The Study of Selected Chemical Properties and Statistical Analysis of Tigris River Water Samples in Wasit Province/Iraq

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Abstract

This research was conducted and aimed to study selected chemical properties of water samples taken from Tigris river in selected areas from the province of Wasit .The areas are regions of Suwiara and Numaniyah districts. Water chemical analyses were conducted and analyzed in the chemical laboratories of environment directorate in Wasit province. Data were statistically treated using Data fit software package. Simulations and models were built depending on the values of SAR, Ec, and pH. The results showed an existence of high significant statistical relationships between (SAR, EC, and pH) , (SAR and EC) and (EC ,and pH) were found as represented in the high values of the coefficient of determination(R^2) for WQMsS2 and WQMsN2. Also, results showed that, the best statistical relationship was between (SAR and EC,) for both locations .

Keyword : Statistical analysis, SAR, EC, pH, irrigation water quality,Tigris, WQMsS,WQMsN,coefficient of variation.

دراسة الخصائص الكيميائية والتحليل الإحصائي لعينات لمياه نـهر دجلة في محافظة واسط / العراق

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المستخلص

اجري البحث بهدف دراسة الخصائص الكيميائية لعينات المياه لنهر دجلة لمناطق منتخبة من محافظة واسط / العراق في قضائي الصويرة و النعمانية .تم تحليل المياه في مختبرات مديرية بيئة واسط، وتم معاملة النتائج إحصائيا بالاعتماد على قيم SAR, EC ,PHولكل محطة فضلا عن إيجاد النموذج الرياضي المتحكم بالتنبؤ عن قيم أل SAR وال EC كمتغير معتمد وال time , Ec ,pH كمتغيرات مستقلة . أظهرت النتائج وجود ارتباط معنوي عالي متمثلة بقيم عالية لمعامل التحديد R^2 لنموذجي (نموذج ٢لنوعية مياه دجلة في موقع الصويرة WQMsS2 ونموذج ٥ لنوعية المياه لنهر دجلة لموقع النعمانيةWQMsN5) ، وتم بناء علاقة إحصائية مابين(SAR, EC ,p H) وبين (SAR, EC) وبين(EC , pH) ووجد من قيم التباين الإحصائي ان العلاقة الإحصائية بين (SAR و EC) هي أفضل علاقة لكلا الموقعين .

الكلمات الدالة :

التحليل الإحصائي ، نسبة امتزاز الصوديوم، الايصالية الكهربائية ،درجة التفاعل ، نوعية الماء، نموذج نوعية ماء الري، دجلة ،نموذج نوعية ماء الري للصويرة، نموذج نوعية ماء الري النعمانية، معامل ألأختلاف.

1.1- Introduction

Quality of Irrigation water is one of the main yield factors in the cultivation of agricultural and horticultural crops in the arid and semi-arid area, and, has turned into one of the major ecological concerns overall ,and is affected by common and anthropogenic unsettling influences. For instance, waste water, overflow effluents, land recovery, air testimony and environmental change .Moreover, it is an essential requirement of human and industrial development in addition to being one of the most delicate parts of the environment,(Das and Acharya,2003 ; Sarala and Mageswari, 2014). It is becoming a global concern due to over increasing population and developmental activities that had over-exploited and polluted the water resources available, (Gubta, et al,2009). Parameters in charge for water quality variations are mainly related to domestic waste, industrial, runoff and agricultural (anthropogenic activities), (Ibrahim et al , 2015).

Rivers are vital fresh water systems of strategic importance across the world, providing main water resources for domestic, industrial, and form the lifeline of human society and playing a pivot role in assimilating or carrying industrial and Municipal wastewaters and runoff agricultural fields , (Basu and Lokesh,2013), and human activities have significantly affected its waters,(Radwan and Al-Sadek,2008).

Proper irrigation management is increasingly a demand and competition for high ,potable water grows. Also, accurate interpretation of water quality reports is essential for irrigation managers and this has resulted in increasing demand for monitoring river water quality . Also,it is crucial to understand what management changes are necessary for a long term and short term productivity ,particularly for crops that are sensitive to changes in water quality. Moreover, it provides the primary assessment of the pollution status, (El-Sayed and Omran,2012;Basu and Lokesh,2013;Park, et al ,2014; Sharma, and Walia,2015).In addition, it is a critical factor ,that influences human health and quantity and quality of grain production in the semi-humid and semi-arid area , (Hagras,2013).

The quality of irrigation water is governed by factors such as pH, SAR, EC ,Na ,Mg, and its modelling is employed to predict ,simulate and optimise the values of its qualitative parameters , and, it could be effective tools to simulate and predict pollutants transport in the water environment .Models are constructed and applied as valuable tools for quantitative analysis of the cause-and-effect relation between management scenarios and water quality responses. And ,they widely used to support decision making of water management, (Wang et al ,2013; Sarala Thambavani and Uma Mageswari ,2014; Xuan Yi, et al , 2016). Moreover, the Disposal of ground water with high sodium concentrations has the potential to increase salinity and SAR of water in the river, and potentially reduce the quality of water for irrigation uses, (Cannon et al ,2004). And ,because of Tigris river is the main source of water for all life activities in the study area and, serves huge agricultural and residential area .And, due to the of lack information and little scientific studies of its water quality, it is necessary to evaluate the quality of its water in order to assess its suitability for various uses and to evolve suitable and strategic policies for the best uses of water resources in this area . Accordingly ,the objectives of this study were directed to evaluate and modelling selected chemical properties which are governing water quality in these areas.

1.2-Materials and Methods

1.2.1-Study area :

The work was conducted in two areas related to two districts from Wasit province, fig. (1) .The area is characterised mainly by large agricultural activities with minor industrial works .Tigris is the main source of water for the agricultural and domestic uses .Water samples were collected from Tigris river at both regions (Suwaira and Numaniyah), and chemically analysed for electrical conductivity(Ec),reaction(pH), sodium(Na), calcium(Ca), and magnesium(Mg) in chemical laboratories of Environmental directory of Wasit province according to methods documented in (Richards et al,1954). Sodium adsorption ratio (SAR) was calculated according to method documented in (Richards et al,1954) as well.

1.2.2-Data statistical processing :

Data were statistically analysed for descriptive statistics(minimum, maximum, mean, range, mean standard error ,variance ,standard deviation ,coefficient variation, skewness, kurtosis, and correlation) . Spss

statistical program version 20 was used for this purpose .Results are documented in tables 1 and 2.

Fig.1 : location of study area and samling sites (Google earth)

1.2.3-Construction of mathematical models :

characterising the statistical relationship between (SAR, EC, pH and Time) ; between (SAR, Ecand Time) and between (EC, pH and Time) .The results obtained from chemical tests table (1) for Suwaira and Numaniyah regions were used in statistical nonlinear estimation by using data fit software,9 (2014) to build a model for SAR depending on the variables (EC, Time) .And to create the model for EC depending on the variables (pH ,Time). The maximum number of iterations used were (250) and the convergence criterion was (0.0000000001).Results were documented in tables 3,4,5,6,7, and 8 .

1.3- Results and discussion:

The quality of irrigation water is governed by factors as (pH, SAR ,Ec ,and concentration of ions like Na, Mg, Ca, and potassium (K) , in addition to a time scale. The spatiotemporal variability of these factors affects the quality of irrigation water . Table (1) represents the values of a chemical parameter of Tigris water in Suwaira and Numaniyah regions and their descriptive statistics .

Table (1) chemical parameters and descriptive statistics for Suwaira and Numaniyah regions for the year 2014

	Suwaira Region						Numaniyah Region					
Time	Ca^{+2} ppm	Mg^{+2} ppm	Na^{+1} ppm	EC $\mu S.cm^{-1}$	pH	SAR	Ca^{+2} ppm	Mg^{+2} ppm	Na^{+1} ppm	Ec $\mu S.cm^{-1}$	pH	SAR
January	88.500	35.500	93.000	1210.500	7.550	11.820	86.000	34.500	93.000	1189.000	7.450	11.980
February	84.750	44.800	91.400	1220.000	7.700	11.360	85.000	44.000	86.400	1195.000	7.600	10.760
March	82.500	34.900	95.500	1196.000	7.400	12.470	87.000	34.000	106.500	1257.000	7.350	13.700
April	76.250	35.900	108.500	1198.000	7.635	14.490	79.700	39.000	103.450	1130.000	7.615	13.430
May	73.750	30.400	86.050	1121.000	7.800	11.930	73.250	33.150	89.000	1187.500	7.700	12.200
June	83.500	44.695	89.000	1450.500	7.720	11.120	84.350	47.000	88.600	1483.000	7.640	10.930
July	84.050	41.200	99.500	1530.500	7.310	12.570	86.550	42.100	100.700	1534.000	7.460	12.560
August	77.800	31.500	88.000	1403.500	7.365	11.910	82.650	31.500	92.900	1388.500	7.495	12.300
September	73.000	30.150	86.050	1280.500	7.385	11.980	77.000	32.500	95.250	1358.500	7.435	12.870
October	66.750	33.500	96.500	1226.000	7.700	13.630	68.650	32.700	99.500	1252.000	7.700	13.980
November	80.100	35.500	76.750	1207.500	7.455	10.100	84.250	35.300	77.750	1195.000	7.515	10.060
December	98.750	40.300	86.250	1250.000	7.480	10.340	105.000	41.500	97.000	1133.000	7.555	11.330
Min.	66.570	30.150	76.750	1121.000	7.310	10.100	68.650	31.500	77.750	1130.000	7.350	10.060
Max.	98.750	44.800	108.500	1530.500	7.800	14.490	105.000	47.000	106.500	1534.000	7.700	13.980
Range	32.000	14.650	31.750	409.500	0.490	4.390	36.350	15.500	28.750	404.000	0.350	3.920
Mean	80.808	36.528	91.375	1274.500	7.547	11.976	83.283	37.270	94.170	1292.041	7.542	12.175

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Std.	8.290	5.125	8.085	121.832	0.164	1.242	8.9240	5.225	8.028	127.936	0.110	1.227
MSE	2.393	1.479	2.334	35.169	0.047	0.358	2.576	1.508	2.317	36.920	0.031	0.354
C.V.%	10.256	14.030	8.848	9.559	2.220	10.370	10.715	14.019	8.852	9.901	1.458	10.078
Var.	68.725	26.275	65.373	14843.045	0.027	1.545	79.638	27.303	64.463	16367.703	0.012	1.508
Skew.	0.502	0.498	0.444	1.145	0.150	0.504	0.908	0.680	-0.439	0.729	-.057	-0.179
Kurt.	1.081	-0.928	1.112	0.409	-1.520	0.445	2.936	-0.984	0.185	-0.522	-.894	-0.866

1.3.1-Suwaira region:

Descriptive statistics results presented in table (1) show that Ca^{+2} concentration ranged between 66.75 ppm to 98.75 ppm during October and December respectively .The coefficient of variation(cv) of Ca ions was (cv=10.256%) and of mean squared error (MSE=2.393). Mg concentration ranged between 30.15 ppm and 44.80 ppm in September and February respectively, with a coefficient of variation(14.030%) and MSE 1.479.Whereas Na concentration ranged from 76.75 to 108.50 ppm in November and April respectively and was of less variability (cv=8.848%) and its MSE was (2.334).The electrical conductivity of water in this region ranged between1121.00 $\mu S.cm^{-1}$ and 1530.50 $\mu S.cm^{-1}$ during May and July respectively and its coefficient of variation and MSE were 9.559% and 35.169 respectively. Water reaction (pH) was the least variable parameter (cv=2.220%). It's value ranged between 7.31 and 7.80 during July and May respectively and of MSE value 0.047.Sodium Adsorption Ratio (SAR) ranged between 10.10 and 14.49 in November and April respectively with MSE value (0.358).The pattern of variability of water quality parameters takes the form: Mg > SAR > Ca > Ec > Na > pH . The results show that the studied chemical parameters of water quality in this region was of low variability (< 15%).These variations may be inferred to the effects of anthropogenic influences and to the seasonal runoff ,(Basu and Lokesh , 2013 ; Sahoo, et al , 2016) and to the variations of the physical water qualities as turbidity,water temperature and water current velocity.

1.3.2 Numaniyah region:

Descriptive statistics presented in table (1) show that, Ca concentration ranged between 68.65 ppm and 105.00ppm in October and December respectively ,the coefficient of variation of Calcium ions was 10.715% and its MSE is 2.576. Magnesium concentration was ranging from 31.5 ppm and 47.00 ppm for August and June respectively. The coefficient of variation of Magnesium concentration was 14.019% with MSE value 1.508.But ,sodium concentration ranged from 77.75 ppm to 106.05 ppm during November and March months respectively, it's coefficient of variation and MSE were (cv=8.852%) and 2.317 respectively . The electrical conductivity of water in Numaniyah region ranged between 1130

µS.cm^{-1} and 1534 µS.cm^{-1} during April and July respectively .The coefficient of variation and MSE of Ec was 9.901% and 36.932 respectively. Whereas, pH was the least variable parameter , and its values ranged between 7.35 and 7.70 during March and October respectively.The coefficient of variation of pH was 1.458% and the MSE was 0.031.Whoever, the minimum and maximum values of SAR in this region were 10.06 and 13.98 respectively in November and October respectively and the coefficient of variation of SAR was 10.078% with MSE 0.354.From the above mentioned results, we found that pH is the least variable parameter and Magnesium is the most variable parameter of water quality in this region . These variations may be due to the variation of the concentration these parameters in water,variation of physical environments such as temperature of water and the geologic nature of the origin which the soil derived from that water passed through and coming from, (Singh, et al, 2014; Radwan and El-Sadek,2008). In addition, this is may be due to the variability of these ions in untreated or partially treated wastewater disposed of in the river,(Sahoo, et al ,2016), and to the direct dumping of solid wastes and domestic sewage into the rivers , (Malla , et al, 2015) . The pattern of the variation of these parameters having the form : Mg > Ca > SAR > Ec > Na > pH. Table(2) presents the correlation matrices between the studied parameters in both regions. The highest positive correlation was between SAR and Na ,their coefficients of correlation were 0.704 and 0.846 for Suwaira and Numaniyah regions respectively, they were both significant correlations (ρ= 0.95 and 0.99) .And, the highest significant negative correlation coefficient was (-0.552) between SAR and Ca in Suwaira region ,whereas in Numaniyah region was -0.531 between SAR and Mg. The lowest positive correlation was between SAR and EC(0.032) in Numaniyah region and between EC and Na (0.56) in Suwaira region. However, the lower negative correlation Was (r= -0.028 and -0.133) between pH and Na , and pH and SAR respectively in Suwaira and Numaniyah regions respectively.

Table (2) Correlation metrics of the studied chemical properties for Tigris water

Suwaira Region

	Ca^{+2}	Mg^{+2}	Na^{+1}	Ec	pH	SAR
Ca^{+2}	1.000					
Mg^{+2}	0.725**	1.000				
Na^{+1}	0.074	0.358	1.000			
Ec	0.196	0.277	0.056	1.000		
pH	-0.102	0.175	-0.028	-0.396	1.000	
SAR	-0.552*	-0.308	0.704**	-0.105	-0.123	1.000

Numaniyah Region

	Ca^{+2}	Mg^{+2}	Na^{+1}	Ec	pH	SAR
Ca^{+2}	1.000					
Mg^{+2}	0.545*	1.000				
Na^{+1}	0.175	-0.168	1.000			
Ec	0.308	0.091	0.081	1.000		
pH	-0.515*	0.214	-0.291	-0.316	1.000	
SAR	-0.308	-0.531*	0.846**	0.032	-0.133	1.000

(Spearman -0ne tailed) *significant at 5%, and ** significant at 1%

1.3.3 -Water quality Modelling(WQMs):

Water quality assessment is vital phenomena for water management. And its modelling is very helpful to predict and simulate its fundamental parameters.

1.3.3.1;Suwaira Region:

Three nonlinear models were constructed ,two models for characterising the relation between SAR, pH, EC and time . And the third one was to characterise the relation between Ec ,time and pH ,table (3),fig. 2a and 2b.The construction of these models depended on results derived from chemical tests and Datafit program. The results presented in table (4) show that the coefficients of determination (R^2) of water quality WQMs

Table(3) models constructed to characterise the relation between Time ,pH, Ec ,and SAR for Tigris water in Suwaira region

Model 1WQMsS1) : $SAR= exp (a_0*T+ a_1*EC+ a_2*pH+ a_3)$
Model 2(WQMsS2 : $SAR= a_0+a_1*T+a_2*T^2+a_3*T^3+a_4*T^4+a_5*T^5+a_6/EC+a_7/EC^2+a_8/EC^3+a_9/EC^4+a_{10}/EC^5$
Model 3 (WQMsS3) : $EC=a_0+a_1*log(T)+a_2*log(T)^2+a_3*log(T)^3+a_4*log(T)^4+a_5*log(T)^5+a_6*pH+a_7*(pH)^2+a_8*(pH)^3+a_9*(pH)^4+a_1$

S1,WQMsS2andWQMs S3 are 0.095,0.986 and 0.995 respectively. And, the standard error of the estimates (E.S.E) of these models is 1.387 ,0.489 and 28.248 respectively. Accordingly, we found that model 2 (WQMsS 2) is the

Table (4) coefficients of constructed models for Tigris water in Suwaira region

coefficients	Model 1 (WQMsS1)	Model2 (WQMsS2)	Model3 (WQMsS3)
a_0	-0.0083	-381699	14052484260.0
a_1	1.124	20.550	2561.2
a_2	0.029	-12.382	-9050.9
a_3	2.306	3.056	9969.4
a_4	-	-0.306	-4402.8
a_5	-	0.011	679.6
a_6	-	2.449E+09	-9380178853.0
a_7	-	-6.26E+12	2504201671.0
a_8	-	7.95E+15	-334223285.1
a_9	-	-5.03E+18	22300389.4
a_{10}	-	1.27E+21	-595094.1
Square Regression R^2	*0.095*	*0.986*	*0.995*
Standard Error of the Estimate(S.E)	*1.387*	*0.489*	*28.248*

best model for simulation values of SAR for Tigris water in Suwaira region .This is can be confirmed from the results presented in table (5). The residuals(negatives) in model WQMs S1 ranged from -0.28 to - 1.36 in May and November respectively with error ranged from -2.31 % and -13.50 % in May and November respectively , and its positive residuals ranged between 0.13 and 2.23 in August and April respectively with error ranged between 1.12% and 15.41% in August and April respectively. Whereas, the residuals(negatives) in model WQMsS2 ranged between -0.02 and -0.34 in December and March with error ranged between -0.01 and -2.71 in October and March respectively , and its positive residuals ranged between 0.00 to 0.21 in October and April respectively with error ranged

Table (5) measured and estimated SAR and Ec values from chemical test and Data fit software program for Suwaira region.

Time	Model 1 (WQMsS1)				Model 2 (WQMsS2)				Model 3 (WQMsS3)			
	SAR from chemical test	SAR from data fit	Residuals	Error %	SAR from chemical analysis	SAR from data fit	Residuals	Error %	EC from chemical test $\mu S.cm^{-1}$	EC from data fit $\mu S.cm^{-1}$	Residuals	Error %
January	11.82	12.53	-0.71	-6.04	11.82	11.87	-0.05	-0.42	1210.5	1210.49	0.01	0.001
February	11.36	12.49	-1.13	-9.98	11.36	11.15	0.21	1.88	1220	1220.27	-0.27	-0.023
March	12.47	12.26	0.21	1.66	12.47	12.81	-0.34	-2.71	1196	1194.87	1.13	0.094
April	14.49	12.26	2.23	15.41	14.49	14.28	0.21	1.45	1198	1199.22	-1.22	-0.102
May	11.93	12.21	-0.28	-2.31	11.93	11.92	0.01	0.05	1121	1121.01	-0.01	-0.001
June	11.12	12.14	-1.02	-9.16	11.12	11.20	-0.08	-0.70	1450.5	1451.72	-1.22	-0.084

July	12.57	11.88	0.69	5.46	12.57	12.56	0.01	0.09	1530.5	1532.01	-1.51	-0.099
August	11.91	11.78	0.13	1.12	11.91	11.81	0.10	0.86	1403.5	1387.12	16.38	1.167
September	11.98	11.66	0.32	2.71	11.98	12.09	-0.11	-0.92	1280.5	1301.13	-20.63	-1.611
October	13.63	11.67	1.96	14.37	13.63	13.63	0.00	-0.01	1226	1223.64	2.36	0.193
November	10.1	11.46	-1.36	-13.50	10.10	10.05	0.05	0.49	1207.5	1198.70	8.80	0.728
December	10.34	11.38	-1.04	-10.05	10.34	10.36	-0.02	-0.18	1250	1253.81	-3.81	-0.305

between -0.01% and 1.88% in October and February respectively . And ,in Model WQMsS3 the residuals (negatives) ranged between -0.01 to -20.63 in May and September respectively,with error ranged between -0.001 and -1.611 in May and September respectively . And its positive residuals were ranging from 0.01 to 16.38 in January and August respectively with error ranged between 0.001 % to 1.167 % in January and August respectively. This means that there are some parameters were not included in the construction of modelsWQMsS1 and WQMsS3 ,which caused these large values of residuals and errors in models WQMsS1 and WQMsS3.

1.3.3.2 -Numaniyah Region(WQMsN):

Three models were constructed to characterise the water quality of SAR of water.Two models(WQMsN4 and N5) for characterising the relation between SAR, pH, EC, and time. And the third (WQMsN 6) was to characterise the relation between Ec ,time and pH ,table (6),fig. 3a and 3b. Table(7) presents the coefficients of the constructed water quality models ,WQMsN4 , WQMsN5, and WQMsN6. The coefficients of Determinations

(R^2) of these Models are 0.0269 , ,0.99 and 0.998 for WQMsN 4 ,WQMsN 5 and WQMsN6 respectively with a standard error of estimates (ESE) 1.419,

Table (6) models constructed to characterize the relation between Time ,pH, Ec ,and SAR for Tigris water in Numaniyah region

Model 4 (WQMsN4) : $SAR= \exp(a_0*T+ a_1*EC+ a_2*pH+ a_3)$
Model 5(WQMsN5) : $SAR= a_0+a_1*T+a_2*T^2+a_3*T^3+a_4*T^4+a_5*T^5+a_6*\ln(EC^2)+a_7*\ln(EC)^2+a_8*\ln(EC)^3 +a_9*\ln(EC)^4 + a_{10}*\ln(EC)^5$
Model 6(WQMsN6) : $EC= a_0+a_1/T+a_2*pH+a_3/T^2+a_4*pH^2+a_5*pH/T+a_6/T^3+a_7*pH^3+a_8*pH^2/T+a_9*pH/T^2$

2.096 and 33.145 respectively. As a result, we can notice that the modelWQMsN5 is the best among constructed WQMs . This is because of it's high (R^2) value(0.99) and low ESE value (2.096) comparing to values of WQMsN4 and WQMSN6. Results listed in table (8)confirm these findings . Table 8 presents the SAR and EC measured and estimated from chemical tests and Data fit software .Residuals (negatives) of the WQMsN4 range between -0.54 and -2.04 in January and November respectively with error ranged between -4.49% and -20.27% in January and November respectively. However,its positive residuals ranged between 0.13 to 2.1 during May and October respectively with error ranged between 1.10% and 15.02 % in May and October respectively. Whereas, for WQMsN5 , the residuals(negatives) ranged from -0.001 to -0.013 in January;July and August respectively, with error ranged between - 0.007% -0.108% in January and August respectively and its positive residuals ranged between 0.000 and 0.012 in April and September respectively with error 0.011% and 0.095% during October and September respectively. However in WQMsN6 negative residuals ranged from -0.951 to -20.103 with error ranged between –0.076% and –1.682% in March and November respectively. And, the positive residuals of the WQMsN6 ranged from

0.082 to 27.029 in October and December respectively with error ranged from 0.007% to 2.025% in October and December respectively. Accordingly, the WQMsN5 is the best model for characterising the relation between SAR,

Ec and Time and gives reasonable and acceptable values for SAR of irrigation water in Numaniyah region and very close to results obtained from chemical test. This is due to the low values of its residuals and error percentage comparing to that of WQMsN4 and WQMsN6 models.

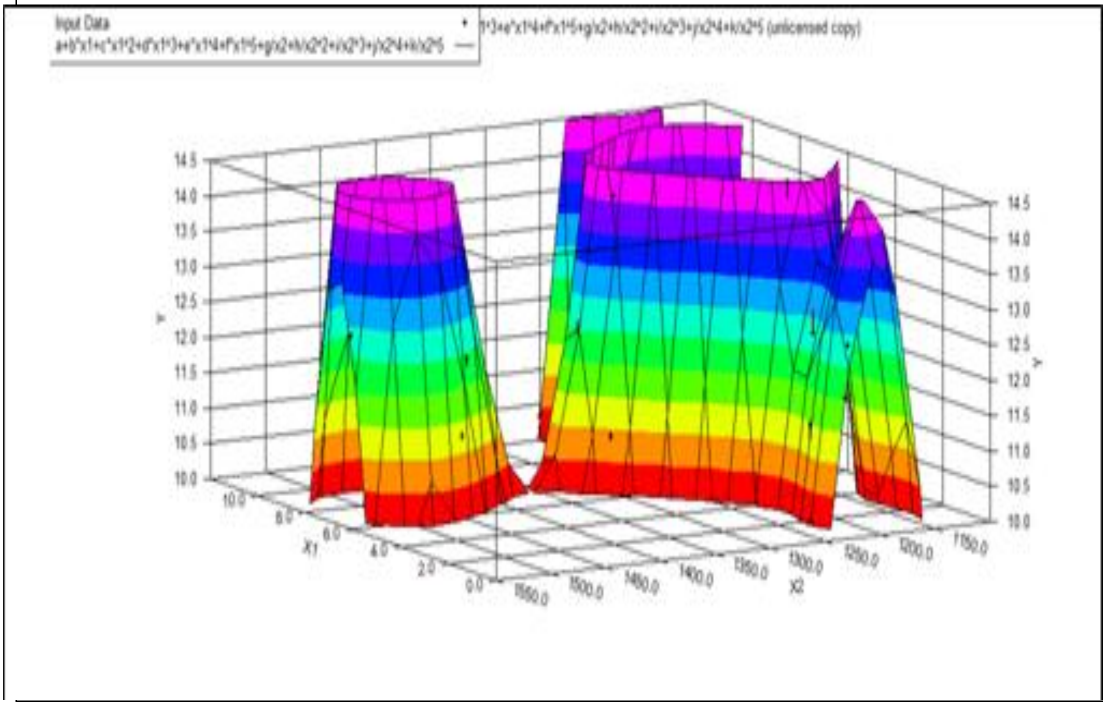
Table (7) coefficients of models constructed to characterise the relation betweenTime ,pH, Ec, and SAR for Tigris water in Numaniyah region

Coefficients	Model 4 (WQMsN4)	Model 5(WQMsN5)	Model 6(WQMsN6)
a_0	-2.75E-03	2.76E+09	66305798.2
a_1	-3.25E-05	-5.52899	9533742.1
a_2	-0.10254	1.72451	-26514527.8
a_3	3.332477	-0.18085	-2280631.8
a_4		5.26E-03	3532598.1
a_5	-	6.01E-05	-2409347.4
a_6	-	-1.9E+09	94524.6
a_7	-	5.31E+08	-156814.3
a_8	-	-7.4E+07	152257.8
a_9	-	5107140	289074.7
a_{10}	-	-141587	-
Square Regressions R^2	0.0269	0.99	0.998
Standard Error of the Estimate(S.E)	1.419	2.096	33.145

Table (8) measured and estimated SAR and Ec values from chemical test and Data fit software program for Numaniyah Region

Time	Model 4 (WQMsN4)				Model 5(WQMsN5)				Model 6 (WQMsN6)			
	SAR from chemical test	SAR from data fit	Residuals	Error %	SAR from chemical analysis	SAR from data fit	Residuals	Error %	EC from chemical test $\mu S.cm^{-1}$	EC from data fit $\mu S.cm^{-1}$	Residuals	Error %
January	11.98	12.52	-0.54	-4.49	11.98	11.98	-0.001	-0.007	1189	1188.9	0.109	0.009
February	10.76	12.29	-1.53	-14.25	10.76	10.75	0.004	0.039	1195	13.5	-1.597	--13.360
March	13.70	12.55	1.14	8.34	13.70	13.70	-0.006	-0.042	1257	1258.0	-0.951	-0.076
April	13.43	12.23	1.20	8.92	13.43	13.43	0.000	-0.003	1130	1119.4	10.553	0.934
May	12.20	12.07	0.13	1.10	12.20	12.20	0.004	0.032	1187.5	1184.2	3.289	0.277
June	10.93	11.99	-1.06	-9.71	10.93	10.93	0.003	0.030	1483	1500.5	-17.460	-1.177
July	12.56	12.16	0.39	3.13	12.56	12.56	-0.001	-0.008	1534	1516.8	17.228	1.123
August	12.30	12.14	0.15	1.25	12.30	12.31	-0.013	-0.108	1388.5	1406.8	--18.310	-1.319
September	12.87	12.20	0.68	5.25	12.87	12.86	0.012	0.095	1358.5	1358.4	0.129	0.010
October	13.98	11.88	2.10	15.02	13.98	13.98	0.002	0.011	1252	1251.9	0.082	0.007
Novemb	10.06	12.1	-2.04	-20.27	10.0	10.0	-0.005	-0.054	1195	1215.1	-20.103	-1.682

er		0			6	6					
December	11.33	11.96	-0.62	-5.51	11.33	11.33	0.002	0.015	1335	1308.0	27.029	2.025



Fig(2 a) plot of model WQMsS3 [y axis represents SAR , X_1 represents Time and X_2 for Ec]

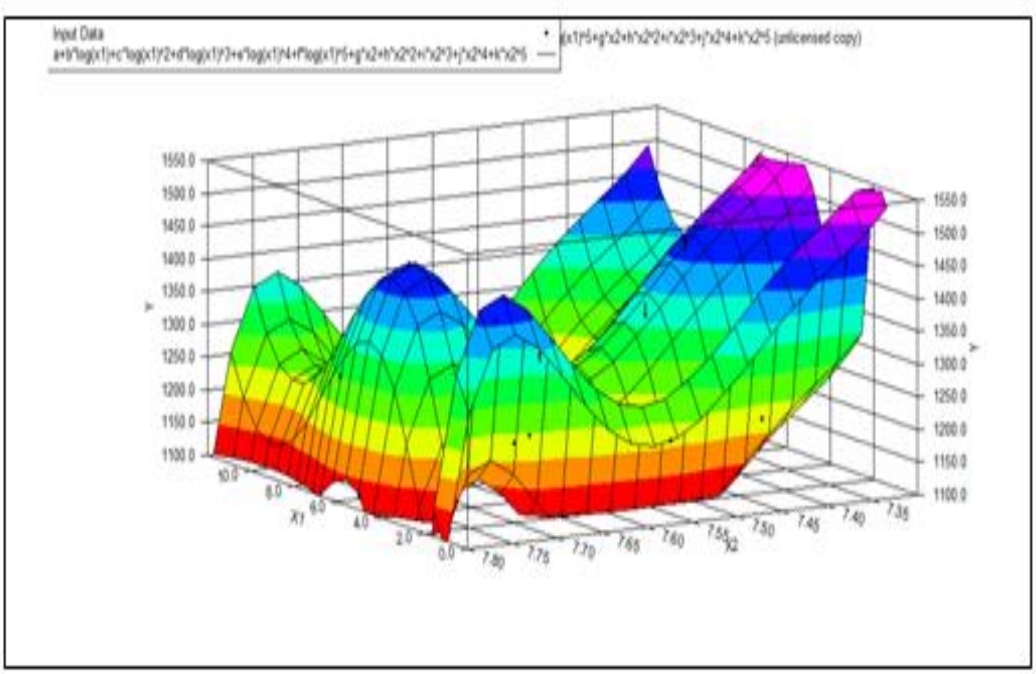


Fig (2 b) plot of model WQMsS3[y axis represents Ec , X_1 for Time and X_2 for pH]

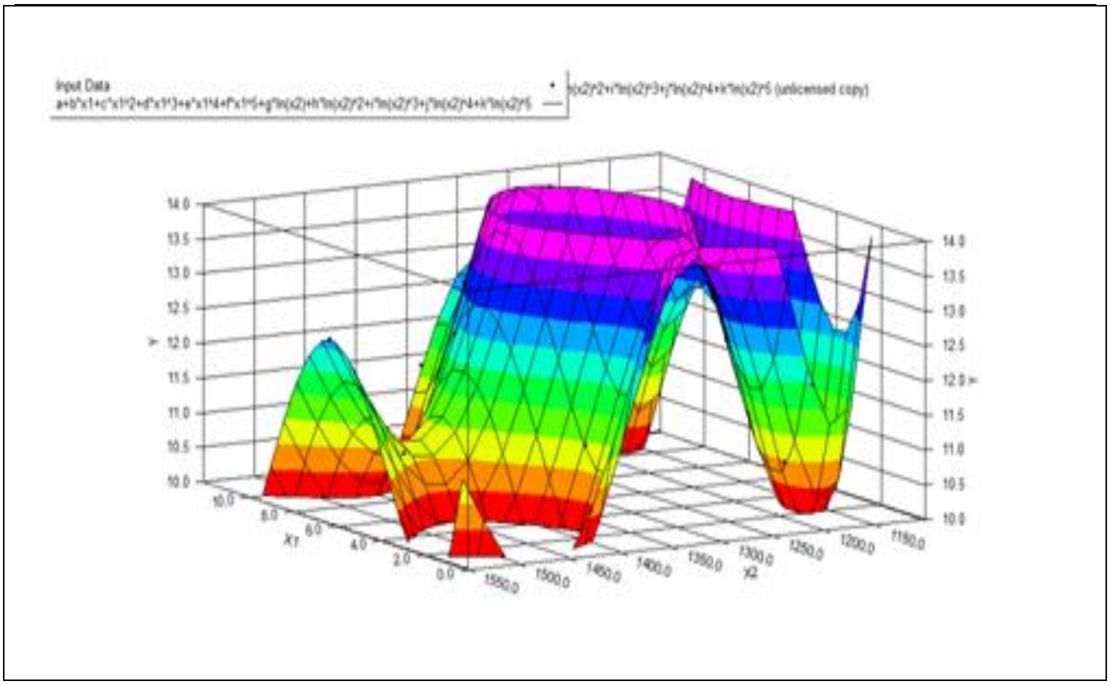


Fig.(3 a) :plot of WQMsN5:[Y represents SAR ,X_1 represents Time and X_2 for Ec]

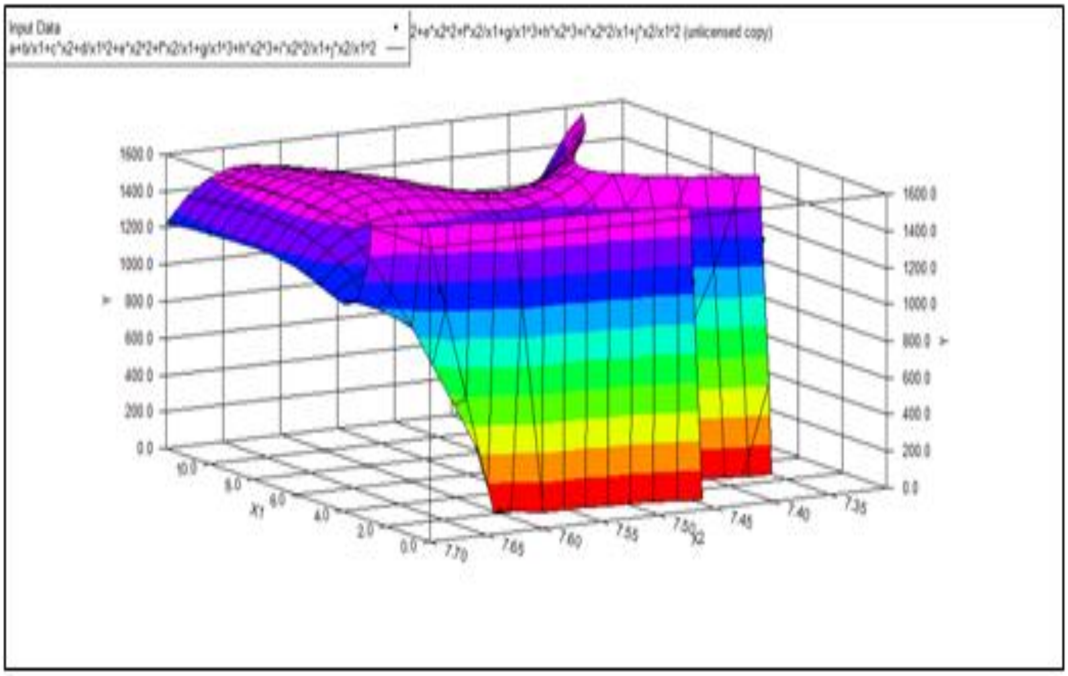


Fig.(3b)plot of WQMsN6 ,[Y represents EC ,X_1 represents time and X_2 for pH]

1.4-Conclusions and Recommendations:-

Quality of irrigation water is governed by factors such as pH, Ec ,Na, Mg, Ca, K,SAR …etc., and it can be used to assess the risks of soil properties related to plant growth and soil uses for engineering purposes for instance, infiltration rate, soil permeability soil structure,and soil tensile strength. Also,it provides the primary assessment of water quality parameters.From the foregoing findings, we concluded that SAR is strongly affected by the concentration of Na, Mg, and Ca ions in Tigris River water in both locations.The most variable parameter was Mg (cv= 14.03%) and the least variable was pH(cv= 2.209%) in Suwaira region .Whereas, in Numaniyah region, the most variable parameter was Ec(cv=32.868%)and the least variable was pH as well (cv=1.226%).The pattern of variability of water quality parameters is taking the form Mg>SAR>Ec > Ca > Na >pH in Suwiara andNumaniyah regions respectively. The parameters of water quality were more variable in Suwaira region than Numaniyah region except Ec was more

variable in Numaniyah region and was very highly variable.Most water quality parameters were of low variability (cv= <15%) except Ec parameter in Numaniyah region was the highly variable class (cv= >25%).SAR was significantly (negative) correlated with Ca ion and (positive) correlated with Na and Mg ions in Suwaira region.But it shows significant (positive)correlation with Na and negative correlation with Mg in Numaniyah region. WQMs in both regions strongly reflected the interactions among the water quality ,and SAR and Ec can be used to assess the quality of irrigation water. Also, the disposal of polluted and untreated or partially treated materials affected the water resources and reduced their quality potentially for agricultural uses in the study area of both regions .Models (WQMs S2 and WQMs N2) were the best models for characterising the relations between SAR, Ec , pH , and time scale.Accordingly , the continuous and periodic monitoring of water quality is highly recommended and it is critical to understand what management changes are necessary for long and short productivity schemes , particularly for crops that are sensitive to changes in water quality

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