Evaluation of Chloride Concentration in River Euphrates at Al-Diwaniya City

Nassrin Jassim H.AL-Manssori
Environmental Engineering Department, Engineering Collage
University of Babylon

Abstract

The quality of surface waters may deteriorate due to the presence of various polluting parameters such as salts, organic and inorganic matters. Chloride is such a polluting parameter. The presence of chloride, in rivers and streams is due to waste water and drainage water disposal. This study is concerned with evaluating chloride concentration in river Euphrates through Al-Diwaniya city. Chloride variation with distance and time was studied and the effect of its concentration on various uses of the water was evaluated.

الخلاصة

تتأثر نوعية المياه السطحية نتيجة لارتفاع تراكيز الملوثات المختلفة منها العضوية وغير العضوية والاملاح ومن هذه الملوثات الكلوريد الذي يوجد في المياه السطحية نتيجة لاذابته من الصخور او تصريف البزل او المياه الثقيلة .تتسبب تراكيز الكلورايد العالية بتغير طعم الماء او زيادة التوصيل الكهربائي للمواد العازلة المستخدمة في الصناعة وعليه فقد أعد هذا البحث لتقييم تغير تركيز الكلورايد اثناء مروره في مدينة الديوانية لفترة سنتين مع عاملي الوقت والمسافة.

1. Introduction

Population increase in most of the Iraqi cities causes an increase in wastewater production which is mostly disposed into rivers and streams. Expansion in agricultural and irrigation schemes results in increased drainage water disposal into surface streams Tchobanoglous and Burton (1991). Chloride concentrations like other water quality parameters are highly affected and in few cases exceeded the maximum allowable limits of 200mg/l of raw surface water, (Tebbutt,1998) .The High concentration of chloride may limit the use of water for various purposes. Evaluation of chloride concentration versus time, distance is required in order to maintain a proper surface water quality management system, and to protect the consumers from using deteriorated water. The purpose of this study is evaluate chloride concentration variation versus time, distance in river Euphrates at Al-Diwaniya city.

2. Site and Data Collection

River Euphrates monthly-chloride concentration at Al-Diwaniya city were analyzed for two years period (2004 and 2005).Water samples were taken from 10 stations distributed along a 65 km reach of the river. The distance between these stations are presented in Table 1. Station no.1 is considered as a reference point at which chloride concentration was at its minimum level prior to entering the city where several drainage and wastewater disposal canals discharge into the river. Figure .1 shows the location of sampling stations and wastewater and drainage canals discharging points into the river.

Chloride concentration in river Euphrates is below the allowable limit for drinking water standards (Schluz (1992 and Smethurst 1997). The highest monthly chloride concentration recorded within the two years period was 192 mg/l at station No.1in January, 2004 compared with the lowest concentration of 108 mg/l recorded at station No. 4 in August, 2005 (ASCE,1990)

3. Time and Distance Affect on Chloride

Chloride concentration in river Euphrates seems to be affected by both time (months) and distance (station number). Hence analysis of variance was performed on the results based on monthly chloride concentration measured at each sampling station for the two-year period. Table 2 shows the results of this analysis. The interaction between the time and station effects on chloride concentration as indicated by the f test is not significant at the 95 percent probability level. However the effects of both time and distance on chloride concentration are significant at the 95 percent level of probability. These results indicated that time and distances are separately affecting the concentration of chloride concentration. Flow rate in the river is not included in this analysis since the flow in the river produces the same effect on chloride concentration as dose the time.

In order to study chloride level behavior versus time and distance, their effect on mean chloride concentration was separated.

Figure 2 shows mean chloride concentration at the 10 sampling stations for the two years period. Two jumps in mean chloride concentration (Figure 2) are mainly due to drainage canals discharging into the river. The first jump is due to discharging into the river. The first jump is due to discharging sewage of industry region into the river prior to sampling station 3. The second jump is due to hospitals discharging into the river prior to sampling station 5. A third degree polynomial equation was fitted to the data points with R value of about 90 percent is shown on figure 2 and presented as follows:-

$$Y = A_0 + A_1 X + A_2 X^2 + A_3 X^3 \quad \text{.....(1)}$$

Where
Y= the predicated chloride concentration in mg/l.
X= distance in Km from reference point (station 1).
A_0 , A_1 , A_2 and A_3 are coefficients and their values are determined to be 47.91, 0.4378, 0.0042 and 5E-05 respectively.

This equation is used in describing the average chloride concentration for the two years period, and the statistical test of this equation is shown in Tables (4 and 5).

Different harmonics were adapted describing mean chloride concentration versus time (months). The mathematical description of mean chloride concentration by the periodic function
μ_t versus time is achieved by selecting a given number of harmonics such as follows:-

$$\mu_t = X + \sum_{j=1}^{m} \{Ajcos(2\pi jt/ w) + Bjsin(2\pi jt/ w)\} \quad \text{.....(2)}$$

Where
μ_t = predicated monthly mean chloride concentration in mg/l.
w = number of data point.
m = number of harmonic.
Aj and Bj = are Fourier coefficients for the jth harmonic and t month number.
X = actual mean chloride concentration, mg/l.
Fourier coefficients can calculate using the following equations:

$$Aj = 2/w \sum_{W} m_t \cos(2\pi jt/ w) \quad \text{.....(3)}$$

t=1

and

$$B_j = 2/w \sum_{t=1}^{W} m_t \sin(2\pi jt/w) \quad \text{.....(4)}$$

where

m_t = mean monthly chloride concentration in mg/l.

The amplitudes C^2_j of these harmonics are computed as follows:

$$C^2_j = A^2_j + B^2_j \quad \text{.....(5)}$$

The percent of the variance explained by the periodic function may be computed as follows (Yevjevich 1975)

$$\text{Percent of explained Variance} = \sum_{J=1}^{m} (C^2_j / 2)/S^2_v \quad \text{.....(6)}$$

Where

S^2_v = the variance of mean chloride concentration.

Table 3 presents the Fourier coefficients and percent of the explained variance for mean chloride concentration versus time for different number of harmonics.

It is seen that models with two harmonics explain 94.7 percent of the variance while those with 6 explain 100 percent of the variance. Thus the model with two harmonics may be used in predicting mean chloride concentration since it contains smaller number of coefficients, five in this case.

Figures 3 and 4 give a graphical representation of the periodic function with 2 and 6 harmonics. Excellent fits of μ_t to m_t are noted in both cases.

Both models show that chloride concentration is at its minimum level in August when the flow rate in river Euphrates is at the highest level. Where chloride concentration reaches its maximum level in January. When flow rate in Euphrates is at its lowest level.

4. Conclusions

The results of two –year chloride concentration analysis in river Euphrates at Al-Diwanyia indicated the following conclusions:

1. There is no interaction between the effect of time and distance on chloride concentration as river Euphrates water flows downstream a 67 km. reach through Al-Diwanyia. Chloride concentration are mainly affected by river discharge as indicated by time (month number) and distance since many wastewater and drainage canals are discharging into the river through this reach.
2. Harmonic Functions were adapted for describing mean chloride concentration versus time, and the function with two harmonic is the best one.
3. Mean chloride concentration versus distance in two –year period was present in term of three degree polynomial equation with R value of about 90 percent.

Table (1) Distance Between Stations and Distance from Reference Point in –KM

Station No.	Distance from Ref. Point	Distance Between Stations
1	1.00	0.00
2	9.71	8.71
3	**20.81**	11.1
4	27.56	6.75
5	**34.18**	6.62
6	45.27	11.09
7	52.435	7.165
8	56.63	4.195
9	63.42	6.79
10	67.135	3.715

Table (2) Analysis of Variance Results Produced on Chloride Concentration in Two –Year Period

Source	DF	SS	MS	F-value
Time	11	44290	4026.364	43.77
Station	9	10368.37	1152.041	12.36
Interaction	160	6879.42	105.50	0.70
Error	99	9226.833	93.20034	
total	279	70764.62		

DF: Degree of freedom, SS: summation square, MS: Mean square

Table (3) Fourier Coefficients Harmonics to Mean of Chloride with Harmonics Number

J	A(J)	B(J)	% of Exp 1.Var1.
1	7.76	-17.53	84.20
2	-4.03	4.08	94.70
3	-0.34	0.58	95.00
4	0.15	0.42	95.00
5	2.68	0.21	98.00
6	1.12	0.00	100.00

Table (4) Analysis of Variance for Equation No.1

Source	DF	SS	MS	F-value	Significance F
Regression	1	4165.83	4165.83	255.02	2.369E-07
Residual	8	130.67	16.33		
total	9	4296.51			

Table (5) Analysis of Variance for Equation No.1

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	41.63	2.571	16.193	2.13E-07	35.70864	47.56755
X Variable	0.942	0.059	15.969	2.37E-07	0.806204	1.078331

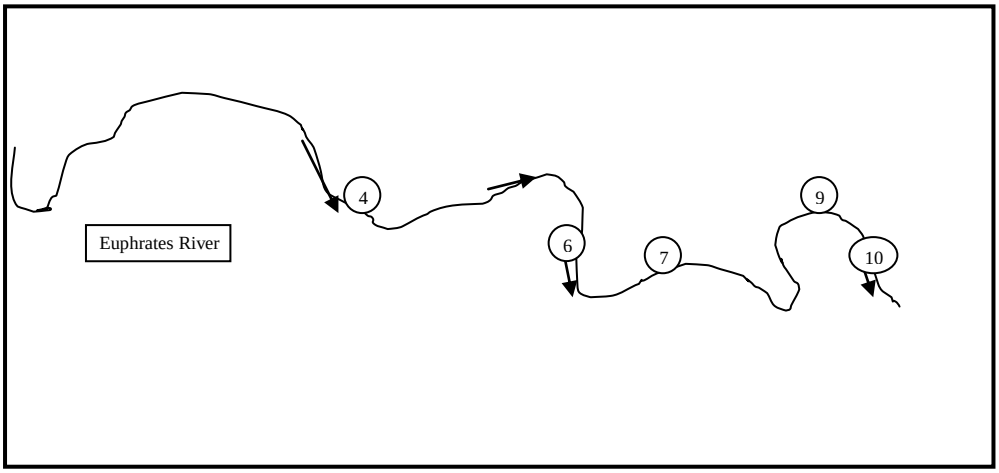

Fig. (1) Location of sampling points along Euphrates River through Al-Diwanyia City. (Not to scale).

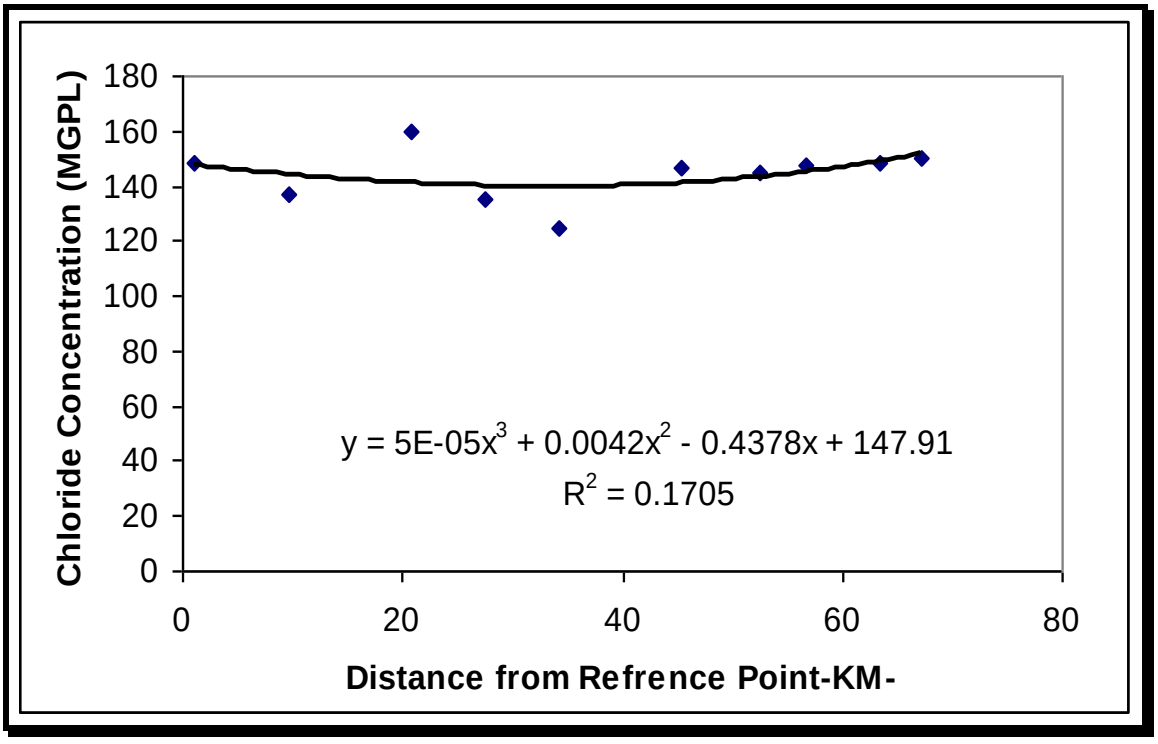

Fig (2) Mean Chloride Concentration Vs. Distance for Two Years Period

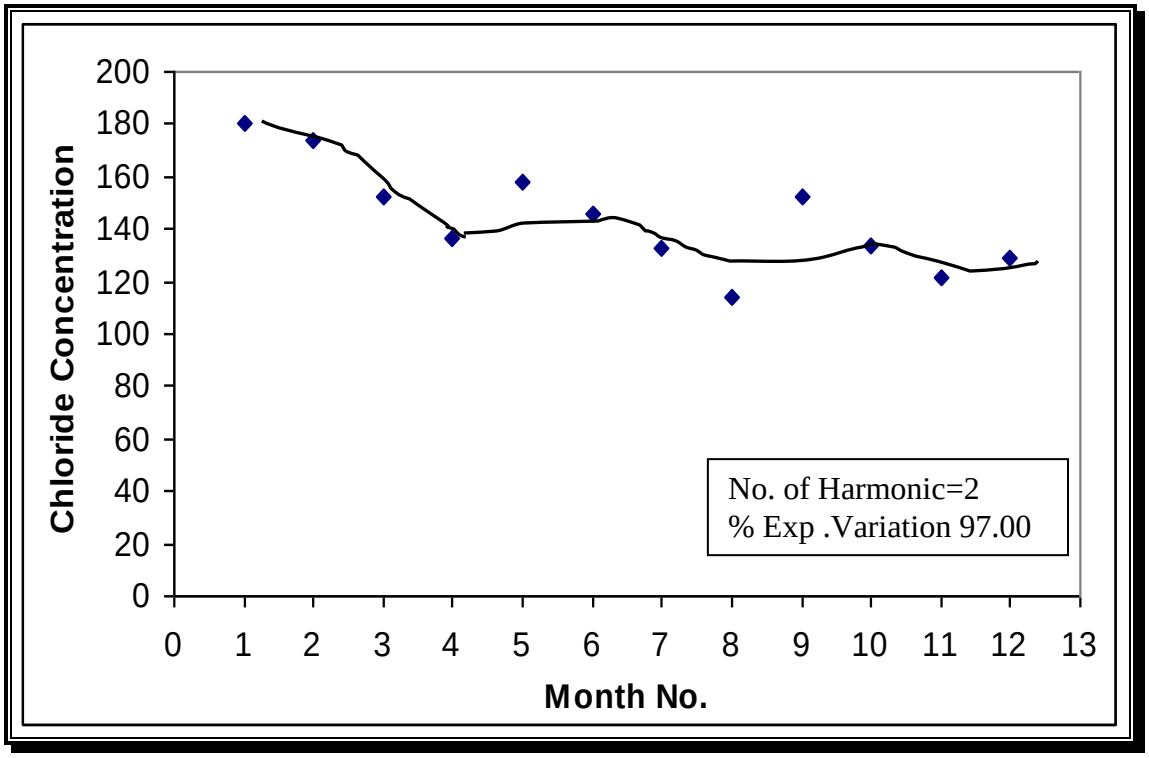

Fig (3) The Chloride Concentration Vs. Month No.(No. of Harmonic=2)

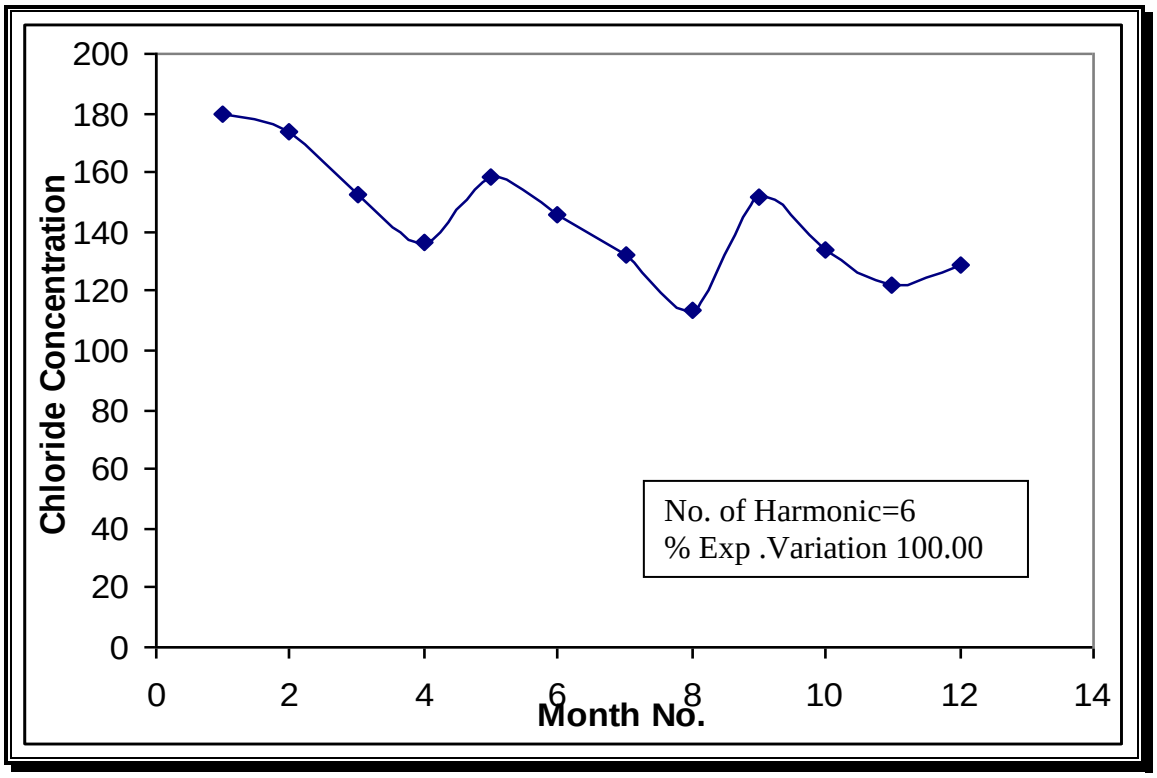

Fig (4) The Chloride Concentration Vs. Month No.

5. References

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