WATER QUALITY ASSESSMENT IN THE AL-MUSAYYIB RIVER/EUPHRATES SYSTEM USING THE RIVER POLLUTION INDEX (RPI)

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Abstract: The water quality and flow level nature of AL-Musayyib River have been experimentally studied. Experimental data monitored within the hours of 05:00 h and 12:00 h in the course of the study include flow level current river depth and width, suspended solids SS, dissolved Oxygen DO, biochemical oxygen demand BOD and ammonia-nitrogen. The quality of water in AL-Musayyib River was fated using the River Pollution Index (RPI). Results indicate that flow level peaks within the hours 6:00 h to 8:00 h and recede within the hours of 11:00. Maximum flow level was 1.90 m and the minimum value was 0.67 m. At the high flow level, measured width varied between 111-131.8 m and at lower ebb, width of the river varied between 49.1 m and 53.1 m. At peak flow level water at an average speed of 1.46 m/s in the North west direction and at ebb flow level River in the reverse direction at a constant speed of 0.22 m/s. Physico-chemical characteristics showed that DO values the ranged between (3.00 and 4.55) with a mean of 3.25 mg/L. Suspended solids (SS) values ranged between 4-8 mg/L with a mean value of 4 mg/L. Observed BOD levels at sampling point ranged between (11.50-18.60 mg/L) with a mean of 15.03 mg/L. Ammonia-nitrogen levels at sampling point ranged between (1.99-5.90 mg/L) with a mean value of 3.78 mg/L. River Pollution Index (RPI) of above 6.0 was obtained and hence water quality is classified as severely polluted. The quality of water is forthright polluted and unacceptable for drinking and domestic purposes and will require best management practice to improve the water quality in future.

Keywords: Water Quality, River Pollution Index (RPI)

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NTRODUCTION

Flow levels are the repetitive movement in river water due to changes in the attractive change in characters (Nikki, 2009). It is the rhythm of the daily cycle of water flowing in and out as if it were retreating to a distant place (Kjerfve and Magill, 1989). The complex flow is mainly influenced by the interactions between sea water and river water. Thus, the flow is in continuous flow as an adaptation to climatic and water conditions. Seasonal changes in flow conditions determine water salinity (Dronkers and Leussen, 1988). The level of flow can either aid in understanding the intelligent use of forecast trends, its enormous biological productivity and proximity to centers of trade and population. For example, near the Musayyib River, large plant assemblies consisting of 62 plant species have been reported (Reyam, 2018). Common plant species include different species such as Eleocharis palustris, Equisetum sp, Leersia oryzoides, Ludwigia palustris, Myriophyllum sp and Phalaris arundinace. In addition to having a large plant community, a large number of fish species have also been reported (Reyam 2019). Common fish species such as Gasterosteus aculeatus, Mylocheilus caurinus, Fundulus diaphanous and Oncorhynchus tshawytscha are found. Globally, pollution from urbanization and industrial waste as well as agricultural activities is becoming an increasingly serious concern for the ecosystem function of flowing rivers (Sather, et al., 2011). The function of flowing rivers' ecosystems is threatened by industry, sewage, and land clearing, and flowing rivers are affected by upstream events and concentration of materials according to (Branch, 1999).
The effects of pollution on fish stocks in the Musayyib River have also been reported (McLusky and Elliott, 2004). Knowledge of river flow characteristics is essential to planning and implementing projects to monitor environmental impact and understand pollutant transport and distribution. In the Euphrates river system, our knowledge of the processes governing these phenomena is limited and the measurements needed to improve our understanding are scarce (Emeka, et al., 2010). This study was a response to a growing awareness of the importance of the delicate ecological balance of flowing rivers through nutrient over-enrichment. The study aims to shed light on hydrological processes and includes the diffuse flow along the Musayyib River system, mainly on field

measurements of current flow, and water levels. It also aims to assess the quality of river water for the purpose of high illumination of the extent of pollution. The ultimate goal of studying the Musayyib River is to generate data that is important for designing management and conservation policies for the river. Moreover, the results obtained will be used in order to suggest a discussion on the Musayyib river flow classifications in our country.

EXPERIMENTAL

Description study site

The study sites is located at 'Euphrates' river near Al-Musayyab of the power plant, in a northern border of a "Babylon Governorate" , central of Iraq, within Mesopotamian a basin of the shaky shelf according to (DiLorenzo, *et al.*, 1994), between 32˚50'50" N 44˚16'12" E. This sites characterized by a flat topography and covered by the deposits quaternary of the flooding levels of "Tigris and Euphrates" rivers, more thick in the layers of a recent all sediments up to 600 m thick according to (Agriculture Jacobson, *et al.*, 1987). Previous study of the meteorology depended on the average atmospheric temperature to be about (25.50 °C) in rainy season and (30.00 °C) in dry season. Relative humidity daily values range about (55.50% - 60.00%) in rainy and dry season.

Sampling Procedure

A choice sampling station include the presence of the following activates industrial effluent discharge and power plant. Water samples for the study were collected in plastic containers. Samples for (BOD) were collected in bottles. All samples were stored in an ice-chest. All samples were conveyed in an ice-cooler and transported to the Anal Concept Laboratory, Port Harcourt for analysis. Water samples for the study were collected on an hourly basis within the hours of 07:00 h to 19:00 h on the 27th of July, 2015. The sampling, handling and analysis of water samples were carried out as recommended (FEPA, 1991; APHA, 1998 and Department of Petroleum Resources, 2002).

Measured Parameters

Parameters analyzed for in all samples collected were (BOD), (DO), (SS) and (NH4). These parameters consider are a good of the environmental impact as an indicators for (RPI) according to (Raty and Kangas, 2012). Within the sampling period of 05:00 h to 12:00 h, hydrodynamic characteristics such as, flow current and width of the water body at the sampling station were also determined. flow current was determined using model 106 light weight current meter. Water depth and width was measured using a calibrated stick, speed of the water body was also determined by using a float like method.

Laboratory Analysis

Fast changing parameters such as (DO) was measured using a multi parameter the water quality depended model 600 UPG , and BOD of the water samples was determined using the Winkler Titration Method. SS was determined by using the mass loss technique (D-Total Non-filtrate Residual Dried at 103-105 °C). NH4 was determined by using (Brucine colorimeter method). All methods of analysis are consistent with those reported (FEPA, 1991; APHA, 1998 and Department of Petroleum Resources, 2002).

RPI "River Pollution Index"

The river system classification for monitoring water quality is RPI dependent (Raty and Kangas, 2012), which includes four variables: "dissolved oxygen (DO), (BOD), (SS), and (NH3-N)." Each water quality variable used to calculate RPI is converted to one of four index scores (Si = 1, 3, 6, or 10). Notably, RPI is the arithmetic average of these index scores in terms of water quality:

$$\text{River pollution Index (RPI)} = \frac{1}{4}\sum_{i=1}^{4} Si$$

Where Si denotes the index scores from Table 1 and RPI denotes the RPI value, which ranges from 1 to 10. The river pollution index listed in Table 1 categorizes pollution into four categories: unpolluted, negligibly polluted, moderately polluted, and severely polluted.

Table 1: Definition of river pollution index (RPI)

Water Quality / Item	Non/mildly-polluted	Lightly-polluted	Moderately-polluted	Severely-polluted
Dissolved Oxygen (DO) mg/L	DO ≧ 6.5	6.5 > DO ≧ 4.6	4.5 ≧ DO ≧ 2.0	DO < 2.0
Biochemical Oxygen Demand (BOD5) mg/L	BOD5 ≦ 3.0	3.0 < BOD5 ≦ 4.9	5.0 ≦ BOD5 ≦ 15.0	BOD5 > 15.0
Suspended Solids (SS) mg/L	SS ≦ 20.0	20.0 < SS ≦ 49.9	50.0 ≦ SS ≦ 100	SS > 100
Ammonia Nitrogen (NH3-N) mg/L	NH3-N ≦ 0.50	0.50 < NH3-N ≦ 0.99	1.00 ≦ NH3-N ≦ 3.00	NH3-N > 3.00
Point Scores	1	3	6	10
Pollution Index Integral Value (S)	S ≦ 2.0	2.0 < S ≦ 3.0	3.1 ≦ S ≦ 6.0	S > 6.0

Table 2: Hydrodynamics characteristics of AL-Musayyib River

Time (h)	Flow (m)	SS (mg/L)	DO (mg/L)	BOD (mg/L)	NH3-N (mg/L)
0.67	111	4	3.9	12.4	4.1
0.88	121	5	4.1	12.8	3.6
0.93	129.3	4.6	3.9	11.5	1.99
1.09	130.1	6.7	3	13.6	2.8
1.23	125	8	4.2	17.8	5.01
1.9	114	7.3	4.55	18.6	5.9
1.33	131.8	5.4	4.22	16.2	4.6
1.49	119	7	3.7	15.8	3.5
Mean 1.19	Mean 122.65	Mean 6	Mean 3.9	Mean 14.8	Mean 3.9

Table 3: Physico-chemical characteristics of AL-Musayyib River

Sampling	Time (h)	Flow (m)	Width (m)	Flow current (m/s)
05:00	0.67	111	49.3	1.46
06:00	0.88	121	49.1	1.11
07:00	0.93	129.3	50.2	0.22
08:00	1.09	130.1	51.8	0.99
09:00	1.23	125	50.9	1.1
10:00	1.9	114	53.1	0.98
11:00	1.33	131.8	52.4	0.77
12:00	1.49	119	50.9	0.13
Mean	1.19	122.65	50.96	0.84
Quartiles:	Q_1 --> 0.905	Q_1 --> 116.5	Q1 --> 49.75	Q1 --> 0.495
	Q_2 --> 1.16	Q_2 --> 123	Q2 --> 50.9	Q2 --> 0.985
	Q_3 --> 1.41	Q_3 --> 129.7	Q3 --> 52.1	Q3 --> 1.105
Range IQR	0.505	13.2	2.35	0.61

Results and Discussion

The results show the hydrodynamic and physicochemical properties of flow AL-Musayyib River monitored between the hours of 5:00 h and 12:00 h at the determined sampling station are presented in Tables 2 and 3 respectively. Fig 1 is a graphical representation of the flow's rise and fall. during the 8 h study period. flow peaks were observed within the hours 9:00 h to 12:00 h and begin to recede within the hours of 5:00. Similar flow fluctuations have been reported (Jacobson, *et al.*, 1987; DiLorenzo, 1994). The curve has the general form of a variable sine curve. In this study, the maximum flow level obtained during the daylight field measurement was 131.8 m and the minimum value was 111 m. Flow change occurs twice daily, as it does in most places, and when there are two high and two low waters each day, with relatively small differences in the respective highs and lows, the form is called semidiurnal. This finding is consistent with other research on Boston Harbour in the United States. (Bothner, *et al.*, 1998). Field measurement showed that the width of the river varies with the observed flow (Fig. 1). At the high flow which occurred between 9:00-12:00 h, the lower flow which occurred at 05:00 h and 7:00 h.

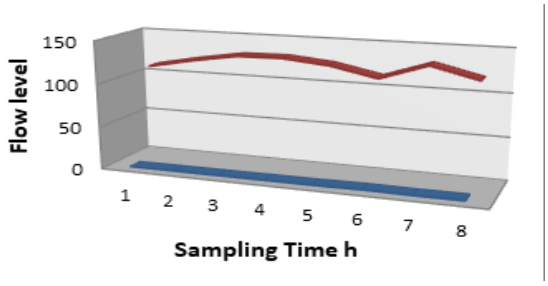

Figure 1. Variance of Flow (m) against sampling time (h)

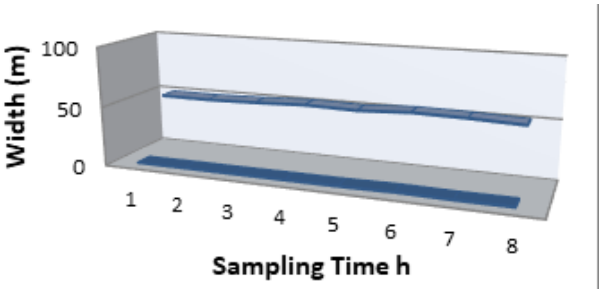

Figure 2. Variance of width of AL-Musayyib River against sampling time (h)

Flow current is the horizontal flow of water that occurs on a regular basis and is accompanied by its rise and fall. Since the River depth range within the channel under investigation do not exceed 10 m, only surface current was considered and measured this agree with (Puyate and Rim-Rukeh, 2008). Field measurement shows that the speed of flow river varies throughout the cycle, passing through two maximums in roughly opposite directions and two minimums roughly halfway between the maximums in both time and direction. Field measurements indicated that at peak flow water flows at an average speed of 0.84 m/s. Observed flow currents are semidiurnal in nature (Fig. 3) because it corresponds to the type of flow at the location to a large extent In many places, there is a clear relationship between current times and times of high and low water in the area. This relationship is frequently used in current atlases and notes on nautical charts, which present the direction and speed of the current at each succeeding hour after high and low water, at a location where flow level predictions are available.

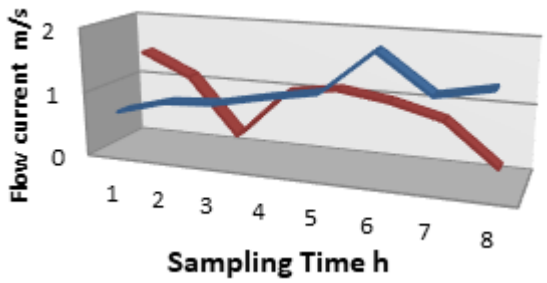

Figure 3. Variance of Flow current against sampling time (h)

Table 3 shows the physical and chemical properties of the Musayyib River system as observed during an 8-hour period. All aquatic organisms require dissolved oxygen. Low levels of dissolved oxygen (hypoxia) can impair animal growth or reproduction, and complete deprivation of oxygen (hypoxia) will kill aquatic organisms. Aquatic organisms with restricted movement are particularly susceptible to hypoxia or hypoxia. Fish can become trapped in low oxygen or no oxygen environments as well. Water temperature, water mixing properties, amount of oxygen produced by biological processes (such as photosynthesis by plants), amount of oxygen used in abiotic and biological processes such as respiration or decomposition of organic matter and dead phytoplankton in column water or in sediments, as well as at the sediment-water interface, They all affect dissolved oxygen levels. According to (Emerson and Abell, 2001; Rim-Rukeh and Agbozu, 2013). The dissolved oxygen levels observed at the sampling point were generally low and ranged between 3.00 and 4.55. However, higher values of oxygen were recorded during the high flow period, which can be attributed to the dissolution factor caused by the different procedure. The low level of dissolved oxygen measured may be due to the appreciable presence of decomposing organic matter, which is consistent with (Emerson and Abell, 2001). The DO value of the normal saturation of fresh water depends on temperature, its value varies from 14.62 mg / l at 0 ° C to 7.63 mg / l at 30 ° C at normal atmospheric pressure. Dissolved oxygen levels are below 5.0 mg/L, aquatic life is under stress and can result in large fish mortality if persisted for a few hours as shown by (Emerson and Abell, 2001). The results of the water bodies in the study area especially in some sampling stations provide a poor condition for the survival of aquatic life.

Suspended solids (SS) are inorganic fractions such as silt and clay and organic fractions such as algae, zooplankton, bacteria and detritus that water carries as it runs off the ground and contributes to the turbidity or turbidity of the water body (Statky Series, 2001). Suspended solids can clog fish gills, causing death or a reduced growth rate. They also reduce light penetration, which reduces the algae's ability to produce food and oxygen. Toxic chemicals, such as pesticides and metals, absorb into suspended solids in water and form complexes with it, making toxic substances less available for uptake by living organisms. The number of macroinvertebrates was reduced by 60% in a study in which total dissolved solids (TSS) was increased to 80 mg/L. (Statky Series, 2001). The observed SS levels at the sampling point were very high, ranging from 4 to 8 mg/L. The observed SS levels can be attributed to the presence of silt and other suspended matter on the water surface. Biochemical oxygen demand (BOD) is the amount of oxygen needed by microorganisms to stabilize biodegradable organic matter at a specified time and temperature, given that they are sewage and energy generation areas. The BOD test is commonly used to determine the polychromatic strength of household and industrial waste in terms of the oxygen required to deliver end products such as CO2 and H2O. The most commonly used parameter for organic pollution applied to both sewage and surface water is 5-day BOD (BOD5) at 20°C. BOD is used to measure and evaluate water quality according to ecology and ecology. It is an indicator of the quality of the water source. Most pristine rivers will have a 5-day BOD of less than 1 mg/L. Highly polluted rivers may have a BOD value in the range of 2 to 8 mg/L. Municipal wastewater that is efficiently treated by a three-stage process will have a value of around 20 mg/L. Untreated wastewater varies, but averages around 600 mg/L in Europe and as low as 200 mg/L in the United States, or where there is severe groundwater or surface water intrusion. The observed BOD levels at the sampling point ranged between 11.50-18.60 mg/L. The relatively high levels of BOD can be attributed to the presence of decomposing organic matter in particular. Using BOD values as an assessment criterion, the Musayyib River can be classified as highly polluted.

Nitrogen is an essential nutrient that all plants and animals need to make amino acids. In its molecular form, nitrogen cannot be used in most aquatic plants, so it must be converted into another form. One such form is ammonia nitrogen (NH3-N). The term ammonia refers to two balanced chemical types in water (NH3, non-ionizing and NH4+, ionized). Ammonia tests usually measure total ammonia (NH3 plus NH4+). The toxicity of ammonia is mainly attributed to the non-ionized form (NH3), in contrast to the ionized form (NH4+). When dissolved in water, natural ammonia (NH3) reacts to form an ionized type called ammonium (NH4+). NH3 is the main form of toxic ammonia. It has been reported to be labeled for freshwater organisms at concentrations ranging from 1.99-5.90 mg/L. Toxic levels depend on pH and temperature. Toxicity increases with decreasing pH and decreasing temperature. Plants are more tolerant of ammonia than

animals, and invertebrates are more tolerant of fish. Fish hatching and growth rates may be affected. In structural development, changes may occur in the tissues of the gills, liver and kidneys. Toxic concentrations of ammonia in humans may cause loss of balance, convulsions, coma, and death. Ammonia levels in excess of the recommended limits may harm aquatic life. Fish may experience loss of balance, excessive excitement, increased respiratory activity, oxygen uptake, and increased heart rate. At extreme ammonia levels, fish may experience convulsions, coma, and death. Experiments have shown that the lethal concentration for different types of fish ranges from 0.2 to 2.0 mg/L. Trout appears to be the most susceptible to this fish and carp least sensitive as mentioned (Emerson, et al., 1975). The observed ammonia-nitrogen levels at the sampling point ranged between 3.9 mg/L which is well above the regulatory limits of 0.5 mg/L according to (WHO, 2003). The relatively high levels of ammonia nitrogen can be attributed to the direct discharge of sewage and industrial waste into the water body. Using the values of ammonia and nitrogen as an assessment criterion, the Musayyib River can be classified as highly polluted by ammonia nitrogen. As an essential step of this study, the pollution status of the Musayyib River was assessed using the River Pollution Index (RPI). During the study, four values of water quality obtained from the sampling station were assigned to the corresponding points; RPIs were calculated at different time intervals for each sampling sites . Based on Table 1, water quality is classified as unpolluted for the integral of RPI under 2.0 negligibly polluted refers to the integral of RPI between 2.0 and 3.0 moderately polluted indicates water quality above 3.0 but under 6.0. For the integral of RPI above 6.0, water quality is classified as severely polluted. In this study the Dissolved Oxygen (DO) 3.7 mg/L, Biochemical Oxygen Demand (BOD5) 15.8 mg/L, Suspended Solids (SS) 7 mg/L, and Ammonia Nitrogen (NH3-N) 3.5 mg/L. The scores are obtained as following (Table 4):

Table 4: Water quality parameter index score

Water Quality	Monitoring Data	Index scores
Dissolved Oxygen (DO)mg/L	2.95	6
Biochemical Oxygen Demand (BOD5)mg/L	15.03	6
Suspended Solids (SS) mg/L	7513	10
Ammonia Nitrogen (NH3-N)mg/L	3.99	10
Total Point Score		32

The total point score is then divided by the number of items for determining water quality in 8 hours . The obtained value 8 was then compared to the above "Pollution Index Integral Value", which was above 6.0, and therefore River Pollution Index (RPI) is determined as severely polluted.

CONCLUSION

The Musayyib River is a flowing body of water that peaks (high flow) between 9:00 and 11:00 and recedes (low tide) between 5:00 and 7:00, and can be semi-double in nature. . The River Pollution Index (PRI) has shown that water quality is severely polluted and is not acceptable for servicing purposes and will require best management practices to improve water quality. This research can be submitted to the Ministry of Agriculture and Environment and Musayyib Municipality to assess this situation in the water quality of the river.

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