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FACTOR ANALYSIS FOR WATER QUALITY AND QUANTITY OF TIGRIS RIVER AT SELECTED SITES SOUTH MOSUL CITY

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ABSTRACT

This research aimed to emphasis Tigris river water quality and quantity variations at two sites: Qaber Al-Abid village downstream Mosul city and Dwezat village after its meeting with the Upper Zab river using factor analysis technique. Weekly samples were collected from the two sites along a year. Samples were tested for pH, electrical conductivity, total alkalinity, total hardness, calcium, magnesium, sodium, potassium, chloride, sulphate, nitrate, phosphate, dissolved oxygen, biochemical oxygen demand, suspended solids, total solids, total dissolved solids, in addition to the discharge of the river. The results of each site were analyzed statistically using factor analysis for each season and for the whole year. Factor analysis concentrated the measured water quality parameters and discharge into two to four factors for seasonal analysis, which represent (90.69%-100%) of the variation in water quality and quantity. On the other hand, five factors were extracted from the yearly data at Qaber Al-Abid site and six factors at Dwezat site.

The results of factor analysis revealed that pH, conductivity and PO_4^{-3} is the highest contributor to the variation in water quality at the two sites. Organic pollution came in the second order in Qaber Al-Abid since it is location downstream of Mosul city, while the effect of Upper Zab made the

 discharge and sediment load (SS, TS and TDS) in the second order for the (36-53)
variation in Dwezat site.

KEYWORDS

Factor Analysis, Water Quality, Tigris River.

INTRODUCTION

Knowledge of water quality variation mode plays significant role in the development, control and management strategies of water resources. For water quality management it is important to indicate the main chemical, physical or biological parameters which contribute to the water quality variation. Conventional studies of water quality record the variation of each parameter with time alone with minimum and maximum values through the study period.

For better understanding of water quality variation mode, multivariate analyses can be performed using water quality parameters together in the analysis. Many researchers have used principal components or factor analysis in their analysis of water quality data[1-8].
Factor analysis is an interpretation method of data that can be used to understand the structure of collected data. It is also used to find the association between parameters so that the number of measured parameters can be reduced.

Tigris river is the main source of water in Mosul city and down to Baghdad. At the same time, it is used as the main source to dump wastewater. This research tries to emphasize the structure of water quality variation in two sites on Tigris river south Mosul city.

MATERIALS AND METHODS

Two sites were selected along Tigris river south Mosul city. The first te is at Qaber Al-Abid village downstream Mosul city and the second site is at Dwezat village after the river has met the Upper Zab river in Al-Makhlat as shown in Fig. 1. Weekly samples were collected for one year interval. Various physical, chemical and biochemical tests have been conducted on each sample (pH, electrical conductivity, total alkalinity, total hardness, calcium, magnesium, sodium, potassium, chloride, sulphate, nitrate, phosphate, dissolved oxygen, biochemical oxygen demand, suspended solids, total solids, total dissolved solids). These tests were performed according to the procedures outlined in the standard methods for the examination of water and wastewater[9]. Additionally, the discharge of the river during the sampling dates were obtained from Mosul Irrigation Records.

The collected data were statistically analyzed using SPSS program. The raw data were standardized as water quality parameters and discharge have different units and scale of measurements[10]. This type of ordination reduce the dimensionality of the data set and minimize the loss of information caused by the reduction[11].

Factor analysis used the correlation matrix of observation (X) to estimate a sorted matrix of eigenvalues (λ) and corresponding eigenvectors (factor loading V). The characteristic equation is $[X-\lambda I]V=0$, where each eigenvalue (λ) is associated with an eigenvector V. The factors with eigenvalues equal to or greater than one are retained using Kaiser criterion (Davis, 1973). Varimax rotation was used to yield a simpler factor structure[12].

RESULTS AND DISCUSSION

The descriptive statistics (mean, standard deviation, minimum and

maximum) for water quality parameters at Qaber Al-Abid and Dwezat
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village sites are listed in table 1.

It is clear from the table, that the parameters which belongs to conductivity and organic pollution show more variation in Qaber Al-Abid site, since this site lies in the downstream of Mosul city. On the other hand, solids (suspended, dissolved and total) exhibit more variation in Dowzat site, since this site lies on Tigris river after its meeting with the Upper Zab River which is not controlled by any hydraulic structure.

The results of factor analysis have concentrated the parameters in two factors for Qaber Al-Abid site at winter (Table 2). Factor I accounts for 62.94% of the variance of water quality and quantity. pH, Conductivity (EC), total alkalinity (Alk), nitrate (NO_3), phosphate (PO_4) total solids (TS) and total dissolved solids (TDS), are directly loaded on this factor, while magnesium (Mg), sodium (Na), potassium (K) and discharge (Q) are negatively loaded on this factor. On the other hand, suspended solids (SS), dissolved oxygen (DO), biochemical oxygen demand (BOD), total hardness (Hard) and Calcium (Ca) are positively loaded on factor II, while chloride (Cl) and sulphate (SO_4) are negatively loaded on this factor. This factor contributes by 37.06% to the variance of water quality and quantity.

In Dwezat village, after Tigris river have met with the Upper Zab river in Al-Makhlat, factor analysis extracted two factors also from water quality and quantity data collected in winter. Factor I accounts for 66.37% of the variance of water quality and quantity. It is directly correlated with pH, EC, TS, TDS, NO_3 and PO_4, while it is inversely correlated with Q, SS, Mg, Na and K. Factor II accounts for 33.63% of the variance, and it is

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ɔsitively correlated with DO, BOD, Alk, Hard and Ca, while it is negatively correlated with Cl and SO_4.

Table (2) also revealed that Mg, Na and K are associated with discharge in the two sites. A comparison between the analysis results of the two sites showed the effect of Upper Zab river in Dwezat on suspended solids which shows more variation as it is loaded on factor I, also it is associated with the discharge.

In spring, four factors were extracted in Qaber Al-Abid site (Table (3). Factor I accounts for 37.97% of variation in water quality and quantity. pH, EC, BOD, Hard, SO_4 and PO_4 are directly loaded on factor I, while Q, and NO_3 are negatively loaded, i.e., this factor represent the effect of sulphuric springs at Hammam Al-Aleel city and fallout of domestic wastes in the river at this season. Factor II accounts for 27.28% of the variation and is designated with DO, TS, Alk and Ca. Factor III is designated with Mg and Na and accounts for 16.78% of the variation. Factor IV accounts for 12.68% of variance and is represented by SS and TDS. These results emphasize that discharge has inverse effect on some water quality parameters and it has no effect on sediment load at this site.

For Dwezat site, three factors were extracted. Table (3) shows that factor I account for 42.15% of variance in water quality and quantity. pH, Hard, Ca, DO and PO_4 positively loaded on it, while NO_3 and Q negatively loaded. For factor II, which accounts for 26.1% of the variance, EC, BOD and Na are positively and K negatively loaded on it. The third factor accounts for 20.62% of the variation and labeled with TS and SO_4 positively and Cl negatively. These results indicate higher variation of water quantity in Dwezat site than Qaber Al-Abid in this flood season. In addition, a negative association between SO_4 and Q is noticed in Qaber Al-Abid site due to the sulphuric springs.

In summer, at Qaber Al-Abid site, two factors were extracted (Table 4). Factor I accounts for 65.5% of the variance in water quality and quantity. pH, Alk, Na, K, PO_4, DO, TS, TDS and Discharge are positively loaded on this factor, while Hard, Ca, Mg, SO_4 and NO_3 are negatively loaded. Factor II accounts for 34.5% of the variance, which is designated by SS, BOD, EC and Cl.

In Dwezat village at the same season, two factors were also extracted. Factor I accounts for 68% of the variance. Eight parameters are positively loaded on this factor: pH, Na, K, PO_4, DO, TS, TDS, and Q, while Alk, Hard, Ca, Mg and BOD are negatively loaded on it. Factor II account for 32.0% of the variance in water quality and quantity, four parameters are loaded on this factor: EC, NO_3 positively and Cl and SO_4 negatively. The results indicate more variation in suspended solids in Dwezat village site, which is associated with Q. Electrical conductivity is associated with chloride in Qaber Al-Abid. An opposing relationship was found between sulphate and discharge in Qaber Al-Abid site due to the existence of sulphric springs along the river in this area.

In autumn at Qaber Al-Abid site, two factors were extracted (Table 5). Factor I accounts for 60.4% of the variance in water quality and quantity. pH, Na, Cl, BOD and Q are positively loaded on this factor, while EC, Hard, K, SO_4, TS and TDS are negatively loaded. Factor II accounts for 39.6% of the variance, Alk, Ca, DO and Q are positively loaded on this factor, while Mg, NO_3 and PO_4 are negatively loaded on this factor.

In Dwezat site, two factors were also extracted by the analysis. Factor I accounts for 54.7% of the variance in water quality and quantity. Conductivity, Alk, K, SO_4, TS and TDS are positively loaded on this factor, while pH, Cl, NO_3, PO_4 and Q are negatively loaded on it. Factor II

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:counts for 45.3% of the variance, Ca, Na, DO, BOD and SS are positively loaded on this factor, while Hard and Mg are negatively loaded on it. It is obvious from these results that hardness is associated with sulphate in Qaber Al-Abid site, while it is associated with magnesium in Dwezat site. In addition, more variation is observed in dissolved oxygen in Qaber Al-Abid than Dwezat sites, since the first site is a downstream of Mosul city, in which the river got a high load of domestic and industrial wastes.

After the research gave the pictures of water quality within seasons, it is also interested to see the picture between seasons.

In Qaber Al-Abid site, six factors were extracted from water quality and quantity data along the year, which represent 90.69% of the variance. Factor I accounts for 20.59% of the variance. Electrical conductivity, pH and PO_4 are positively loaded on it. Factor II accounts for 18.84% of the variance, three parameters were loaded on this factor, DO and Alk positively and Cl negatively. Factor III accounts for 16.79% of the variance and is designated by SS, TS and TDS. Factor IV accounts for 13.37% of the variance and designated by Hard and Mg. Factor V is designated by Na and K and contributed by 12.6% in variance of water quality. The last factor VI is specified with water quantity and accounts for 8.49% of the variance.

These results indicate that water quantity was the lowest contributor to the variation at this site, since Mosul dam regulates the river flow. Additionally, flow variation has no effect on water quality, as it constitutes a single factor in the analysis.

In Dwezat site, five factors were extracted which represent 89.1% of the variance. Factor I accounts for 23.55% of the variance. Conductivity, pH and PO_4 are positively loaded on this factor. Factor II accounts for (42-53) 20.23% of the variance. Discharge, SS, TS and TDS are positively loaded on it. Factor III accounts for 19.98% of the variance. BOD and Ca are positively loaded on it, while Na and K are negatively loaded. Factor IV account for 14.03% of the variance. Hardness and Mg are positively loaded on it, while DO is negatively loaded. Factor V accounts only for 11.31% of the variance. Sulphate is the single parameter, which is positively loaded on it.

It is obvious that pH, conductivity and PO_4^{-3} is the highest contributor to the variation in water quality at the two sites. Organic pollution represented by DO comes in the second order in Qaber Al-Abid since it is the downstream of Mosul city, while the effect of Upper Zab made the sediment load and discharge (SS, TS and TDS) in the second order for the variation in Dwezat site.

CONCLUSIONS

1. In winter, most of the measured parameters contributed to water quality and quantity variation including discharge, conductivity, sediment load, organic load, cations and anions at the two sites.
2. In spring, pH is the largest contributor to water quality at Qaber Al-Abid site, it is highly associated with EC, Hardness, $SO_4^{=}$ and PO_4^{-3}. In Dwezat site, dissolved oxygen is the largest contributor to water quality, it is highly associated with pH, hardness, Ca and PO_4^{-3}.
3. In summer, the variation in water quality which include alkalinity parameters, dissolved oxygen, some anions and cations is associated with discharge at Qaber Al-Abid site. At Dwezat site, discharge is associated with sediment load, pH, DO, some anions and cations.

4. In autumn, conductivity is the largest contributor to water quality. It is associated with TS, TDS, hardness, $SO_4^{=}$ and K at associated Qaber Al-Abid site. In addition, pH, BOD and Na were associated with discharge. At Dwezat site, discharge is the largest contributor to the variation, it is associated with pH, Cl, $NO_3^{\square}$ and $PO_4^{\square\square}$. Conductivity also contribute to water quality variation and associated with TS, TDS, alkalinity, $SO_4^{=}$ and K.
5. The yearly analysis shows that pH, PO_4^{-3} and conductivity is the largest contributors to water quality variations at Qaber Al-Abid and Dwezat sites. Discharge and sediment load came in the second order for the variation at Dwezat site, while discharge was the last contributor at Qaber Al-Abid site and the organic load represented by dissolved oxygen came in the second order.

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Table 1. Descriptive statistics for measured water quality parameters and discharge of Tigris river at Qaber Al-Abid and Dwezat sites.

Site	Symbol	Parameters	Mean	SD	Min.	Max.
Qaber Al-Abid	pH	pH	8.12	0.44	7.53	8.97
	EC	Electrical conductivity (μmos/cm)	257.14	72.36	134.1	357
	Alk	Total Alkalinity (mg/dl)	162.74	19.91	142	218
	Hard	Total Hardness (mg/l)	241.25	44.85	160	360
	Ca	Calcium (mg/l)	61.91	9.85	48.85	80.35
	Mg	Magnesium (mg/l)	20.78	10.7	8.75	49.8
	Na	Sodium (mg/l)	10.52	4.54	4.1	21.04
	K	Potassium (mg/l)	4.15	3.82	2	16.57
	Cl	Chloride (mg/l)	41.59	3.55	34	49
	SO_4	Sulphate (mg/l)	54.05	14.1	22.5	77
	NO_3	Nitrate (mg/l)	1.81	0.91	0.2	4.72
	PO_4	Phosphate (mg/l)	0.2	0.19	0	0.59
	DO	Dissolved Oxygen (mg/l)	6.4	0.77	5.2	7.64
	BOD	Biochemical Oxygen Demand (mg/l)	2.02	0.80	0.59	3.56
	SS	Suspended solids (mg/l)	35.61	56.32	6	276
	TS	Total Solids (mg/l)	348.77	155.96	180	865
	TDS	Total Dissolved Solids (mg/l)	279.7	138.11	155	840
	Q	Discharge (m^3/sec)	1473.26	912.28	517.88	4824.27
	pH	pH	8.22	0.41	7.53	8.85
	EC	Electrical conductivity (□mos/cm)	248.21	59.48	157.7	340
	Alk	Total Alkalinity (mg/dl)	173.13	18.41	150	216
	Hard	Total Hardness (mg/l)	224.44	46.05	160	352
	Ca	Calcium (mg/l)	58.39	9.85	42	80
	Mg	Magnesium (mg/l)	18.59	10.48	8	46.7

Na	Sodium (mg/l)	11.47	16.47	3	65

Table 1. Continued

Site	Symbol	Parameters	Mean	SD	Min.	Max.
Dwezat	K	Potassium (mg/l)	4.22	4.83	1.9	20
	Cl	Chloride (mg/l)	35.83	6.51	20	41
	SO_4	Sulphate (mg/l)	47.42	24.41	15.5	131
	NO_3	Nitrate (mg/l)	2.27	0.70	0.75	3.52
	PO_4	Phosphate (mg/l)	0.26	0.18	0	0.53
	DO	Dissolved Oxygen (mg/l)	5.72	0.96	4.2	7.2
	BOD	Biochemical Oxygen Demand (mg/l)	1.84	0.65	0.81	3.18
	SS	Suspended solids (mg/l)	140.35	202.94	12	688
	TS	Total Solids (mg/l)	448.23	370.1	194	1587
	TDS	Total Dissolved Solids (mg/l)	270.68	98.13	155	537.5
	Q	Discharge (m^3/sec)	1665.80	864.53	853.59	5224.73

Table 2. Rotated factor loading, eigenvalues and percentage of variance for Tigris river water quality parameters and discharge for Qaber Al-Abid and Dwezat sites at winter season (Loaded parameters are bolded).

Sites / Parameters	Qaber Al-Abid		Dwezat	
	Factor I	**Factor II**	**Factor I**	**Factor II**
pH	**0.99**	0.03	**0.99**	0.12
EC	**0.99**	0.03	**0.99**	0.12
Alk	**0.76**	0.65	0.70	**0.72**
Hard	0.16	**0.99**	0.07	**0.99**
Ca	0.55	**0.84**	0.47	**0.88**
Mg	**-0.89**	-0.45	**-0.85**	-0.53
Na	**-0.93**	-0.36	**-0.90**	-0.44
K	**-0.94**	-0.35	**-0.90**	-0.43
Cl	0.23	**-0.97**	0.31	**-0.95**
SO_4	0.62	**-0.79**	0.68	**-0.73**
NO_3	**0.99**	0.01	**0.99**	0.10
PO_4	**0.99**	0.03	**0.99**	0.12
DO	0.55	**0.84**	0.47	**0.88**
BOD	0.55	**0.84**	0.47	**0.88**
SS	0.06	**0.99**	**-0.99**	-0.03

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TS	**0.99**	0.03	**0.99**	0.12
TDS	**0.99**	0.01	**0.99**	0.10
Q	**-0.93**	-0.36	**-0.98**	-0.18
Eigenvalue	11.329	6.671	11.946	6.054
% Variance	62.938	37.062	66.365	33.635
% Cumulative	62.938	100.0	66.365	100.0

Table 3. Rotated factor loading, eigenvalues and percentage of variance for Tigris river water quality parameters and discharge for Qaber Al-Abid and Dwezat sites at spring season (Loaded parameters are bolded).

Sites / Parameters	Qaber Al-Abid				Dwezat		
	I	II	III	IV	I	II	III
pH	**0.99**	-0.02	-0.10	-0.02	**0.86**	0.1	0.49
EC	**0.78**	0.60	0.12	0.10	0.64	**0.71**	0.19
Alk	0.39	**0.79**	0.04	0.30	0.62	0.41	0.64
Hard	**0.80**	0.39	0.45	0.11	**0.80**	0.58	-0.09
Ca	0.56	**0.78**	-0.10	0.04	**0.73**	0.59	0.01
Mg	0.44	-0.18	**0.84**	0.15	0.61	0.38	-0.26
Na	0.04	-0.69	0.54	0.13	0.17	**0.89**	-0.07
K	0.05	-0.08	**0.99**	0.06	-0.06	**-0.85**	0.51
Cl	-0.39	-0.69	0.44	-0.28	-0.54	-0.01	**-0.79**
SO_4	**0.88**	0.34	0.27	0.09	0.15	0.03	**0.96**
NO_3	**-0.81**	-0.49	-0.22	-0.01	**-0.89**	-0.4	-0.07
PO_4	**0.99**	-0.04	-0.13	-0.02	**0.92**	0.08	0.37
DO	-0.09	**0.93**	-0.27	0.21	**0.99**	-0.12	0.01
BOD	0.65	0.38	-0.53	0.20	0.08	**0.99**	0.04
SS	-0.13	0.30	0.21	**0.90**	-0.59	-0.41	0.67
TS	0.08	**0.82**	0.10	0.49	-0.34	-0.57	**0.72**
TDS	0.06	0.15	-0.03	**0.94**	-0.45	-0.52	-0.15
Q	**-0.95**	0.04	-0.25	0.17	**-0.94**	-0.33	-0.001
Eigenvalue	6.84	4.91	3.02	2.28	7.59	5.05	3.71
% Variance	37.97	27.28	16.78	12.68	42.15	28.07	20.62
% Cumulative	37.97	65.25	82.03	94.71	42.15	70.22	90.84

Table 4. Factor loading, eigenvalues and percentage of variance for Tigris river water quality parameters and discharge for Qaber Al-Abid and Dwezat sites at summer season (Loaded parameters are bolded).

Sites / Parameters	Qaber Al-Abid		Dwezat	
	Factor I	Factor II	Factor I	Factor II
pH	**0.84**	0.54	**0.78**	0.63
EC	0.56	**0.83**	0.29	**0.96**
Alk	**0.97**	0.23	**-0.90**	0.43
Hard	**-0.74**	0.67	**-0.91**	0.41
Ca	**-0.78**	0.62	**-0.99**	-0.12
Mg	**-0.76**	0.65	**-0.89**	0.45
Na	**0.99**	0.16	**0.97**	-0.25
K	**0.96**	-0.28	**0.99**	0.03
Cl	-0.57	**0.82**	0.66	**-0.75**
SO_4	**-0.90**	-0.44	0.08	**-0.99**
NO_3	**-0.71**	-0.70	0.23	**0.97**
PO_4	**0.91**	0.41	**0.85**	0.52
DO	**0.91**	0.42	**0.97**	-0.26
BOD	-0.13	**0.99**	**-0.86**	-0.52
SS	0.43	**0.91**	**0.93**	0.37
TS	**0.93**	-0.37	**0.99**	-0.09
TDS	**0.98**	-0.21	**0.81**	-0.59
Q	**0.93**	0.37	**0.88**	0.48
Eigenvalue	11.787	6.213	12.232	5.768
% Variance	65.48	34.52	67.95	32.05
% Cumulative	65.48	100.0	67.95	100.0

Table 5. Rotated factor loading, eigenvalues and percentage of variance for Tigris river water quality parameters and discharge for Qaber Al-Abid and Dwezat sites at autumn season (Loaded parameters are bolded).

Sites / Parameters	Qaber Al-Abid		Dwezat	
	Factor I	**Factor II**	**Factor I**	**Factor II**
pH	**0.97**	-0.23	**-0.94**	0.35
EC	**-0.99**	-0.14	**0.75**	-0.67
Alk	-0.27	**0.96**	**0.76**	0.65
Hard	**-0.80**	-0.61	0.33	**-0.95**
Ca	0.50	**0.86**	0.06	**0.99**
Mg	-0.68	**-0.73**	0.16	**-0.99**
Na	**0.84**	0.54	-0.4	**0.92**
K	**-0.94**	0.36	**0.98**	-0.22
Cl	**0.98**	-0.20	**-0.92**	0.38
SO_4	**-0.85**	0.53	**0.99**	-0.03
NO_3	0.62	**-0.78**	**-0.95**	-0.31
PO_4	0.67	**-0.74**	**-0.97**	-0.24
DO	0.06	**0.99**	0.51	**0.86**
BOD	**0.71**	0.70	-0.2	**0.98**
SS	0.67	**0.74**	-0.14	**0.99**
TS	**-0.96**	0.28	**0.96**	-0.3
TDS	**-0.99**	0.02	**0.84**	-0.54
Q	**0.94**	-0.35	**-0.97**	0.23
Eigenvalue	10.864	7.136	9.847	8.153
% Variance	60.36	39.64	54.70	45.30
% Cumulative	60.36	100	54.70	10.0

Table 6. Rotated factor loading, eigenvalues and percentage of variance for Tigris river water quality parameters and discharge for data collected along a year (Loaded parameters are bolded).

a. For Qaber Al-Abid site.

Parameters	**Factors**					
	I	**II**	**III**	**IV**	**V**	**VI**
pH	**0.97**	0.12	0.15	-0.04	0.1	0.01
EC	**0.78**	0.46	0.12	0.11	0.21	0.11
Alk	0.38	**0.77**	0.38	-0.03	-0.2	-0.09
Hard	0.09	0.02	0.02	**0.96**	-0.14	-0.14
Ca	0.47	**0.54**	0.15	0.22	-0.48	-0.23
Mg	-0.25	-0.24	-0.06	**0.90**	0.14	0.02
Na	0.58	0.06	0.1	-0.22	**0.74**	0.15
K	0.12	-0.06	-0.09	0.00	**0.96**	0.00
Cl	-0.07	**-0.89**	-0.13	0.07	0.01	0.07
SO_4	0.39	0.23	0.48	-0.2	0.12	-0.63
NO_3	-0.16	-0.49	0.31	-0.27	-0.5	0.45
PO_4	**0.96**	0.10	0.19	-0.05	0.08	-0.02
DO	0.11	**0.80**	0.3	-0.18	0.17	0.11
BOD	0.27	0.57	-0.14	0.58	-0.31	0.11
SS	0.19	0.19	**0.84**	0.15	0.01	0.23
TS	0.27	0.35	**0.80**	-0.09	-0.02	0.03
TDS	0.03	0.05	**0.92**	-0.1	-0.11	-0.02
Q	0.24	0.09	0.33	-0.17	0.16	**0.86**
Eigenvalue	3.706	3.392	3.022	2.407	2.268	1.529
% Variance	20.59	18.84	16.79	13.37	12.60	8.49
% Cumulative	20.59	39.43	56.22	69.59	82.19	90.69

b. For Dwezat site.

Parameters	Factors				
	I	II	III	IV	V
pH	**0.95**	0.11	0.02	-0.16	0.10
EC	**0.93**	0.01	0.03	0.12	-0.08
Alk	0.63	0.01	0.62	-0.02	0.46
Hard	-0.03	-0.27	0.29	**0.89**	0.02
Ca	0.32	-0.26	**0.85**	-0.09	0.17
Mg	-0.21	-0.13	-0.15	**0.94**	-0.04
Na	0.25	-0.43	**-0.83**	-0.01	0.06
K	0.23	-0.32	**-0.88**	0.01	0.08
Cl	-0.69	-0.06	-0.18	-0.04	-0.62
SO_4	0.03	0.13	0.01	-0.14	**0.89**
NO_3	-0.43	0.69	0.32	0.17	-0.29
PO_4	**0.90**	0.01	0.02	-0.18	0.11
DO	-0.04	-0.3	0.32	**-0.76**	0.25
BOD	0.27	-0.18	**0.83**	-0.07	0.02
SS	0.41	**0.78**	-0.11	-0.07	0.37
TS	0.30	**0.78**	-0.06	-0.11	0.52
TDS	-0.17	**0.71**	0.01	-0.33	0.17
Q	0.09	**0.93**	0.07	0.05	-0.10
Eigenvalue	4.239	3.642	3.596	2.526	2.035
% Variance	23.55	20.23	19.98	14.03	11.31
% Cumulative	23.55	43.79	63.76	77.79	89.10

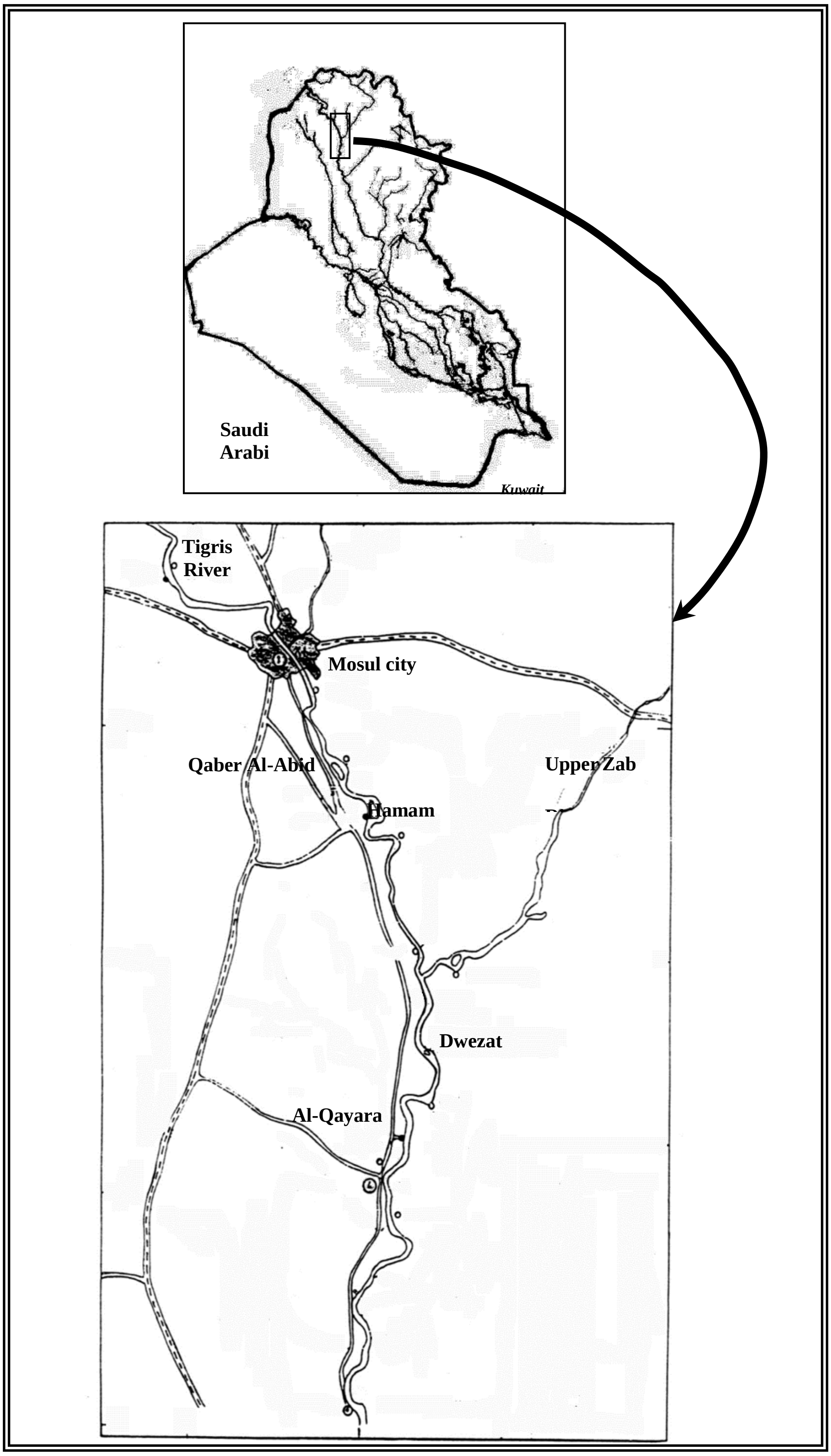

Fig. 1. Location map and sampling sits

التحليل العاملي لنوعية مياه نهر دجلة في موقعين مختارين جنوب مدينة الموصل

عبد المحسن سعد الله شهاب

أستاذ مساعد

مركز بحوث البيئة والسيطرة على التلوث- جامعة الموصل

الخلاصة

يهدف البحث إلى دراسة تغاير نوعية وكمية مياه نهر دجلة في موقعي قرية قبر العبد جنوب مدينة الموصل وقرية دويزات بعد التقائه بنهر الزاب الكبير باستخدام التحليل العاملي . تم جمع نماذج مياه من الموقعين كل اسبوع ولمدة سنة كاملة وفحصت النماذج للعوامل: الدالة الحامضية ، التوصيلية الكهربائية ، القاعدية الكلية ، العسرة الكلية ، الكالسيوم ، المغنيسيوم ، الصوديوم ، البوتاسيوم ، الكلورايد، الكبريتات ، النترات ، الفوسفات ، الاوكسجين المذاب ، المتطلب الحيوي للاوكسجين ، المواد العالقة ، المواد الصلبة الكلية ، المواد المذابة الكلية ، مع التصريف . تم اجراء التحليل العاملي على نتائج الفحوصات لكل فصل من السنة وللسنة جميعها في كل موقع . قام التحليل العاملي بتركيز خصائص نوعية المياه والتصريف إلى 2-4 عوامل بالنسبة لكل فصل التي مثلت 90.69-100% من التغاير في كمية المياه ونوعيتها في الموقعين. في حين ركزت الخصائص في 5 عوامل في موقع قبر العبد و6 عوامل في موقع دويزات . أظهرت نتائج التحليل العاملي ان الدالة الحامضية والتوصيلية الكهربائية والفوسفات هي اكثر الخصائص المساهمة في تغاير نوعية المياه في الموقعين ، ويأتي التلوث العضوي في المرتبة الثانية في موقع قبر العبد لكونه يقع أسفل مدينة الموصل ويتأثر بالمطروحات المدنية والصناعية ، بينما أدى تأثير التقاء نهر دجلة مع الزاب الكبير قبل موقع دويزات إلى جعل التصريف والحمل الرسوبي (المواد العالقة ، المواد الصلبة الكلية، المواد الذائبة الكلية) في المرتبة الثانية في المساهمة في تغير نوعية وكمية المياه.

الكلمات الدالة

التحليل العاملي ، نوعية المياه ، نهر دجلة