WATER QUALITY ASSESSMENT OF TIGRIS RIVER IN ALAMARAH REGION IN IRAQ

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ABSTRACT

Water pollution of Tigris River in Al-Amarah region in Iraq (Ali Al-Garbi, Unified water project, Complex water project near the Islamic unity, Castle project, Uzayr project) occurs in both rural and urban areas. Drinking water from natural sources such as rivers and streams is usually polluted by organic substances from upstream users who use water for different activities. To protect the water resources from pollution and deterioration caused by natural pollutants and human activities, an environmental database was constructed and applied. A Visual Basic Software 6.0 program was constructed to evaluate the pollutant concentrations using regression models obtained by Data Fit Software program (version 8.0). The program was divided into two main parts: first gathering of general data and second calculation of the pollutant concentrations. This research covers the study and analysis of monthly water quality parameters for Tigris River at Ali Al-Garbi, Unified water project, Complex water project near the Islamic unity, Castle project and Uzayr project in Al-amarah Region for the period 2008 to 2010.

In the present study, multiple regression models in three forms were used for each design requirement to choose which form gives the best data fitting. The results of the program were verified with data of year 2011 which were not included in the regression model. This verification showed a good agreement with coefficient of determination between “0.849 to 0.924”.

Assessment of water bodies quality should be with standards that have been set to define requirements for various functions and uses as to be compared with the Iraqi, and WHO standards for domestic and irrigation purposes. The comparison showed that the parameters in the selected stations are within the Iraqi and WHO standards for domestic and irrigation purposes (Ca: in Ali Al-Garbi). While in other stations are out of limits (Ca: Castle project) and (CL: Unified water project ,Complex water project near the Islamic unity and Uzayr project).

Keywords: Water quality assessment, Regressuion models, Tigris river, Al-amarah, Iraq.

تقييم نوعية مياه نهر دجلة في منطقة العمارة في العراق

لخلاصة

ان تلوث المياه لنهر دجلة في منطقة العمارة من العراق وفي مواقع محدده (علي الغربي ، مشروع ماء الموحد ، مشروع قرب مجمع ماء الوحدة الاسلامية، مشروع القلعة، مشروع العزير) يحدث في كلا من المناطق الريفية والحضرية. ففي المناطق الريفية مياه الشرب تكون من مصادر طبيعية، مثل الانهار والجداول وعادة ما تتلوث بالمواد العضوية من المستهلكين الذين يستخدمون المياه للأنشطة الزراعية، لحماية الموارد المائية من التلوث والتدهور التي تسببها الملوثات الطبيعية أو الأنشطة البشرية. تم انشاء وتطبيق قاعدة بيانات. وشيد البرنامج فيجول بيسك "6" لتقييم تركيز الملوثات باستخدام نماذج الأنحدار التي تم الحصول عليها عن طريق البرنامج الأحصائي Data Fit "8.0" الذي ينقسم الى جزأين رئيسين : الأول : جمع البيانات العامة والثاني : حساب تراكيز الملوثات . يعطي هذا البحث دراسة وتحليل المتغيرات الشهرية لنوعية مياه نهر دجلة (علي الغربي،مشروع ماء الموحد ، مشروع قرب مجمع ماء الوحدة الاسلامية ، مشروع القلعة ،مشروع العزير) في منطقة العمارة للفترة من 2008 الى 2010.

في هذه الدراسة ، تم استخدام طريقة تحليل الأنحدار المتعدد في ثلاثة أشكال لكل متطلبات التصميم لاختيار الشكل المناسب الذي يعطي أفضل ملائمة للبيانات. تم أثبات صحة نتائج هذا البرنامج من التحقق من بيانات عام 2011 والتي لم يتم تضمينها في نموذج الانحدار. ويبين هذا التحقق اتفاق جيد مع معامل التحديد الذي تراوح مابين0.849 الى 0.924

تقييم المسطحات المائية عن طريق الفحص الدوري والامتثال للمعايير التي تم وضعها لتحديد الاحتياجات اللازمة لمختلف وظائف واستخدامات المياه من المسطح المائي، وتمت المقارنة مع المواصفة القياسيه العراقية، ومعايير منظمة الصحة العالمية للأغراض المنزلية والري، من أجل تحديد نوعية المياه في مواقع أخذ العينات التي تتجاوز عن معايير نوعية المياه. والمقارنة تبين ان بعض مواصفات مياه النهر في بعض المحطات كانت ضمن المواصفة العراقية ومعايير منظمة الصحة العالمية للاغراض المنزلية والري مثلا (Ca: علي الغربي). بينما في المحطات الاخرئ هي خارج حدود المواصفة مثلا (Ca: مشروع القلعة) و (Cl: مشروع ماء الموحد، مشروع قرب مجمع ماء الوحدة الاسلامية ومشروع العزير).

INTRODUCTION

River are most important freshwater resources for man; social economic and political development has in the past been largely related to the availability and distribution of fresh water contained in river system (Chapman, 1996).

Tigries river has a large importance for Iraqi environment researchers because of the detrimental effect of pollutants resulting from treated and untreated domestic sewage, treated and untreated industrial wastewater and agricultural pollutants. The main squrce of water for this river are rain water, stored water as lakes and reservoirs.

Water quality models can be a valuable tool for water management because they can simulate the potential response of the aquatic system to such changes as the addition of organic pollution or nutrients, the increase or decrease in nutrient levels, or water abstraction rates and changes in sewage treatment operations. The potential effects of toxic chemicals can also be estimated using models of different types (Helmer et. al., 1997).

Many statistical analyses are based on a specific model for a set of data, where the model consists of one or more equations that describe the observations in terms of parameters of distributions and random variables. In situations where a model is used,

an important task for the data analyst is to select a plausible model and to check, as far as possible, that the data are in agreement with this model(Bryan, 2000). This includes both examining the form of the equations assumed, and the distribution or distributions that are assumed for the random variables. In addition, there are some standard types of models that are useful for many sets of data (Alaa,2010).

This research covers the study and analysis of monthly water quality parameters from five sampling stations of Tigries river in Al- Amarah region in Iraq as shown in Fig (1), these stations are located at Ali Al-Garbi, Unified water project, Complex water project near the Islamic unity, Castle project and Uzayr project. Data for Tigries river in Al-Amarah region in these station were collected form the period 2008 to 2011.

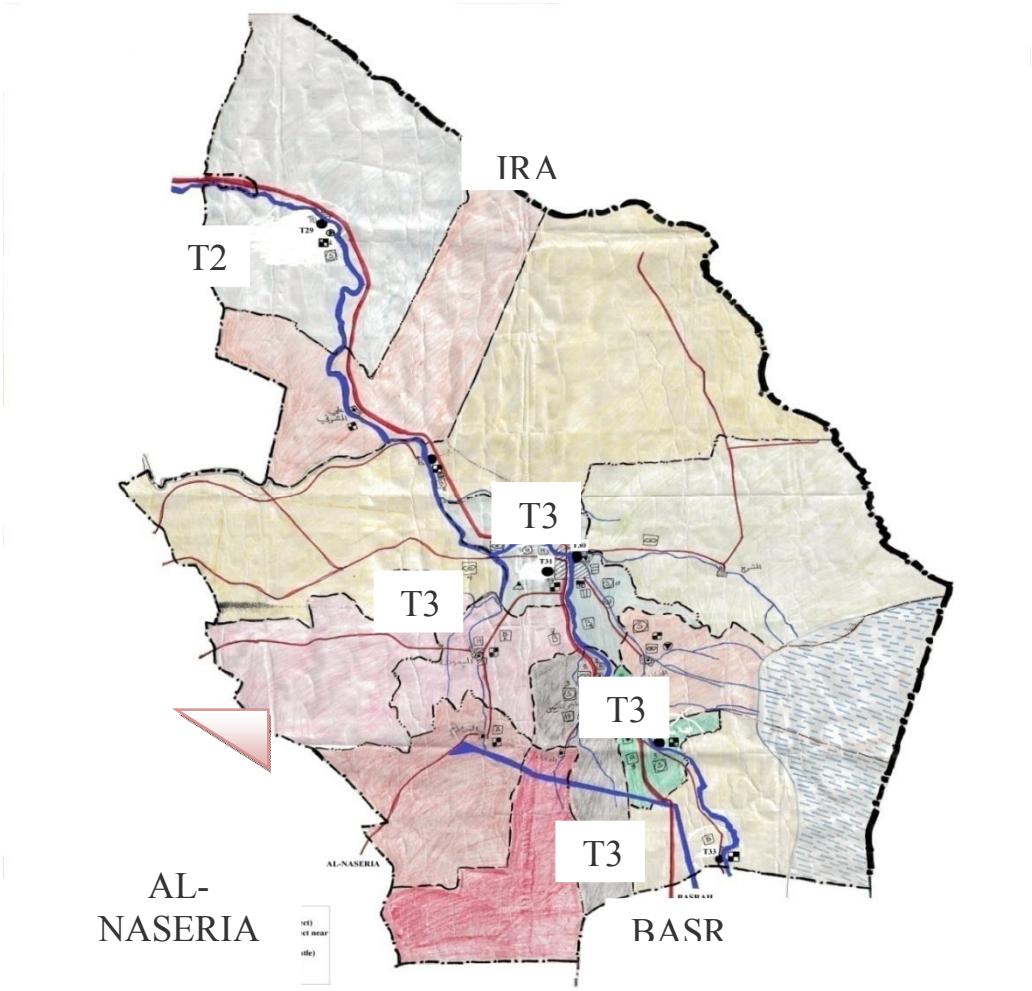


Fig.(1) : Map of studying area

Table (1) Locations of sampling stations at Tigris river in Al-Amarah region (Al-Amarah Environmental Office, 2011).

No.	No. Location	Location name
1	T29	Ali Al-Garbi
2	T30	Unified water project
3	T31	Complex water project near the Islamic unity
4	T32	Castle project
5	T33	Uzayr project

DATA COLLECTION AND ANALYSES

Statistical information is the most useful treatment of data for making quantitative decisions, such as whether water quality is improving or getting worse over time, or whether the installation of a wastewater treatment plant has been effective, or whether water quality criteria or emission standards are being complied with. Statistics can also be used to summarize water quality and emission data into simpler and more understandable forms, such as the mean and median (Demayo and Steel,1996).

In the present study, two statistical methods were utilized for analyzing data collected from the sampling sites: correlation analyses and ANOVA analyses. Correlation analyses were performed on the individual water quality parameters to identify relationships between them. ANOVA analyses were completed to determine difference between different sites each water quality parameter. Multiple regression models in three forms were used for each design requirement to choose which form gives the best data fitting. The regression models that were proposed and investigated can be seen in Table(2).

Table(2): The proposed models.

Rank	Equation Description
A	$y = \exp (b_1x_1+ b_2x_2+\cdots+ b_kx_k+G)$
B	$y = b_1x_1+ b_2x_2+\cdots+ b_kx_k+G$
C	$y = b_1x_1+ b_2x_2+\cdots+ b_kx_k$

Where;

y =dependent variables.

$x_1, x_2, \ldots, x_k$ = the independent variables.

$b_1, b_2, b_3, \ldots, b_k$ = are model coefficients,

and G=model constant term.

To gauge the success of the program, data of water quality for the Tigris river are being analyzed monthly, and the pollution levels are being determined. The program depended on Five sampling stations along the river including (Ali Al-Garbi, Unified water project, Complex water project near the Islamic unity, Castle project and Uzayr project). Data summary of Tigris River in Al-amarah regions are shown in Table(3, 4, 5, 6, 7, 8, 9, 10, 11 to 12). The plot of Tigris river in Al-Amarah regions are shown in Figs (2, 3 ,4, 5 to 6).

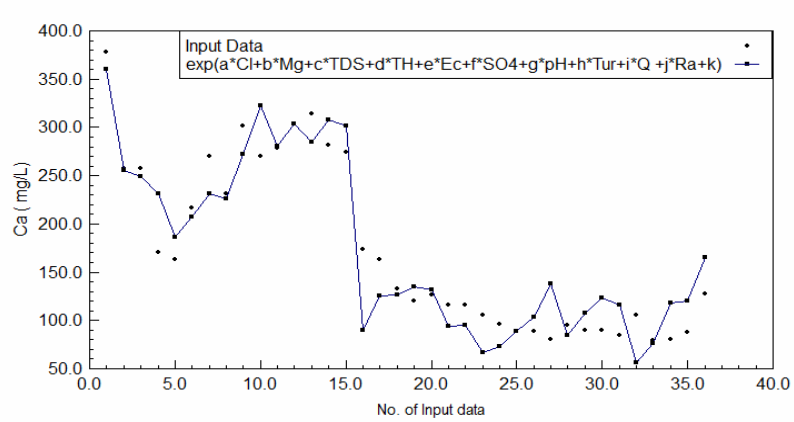
Table(3) : Data summary of Tigers river in Al-Amarah region. (T29 Ali Al-Garbi)

T29 Ali western									
Type of variable	var	Description	Data period	No. of reading	Min	Max	Range	Averag	Stand. Dev.
Independent	X_1	Cl (mg/L)	2008 - 2010	36	23	572	549	321.57	141.15
	X_2	Mg (mg/L)		36	18.05	206	187.95	38.45	30.26
	X_3	TDS(mg/L)		36	430	2346	1916	1201.08	545.79
	X_4	TH(mg/L)		36	47.2	650	602.8	452.96	128.14
	X_5	Ec(µs/cm)		36	855	1882	1027	1679.08	253.11
	X_6	SO_4(mg/L)		36	150	350	200	268.71	46.94
	X_7	pH		36	7	8.4	1.4	7.54	0.33
	X_8	Tur (NTU)		36	10	82	72	43.86	19.60
	X_9	Q (m^3/sec)		36	102	200	98	140.52	20.13
	X_{10}	Ra (mm)		36	0	36.7	36.7	5.71	9.27
Dependent	y	Ca (mg/L)		36	79.2	386	306.8	175	92.72

Regression Model			
Rank	Equation	Std. Err.	R^2
A	Y=exp(a*x1+b*x2+c*x3+d*x4+e*x5+f*x6+g*x7+h*x8+i*x9+j*x10+k)	41.59	0.856

Table(4): Regression coefficients of Tigers river in Al-Amarah region. (T29 Ali Al-Garbi)

Variable	Value	Standard Error	t-ratio	Prob(t)
a	0.00043	0.00063	0.69144	0.49566
b	0.00332	0.00150	2.20397	0.03696
c	0.00044	0.00014	3.09627	0.00479
d	0.00038	0.00089	0.42910	0.67152
e	0.00056	0.00047	1.18737	0.24624
f	-0.00186	0.00099	-1.87053	0.07316
g	0.06267	0.16535	0.37903	0.70786
h	-0.00273	0.00237	-1.15074	0.26073
i	0.00009	0.00227	0.04181	0.96698
j	-0.01191	0.00557	-2.13890	0.0424
k	3.30126	1.40211	2.35449	0.02671



Fig(2): Plot model of Tigers river in Al-Amarah region (T29 Ali Al-Garbi)

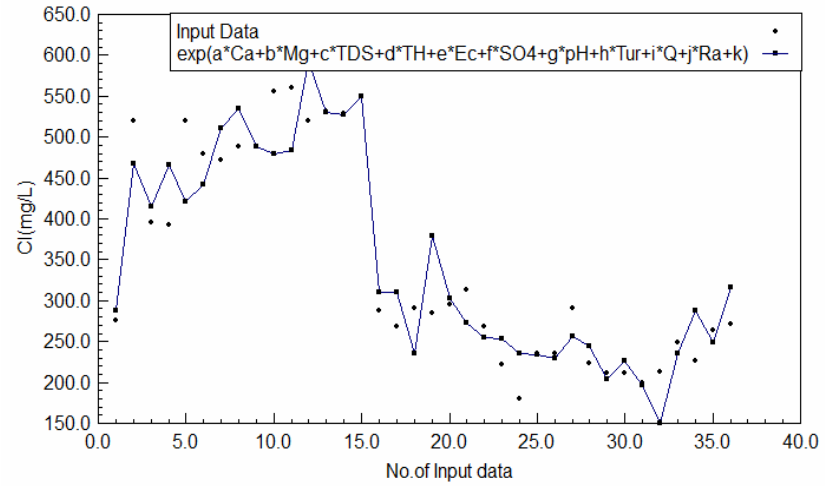
Table(5) : Data summary of Tigers river in Al-Amarah region. (T30 Unified water project)

T30 unified water project									
Type of variable	var	Description	Data period	No. of reading	Min	Max	Range	Averag	Stand. Dev.
Independent	X_1	Ca(mg/L)	2008 - 2010	36	67	390	323	174.37	88.34
	X_2	Mg(mg/L)		36	17	242	225	42.50	35.52
	X_3	TDS(mg/L)		36	501	2405	1904	1233.47	536.23
	X_4	TH (mg/L)		36	341	660	319	490.14	89.39
	X_5	Ec (µs/cm)		36	1013	1948	935	1754.47	237.95
	X_6	SO_4(mg/L)		36	215	428	213	265.63	56.26
	X_7	pH		36	7	8.23	1.23	7.53	0.27
	X_8	Tur(NTU)		36	7	100	93	45.45	26.86
	X_9	Q (m^3/sec)		36	20	73	53	45.27	15.88
	X_{10}	Ra(mm)		36	0	30.7	30.7	7.55	9.13
Dependent	y	Cl(mg/L)		36	179.74	620	440.26	349.70	134.11

Regression Model			
Rank	Equation	Std. Err	R^2
A	Y=exp(a*x1+b*x2+c*x3+d*x4+e*x5+f*x6+g*x7+h*x8+i*x9+j*x10+k)	55.79	0.876

Table(6): Regression coefficients of Tigers river in Al-Amarah region. (T30 unified water project)

Variable	Value	Standard Error	t-ratio	Prob(t)
a	0.00055	0.00061	0.91439	0.36924
b	-0.00215	0.00103	-2.07997	0.04793
c	0.00020	0.00009	2.16105	0.04047
d	0.00090	0.00049	1.80491	0.08315
e	0.00070	0.00027	2.53099	0.01804
f	0.00097	0.00075	1.28905	0.20918
g	-0.09002	0.11068	-0.81330	0.42372
h	0.00247	0.00146	1.68866	0.10372
i	-0.00323	0.00338	-0.95659	0.34793
j	-0.00260	0.00323	-0.80465	0.42861
k	4.34069	0.94682	4.58448	0.00011



Fig(3): Plot model of Tigers river in Al- Amarah region (T30 Unified water project)

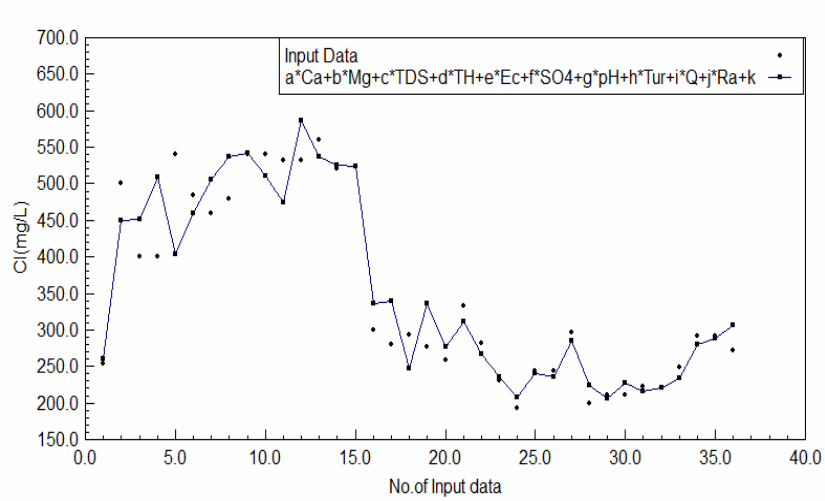
Table(7) : Data summary of Tigers river in Al-Amarah region.
(T31 Complex water project near the Islamic unity)

(T31 Complex water project near the Islamic unity)									
Type of variable	var	Description	Data period	No. of reading	Min	Max	Range	Averag	Stand. Dev.
Independent	X_1	Ca (mg/L)	2008 - 2010	36	83	378	295	174.53	84.62
	X_2	Mg (mg/L)		36	22	246	224	43.44	36.23
	X_3	TDS(mg/L)		36	694	2447	1753	1246.33	511.60
	X_4	TH (mg/L)		36	334	652	318	492.83	86.96
	X_5	Ec (µs/cm)		36	1335	1976	641	1805.08	192.85
	X_6	SO_4 (mg/L)		36	210	350	140	273.37	42.67
	X_7	pH		36	6.9	8.25	1.35	7.62	0.32
	X_8	Tur (NTU)		36	6	95	89	38.09	22.50
	X_9	Q (m^3/sec)		36	20	73	53	45.27	15.88
	X_{10}	Ra (mm)		36	0	30.7	30.7	7.55	9.13
Dependent	y	Cl (mg/L)		36	192.7	660	467.3	355.60	134.90

Regression Model			
Rank	Equation	Std. Err.	R^2
B	Y=a*x1+b*x2+c*x3+d*x4+e*x5+f*x6+g*x7+h*x8+i*x9 +j*x10+k	57.438	0.870

Table(8): Regression coefficients of Tigers river in Al-Amarah region.
(T31 Complex water project near the Islamic unity)

Variable	Value	Standard Error	t-ratio	Prob(t)
a	0.42090	0.27679	1.52065	0.14089
b	-0.67581	0.31868	-2.12060	0.04405
c	0.08536	0.03927	2.17353	0.03942
d	0.15531	0.19281	0.80548	0.42813
e	0.26410	0.11723	2.25281	0.0333
f	-0.13317	0.31382	-0.42435	0.67494
g	-24.0024	33.3834	-0.71899	0.47881
h	0.69721	0.82778	0.84227	0.40762
i	-0.71252	1.12700	-0.63222	0.53298
j	-0.51190	1.16851	-0.43808	0.66509
k	-119.071	332.115	-0.35852	0.72296



Fig(4): Plot model of Tigers river in Al-Amarah region (T31 Complex water project near the Islamic unity)

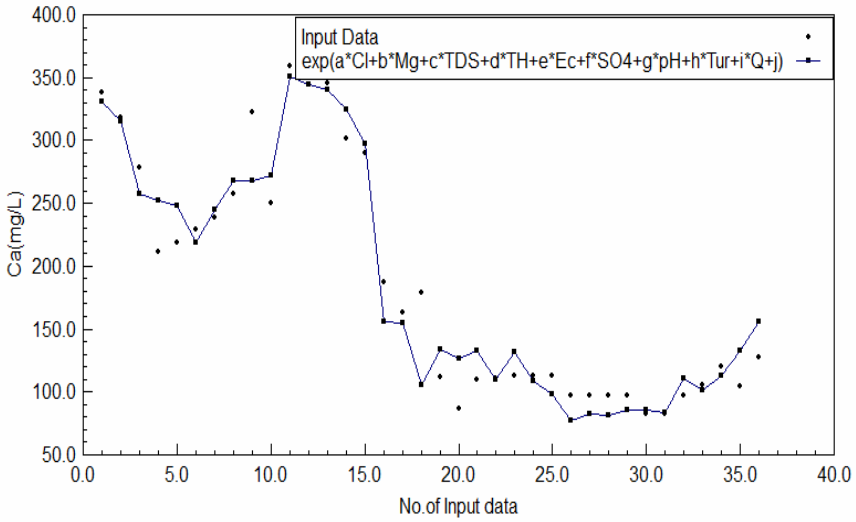
Table(9) : Data summary of Tigers river in Al-Amarah region. (T32 Castle project)

(T32 Castle project)									
Type o variable	var	Description	Data period	No. o reading	Min	Max	Range	Averag	Stand. Dev.
Independent	X_1	Cl (mg/L)	2008 - 2010	36	217.5	664	446.5	364.01	143.25
	X_2	Mg (mg/L)		36	23.3	222	198.7	41.35	32.53
	X_3	TDS(mg/L)		36	550	2495	1945	1274.97	590.11
	X_4	TH (mg/L)		36	364	688	324	507.08	91.48
	X_5	Ec (µs/cm)		36	1096	2000	904	1783.30	256.26
	X_6	SO_4 (mg/L)		36	187	376	189	252.77	50.18
	X_7	pH		36	6.3	7.8	1.5	7.31	0.33
	X_8	Tur (NTU)		36	5	95	90	34.65	23.20
	X_9	Q (m^3/sec)		36	9	60	51	32.22	17.15
Dependent	y	Ca (mg/L)		36	82	370	288	186.74	95.95

Regression Model			
Rank	Equation	Std. Err.	R^2
A	Y=exp(a*x1+b*x2+c*x3+d*x4+e*x5+f*x6+g*x7+h*x8+i*x9+j)	27.980	0.936

Table(10)
Regression coefficients of Tigers river in Al-Amarah region.
(T32 Castle project)

Variable	Value	Standard Error	t-ratio	Prob(t)
a	-0.00031	0.00047	-0.66075	0.51458
b	-0.00035	0.00082	-0.43382	0.668
c	0.00009	0.00008	1.02278	0.31583
d	0.00168	0.00055	3.05725	0.00512
e	-0.00013	0.00028	-0.47179	0.64101
f	0.00473	0.00090	5.24882	0.00002
g	-0.14561	0.10449	-1.39346	0.17528
h	-0.00020	0.00184	-0.11116	0.91234
i	0.01585	0.00398	-3.97599	0.0005
j	4.87705	1.08864	4.47993	0.00013



Fig(5): Plot model of Tigers river in Al- Amarah region
(T32 Castle project)

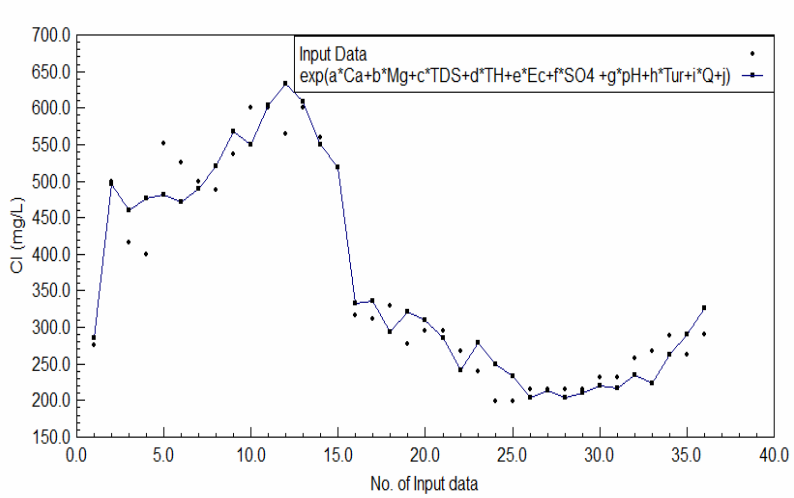
Table(11)
Data summary of Tigers river in Al-Amarah region.
(T33 Uzayr project)

(T33 Uzayr project)									
Type of variable	var	Description	Data period	No. of reading	Min	Max	Range	Average	Stand. Dev.
Independent	X_1	Ca (mg/L)	2008 - 2010	36	83	398	315	190.23	104.60
	X_2	Mg (mg/L)		36	10	182	172	38.52	26.73
	X_3	TDS(mg/L)		36	730	2518	1788	1362.05	544.11
	X_4	TH (mg/L)		36	352	700	348	497.91	102.33
	X_5	Ec (µs/cm)		36	1421	2949	1528	1852.91	311.52
	X_6	SO_4 (mg/L)		36	186	364	178	245.69	51.21
	X_7	pH		36	6.7	8.09	1.39	7.41	0.35
	X_8	Tur (NTU)		36	6	100	94	41.12	27.75
	X_9	Q (m^3/sec)		36	9	60	51	32.22	17.15
Dependent	y	Cl (mg/L)		36	198.66	668	469.34	366.85	147.48

Regression Model			
Rank	Equation	Std. Err.	R^2
A	Y=exp(a*x1+b*x2+c*x3+d*x4+e*x5+f*x6+g*x7+h*x8+i*x9+j)	49.503	0.916

Table(12): Regression coefficients of Tigers river in Al-Amarah region.
(T33 Uzayr project)

Variable	Value	Standard Error	t-ratio	Prob(t)
a	0.00030	0.00062	0.49127	0.62735
b	-0.00367	0.00123	-2.98168	0.00615
c	0.00007	0.00006	1.11841	0.27362
d	0.00071	0.00045	1.54753	0.13382
e	0.00012	0.00013	0.88766	0.38286
f	0.00201	0.00079	2.53789	0.01749
g	-0.03316	0.07928	-0.41825	0.6792
h	0.00081	0.00168	0.48509	0.63167
i	-0.01142	0.00306	-3.72564	0.00095
j	5.32440	0.82126	6.48315	0.0



Fig(6): Plot model of Tigers river in Al-Amarah region.
(T33 Uzayr project)

COMPUTER PROGRM

Designing monitoring program that is fitting the information needs and consequently a best-fit of monitoring strategy, Characterizing waters and identify changes or trends in water quality over space and time and Gathering information to design specific pollution prevention or water quality remediation programs.

In this study a computer program was written to construct a monitoring system that works with the data collected to estimate pollutant concentrations for the surface water which are to be compared with the Iraqi and WHO standards for domestic and irrigation purposes.

The program was divided into two main parts:

First: statistical models which describe the relations between parameters of water quality as choosen. The regression model was performed using "Data Fit" program version 8.0 (http://www.oakdaleengr.com),

Second: The output data from the regression model was used in Visual Basic software (6.0), in order to make an assessment for that resource and give the decision of the suitability of the resource for different purposes, as shown in Fig (7).

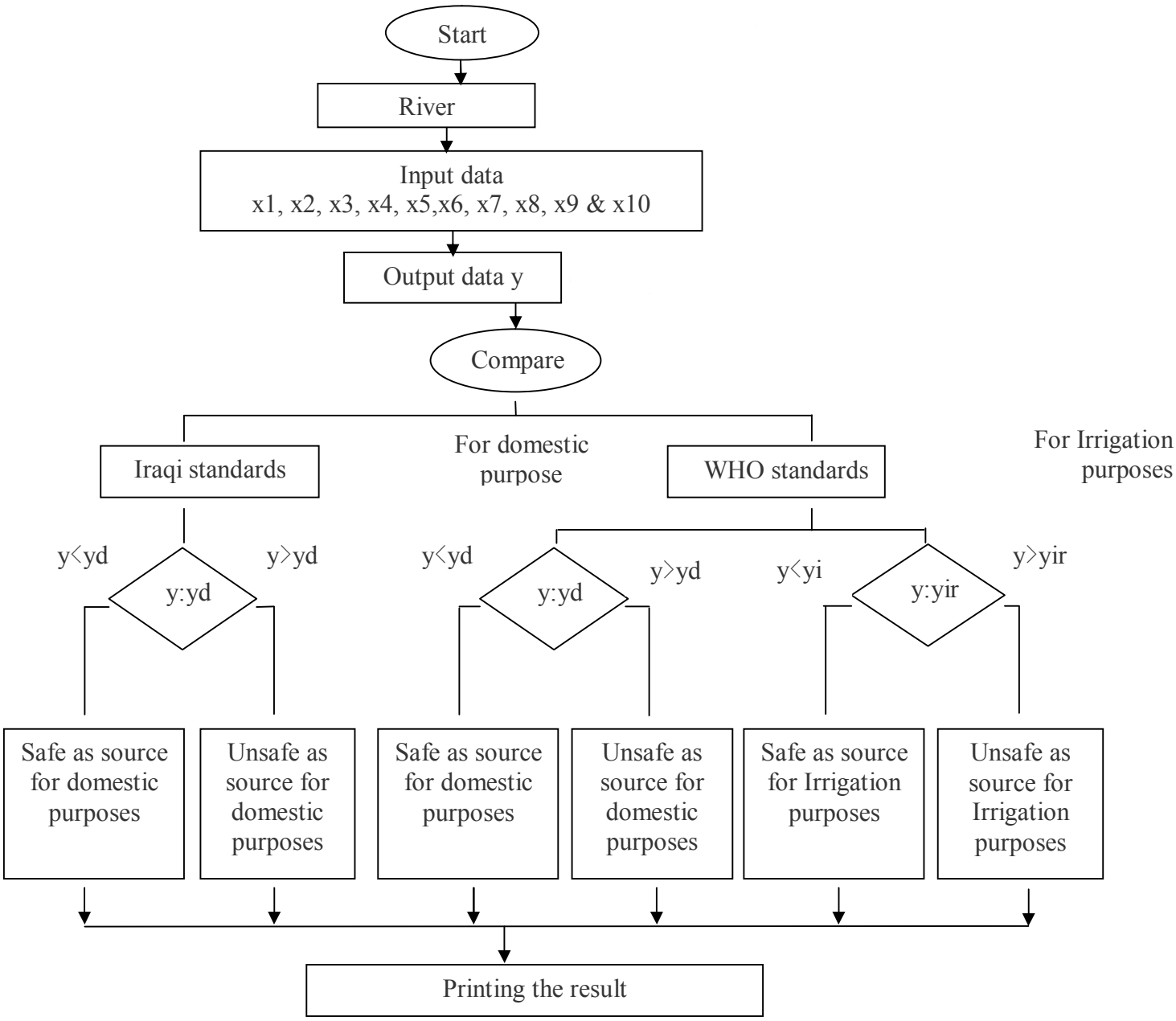


Fig.(7): Flow chart of computer program

RESULTS AND DISCUSSION

The correlation matrix of Tigers river in Al-Amarah region (Ali Al-Garbi, Unified water project, Complex water project near the Islamic unity, Castle project and Uzayr project), are shown in Table(13, 14, 15, 1 6 to 17).

Table(13): Correlation matrix of Tigers river in Al-Amarah Region. (T29 Ali Al-Garbi)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	y
X_1	1										
X_2	0.08	1									
X_3	0.82	-0.006	1								
X_4	0.80	0.28	0.66	1							
X_5	0.72	0.16	0.70	0.62	1						
X_6	-0.22	-0.31	-0.18	-0.08	-0.25	1					
X_7	0.25	0.41	0.20	0.14	0.37	-0.44	1				
X_8	-0.36	0.08	-0.35	-0.37	-0.37	-0.27	-0.13	1			
X_9	-0.26	0.18	-0.25	-0.27	-0.03	-0.04	0.21	0.01	1		
X_{10}	-0.001	0.11	0.08	-0.04	0.16	-0.06	0.13	-0.07	0.41	1	
y	0.79	0.31	0.79	0.67	0.67	-0.35	0.28	-0.32	-0.12	-0.03	1

Table(14): Correlation matrix of Tigers river in Al-Amarah Region. (T30 Unified water project)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	y
X_1	1										
X_2	0.16	1									
X_3	0.81	0.01	1								
X_4	0.72	0.11	0.68	1							
X_5	0.67	0.13	0.71	0.47	1						
X_6	0.45	0.44	0.29	0.12	0.43	1					
X_7	0.18	0.29	0.14	0.06	0.34	0.32	1				
X_8	-0.62	-0.003	-0.57	-0.29	-0.52	-0.50	-0.03	1			
X_9	-0.66	0.16	-0.59	-0.65	-0.56	0.03	0.01	0.33	1		
X_{10}	0.11	0.15	0.02	-0.05	0.16	0.41	0.07	-0.12	0.06	1	
y	0.81	-0.09	0.86	0.73	0.71	0.21	0.10	-0.46	-0.73	-0.02	1

Table(15): Correlation matrix of Tigers river in Al-Amarah Region. (T31 Complex water project near the Islamic unity)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	y
X_1	1										
X_2	0.14	1									
X_3	0.82	-0.04	1								
X_4	0.72	0.10	0.63	1							
X_5	0.74	0.14	0.72	0.47	1						
X_6	0.17	0.33	0.10	-0.03	0.23	1					
X_7	0.08	0.15	0.01	-0.12	0.16	0.05	1				
X_8	-0.65	-0.10	-0.57	-0.42	-0.81	-0.32	-0.01	1			
X_9	-0.64	0.14	-0.58	-0.67	-0.57	0.28	0.05	0.50	1		
X_{10}	0.11	0.17	0.003	-0.08	0.15	0.33	0.05	-0.16	0.06	1	
y	0.82	-0.14	0.86	0.67	0.75	-0.01	-0.01	-0.59	-0.71	-0.02	1

Table(16): Correlation matrix of Tigers river in Al-amarah Region.

(T32 Castle project)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	y
X_1	1									
X_2	-0.04	1								
X_3	0.89	0.02	1							
X_4	0.74	0.18	0.74	1						
X_5	0.75	0.18	0.73	0.57	1					
X_6	0.52	0.39	0.53	0.29	0.67	1				
X_7	0.01	0.18	0.14	-0.17	0.03	0.33	1			
X_8	-0.44	-0.18	-0.48	-0.29	-0.50	-0.54	-0.25	1		
X_9	-0.87	-0.08	-0.81	-0.69	-0.75	-0.46	-0.06	0.38	1	
y	0.85	0.24	0.85	0.74	0.74	0.70	0.11	-0.49	-0.83	1

Table(17): Correlation matrix of Tigers river in Al-Amarah station.

(T33 Uzayr project)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	y
X_1	1									
X_2	0.27	1								
X_3	0.75	0.03	1							
X_4	0.81	0.20	0.67	1						
X_5	0.52	0.24	0.42	0.48	1					
X_6	0.68	0.38	0.52	0.51	0.56	1				
X_7	0.07	0.26	0.19	-0.11	0.03	0.15	1			
X_8	-0.65	-0.23	-0.53	-0.62	-0.67	-0.70	-0.08	1		
X_9	-0.85	-0.09	-0.68	-0.72	-0.57	-0.52	-0.02	0.57	1	
y	0.86	-0.04	0.81	0.78	0.54	0.59	-0.02	-0.61	-0.87	1

VERIFICATION AND ASSESSMENT

Verification of Regression Model

Verifying of the effectiveness of pollution control strategies,i.e. by obtaining information on the degree of implementation of measures and by detection of long – trem trends in concentrations and loads. Verification of the obtained model can be made by plotting the data of the year 2011 which were not included in the building of the regression model versus modeling data.

Verification of the regression model is shown in Figs (8, 9, 10, 11 to 12). These Figs. show that the experimental data are correlated well with modeling data. Figs. are show a difference in results with calibration equation which is indicates that there is a very good agreement.

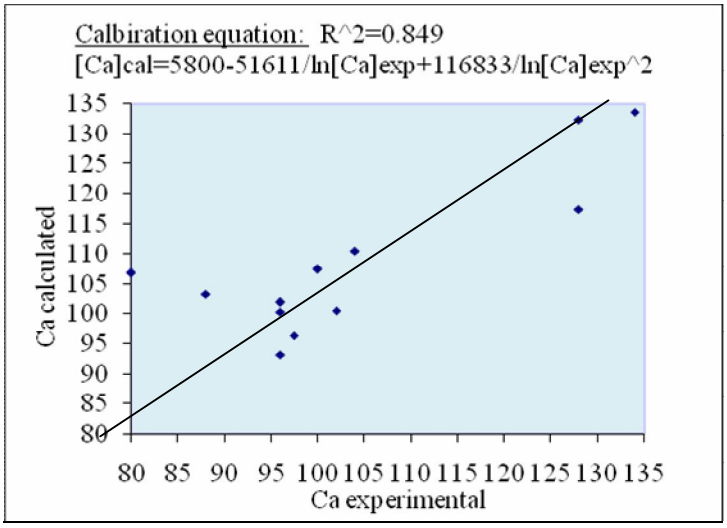


Fig.(8): Verfication of regression model for Tigris river in Al-Amarah region (T29 Ali Al-Garbi)

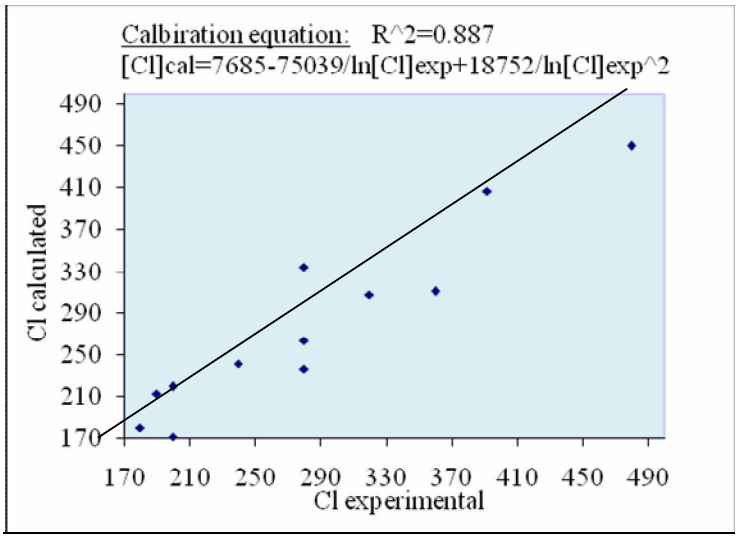


Fig.(9) : Verfication of regression model for Tigris river in Al-Amarah region (T30 Unified water project)

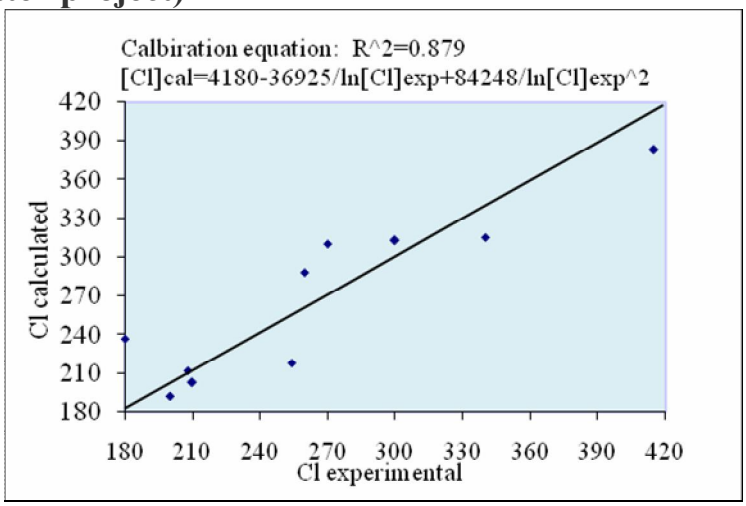


Fig.(10): Verfication of regression model for Tigris river in Al-Amarah region (T31 Complex water project near the Islamic unity)

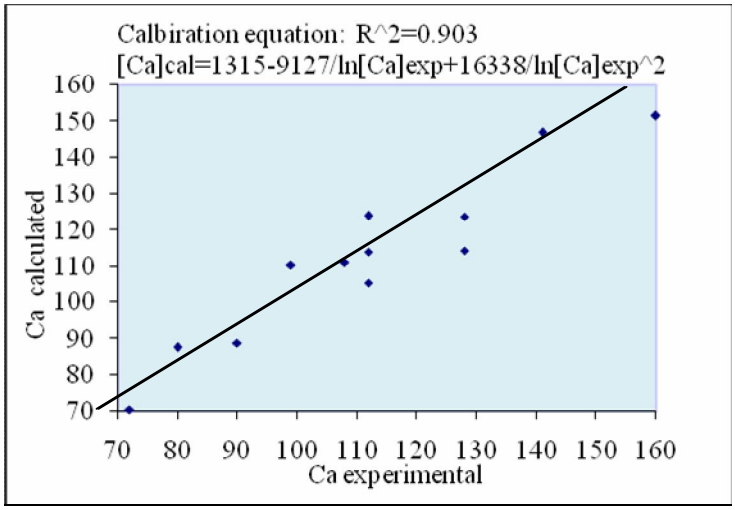


Fig.(11): Verfication of regression model for Tigris river in Al-Amarah region (T32 Castle project)

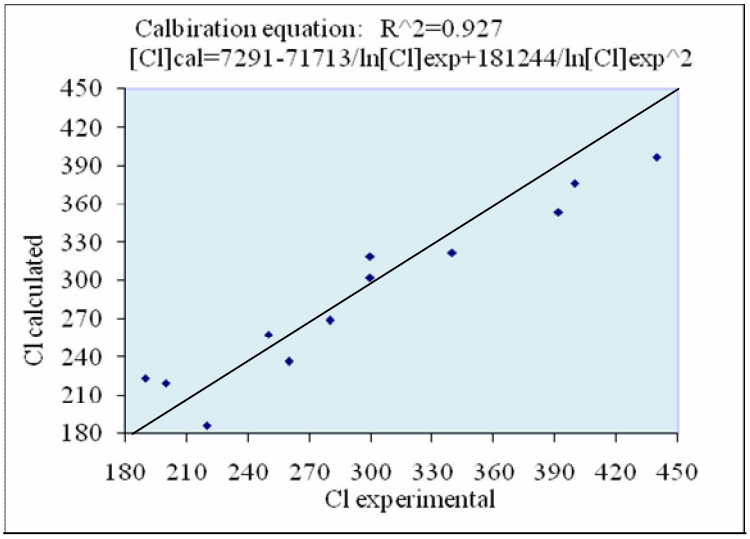


Fig.(12): Verfication of regression model for Tigris river in Al-Amarah region (T33 Uzayr project)

ASSESSMENT OF SURFACE WATER QUALITY

Water quality depends on many factors, including the proportion of surface runoff and ground water, reactions within the river system governed by internal process, the mixing of water from tributaries of different quality and inputs of pollutants(WHO, 1996).

An assessment of the water quality in the Al-amarah region was done by comparing the output data of the program with Iraqi and WHO standards for domestic and irrigation purposes which are given in Table (18).

Table (18): 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,2006).

Parameter	Unit	Domestic water standards (Iraqi)	Domestic water standards (WHO)	Irrigation water standards (WHO)
pH		6.5-8.5	6.5-8.5	6-8.5
EC	µ s/cm	2000		<250 Excellent 250-750 Good 750-2000 Permissible
Ca^{+2}	mg/L	200	75-200	0-200
Cl^{-1}	mg/L	200	250-600	0-300
Mg^{+2}	mg/L	50	30-150	0-50
TDS	mg/L	1500	500-1000	0-700 Excellent 700-2000 Good >2000 Unsuitable
TH	mg/L	500	100-500	
Tur	NTU	<10	5-25	
SO_4^{-2}	mg/L	200	200-400	

Table (19) shows the comparisons of surface water quality in the Alamarra region with Iraqi and WHO standards. This table shows that the Tigris River in Al-amarah region, Ali Al-Garbi are suitable for drinking and irrigation purposes while some of water resource show that it exceeded the Iraqi and standards for irrigation purposes i.e. Unified water project, Complex water project near the Islamic unity , Castle project and Uzayr project are unsuitable for Iraqi standards for domestic and irrigation purposes. The indicator unsuitable means that the class of water is very high in salinity so the water is suitable for types of plants that are highly resistance for salts but grow in good permeable soils .

Table (19): Comparison of surface water quality parameters of Tigris River in the Alamarra region with Iraqi and WHO standards.

River	Station	Standards for Domestic purposes(Iraqi)	Standards for Domestic purposes(WHO)	Standards for Irrigation purposes
Tigris Al-Amarah region	Ali Al-Garbi	Suitable	Suitable	Suitable
	Unified water project	Unsuitable	Suitable	Unsuitable
	Complex water project near the Islamic unity	Unsuitable	Suitable	Unsuitable
	Castle project	Unsuitable	Unsuitable	Unsuitable
	Uzayr project	Unsuitable	Unsuitable	Unsuitable

CONCLUSIONS

1) Tigris river in Al-Amarah region:

Ali Al-Garbi: It was found that there is a positive relation among chloride, magnesium, total dissolved solids, total hardness, electrical conductivity and ion hydrogen, and negative relation among Sulphate,Turbidity, discharge and Rain.

Unified water project: It was found that there is a positive relation among calcium, total dissolved solids, total hardness, electrical conductivity, Sulphate and ion hydrogen, and negative relation among magnesium, Turbidity, discharge and Rain.

Complex water project near the Islamic unity: It was found that there is a positive relation among calcium, total dissolved solids, total hardness and electrical conductivity, and negative relation among magnesium, Sulphate, ion hydrogen, Turbidity, discharge and Rain.

Castle project: It was found that there is a positive relation among chloride, magnesium, total dissolved solids, total hardness, electrical conductivity Sulphate and ion hydrogen, and negative relation among Turbidity and discharge.

Uzayr project: It was found that there is a positive relation among calcium, total dissolved solids, total hardness, electrical conductivity and Sulphate, and negative relation among magnesium, ion hydrogen, Turbidity and discharge.

2)Environmental Assessment procedure is necessary to further characterize conditions of water quality in Al-Amarah region.

3)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.

4)Improved surface water quality in Al-Amarah region leading to improve the drinking water quality, reduced chemical treatment, reduce the rate of disease and improved hygienic condition in the area.

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