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RESEARCH ARTICLE

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.
The purpose of this study, samples was collected from two stations along the Diyala River within 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 the Diyala River and Al-Rustumiya Wastewater Treatment Plant (WWTP). Violation for Diyala River shows the parameters (BOD, SO_4, PO_4 & Cl) are 100% violations and that maximum level of pollution. Al-Rustumiya Wastewater Treatment Plant was having very high levels of violation for the years (2005, 2006 & 2007) and the values were between (55% - 87%).

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 (Allaa et al., 2012 (c)).
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 (Mohannad et al. 2013).
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 (Allaa et al., 2012). 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. 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 t 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 (Allaa et al. 2011). Al-Rustamiya sewage treatment plant (WWTP) serves the east side of Baghdad city (Rusafa) and

is considered one of the largest projects.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 (AbdulKarim, 2013).

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 (AbdulKarim, 2013).

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 (Allaa et al., 2012 (b)).

2. Objectives and Approach

This study is an attempt to evaluate the current environmental 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.

3. Materials and Methods

3.1 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 (Haitham A. Hussein, 2010). 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 (Lehner et al., 2008), the river has a drainage area of 32,600 km2, of which 25% are located in Iran and 75% in Iraq (Shahin, 2007). The Diyala joins the Tigris 15 km south of Baghdad (UN-ESCWA and BGR, 2013).

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 (ACSAD and UNEP-ROWA, 2001). The 17,850 km^2 catchment area lies mainly in Iran (MEI, 2006). 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.

3.2 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 (BOD_5), nitrate (NO_3), phosphate (PO_4), Total Dissolved Solids (TDS), Total Hardness (TH), Magnesium (Mg), Calcium (Ca), Chlorides (Cl), Sulphates (SO_4), 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 (Chapman, 1992):

- 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.

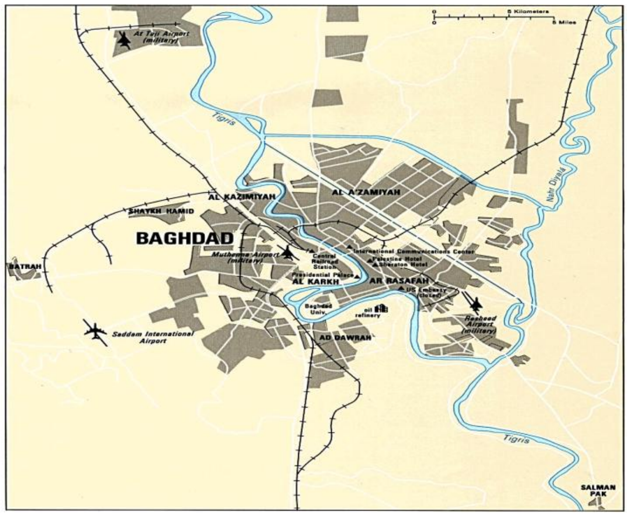

Figure (1) Map of Tigris & Diyala Rivers within Baghdad city

4. Results

4.1 Violation of Diyala River

Table (1) shows all the parameters (BOD, SO_4, PO_4 & 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

4.2 Violation of Al-Rustumiya Wastewater Treatment Plant

Performance assessment of wastewater treatment plants

Efficiency of removal

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

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

Time	PO_4	NO_3	SO_4	BOD	O&G
Apr.2005	21%	34%	0%	88%	63%
May.2005	32%	61%	43%	97%	96%
Sept.2005	71%	53%	0%	87%	70%
Jan.2006	0%	0%	27%	53%	72%
Mar.2006	70%	57%	0%	86%	16%
Apr.2006	0%	37%	37%	75%	50%
May.2006	74%	0%	0%	97%	98%
Jun.2006	20%	50%	27%	95%	68%
Aug.2006	10%	15%	14%	26%	90%
Feb.2007	25%	0%	9%	58%	95%
Mar.2007	33%	57%	0%	0%	92%
May.2007	0%	65%	14%	81%	0%
Aug.2007	54%	59%	48%	92%	0%
Sept.2007	55%	0%	17%	0%	84%

Table (3) Al-Rustamiya wastewater treatment plant

	Before treatment						After treatment					
Time	**PO_4 (mg/l)**	**NO_3 (mg/l)**	**SO_4 (mg/l)**	**T.D.S (mg/l)**	**BOD (mg/l)**	**O&G (mg/l)**	**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**
Aug.2004	6.6	8.37	576	1718	288	4.4	6.6	8.37	514	1718	288	4.4
Apr.2005	8.1	17.4	414	1598	1500	21	6.4	11.4	496	1398	168	7.7
May.2005	5.63	10	795	1820	1350	29.8	3.8	3.9	450	1560	38	1.2
Sept.2005	5.6	12.4	620	1320	420	25	1.6	5.8	740	1330	54	7.4
Jan.2006	8.87	17.05	740	1866	458	31	17.7	40.09	540	1784	215	8.6
Mar.2006	21.4	40.1	480	1690	222	23.8	6.4	17.1	710	1674	30	19.8
Apr.2006	4.96	12.4	560	1070	84	8	7.65	7.75	348	851	21	4
May.2006	15.97	13.15	385	1240	432	6.8	4.1	15.06	390	1220	9.6	0.1
Jun.2006	10.71	8.9	582	1488	180	5	8.568	4.4	420	1376	8.4	1.6
Aug.2006	7.344	4.43	1000	2792	102	4	6.61	3.76	860	1248	75	0.4
Feb.2007	5.41	5.05	616	2020	300	81.6	4.025	18.1	556.5	1936	125	4
Mar.2007	8.7	13.2	577	1684	459	20	5.81	5.625	788	2140	870	1.5
May.2007	4.38	15.3	403	1828	576	8.2	6.24	5.3	345	1464	108	14.4
Aug.2007	8.73	13	576	1683	457	21	3.95	5.3	295	1330	34.2	37
Sept.2007	8.5	7	322	1440	42	18.4	3.8	9.4	266	1200	45	2.8

Violation of standard of post treatment disposal

Table (4) presents the violation of post treatment standards. Substantial violation in many parameters indicates the shortfall in the level of treatment offered by Rustomiya treatment plant.

Table (4) Summary of Violation in WWTP's

NO.	Year	Parameter	Violation	WWTP
1	2005	BOD	65%	Al-Rustomiya
2	2005	SO_4	75%	Al-Rustomiya
3	2005	PO_4	60%	Al-Rustomiya
4	2006	BOD	55%	Al-Rustomiya
5	2006	SO_4	68%	Al-Rustomiya
6	2006	PO_4	75%	Al-Rustomiya
7	2007	BOD	61%	Al-Rustomiya
8	2007	SO_4	55%	Al-Rustomiya
9	2007	PO_4	87%	Al-Rustomiya

Conclusions

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 and the concentrations of TH, Oil & Grease, Na, K, PH, NO_3, 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.
Environment has had a major impact on human lives. The endeavors of the local people of Iraq are required in keeping their environment clean. Thus the people should be made aware about the dire consequences of negligence towards these issues.

References

1. Haitham A. Hussein, 2010. DEPENDABLE DISCHARGES OF THE UPPER AND MIDDLE DIYALA BASINS. Number 2 Volume 16 June 2010 Journal of Engineering.
2. Mohannad Mohammed, Safaa Abdul Hamid - June 12, 2013, Pollution reduces aquatic life in Iraqi Diyala River by 60%. Al-Sumaria NEWS
3. Lehner, B., Verdin, K. and Jarvis, A. 2008. New Global Hydrography Derived From Spaceborne Elevation Data. Transactions American Geophysical Union, 89(10): p. 93-94.
4. Shahin, M. 2007. Water Resources and Hydrometeorology of the Arab Region. In Water Science and Technology
5. ACSAD and UNEP-ROWA (Arab Center for the Studies of Arid Zones and Dry Lands; United Nations Environment Programme- Regional Office for West Asia). 2001.
6. Ministry of Environment in Iraq, Ministry of Water Resources in Iraq and Ministry of Municipalities and Public Work in Iraq. 2006. Main Water Control Structures (Dams and Water Diversions) and Reservoirs (Annex III). In New Eden Master Plan for Integrated Water Resources Management in the Marshlands Area. New Eden Group. Italy-Iraq.
7. Allaa M. Aenab, S. K. Singh, 2011. Critical Assessment of Environmental Quality of Baghdad, Iraq. Journal of Environmental Engineering, Vol. 138, No. 5, May 1, 2012. @ASCE, ISSN 0733-9372/2012/5-601-606/$25.00.

8. Allaa M. Aenab, S. K. Singh, 2012. Environmental Assessment of Infrastructure Projects of Water Sector in Baghdad, Iraq. Journal of Environmental Protection, 2012, 3, 1-10. doi:10.4236/jep.2012.31001 Published Online January
9. Allaa M. Aenab, S. K. Singh, 2012 (b). Evaluation of Drinking Water Pollution and Health Effects in Baghdad, Iraq. *Journal of Environmental Protection*, 2012, 3, 533-537 doi:10.4236/jep.2012.36064 Published Online June 2012
10. Allaa M. Aenab, S. K. Singh, Adil Abbas Majeed Al-Rubaye, 2012 (c). Evaluation of Tigris River by Water Quality Index Analysis Using C++ Program. ***Journal of Water Resource and Protection*, 2012, 4, 523-527** doi:10.4236/jwarp.2012.47061 Published Online July 2012
11. Chapman & Hall, 1992. First edition 1992. UNESCO, WHO, UNEP. Printed in Great Britain at the University Press, Cambridge. ISBN 0-412-45610-9.
12. AbdulKarim Muneer AbdulRazzak, 2013. Performance Evaluation of Al-Rustamiya Wastewater Treatment Plant. Journal of Engineering, Number 4, Volume 19 April 2013.
13. UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe). 2013. Inventory of Shared Water Resources in Western Asia. Beirut. Shared Tributaries of the Tigris River Chapter 4.