

Critical Assessment of River Water Quality and Wastewater Treatment Plant (WWTP)

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Abstract : Water and wastewater systems in Iraq have thoroughly been damaged in the First and Second Gulf Wars. Moreover, the Hussein regime in Iraq left the water system to collapse, and caused it to be in desperate need of modernization, redevelopment and improvement.

For the purpose of this study, samples were collected from two stations along with Diyala River in Baghdad City. The major sources of data are the Ministry of Environment and Ministry of Water Resources. We used Detection of Violation to determine the water quality of Diyala River and Al-Rustumiya Wastewater Treatment Plant (WWTP). Violation for Diyala River shows the parameters (BOD, SO₄, PO₄ & Cl) are 100% violations and that maximum level of pollution. Al-Rustumiya Wastewater Treatment Plant was having very high level of violation for the years (2005, 2006 & 2007) and the values were between (55% - 87%).

Keywords: Water Quality, Water Pollution, River Pollution, WWTP, Detection of Violation, Water resource and Diyala River.

I. INTRODUCTION

In the capital city of Baghdad, The surface water suffering from effect of conservative pollutants. Baghdad city has two rivers, the main river Tigris River and Diyala River in boundary of Baghdad City (Jassir Diyala) eastern of Baghdad as is shown in Figure 1 [6].

Diyala provincial council confirmed at the beginning of 2013, that 60% of the pollution in the province's rivers and streams are a result of the citizen's actions and demanded the spreading of environmental preservation awareness to maintain the necessary components of life [10].

Most streams and rivers in Diyala province suffer from an exponential increase in environmental pollution rates resulting from numerous factors namely the negligence of citizens and the infractions of many service administrations that bump their waste directly into the rivers. Diyala River is considered to be one of the main rivers in the province stretching through more than 150 km. The river springs from Iran and it is considered to be one of Tigris most important feeders.

Today most Iraqis have limited access to essential basic services, including electricity, water supply, sanitation, and refuse collection. Serious environmental and health risks associated with contaminated water supplies, inappropriate handling of solid waste, and disposal of sewage threaten to further burden the already stressed health system [5]. Approximately 30% of Baghdad's population is not connected to a sewage collection and treatment system. Sewage treatment plants are operating at 50% of the installed capacity, and untreated sewage is being discharged into rivers and waterways. This problem is exacerbated by the illegal discharge of septic sewage collected from houses into rivers or onto land. Leakage from sewer pipes is also contaminating both the potable water networks and the underground water, which is further adding to the health and environmental problems. According to CARE International, the U.S.-based charity, 300,000 ton of raw sewage escapes into the Tigris River daily. Diseases associated with poor sanitation, unsafe water, and unhygienic practices had increased to alarming rates. It is estimated that water-related diseases are responsible for approximately 25% of all deaths of children in Iraq; approximately 109 per 1,000 children die before the age of 1 [3]. Al-Rustamiya sewage treatment plant (WWTP) serves the east side of Baghdad City (Rusafa) and is considered one of the largest projects in Iraq. It consists of three parts (old project F0, first extension F1, and second extension F2) that treat wastewater and the effluent is discharged into Diyala River and thus into the Tigris River [1].

Sewage is created by residences, institutions, commercial and industrial establishments. It can be treated close to where it is created (in septic tanks, onsite package plants or other aerobic treatment systems), or collected and transported via a network of pipes and pumping stations to a treatment plant. Industrial sources of wastewater often require specialized treatment processes. Wastewater treatment is the process of removing the contaminants from it by physical, chemical and biological processes. Its objective is to produce a treated effluent and a solid waste or sludge suitable for discharge. This sludge may also be reused [1].

Environmental issues Iraq are also facing very serious environmental problems, including poor water

quality, air pollution, waste management, contaminated sites and the deterioration of key ecosystems. With environmental problems neglected to a large extent prior to the war as well, the decades of war, conflicts and economic sanctions have further worsened the environmental conditions. The problems are aggravated by the country's weak environmental governance structure [4].

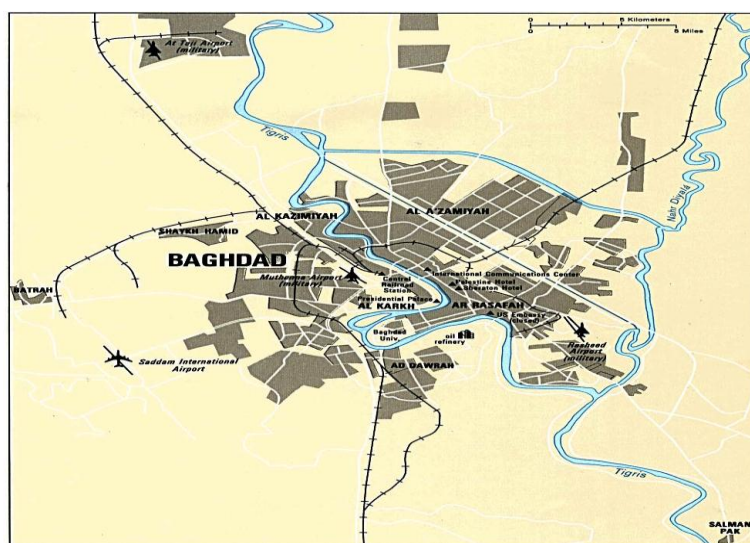


Figure (1) Map of Tigris & Diyala Rivers within Baghdad City

II. Objective and Approach

This study is an attempt to evaluate the current water quality status in Baghdad, Iraq and conduct an environmental assessment of the real status of water quality in Diyala River within Baghdad border and analyzed as follows:

- Evaluation of Diyala River water quality.
- Refine or create Diyala River specific water quality standards pursuant to International standards including development of appropriate reference conditions.
- To provide an early warning system for downstream users about adverse water quality conditions.

III. Materials and Methods

A) Study Area

The Diyala River is a major tributary of the Tigris River that runs through Iran and Iraq which drains an area of 32,600 km² [8]. The Diyala River originates near Sanandaj in the Zagros Mountains in Iran, forming the Iran- Iraq border for over 30 km. With a total length of 574 km [12], the river has a drainage area of 32,600 km², of which 25% are located in Iran and 75% in Iraq [11]. The Diyala joins the Tigris 15 km south of Baghdad [12].

Despite the construction of a major reservoir in the upper Diyala catchment in 1962, no significant impact on flow volumes and flow regime can be detected. As with the other Tigris tributaries, 1963 is the wettest year within the period of record. Since 1999 below-average flow volumes mark a dry period in the catchment, which potentially indicates intensified stream regulation. However, no long-term trend is detectable over the whole period of record from 1931 to 2011. The Diyala streamflow is very similar to that of the Lesser Zab. It is characterized by peak flows in April and a low-flow season from July until November. The Derbendikhan Dam was constructed in 1962 as a multi-purpose dam on the upper course of the Diyala in Iraq. Besides flood protection and power generation, the dam secures domestic water supply and irrigation water [2]. The 17,850 km² catchment area lies mainly in Iran [9]. Iraq built the Hemrin Dam in the early 1980s, creating Lake Hemrin with a storage capacity of over 2 BCM. Inflows originate primarily from the Wand River in Iran and runoff from Iraq is only generated during the rainy season.

B) Data Procurement and Methods

Water samples were collected from selected two stations (Di6 & Di7) along with Diyala River from January 2004 to December 2007. The samples were collected from just under water surface for analysis of selected parameters included: pH, biological oxygen demand (BOD₅), nitrate (NO₃), phosphate (PO₄), Total Dissolved Solids (TDS), Total Hardness (TH), Magnesium (Mg), Calcium (Ca), Chlorides (Cl), Sulphates (SO₄), Sodium (Na) and electrical conductivity (EC).

Violations of the permissible water or wastewater quality standards may be detected by plotting the cumulative frequency distribution (cfd) for the desired parameter and then checking the value against the standard. The cfd will plot as a straight line on normal probability graph paper. To apply this method, the following steps are necessary [7]:

- Arrange the data in ascending order.
- Give each values a rank (position) number of symbols i . This number will run from 1 to n , (n) being the number of points in the data set.
- Calculate cfd_i for each point from as shows in table (1):

$$cfd_i(\%) = \frac{i}{n+1} * 100$$

- Plot the value of each data point against its cfd on normal probability graph paper.

IV. RESULTS

A) Violation of Diyala River

Table (1) shows all the parameters (BOD, SO₄, PO₄ & Cl) are 100% violations for the years (2004, 2005, 2006 & 2007) in Diyala River within Baghdad City.

Table (1) Summary of Violation in Diyala River

NO.	Year	Parameter	Violation	Station
1	2004	BOD	100%	Di6 and Di7
2	2004	SO ₄	100%	Di6 and Di7
3	2004	PO ₄	100%	Di6 and Di7
4	2005	BOD	100%	Di6 and Di7
5	2005	SO ₄	100%	Di6 and Di7
6	2005	PO ₄	100%	Di6 and Di7
7	2005	Cl	100%	Di6 and Di7
8	2006	BOD	100%	Di6 and Di7
9	2006	SO ₄	100%	Di6 and Di7
10	2006	PO ₄	100%	Di6 and Di7
11	2006	Cl	100%	Di6 and Di7
12	2007	BOD	100%	Di6 and Di7
13	2007	SO ₄	100%	Di6 and Di7
14	2007	PO ₄	100%	Di6 and Di7
15	2007	Cl	100%	Di6 and Di7

B) Violation of Al-Rustumiya Wastewater Treatment Plant

Performance assessment of wastewater treatment plants and efficiency of removal

The extent and efficiency of removal of the impurities are presented in table (2), (3) and (4).

Table (2) Efficiency of removal for Al-Rustumiya WWTP

Time	PO ₄	NO ₃	SO ₄	BOD	O&G
April 2005	21%	34%	0%	88%	63%
May 2005	32%	61%	43%	97%	96%
September 2005	71%	53%	0%	87%	70%
January 2006	0%	0%	27%	53%	72%
March 2006	70%	57%	0%	86%	16%
April 2006	0%	37%	37%	75%	50%
May 2006	74%	0%	0%	97%	98%
June 2006	20%	50%	27%	95%	68%
August 2006	10%	15%	14%	26%	90%
February 2007	25%	0%	9%	58%	95%
March 2007	33%	57%	0%	0%	92%
May 2007	0%	65%	14%	81%	0%
August 2007	54%	59%	48%	92%	0%
September 2007	55%	0%	17%	0%	84%

Table (3) Al-Rustumiya wastewater treatment plant before treatment

Time	Before treatment					
	PO ₄ (mg/l)	NO ₃ (mg/l)	SO ₄ (mg/l)	T.D.S (mg/l)	BOD (mg/l)	O&G (mg/l)
Standard limit						
August 2004	6.6	8.37	576	1718	288	4.4
April 2005	8.1	17.4	414	1598	1500	21
May 2005	5.63	10	795	1820	1350	29.8
September 2005	5.6	12.4	620	1320	420	25
January 2006	8.87	17.05	740	1866	458	31
March 2006	21.4	40.1	480	1690	222	23.8
April 2006	4.96	12.4	560	1070	84	8
May 2006	15.97	13.15	385	1240	432	6.8
June 2006	10.71	8.9	582	1488	180	5
August 2006	7.344	4.43	1000	2792	102	4
February 2007	5.41	5.05	616	2020	300	81.6
March 2007	8.7	13.2	577	1684	459	20
May 2007	4.38	15.3	403	1828	576	8.2
August 2007	8.73	13	576	1683	457	21
September 2007	8.5	7	322	1440	42	18.4

Table (4) Al-Rustumiya wastewater treatment plant after treatment

Time	After treatment					
	PO ₄ (mg/l)	NO ₃ (mg/l)	SO ₄ (mg/l)	T.D.S (mg/l)	BOD (mg/l)	O&G (mg/l)
Standard limit	3	50	400		40	3 to 10
August 2004	6.6	8.37	514	1718	288	4.4
April 2005	6.4	11.4	496	1398	168	7.7
May 2005	3.8	3.9	450	1560	38	1.2
September 2005	1.6	5.8	740	1330	54	7.4
January 2006	17.7	40.09	540	1784	215	8.6
March 2006	6.4	17.1	710	1674	30	19.8
April 2006	7.65	7.75	348	851	21	4
May 2006	4.1	15.06	390	1220	9.6	0.1
June 2006	8.568	4.4	420	1376	8.4	1.6
August 2006	6.61	3.76	860	1248	75	0.4
February 2007	4.025	18.1	556.5	1936	125	4
March 2007	5.81	5.625	788	2140	870	1.5
May 2007	6.24	5.3	345	1464	108	14.4
August 2007	3.95	5.3	295	1330	34.2	37
September 2007	3.8	9.4	266	1200	45	2.8

Violation of standard of post treatment disposal

Table (5) presents the violation of post treatment standards. Substantial violation in many parameters indicates the shortfall in the level of treatment offered by Al-Rustumiya treatment plant.

Table (5) Summary of Violation in WWTP's

NO.	Year	Parameter	Violation	WWTP
1	2005	BOD	65%	Al-Rustumiya
2	2005	SO ₄	75%	Al-Rustumiya
3	2005	PO ₄	60%	Al-Rustumiya
4	2006	BOD	55%	Al-Rustumiya
5	2006	SO ₄	68%	Al-Rustumiya
6	2006	PO ₄	75%	Al-Rustumiya
7	2007	BOD	61%	Al-Rustumiya
8	2007	SO ₄	55%	Al-Rustumiya
9	2007	PO ₄	87%	Al-Rustumiya

V. CONCLUSION

The present study deals with the critical assessment of Diyala River water quality and performance of the water supply and sewerage systems in Baghdad. In the case of Diyala River were found to be high for the concentrations BOD, Cl, SO₄ and PO₄ and the concentrations of TH, Oil & Grease, Na, K, PH, NO₃, T.D.S, Ca, Mg, and Alk are within the limits. Diyala River is one of the major rivers of Baghdad and special attention must be taken towards enhancing the water quality standards. This is in turn closely related to the development of Iraq. Efforts are needed from the concerned authorities for renovation of water treatment plants and network in inaccessible and ware prone areas.

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