH, Ca⁺² and Mg⁺² in the Shatt Al-Arab River Southern of Iraq

Study area (All selected locations in Basra city)	Period of Study	TH (mg/l)	Ca ⁺² (mg/l)	Mg ⁺² (mg/l)	Ref.
Al-Qurna, Paper factory, Al- Sindebad, Al-Ashar, Al-Sebah and Al-Fao	Aug/2008-Jul/2009	-	172.4, 128.8, 131.2, 137.1, 163.2 and 153.3	163.4, 160, 183.7, 161.1, 133.1 and 151.9	[19]
St-1, St-2, St-3, St-4, St-5, St-6, St-7, St-8, St-9 and St-10	Oct/2009-Sep/2010	600, 615, 700, 1420, 1210, 1150, 2100, 1775, 2810 and 3790		-	[22]
Shatt Al Arab River in Basrah city	Monthly from 2010 to 2012	763.095	289.061	463.645	[23]
Garma I, Al-Muwahad, Twenty five and Jubaila	Mar, Apr, May and Octo/ 2011	556.9, 446.3, 466.3 and 533.8	104.5, 99.7, 106.2 and 112.7	71.9, 51.6, 48.9 and 61.4	[24]
Baradia, Shatt Al- Arab , Al- Rabat, Al Jubiala, Garma 1, Garma 2, Twenty Five Millon, Basrah Mohad, Al Diar and Al Qurna	Mar/2011-Mar/2012	715.3, 713, 634, 682, 640, 683.3, 502.4, 522, 562 and 450	139, 142.3, 127.3, 157.8, 120, 120.8, 99.5, 104.3, 115 and 97.5	76.17, 87.5, 77, 121.2, 80.5, 93, 61.5, 75.3, 67.3 and 58	[26]
Hartha, Qurna, Abul Khaseeb, Jazaaer, Junaina, Kebla, Khour Al Zubair, Tanuma, Hyania and Al Zubair	Jan, May and Dec 2012 (for RO water)	24, 60, 33, 22, 19.5, 32, 28, 30,36 and 25	8.6, 11.8, 8.6,9, 5.9, 9.8, 10.4, 8.2, 7.9 and 7	5.4, 13.9, 7.5, 4.8, 4.4, 7.2, 6.2, 6.8, 8.3 and 51	[40]
Hartha, Qurna, Abul Khaseeb, Jazaaer, Junaina, Kebla, Khour Al Zubair, Tanuma, Hyania and Al Zubair	Jan, May and Dec 2012 (for Tap water)	488, 340, 710, 340, 480, 370, 650, 630, 340 and 180	86, 90, 88, 122, 88, 66, 56, 110, 102 and 86	74.6, 48, 128.5, 46.8, 82.1, 56, 111.8, 107.7, 47.9 and 23	[40]
Abo Al-Kaseeb, Al-Dear and Qurna	Dec/2012-Nov/2013	-	165.42, 175.14 and 184.08	85.35, 74.04 and 99.94	[29]
Qurna, Basrah, Maqual, Abo Al-Khasib, Sayba and Al-Fao	Jan/2013-Apr/2013	628, 722.5, 4914, 1334, 977.5 and 1870	126, 131, 368.5, 215.5, 198 and 219	75, 95, 955, 190, 116 and 317	[30]
Five sampling locations within the Shatt Al Arab River	winter 2014 summer 2014	812.30 2790.00	187.30 302.40	187.30 488.10	[31]
ALQurna, Paper factory, Al- Sindebad, Al- Ashare, AL-Sebah and Al- Fao	2015	-	158, 211, 170, 130, 112 and 2169	80, 68, 100, 173, 69 and 1158	[32]
St-1, St-2, St-3, St-4, St-5 and St-6	Dry season (August, 2016) and the wet season (January, 2017).	1127, 884, 1129, 1042, 1023 and 1148	201, 122, 173, 125, 134 and 152	87, 84, 87, 101, 96 and 111	[34]
Shatt Al-Arab River in Basrah	2016–2017	851.9167	174.6875	101.2917	[35]
The Canal of Shatt Al-Basrah	2017	5288	606.51	907.51	[36]

Table 3. Summary of the studies that reported the Turbidity and TSS in the Shatt Al-Arab River Southern of Iraq

Study area (All selected locations in Basra city)	Period of Study	Turb.(NTU)	TSS (mg/l)	Ref.
Najibia power plant	2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 and 2012	-	23, 27, 36.5, 30, 28, 27, 45, 42.6, 42.7, 39.6 and 34.6	[18]
Basrah oil refinery (3 stations)	Oct/2009-July/2010	23	31, 30 and 20.5	[21]
St-1, St-2, St-3, St-4, St-5, St-6, St-7, St-8, St-9 and St-10	Oct/2009-Sep/2010	36.4, 17.6, 14.3, 17.15, 23.9, 15, 16.9, 13.95, 34.4 and 73.95	13, 18, 16, 52, 51, 32, 77, 103, 18 and 22	[22]
Garma I, Al-Muwahad, Twenty five and Jubaila	Mar, Apr, May and Octo/ 2011	-	16, 15, 14 and 13	[24]
Baradia, Shatt Al- Arab , Al- Rabat, Al Jubiala, Garma 1, Garma 2, Twenty Five Millon, Basrah Mohad, Al Diar and Al Qurna	Mar/2011-Mar/2012	15.6, 14, 17.26, 23.20, 25.35, 34.5, 29.8, 23.8, 24.9 and 47.1	19, 18, 16, 23, 14, 17, 10, 98, 12 and 9	[26]
Qurna, Basrah, Maqual, Abo Al-Khasib, Sayba and Al-Fao	Jan/2013-Apr/2013	-	128, 166, 43, 44, 28 and 96	[30]
Five sampling locations within the Shatt Al Arab River	winter 2014 summer 2014	-	25 107	[31]
ALQurna, Paper factory, Al- Sindebad, Al- Ashare, AL-Sebah and Al- Fao	2015	25.02, 15.40, 31.03, 9, 59.8 and 120	14, 25, 30, 20, 47 and 150	[32]
The region between the confluence of Tigris and Euphrates Rivers	Dec/2016	34.75	365.95	[33]
St-1, St-2, St-3, St-4, St-5 and St-6	(Aug., 2016) and (Jan., 2017)	-	20, 14, 19, 27, 23 and 24	[34]
Shatt Al-Arab River in Basrah	2016–2017	7.47	100.83	[35]

Table 4. Summary of The studies that reported the Cl^- , Na^+ and K^+ in the Shatt Al-Arab River Southern of Iraq

Study area(All selected locations in Basra city)	Period of Study	SO_4^{2-} (mg/l)	Cl^- (mg/l)	Na^+ (mg/l)	K^+ (mg/l)	Ref.
Najibia power plant	2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 and 2012	-	660, 680, 350, 400, 360, 370, 580, 700, 600, 410 and 483.5	-	-	[18]
Basrah oil refinery (3 stations)	Oct/2009-July/2010	1806, 1325 and 1544	-	-	-	[21]
Garma I, Al-Muwahad, Twenty five and Jubaila	Mar, Apr, May and Octo/ 2011	1050.8, 925.2, 919.2 and 1023.6	444.9, 303.7, 319.9 and 382.4	-	-	[24]
Baradia, Shatt Al- Arab , Al- Rabat, Al Jubiala, Garma 1, Garma 2, Twenty Five Millon, Basrah Mohad, Al Diar and Al Qurna	Mar/2011-Mar/2012	528.1, 528.5, 463.3, 623.8, 447.8, 497.8, 320.5, 337, 381 and 259	649.5, 580, 521.3, 520.5, 416.3, 577.3, 326.3, 351, 389.8 and 282.5	41.2, 170.3, 338.3, 495, 254, 367.3, 203.5, 216.3, 231 and 172.8	11.7, 7.65, 10.2, 12, 10.25, 7.9, 7.3, 7.71, 8.15 and 5.65	[26]
Abo Al-Kaseeb, Al-Dear and Qurna	Dec/2012-Nov/2013	705.53, 904.70 and 648.43	600.3, 668.4 and 613.8	367.9, 423.5 and 371.5	8.13, 9.92 and 7.14	[29]
Qurna, Basrah, Maqual,	Jan/2013-	255, 300, 575,	279.5, 409,	-	-	[30]

Abo Al-Khasib, Sayba and Al-Fao	Apr/2013	850, 500 and 1100	1303, 1629, 1126 and 4178			
Five sampling locations within the Shatt Al Arab River	winter 2014 summer 2014	455.0 562.0	732.5 4638	654.5 3742	11.5 81.9	[31]
ALQurna, Paper factory, Al-Sindebad, Al- Ashare, AL-Sebah and Al- Fao	2015	398.11, 415.2, 438.11, 312, 295 and 146	435, 470, 1040, 950, 2060 and 13350	-	-	[32]
St-1, St-2, St-3, St-4, St-5 and St-6	Aug., 2016 and Jan., 2017.	432, 412, 253, 169, 163 and 156	331, 340, 519, 524, 232 and 534	375, 260, 346, 323, 341 and 432	42.7, 71, 42, 43,52 and 121	[34]
Shatt Al-Arab River in Basrah	2016–2017	686.2	876.7	581.8	12.3	[35]
The Canal of Shatt Al-Basrah	2017	1888	6707	6172	218	[36]

7. Chloride (Cl^-), Sodium (Na^+) and Potassium (K^+) ions

The concentration of Cl in wastewater is higher than in raw water due to the fact that NaCl is a diet main article and passes no change in the digestive system. In the coastal area, Cl exists in large concentrations because of the leakage of saltwater in the system of sewerage. A Cl increased level could harm growing plants, structures as well as metallic pipes [44].

Na salts are generally soluble highly in water and are drained to surface water and groundwater from the terrestrial environment, majority supplies of water include less than 20 mg/l, but in several states, it may increase 250 mg/l. The Na concentration of taste threshold in water relays on the temperature of the solution and associated anions, Na might influence drinking water taste at levels more than 200 mg/l at room temperature [15].

Potassium is an important nutrient which plays a central role in plant growth. Several potassium compounds, mainly potassium nitrate, are used as plants fertilizers added to agricultural soils. Other potassium compounds are used in fluid soap production. The studies that reported the Cl^- , Na^+ and K^+ in the River Southern of Iraq are tabulated in Table 4.

8. Conclusions

We can conclude from all of the above, the water bodies in Iraq face constantly to many sources of pollution, some of them, natural sources, such as the nature and type of land which the rivers passing through, or low precipitations which cause decrease in flow, and the others, due to human activities, such as untreated waste water, return irrigation flow, industry waste water or illegal practices. There is no easy way, or non-costly, or do not need to big efforts to prevent pollution, otherwise doesn't become the problem of the times. But there are some solutions, proposals and actions that lead to prevent or reduce the concentration of pollutants or mitigate their damages, like:

- 1- Improvements and enlarged wastewater treatment system on Shatt Al-Arab River and other agricultural, industrial activities, and diversion of untreated discharging effluents from the Shatt Al-Arab River.
- 2- Establishment of appropriate sanitary facilities on Shatt Al-Arab River domestic sewage.
- 3- Urgent need for improvements of the river water quality managements to meet the national and world standards.
- 4- It is of prime importance for establishment of more strict water quality index for Iraqi rivers and lakes.

- 5- Closing the factories which do not have waste water processing units, or having processing units, but it is not efficient.
- 6- Make strict laws to prevent factories using fuel, which cause pollution.
- 7- Increasing the amount of freshwater discharge to the Shatt Al-Arab River from Tigris and the Euphrates.
- 8- Constricted a baseline data concerned with the water and sediments qualities of Shatt Al-Arab River.

Acknowledgments

The author acknowledges the faculty members of the postgraduate studies of the Department of Environmental Engineering at the College of Engineering, Al-Mustansiriyah University (www.uomustansiriyah.edu.iq), especially the professors supervising the master's thesis of the author, Dr. Abdul-Saheb Tawfiq Al-Madhhaji and Dr. Dawood Issa Sajit, for their valuable assistance used in this research.

Conflict of interest

That the publication of this article causes no conflict of interest.

Abbreviations

WT	Water Temperature
TDS	Total Dissolved Solids
Sal.	Salinity
EC	Electrical Conductivity
TH	Total Hardness
Ca ⁺²	Calcium ions
Mg ⁺²	Magnesium ions
Turb.	Turbidity
TSS	Total Suspended Solids
SO ₄ ⁻²	Sulfate ions
Cl ⁻	Chloride ions
Na ⁺	Sodium ions
K ⁺	Potassium ions

9. References

1. Singh, K. P., Malik, A., Mohan, D., & Sinha, S. (2004). Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India)—a case study. *Water Res.*, **38**, 3980-3992.
2. Vega, M., Pardo, R., Barrado, E., & Debán, L. (1998). Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis. *Water Res.*, **32**, 3581-3592.
3. Szymanowska, A., Samecka-Cymerman, A., & Kempers, A. J. (1999). Heavy metals in three lakes in West Poland. *Ecotox Environ Safe.*, **43**, 21-29.
4. Issa, Y. M., Elewa, A. A., Rizk, M. S., & Hassouna, A. F. A. (1996). Distribution of some heavy metals in Qaroun lake and river Nile, Egypt, Menofiya. *J. Agric. Res.*, **21**, 733-746.
5. Poonam, T., Tanushree, B., & Sukalyan, C., (2013). Water quality indices-important tools for water quality assessment: a review. *Int. J. Adv. Chem.*, **1**, 15-28.
6. Niemi, G. J., DeVore, P., Detenbeck, N., Taylor, D., Lima, A., Pastor, J., & Naiman, R. J. (1990). Overview of case studies on recovery of aquatic systems from disturbance. *J. Environ. Manage.*, **14**, 571-587.
7. Yuaqub, R. R., & Salman, H. H. (1992). Some aspects of selected meteorological

- elements in the marshes of Lower Mesopotamia. N.A. Hussain (Ed.). Ahwar of Iraq: Environmental Approach. Marine Science Centre, Basrah University, 299 pp.
8. Yaqoob, Y. F., & Seikian, F. (1992). Sediments of lakes and marshes in the southern part of Mesopotamia plain. N.A. Hussain (Ed.) Ahwar of Iraq: Environmental Approach. Marine Science Centre, Basrah University, 299 pp.
9. IUCN (International Union Conservancy of Nature). 2005. A Directory of Wetlands in the Middle East. (<http://www.wetlands.org/inventoryand/MiddleEastDir/IRAQ1.htm>).
10. Elshemy, M., & Meon, G. (2011). Climate Change Impacts on Water Quality Indices of the Southern Part of Aswan High Dam Reservoir, Lake Nubia. Fifteenth International Water Technology Conference, IWTC-15 2011, Alexandria, Egypt, 17.
11. Bharti, N., & Katyal, D. (2011). Water quality indices used for surface water vulnerability assessment. *Int. J. Environ. Sci.*, **2**, 154–173.
12. Choudhary, P., Routh, J., & Chakrapani, G. J. (2010). Organic geochemical record of increased productivity in Lake Naukuchiyatal, Kumaun Himalayas, India. *Environ Earth Sci.*, **60**, 837–843.
13. Zan, F., Huo, S., Xi, B., Li, Q., Liao, H., Zhang, J. (2010). Phosphorus distribution in the sediments of a shallow eutrophic lake, Lake Chaohu, China. *Environ Earth Sci.*, **62**, 1643–1653.
14. WQC, 1963: Water Quality Criteria, California Water Quality Resources Board, Publication No. 3-A.
15. WHO: World Health Organization. (2011). Guidelines for Drinking-Water Quality. 4th edition. Geneva 27, Switzerland.
16. APHA: American Public Health Association. (2005). Standard methods for the examination of water and wastewater, 21st Edition. Washington, DC. USA.
17. Abawi, S. A., & Hassan, M. S. (1990). Environmental Engineering water analysis. Dar Al-Hikmma press, Al-Mousil University -Iraq. 296. (In Arabic).
18. Mohammed, I. K., Eassa, A. M., & Mohammed, L. J. (2013). The study of potential environmental risks of some industrial pollutants factors discharged from Najibia Power Plant upon Shatt Al-Arab River. *J. Basrah. Res.*, **40**, 110-121.
19. AL-Saad, H. T., Alhello, A. A., AL-Kazaeh, D. K., Al-Hello, M. A., Hassan, W. F., & Mahdi, S. (2015). Analysis of Water Quality Using Physico-Chemical Parameters in the Shatt AL-Arab Estuary, Iraq. *Int. J. Mar. Sci.*, **5**, 1-9.
20. Eassa, A. M. (2012). The use of diatom indices for the assessment of Shatt AL-Arab river water quality. *J. Basrah. Res.*, **38**, 114-124.

21. Aziz, N. M., & Sabbar, A. A. (2013). Physiochemical Properties of Basrah oil refinery discharges and its potential effects on Shatt Al-Basrah Canal. *Marsh Bulletin*, **8**, 39-57.
22. Hameed, H. A., Ali, M. H., Aljorany, Y. S., Hassan, W. F., & Al-Hello, A. A. Z. N. (2013). Assessing changes in seawater intrusion and water quality of the Shatt Al-Arab River, Iraq. *Int. J. Lim.*, **49**, 199 – 206.
23. Hassan, A. A. (2017). Solubility of surface water for drinking purposes in Basrah city Using water quality index (WQI). *Iraqi j. Civ. Eng.*, **12**, 86-95.
24. Eassa, A. M., & Mahmood, A. A. (2012). An Assessment of the treated water quality for some drinking water supplies at Basrah. *J. Basrah. Res.*, **38**, 95-105.
25. Aldoghachi, M. A. (2017). Oxygen Measurement as an Indicator of the Pollution of the Shatt Al - Arab River and the North - West of the Arabian Gulf. *Academy of Agriculture Journal*, **2**, 52-55.
26. Al-Badran, F. A. A. (2013). Determination of Water Quality Index and Suitability of Shatt Al Arab River and Treated Water for Some Water Treated Plants in Basrah. *Basrah J. Eng. Sci.*, **13**, 50-62.
27. Hassan, W. F. (2013). The nitrogen and phosphate forms in water of Shatt Al-Arab River in Basra/ Iraq. *Marsh Bulletin*, **8**, 182-192.
28. Moyel, M. S., Amteghy, A. H., Hassan, W. F., Mahdi, E. A., & Khalaf, H. H. (2015). Application and evaluation of water quality pollution indices for heavy metal contamination as a monitoring tool in Shatt al Arab River. estuary. *Int. j. multidiscip.*, **3**, 67-75.
29. Al-Khuzai, D. K. K., Abdul-Nabi, Z. A., Hussein-Maliky, J., Hassan, W., Kzaal, R. S., & Abood, M. A. (2015). Evaluation the suitability of Shatt al-Arab River water for drinking and irrigation used according to international classification systems. *Int. j. multidiscip.*, **3**, 18-28.
30. Gatea, M. H. (2018). Study of Water Quality Changes of Shatt Al-Arab River, South of Iraq. *J. Univ. Babylon Eng.*, **26**, 228- 241.
31. Dawood, A. S., Hamdan, Ahmed, N. A., & Khudier, A. S. (2018). Assessment of Water Quality Index with Analysis of Physico-Chemical Parameters (Case Study: The Shatt Al-Arab River-Iraq). *IEEF*, **5**, 93-106.
32. Mahdi, B. A. (2015). Environmental pollution in Shatt al-Arab estuary. *Int. j. multidiscip.*, **3**, 32-42.
33. Hamdan. A., Dawood, A., & Naeem, D. (2018). Assessment study of water quality index (WQI) for Shatt Al-Arab River and its branches, Iraq. *MATEC Web of Conferences*, **162**, 05005.

34. Al-Aboodi, A. H., Abbas, S. A., & Ibrahim, H. T. (2018). Effect of Hartha and Najibia power plants on water quality indices of Shatt Al-Arab River, south of Iraq. *Appl. Water Sci.*, **8**, 1-10.
35. Al-Adhab, H., Salman, A., & Sagban, A. (2019). Using multivariate statistical methods to Evaluate water quality in some of Basrah province locations. *Proceeding of ICCEET*, **2019**, 65-72.
36. Hassan, A. A., Dawood, A. S., & AL-Mansori, N. J. (2018). Assessment of Water Quality of Shatt Al-Basrah Canal using Water Pollution Index. *Int. J. Eng. Technol.*, **7**, 757-762.
37. Al-Mayah, A. A., & Al-Asadi, W. M. (2018). The impact of increase Salinity on the Aquatic Plants assemblage in Shatt Al-Arab river, Iraq. *Marsh Bulletin*, **13**, 74–86.
38. Lind, O.T. (1979). Handbook of common method in limnology, 2nd edition. C.V. mosby Co., ST. Louis.
39. Carlson, M. P., & Ensley, S. (2007). Water quality and contaminants. Chapter, 85:1045-1059 in Veterinary Toxicology, Edited by Ramesh C. Gupta Copyright © 2007, Elsevier Inc.
40. Pradeep, V., Deepika, C., Urvi, G., & Hitesh, S. (2012). Water Quality Analysis of an Organically Polluted Lake by Investigating Different Physical and Chemical Parameters. *Int. J. Res. Chem. Environ.*, **2**, 105-111.
41. Moyel, M. S., Amteghy, A. H., Naseer, T. K., Mahdi, E. A., Younus, B. M., & Albadran, M. A. (2013). Comparison of total hardness, calcium and magnesium concentrations in drinking water (RO), and municipal water with WHO and local authorities at Basrah province, Iraq. *Marsh Bulletin*, **8**, 65-75.
42. Simões, F., Moreira, A. B., Bisinot, M. C., Gimenez, S. M., & Yaba, M. J. (2008). Water quality index as a simple indicator of aquaculture effects on aquatic bodies. *Ecological Indicator*, **8**, 476-484.
43. Abel, P. D. (2002). Water Pollution Biology. 2nd ed. Copyright © Taylor & Francis Ltd.
44. UNEP and WHO (United Nation Environmental Programme and World Health Organization) (1996). Water quality monitoring: A practical guide to the design and implementation of fresh water quality studies monitoring programmers.