Assessment And Monitoring Of Shatt Al-Hilla River Within The Middle Euphrates Region

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Abstract

The aim of water quality assessment and monitoring program is to provide timely and accurate water quality data to various clients within the Department of Ecology and elsewhere. Water pollution for Shatt Al-Hilla river in Middle Euphrates region of Iraq (Babylon and Al-Diwaniya governorates) occurs in both rural and urban areas. In rural areas, drinking water from natural sources such as rivers and streams is usually polluted by organic substances from upstream users who use water for agricultural activities. To protect the water resources from pollution and deterioration which caused by natural pollutants or human activities. An environmental database was constructed and applied. To evaluate the pollutant concentrations, regression models were obtained by Data Fit Software program (version 8.0). The results were compared with the Iraqi and WHO standards for domestic and irrigation purposes to determine pollution extend and suggest suitable solutions. The results of the program are verified with data of year 2008 which is not included in regression model. This verification shows a good agreement with coefficient of determination ranged between "0.927 to 0.996".

الخلاصة

الهدف من تقييم نوعية المياه وبرنامج الرصد هو توفير الوقت والبيانات الدقيقة لنوعية المياه لمختلف العملاء داخل وزارة البيئة وغيرها. تلوث المياه في نهر شط الحلة لمنطقة الفرات الأوسط من العراق (بابل والديوانية) يحدث في كل من المناطق الريفية والحضرية. في المناطق الريفية مياه الشرب من مصادر طبيعية ، مثل الأنهار والجداول وعادة ما تلوثت بالمواد العضوية من المنبع المستخدمين الذين يستخدمون المياه للأنشطة الزراعية. لحماية الموارد المائية من التلوث والتدهور التي تسببها الملوثات الطبيعية أو الأنشطة البشرية.تم إنشاء وتطبيق قاعدة بيانات. لتقييم تركيز الملوثات باستخدام نماذج الانحدار التي تم الحصول عليها عن طريق البرنامج الإحصائي Data Fit "8.0". النتائج البيئية قورنت مع معادلات الارتداد المستخرجة والمحددات العراقية لأغراض الشرب والسقي. تم اختبار صلاحية معادلات الارتداد المستخرجة بإجراء تحقيق باستخدام بيانات من عام ٢٠٠٨ والتي لم يتم تضمينها في نموذج الانحدار ويبين هذا التحقق اتفاق جيد مع معامل التحديد تراوحت بين ٠,٩٢٧ إلى ٠,٩٩٦ .

Introduction

Surface waters are used for a number of purposes including potable water sources, recreation, transportation, and aesthetics. With so many uses, water bodies are susceptible to affects that can degrade water quality. Therefore, mechanisms to protect surface waters, maintain current water quality, or reduce the degradation of surface water bodies are important.

Many researchers have been interested in studying the quality of surface water quality and it is relations with the some mentioned quality parameters. These parameters are analyzed either by applying different statistical models or by qualitative comparison with available standards (Al-Masri and Ali 1985, Mohammed 1988, Al-Delami 1989, Al-Malikey 1993, Jalut 1998, Al-Husseini 1999, Al-Shukur and Al-Bedeyry 1999, Al-Fatlawi 2005 and Fahd 2006).

Fahd 2006 studied some of physical and chemical characteristics of Al-Masab Al-Aam river. Monthly samples were collected from two stations extended from November 2000 to October 2001. Results show monthly variation in air temperature ranged 14-43 ̊C and the light penetration was 38-64cm. Dissolved oxygen concentrations and free CO_2 inversely correlated with water temperature. The total alkalinity of water was due to the bicarbonate and carbonate. Salinity between 4.20-8.4 g/L. Significant positive relation were found between water temperature, alkalinity and salinity, while negative relation between dissolved oxygen and temperature.

Data Collection

To gauge the success of the program, data of water quality of the Shatt Al-Hilla river are being analyzed monthly, and the pollution levels are being determined. The program depend four sampling stations along the river including (Al-Hindya Barrage, Al-Hilla, Al-Diwaniya and Al-Hashimiya) as shown in Fig. (1) to gauge the degree of pollutants based on dependent variables.

In this study, water samples were analyzed at Al-Hindya Barrage station for the period between 2000 to 2008, period between 1987 to 2000 are analyzed for Al-Hilla station, and period between 1987 to 2000 for Al-Diwaniya and Al-Hashimiya stations, to construct the monitoring system along Shatt Al-Hilla river.

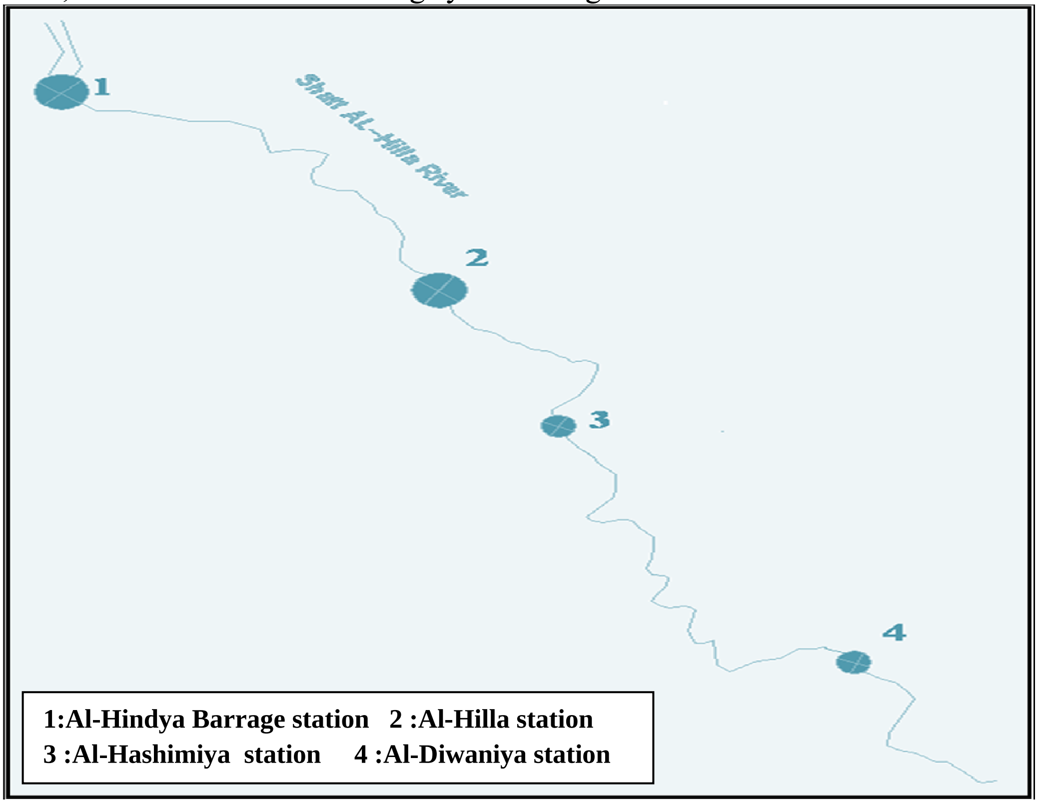

Fig. (1): Map of the studying area.

Table (1) show the independent and dependent variables for Shatt Al-Hilla river used in Al-Hindya Barrage, Al-Hilla, Al-Hashimiya and Al-Diwaniya stations.

Table (1): Description of the independent and dependent variables for Shatt Al- Hilla river.

Stations	Variables									
	Independent									Dependent
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	y
Al-Hindya Barrage	Ec	TDS	So_4	TH	Mg	Cl	Ra	Q	T	Ca
Al-Hilla	TA	Ca	Cl	Ec	Mg	TDS	RD	-	-	TH
Al-Hashimiya	TA	Ca	Cl	Ec	Mg	TDS	SSD	RD	SD	TH
Al-Diwaniya	pH	Ec	Ra	SD	SSD	RD	T	-	-	TDS

Where: Ec : electrical conductivity (□s/cm),
TDS : total dissolved solids (mg/L),
So_4 : sulphate (mg/L),
TH : total hardness (mg/L),
Mg : magnesium (mg/L),
Cl : chloride (mg/L),
Q : discharge (m^3/sec),
Ca : calcium (mg/L),
pH : hydrogen ion concentration,
TA : Total Alkalinity (mg/L),
Ra : monthly rainfall totals (mm),
SSD : no. of days of suspended dust,
RD : no. of days of rising dust,
SD : No. of days of storm dust, and
T : ambient temperature (^{0}C).

Statistical analyses and regression models

The multiple regression analysis was used to build the present models .The general purposes of regression analysis is to learn more about relation between one or several independent or predictor variables and dependent or criterion variable. The regression equation or best-fitting line is determined by minimizing the sum squares of the residuals between the actual and predicted values of the dependent variables. To evaluate the proposed models, the following statistical factor are used:

Multiple R: the coefficient of multiple correlation is the positive square root of R-square. This statistical factor is useful in multivariate regression when it is wanted to describe the relationship between variables.

R-square: This coefficient of multiple determination measures the reduction in the total variation of the dependent variable due to the independent variable.

Std. Error of estimate: This statistical coefficient measures the dispersion of observed values about the regression line (Al-Saegh, 2008).

In water quality studies correlation analysis is used to measure the strength and statistical significance of the association between two or more random water quality variables. Random in this case means that the variables are not under the control of the investigator and are, therefore, measured with an associated error. The multiple correlation coefficient R(y,x_1,x_2, ...) measures the strength of the relationship between a dependent variable and a set of independent ones. The coefficient of multiple determination R^2 is an estimate of the proportion of the variance of y that can be attributed to its linear regression on the observed independent variables $x_1, x_2, ..., x_n$. Due to the complexity of the calculations, multiple correlations are now usually only performed on a computer (Chapman, 1996).

In the present study when number of parameters of water quality over eight without parameters of ambient we neglected the parameter having the correlation coefficient (r) lower than 0.20 like turbidity at Al-Hilla and Al-Hashimiya station and T, SD and SSD in Al-Hilla station. Table (2), (3), (4) and (5) show the correlation matrix in Al-Hindya Barrage, Al-Hilla, Al-Hashimiya and Al-Diwaniya station respectively.

In the present study, multiple non-linear regression models in three forms were used for each design requirements to choose which form gives the best fitting of data. The regression models of Shatt Al-Hilla. river that were proposed and investigated can be seen in table 6. while plot models of these stations were shown in Figs. 2 to 5.

Table (2): Correlation Matrix of Shatt Al-Hilla river in Al-Hindya Barrage station

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Y
X1	1									
X2	0.825	1								
X3	0.564	0.574	1							
X4	0.489	0.501	0.810	1						
X5	0.256	0.306	0.571	0.544	1					
X6	0.603	0.617	0.810	0.748	0.432	1				
X7	0.233	0.167	0.365	0.380	0.120	0.299	1			
X8	-0.082	-0.222	-0.097	-0.175	0.034	-0.306	-0.131	1		
X9	-0.135	-0.082	-0.257	-0.188	0.013	-0.228	-0.541	0.268	1	
Y	0.565	0.640	0.841	0.897	0.423	0.907	0.390	-0.395	-0.241	1

Table (3): Correlation Matrix of Shatt Al-Hilla river in Al-Hilla station

	X1	X2	X3	X4	X5	X6	X7	Y
X1	1							
X2	-0.0931	1						
X3	-0.0389	0.6521	1					
X4	-0.2003	0.6506	0.590	1				
X5	-0.2357	0.0856	0.108	0.272	1			
X6	-0.2401	0.5370	0.382	0.757	0.265	1		
X7	-0.1072	0.2492	0.205	0.213	-0.043	0.014	1	
Y	-0.2445	0.9477	0.641	0.730	0.339	0.630	0.279	1

Table (4): Correlation Matrix of Shatt Al-Hilla river in Al-Hashimiya station

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Y
X1	1									
X2	-0.183	1								
X3	-0.083	0.583	1							
X4	-0.124	0.630	0.525	1						
X5	-0.318	0.266	0.468	0.414	1					
X6	-0.128	0.702	0.472	0.539	0.265	1				
X7	-0.033	0.145	0.021	0.028	0.097	-0.056	1			
X8	-0.064	0.266	0.195	0.152	0.195	0.131	0.639	1		
X9	-0.039	0.217	0.083	0.114	0.041	0.169	0.434	0.334	1	
Y	-0.330	0.929	0.686	0.716	0.542	0.675	0.225	0.341	0.221	1

Table (5): Correlation Matrix of Shatt Al-Hilla river in Al-Diwaniya station

	X1	X2	X3	X4	X5	X6	X7	Y
X1	1							
X2	0.196	1						
X3	0.134	-0.069	1					
X4	-0.152	-0.038	-0.007	1				
X5	0.065	-0.083	-0.339	-0.086	1			
X6	0.003	-0.080	0.089	0.157	0.459	1		
X7	0.108	0.179	-0.648	-0.096	0.471	0.191	1	
Y	-0.170	0.569	0.346	0.353	-0.459	-0.397	-0.287	1

Station	Equation	Std. Err.	R^2
Al-Diwaniya	Y=46.033*X1+0.111*X2+3.536*X3+18.545*X4+ 0.030*X5-9.873*X6+0.899*X7+819.688	20.467	0.908
Al-Hindya Barrage	Y= exp(-0.0004*X1+0.0005X2+0.0005*X3+0.0013*X4-0.0049X5-0.0034*X6+0.0025*X7 0.0017*X8 + 0.0033*X9+3.6529)	2.522	0.997
Al-Hilla	Y=0.436*X1+2.654*X2+0.005*X3+0.027*X4+3.980*X5+0.059*X6+2.379*X7-21.973	20.617	0.983
Al-Hashimiya	Y=exp(0.00053*X1+0.00406*X2+0.00019*X3+0.00019*X4+0.00320*X5 +0.00001*X6 + 0.00594*X7 + 0.00168*X8 0.00882*X9 + 5.29827)	14.328	0.989

Table (6): The proposed models of Shatt Al-Hilla river

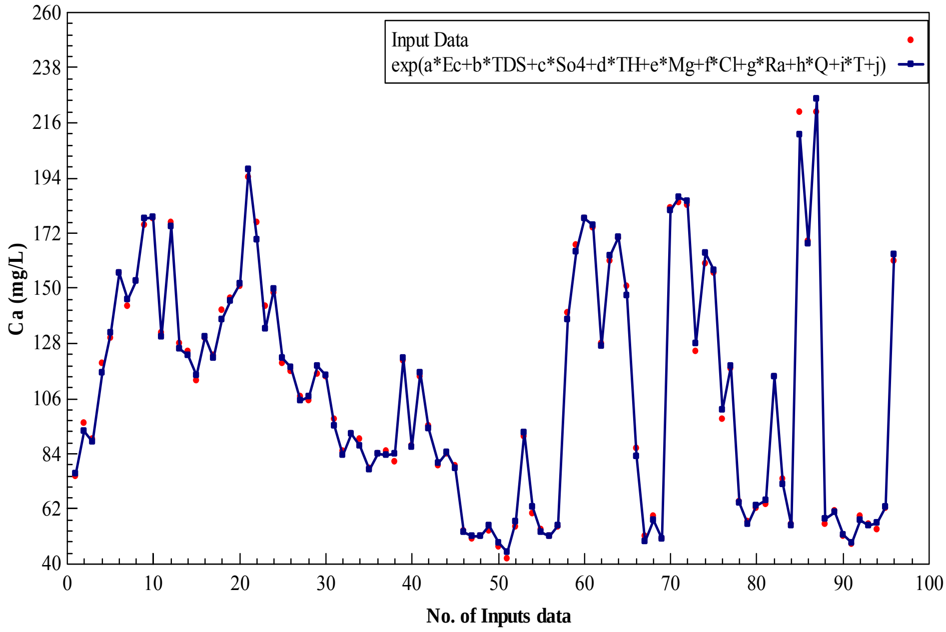

Fig. (2): Plot model of Shatt Al-Hilla river in Al-Hindya Barrage station.

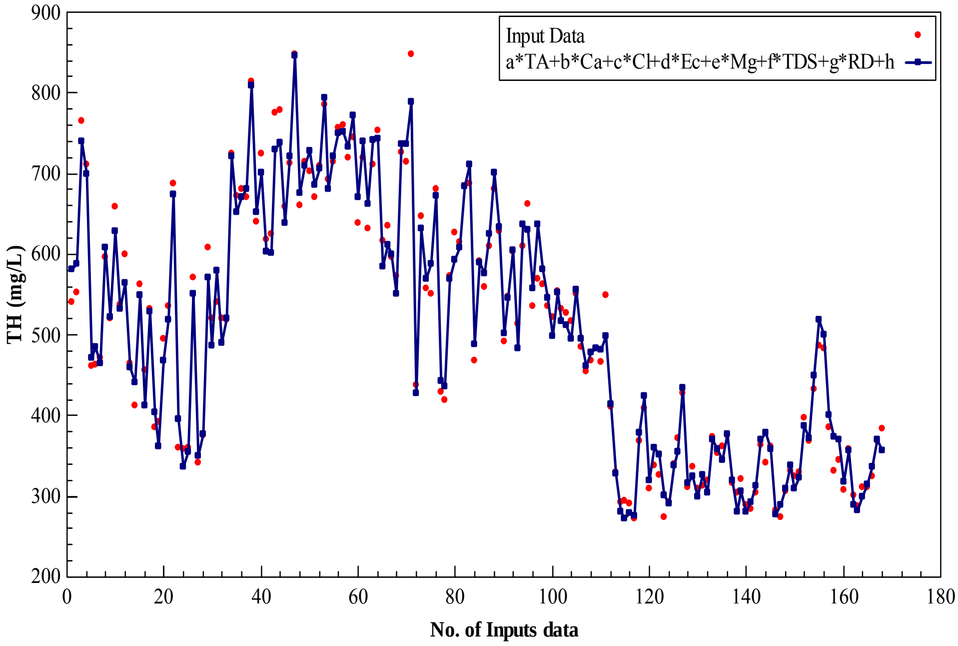

Fig. (3): Plot model of Shatt Al-Hilla river in Al-Hilla station.

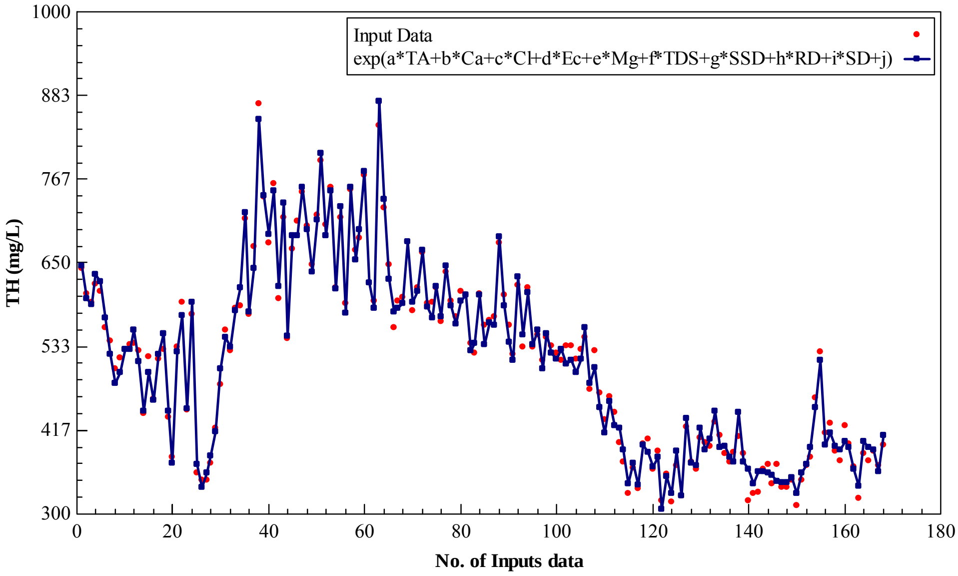

Fig. (4): Plot model of Shatt Al-Hilla river in Al-Hashimiya station.

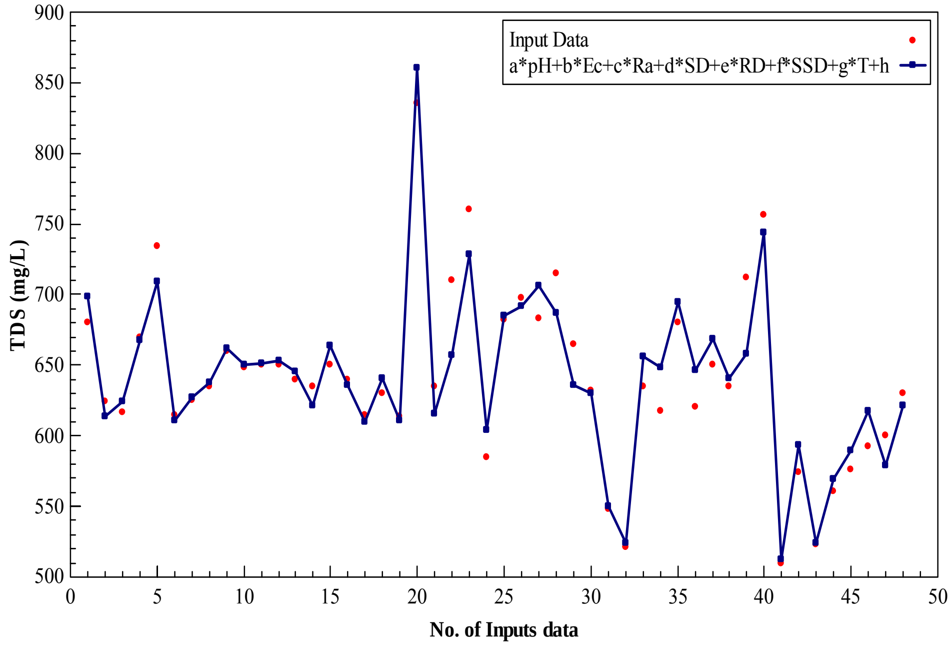

Fig. (5): Plot model of Shatt Al-Hilla river in Al-Diwaniya station.

Verification of regression model

Verification of the obtained model can be made by plotting the data of the year 2008 which were not included in the building of the regression model versus modeling data. The obtained model was also calibrated by the following equation:

$$y = ax^{b}$$

Verification of regression model is shown in Figs. (2 to 5). These Figs. showed that the experimental data are correlated well with modeling data.

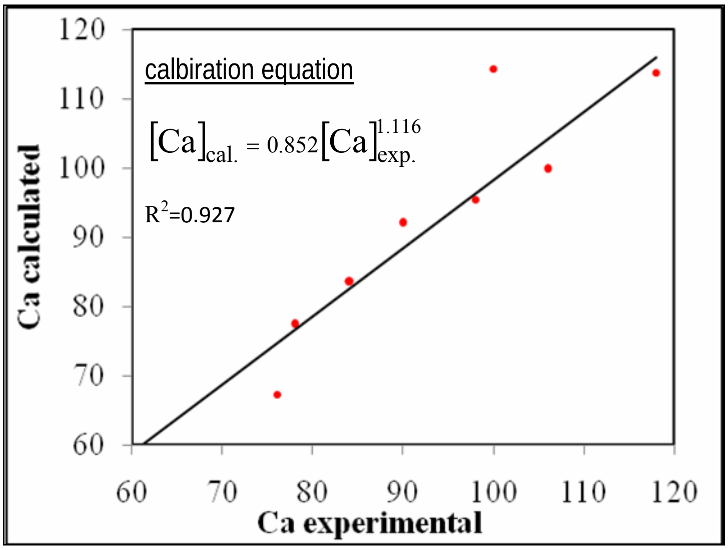

Fig.(6): Verfication of regression model for Shutt Al-Hilla river in Al-Hindya Barrage station.

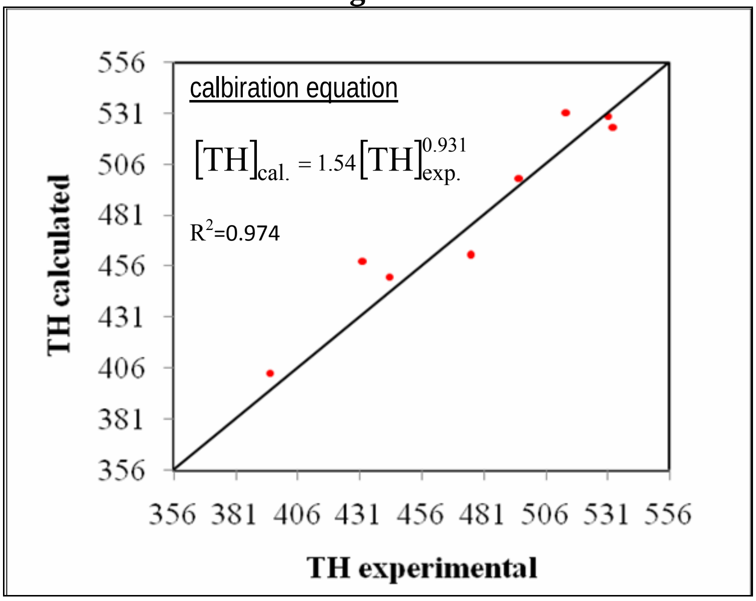

Fig.(7): Verfication of regression model for Shutt Al-Hilla river in Al-Hilla station.

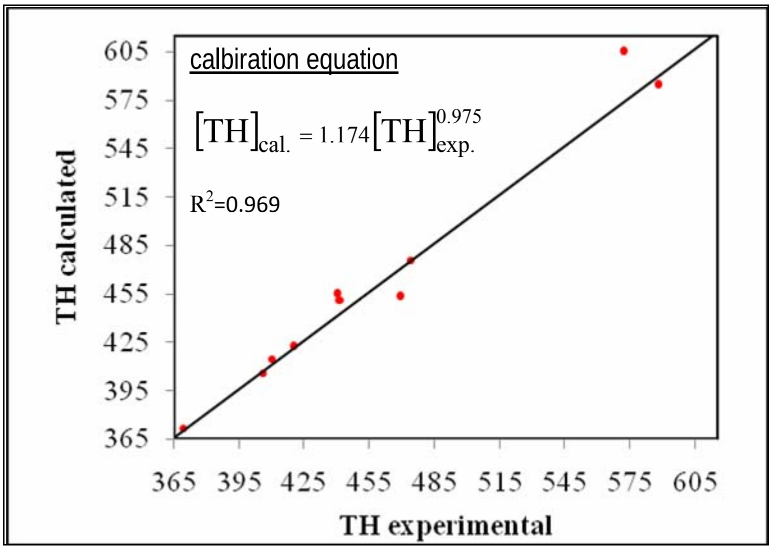

Fig.(8): Verfication of regression model for Shutt Al-Hilla river in Al-Hashimiya station.

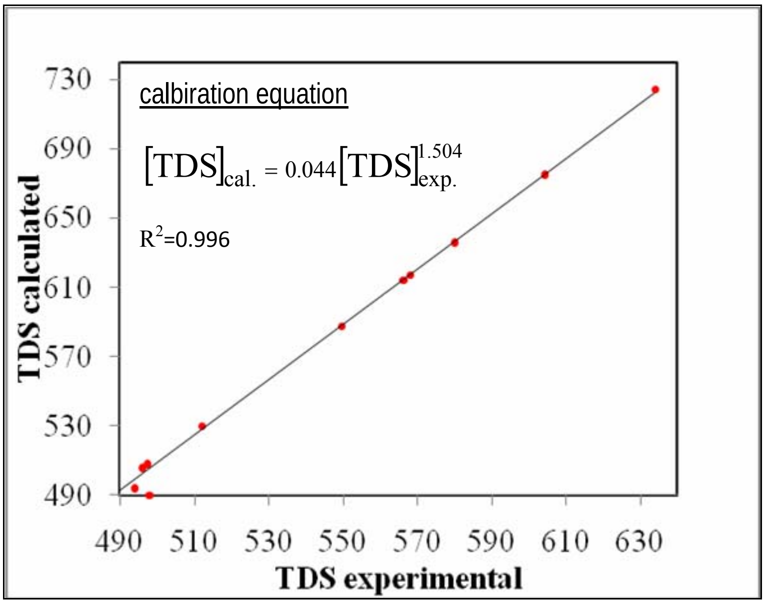

Fig.(9): Verfication of regression model for Shutt Al-Hilla river in Al-Diwaniya station.

Table (7): Allowable limits of water quality parameters in surface water body used as domestic and irrigation water source according to Iraqi and WHO standards (Abbawi & Mohsen, 1990, WHO, 2005).

Parameter	Unit	Domestic water standards		Irrigation water standards
		Iraqi	WHO	WHO
pH		6.5-8.5	6.5-8	6-8.5
Ec	□s/cm	2000	-	<250 Excellent, 250-750 Good and 750-2000 Permissible
Ca	mg/L	200	75-200	0-200
Cl	mg/L	200	250-600	0-300
Mg	mg/L	50	30-150	0-50
TA	mg/L	170	5-200	-
TDS	mg/L	1500	500-1000	0-700 Excellent, 700-2000 Good and >2000 Unsuitable
TH	mg/L	500	100-500	
Tur	NTU	<10	5-25	
So_4	mg/L	200	200-400	

Table (8): Qualitative properties of Shatt Al-Hilla river for drinking and irrigation water source.

Station	Raw water suitability for following purposes		
	Demotic		Irrigation
	Iraqi	WHO	WHO
Al-Hindya Barrage	Suitable	Suitable	Suitable
Al-Hilla	Suitable	Suitable	__
Al-Hashimiya	Suitable	Suitable	__
Al-Diwaniya	Suitable	Suitable	Excelent

Conclusion

From this study the following conclusions are obtained :

1. Strategic Environmental Assessment (SEA) procedure is most useful in making an initial appraisal of the sources and levels of discharges from an area that has little or no previous pollution load data.
2. The computer program can be considered as a guide to the application of rapid technique in the inventory stage in each tool of the environmental management.
3. The regression models for Shatt Al-Hilla river in those stations are more suitable to predict the pollutants concentrations.

4. A good management for Shatt Al-Hilla river in the middle Euphrates region important to protect the soil of region and surface water from pollution.
5. Improved drinking water quality, leading to a reduced rate of disease and improved hygienic conditions in the area.

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