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RESEARCH ARTICLE

ASSESSMENT OF WATER QUALITY IN KHREISAN RIVER FROM BAQUBA CITY, DIYALA (IRAQ) BY USING ALGAE AS A BIOINDICATOR

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ABSTRACT

The current study conducted at nine sampling stations across the section of Khreisan River passing through Baquba city which is located in Iraq-Diyala in order to assessment the quality of water at this section of river by using of the most pollution tolerant genera and species for four groups of algae and employing of Palmer's and Nygaard's biotic indices as well as analytical of water samples for Dissolved Solids, Suspended Solids and Volatile Solids. The water samples were collected monthly from selected sampling stations for a period of 6 months starting from November 2014 to April 2015. According to Palmer's biotic indices, Dominance of *Chlorella*, *Scenedesmus*, *Oscillatoria*, *Navicula*, *Nitzschia* and *Euglena* particularly with a total score greater than 20 for algal species Pollution Index at sampling stations (S3 and S1) which are located in Old Baquba's region and sampling station (S7) which is located in Buhriz's region considered to be indicate a confirmed high organic pollution. A probable high organic pollution induced in both of sampling stations (S8, S5 and S6) which are located in Buhriz's region due to frequently of *Nitzschiapalea* and *Oscillatorialimosa* and the dominance of *Chlamydomonas spp.*, *Navicula spp.*, which were caused a relatively high total score less than 20 for algal genera Pollution Index. According to Nygaard's biotic indices, Eutrophic nature indicated from water sampling stations (S3 and S7) which are represented respectively (before river entry in popular Baquba's market and at beginning river entry in popular Buhriz's market), Meso-eutrophic nature indicated from water sampling stations (S1,S4 and S5), while the remaining sampling stations indicated Mesotrophic nature. Meso-eutrophic nature was obtained only by Chlorophycean at water sampling station (S3) and it wasn't recorded by the remaining groups of algae In the current study. Bacillariophycean wasn't recorded Olig-mesotrophic or Ultra-oligotrophic nature at any sampling stations. Chlorophycean wasn't recorded Oligotrophic and Ultra-oligotrophic nature at any sampling stations. Old Baquba's region recorded increase values of Total Volatile Solids (T.V.S.) in water sampling stations (S3) approximately (1.8)% followed by (S1) about (1.7)%, This was associated with decreased values of Total Dissolved Solids (T.D.S.) about (528 and 652) ppm and Total Suspended Solids (T.S.S.) about (114 and 163) ppm at sampling stations respectively (S3 and S1). Buhriz's region recorded increase value of (T.V.S.) in water sampling station (S7) approximately (1.7)% and this was associated with decreased value of (T.D.S.) about (572)ppm and (T.S.S.) about (130) ppm at the same sampling station. Uncoated by concrete and the zigzag path may effect on the flow rate of Khreisan River as well as high population density in some regions which is reflect directly on pollution levels due to decrease of dissolved oxygen and increased sedimentation rates as well as low solubility of pollutants, Perhaps this explains the high levels of organic pollution in those sampling stations across that section of river.

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INTRODUCTION

Bioindicator are taxa or groups of organisms that show signs that they are affected with environmental pressure because of human activities or the destruction of biotic system (Mc Geoch, 1998). The value of algae as bio-monitors for fresh waters has already recognized in the mid-19th century (Cohn,1853).The first attempt to classify aquatic organisms as indicators of water quality was made by Cohn (1870), later modified by Mez (1898).The relation of organisms to the quality of water was more clearly defined by Kolkutiz and Marsson (1902 and 1908) who also created the name "saprobicorganisms". The potential for freshwater organisms to reflect changes in environmental conditions was first noted by Cohn (1853), who observed that biota in polluted waters were different from those in non-polluted situations (quoted in Liebmann, 1962).The presence or absence of the indicator organisms reflects aquatic environmental conditions. Therefore to conserve valuable resources from further deterioration there is a need for regular monitoring of the river (Kshirsagar *et al*., 2012). Algae are one of the most rapid bio indicator of water quality changes due to their short life spans, quick response to pollutants and easy to determine their numbers (Sonneman *et al.,* 2001; Plafkin *et al.,* 1989). Phytoplankton encountered in the water body reflects the average ecological condition and therefore, they may be used as indicator of water quality (Bhatt *et al*.,1999; Saha *et al*., 2000). Algae are frequently found in polluted and unpolluted water and due to this behavior they are generally considered useful to determine the quality of water. These are very suitable organisms for the determination of the impact of toxic substances on the aquatic environment because any effect on the lower level of the food chain will also have consequence on the higher level (Joubert, 1980). Algae are used for assessing the degree of pollution or as indicator of water pollution of different water bodies (Trivedy, 1986; Sudhaker *et al.*, 1994; Dwivedi and Pandey, 2002). According to Palmer (1969), organic pollution tends to influence the algal flora more than many other factors in the aquatic hardness, trophic status, light intensity, pH, DO (dissolved oxygen), environment such as water rate of flow, size of water body and other types trophic status in relating to nutrient of pollutants. Organic pollution resembles availability, but differs in being than inorganic nutrients. Palmer carried out an extensive literature survey to assess the tolerance of algal species to organic pollution, and to incorporate the data into an organic pollution index for rating water quality. Alga genera and species were listed separately in ordered their pollution tolerance, and included a wide range of taxa (euglenoids, blue-greens, green algae and diatoms) as well as planktonic and benthic forms. The assessment of genera was determined as the average of all recorded species within the genus, and is perhaps less useful than the species rating –where single, readily identifiable tax a can be directly related to pollution level. Palmer's index was used by Rai *et al.* (2008) in their studies on a fluvial lake of the St. Laurence River system (Canada), with values from 15–24 at different sampling sites indicating moderate to high levels of organic pollution. As a general rule, large quantities of organic solids will create more pollution problems than will the same quantity of inorganic solids. Therefore, not only is it important to know how much solids are present in the waste, but also the type of solids that are present. The amount of solids in wastewater is frequently used to describe the strength of the waste. The more solids present in a particular wastewater, the stronger that wastewater will be. If the solids in wastewater are mostly organic, the impact on a treatment plant is greater than if the solids are mostly inorganic (Olsson *et al.,* 2013).

Khreisan River is the main reason for the emergence of human settlements that lived on its banks. It's the only water source to feed the city of Baquba drinking water, especially after the rise in pollution rates in the Diyala River and considered as non-drinkable, In addition of that Khreisan River rules as the main water source for the province after the Diyala River for being irrigation agricultural tracts and orchards located on the left bank of the Diyala River. In present study Palmer, (1969) Algal Genus Pollution Index and Algal Species Pollution Index were employed to study the water quality of Khreisan River passing through the section of the city of Baquba, in Diyala province northeast of Baghdad. A list of most pollution tolerant genera and species according to Palmers index were calculated for all sampling stations. The aim of this study is to investigation about the quality of water in the section of Khreisan River passing in Baquba city by using algae as bioindicator to determine the organic pollution, and try to explain that with the relation to the assessment of solids which were present in water samples**.**

MATERIALS AND METHODS

Studied Area

Baquba is Iraqi city located in north-eastern of Baghdad, within the district of Baquba, which is the center of Diyala province, going through the Diyala River and divides it into two parts, east and west. Khreisan River passes in the eastern part which is one of the branches of the Diyala River. Baquba is located in the south-western part of the province of Diyala between latitudes 25-33 ˚ and 54-33 ˚ north and longitudes 24-44 ˚ and 58-44 ˚ east (Yacoubi, 2000).

Sampling Stations

For present study, Khreisan River water were collected from nine sampling stations, Which have been selected within Khreisan River passing through the section of Baquba city (Figure 1).

Sampling stations were encoded as shown below:

S1: before river entry in Baquba.
S2: beginning river entry in Baquba.
S3: before river entry in popular Baquba's market.
S4: beginning river entry in popular Baquba's market.
S5: after river exit from popular Baquba's market.
S6: before river entry in popular Buhriz's market.
S7: beginning river entry in popular Buhriz's market.
S8: after river exit from popular Buhriz's market.
S9: after river exit from Baquba.

Collection and analysis of Algal samples

The water samples for algal analysis were collected monthly from nine selected sampling stations located in Khreisan River for a period of 6 months starting from November 2014 to April 2015. The sample was preserved according to methods for the examination of water and wastewater (APHA, 2003). The total number of Phytoplankton calculated using the method of precipitation (Furet and Benson-Evans, 1982). Taxonomic units of Algae and Phytoplankton were diagnosed relying on several sources (Hustedt, 1985; Germain, 1981; Prescott, 1973; Patrick and Riemer, 1975). The present investigation of the pollution tolerant genera and species of algal communities were recorded, made the assessment of water quality for nine sampling stations of Khreisan River by using a pollution index which was proposed by Palmer (1969), based on algal genus and species used in the rating water sample for high or low organic pollution as shown in (Table 1. and Table 2). A list of most pollution tolerant genera and species according to

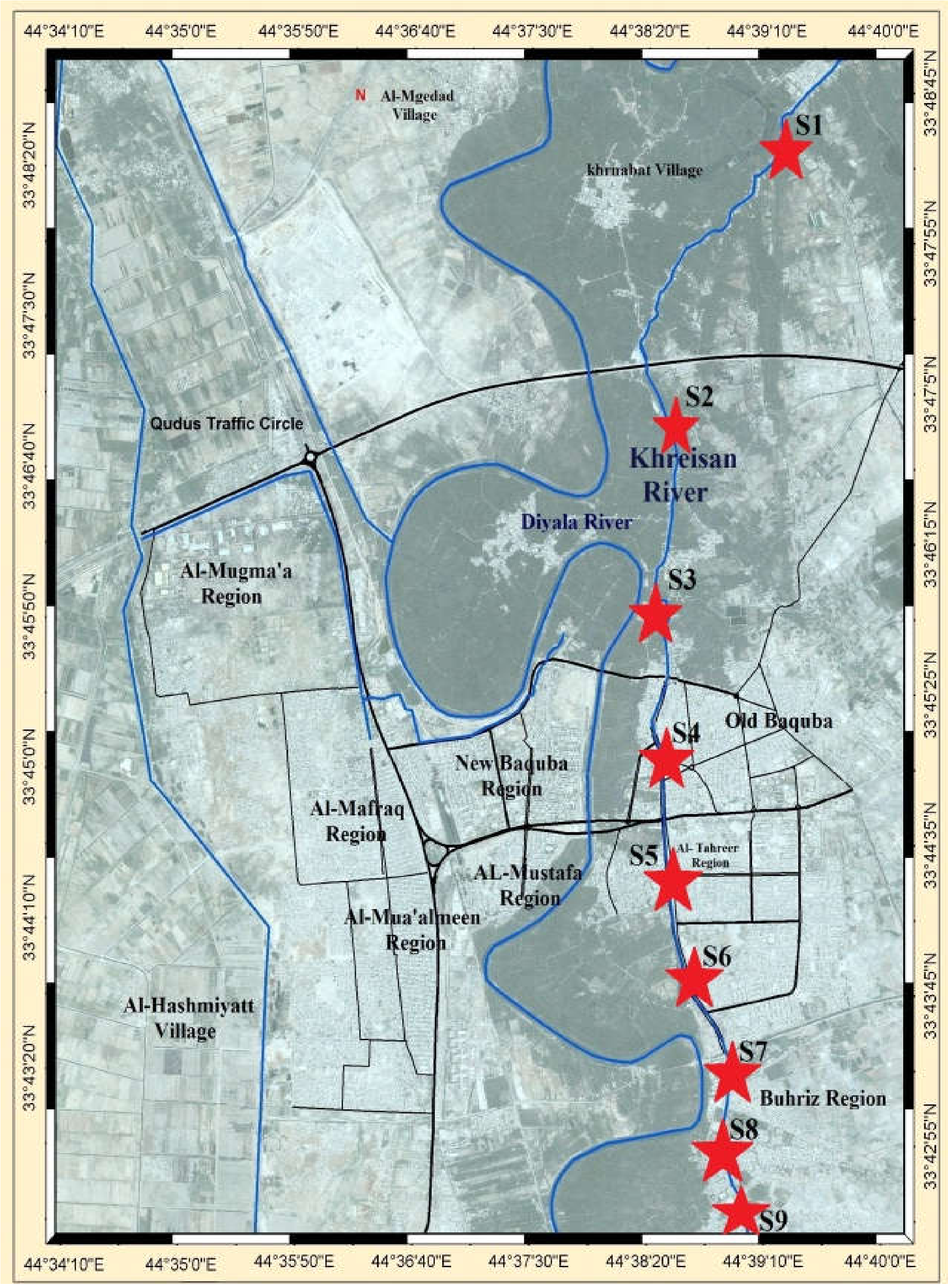

Figure 1. Select sampling stations

Palmers index were calculated for all sampling stations. pollution index factor was assigned to each genus and species by determining the relative number of total points scored by each alga. The organic pollution status of sampling stations of Khreisan River were determined based on their index. While the assessment of their trophic status were determined according to Nygaard's (1949) index which was modified by Felföldy (1987) for trophic state indices. For Total Solids analysis, the water samples were collected in glass bottles at about 10 cm below the surface. All collected water samples were refrigerated at 4 C and analyzed within 24 h.

(APHA, 1998). A well-mixed water samples were drawn through a glass fiber filter with a specific pore size range. The filtered water were evaporated in a weighed dish, then dried to constant weight at 180°C.The increase in weight of the dish and solids compared to the empty dish represents the total dissolved solids (TDS). A well-mixed measured samples were poured into a filtration apparatus and, with the aid of a vacuum pump or aspirator, drawn through a reweighing standard laboratory glass fiber After filtration, the glass fiber filter were dried at 103-105°C, cooled, and reweighing. The increase in weight of the filter and solids compared to the filter alone represents the total suspended solids (TSS). Solids remaining after the analysis for total dissolved solids or total suspended solids were ignited at 550 +/-50°C to a constant weight. The results were called Dissolved Volatile Solids (DVS) and Total Volatile Suspended Solids (TVSS). The weight loss as a result of the ignition represents the volatile portion of the solids. The difference in weight of the ash and support vessel remaining after ignition compared to the empty vessel represents the fixed solids (APHA, 2003; APHA, 1998).

Table 1. Algal Genus Pollution Index (Palmer, 1969)

Genus	Pollution Index
Anacystis	1
Ankistrodesmus	2
Chlamydomonas	4
Chlorella	3
Closterium	1
Cyclotella	1
Euglena	5
Gomphonema	1
Lepocinclis	1
Melosira	1
Micractinium	1
Navicula	3
Nitzschia	3
Oscillatoria	5
Pandorina	1
Phacus	2
Phormidium	1
Scenedesmus	4
Stigeoclonium	2
Synedra	2

Following numerical values for pollution classification of Palmer (1969), 0-10= Lack of organic pollution, 10-15= Moderate pollution, 15-20= Probable high organic pollution, 20 or more = Confirms high organic pollution.

Table 2. Algal Species Pollution Index (Palmer, 1969)

Algal species	Pollution Index
Ankistrodesmusfalcatus	3
Arthrospirajenneri	2
Chlorella vulgaris	2
Cyclotellameneghiniana	2
Euglena gracilis	1
Euglena viridis	6
Gomphonemaparvulum	1
Melosiravarians	2
Naviculacrptocaphala	1
Nitzschiaacicularis	1
Nitzschiapalea	5
Oscillatoria chlorine	2
Oscillatorialimosa	4
Oscillatoriaprinceps	1
Oscillatoria putrid	1
Oscillatoriatenuis	4
Pandorinamorum	3
Scenedesmusquadricauda	4
Stigeocloniumtenue	3
Synedra ulna	3

Following numerical values for pollution classification of Palmer (1969), 0-10 suggests lack of organic pollution, 11-15 indicated moderate pollution, 16-20 indicates probable high organic pollution, 21 or more confirm high organic pollution.

RESULTS AND DISCUSSION

Out of a total (11) genera and (9) species of algae tolerant to organic pollution belonging to four groups of algae were diagnosed from nine stations of water sampling in Khreisan River,(6) genera belonging to Chlorophycean, (3) genera belonging to Bacillariophycean, (1) genera belonging to Euglenophycean and (1) genera belonging to Myxophycean, were recorded in Table 3. Palmer's (1969) has shown that the genera like *Oscillatoria, Euglena, Scenedesmus, Chlamydomonas, Navicula, Nitzschia, Stigeoclonium, and Ankistrodesmus* are found in organically polluted waters supported by Gunale and (Ramakrishnan, 2003; Jafari and Gunale, 2006). Similar genera were recorded in the present investigation, like the dominance of *Chlorella*, *Scenedesmus*, *Oscillatoria*, *Navicula*, *Nitzschia* and *Euglena* particularly with a total score greater than 20 for algal genera Pollution Index, As shown in (Table 3) and (Figure 2) total score about (31 and 24) at sampling stations (S3 and S1) which are respectively represented (before river entry in popular Baquba's market and before river entry in Baquba city) and both of them located in Old Baquba's region in addition of that total score about (28) at sampling station (S7) which is located in Buhriz's region and represents the beginning of river entry in popular Buhriz's market), considered to beindicate a confirmed high organic pollution according to Palmer's biotic indices. As well as, In spite of very rare *Cyclotellamene ghiniana* and *Scenedesmusquadricauda* and rare *Euglena viridis*a probable high organic pollution was induced in both of sampling stations (S8,S5 and S6) which are respectively represented (after river exit from popular Buhriz's market, after river exit from popular Baquba's market and before river exit from popular Buhriz's market) and both of them located in Buhriz's region due to frequently of algal species like *Nitzschiapalea* (Bacillariophycean) and *Oscillatorialimosa* (Myxophycean) and the dominance of *Chlamydomonas spp.*, *Navicula spp.*, which were caused a relatively high total score less than 20 for algal species Pollution Index as shown in (Table 3.) and (Figure 2)

Total score about (19, 18 and 17) at sampling stations respectively (S8, S5 and S6). The clearly correlation between organic pollution and blue-green algae with diatoms was showed firstly by Pearsal1 (1932)supported by (Kshirsagar and Gunale, 2011; Kshirsagar *et al.,* 2012), They showed that the dominance of *Chlorella*, *Scenedesmus*, *Pediastrum*, *Oscillatoria*, *Melosira*, *Navicula*, *Nitzschia*, *Gomphonema*, *Euglena* etc throughout the study, which considered to be indicators of organic pollution. The similar observations were encountered by Hosmani and Bharti, (1980); Trivedy, (1988); More and Nandan, (2000). Very rare of algal species like *Scenedesmusquadricauda*, *Oscillatorialimosa* and *Navicula spp.*, As well as frequent of *Euglena viridis* and rare of *Nitzschiapalea* and *Stigeocloniumtenue* pariculary with a total score less than 16 for algal species Pollution Index particularly, As shown in (Table 3.)total score about (14 and 15) at sampling stations (S2 and S4) which are respectively represented (beginning river entry in Baquba city and beginning river entry in popular Baquba's market) and both of them located in Old Baquba's regionin addition of that total score about (15) at sampling station (S9) which is located in Buhriz's region and represents the river exit from Baquba district, considered to be indicate amoderate organic pollution according to Palmer's biotic indices. Figure 2., showed the comparatively high average of total score of pollution index due to the dominant of Bacillariophyceae like, *Navicula* and *Nitzschia* which were observed at Buhriz's region which

Table 3. Enumeration of selected algal genera and species as a bioindicator in the water of sampling stations across the section of Khreisan River from Baquba city

Algal species	Algal group	Total count Million / liter	Pollution index	Sampling stations								
				S1	S2	S3	S4	S5	S6	S7	S8	S9
Chlamydomonas spp.	Chlorophycean	1.14	4	+	+	+	+	+	+	+	+	+
Euglena viridis	Euglenophycean	0.95	6	+	-	+	+	+	-	+	-	+
Cyclotellameneghiniana	Bacillariophycean	0.17	2	-	+	-	+	-	-	-	-	+
Nitzschiapalea	Bacillariophycean	0.63	5	+	+	+	-	+	+	+	-	-
Ankistrodesmusfalcatus	Chlorophycean	0.41	3	-	+	+	-	-	-	+	+	-
Scenedesmusquadricauda	Chlorophycean	0.27	4	-	-	+	-	-	-	-	-	-
Oscillatorialimosa	Myxophycean	0.52	4	+	-	+	-	-	+	+	+	-
Chlorella vulgaris	Chlorophycean	0.32	2	+	-	+	-	-	-	-	+	+
Stigeocloniumtenue	Chlorophycean	0.21	3	-	-	-	+	-	-	+	+	-
Navicula spp.	Bacillariophycean	0.78	3	+	-	+	-	+	+	+	+	-
Micractiniumpusillum spp.	Chlorophycean	0.04	1	-	-	-	-	-	+	-	-	+
Total score		5.44		24	14	31	15	18	17	28	19	15

Key: + = present - = absent

NOTE: In the below Index of Organic pollution based on the presence of algal species as a bioindicator for organic pollution in fresh water depending on the total pollution index: (Palmer, 1969).

0-10 suggests lack of organic pollution; 11-15 indicated moderate pollution; 16-20 indicates probable high organic pollution; 21 or more confirm high organic pollution.

Table 4. Trophic State Indices (T.S.I.) for algal groups in the water of sampling stations across the section of Khreisan River from Baquba city

Algal group	Total count Million / liter	Sampling stations								
		S1	S2	S3	S4	S5	S6	S7	S8	S9
Myxophycean	0.52	0.06	0	0.26	0	0	0.01	0.17	0.02	**0**
Chlorophycean	2.39	0.27	0.23	0.63	0.35	0.28	0.05	0.38	0.11	0.09
Bacillariophycean	1.58	0.21	0.14	0.51	0.17	0.13	0.04	0.29	0.04	0.05
Euglenophycean	0.95	0.14	0	0.32	0.09	0.11	0	0.26	0	0.03
Total count Million / liter	5.44	0.68	0.37	1.72	0.61	0.52	0.1	1.10	0.17	0.17

NOTE: In the below index for Trophic State Indices (T.S.I.) as correspond with numerical account of algal groups(million/liter).

(Nygaard ,1949; Felföldy,1987).

Ultra-oligotrophic < 0.01; Oligotrophic 0.01-0.05; Olig-mesotrophic 0.05-0.1; Mesotrophic 0.1-0.5; Meso-eutrophic 0.5-1.0; Eutrophic 1-10; Eu-polytrophic 10-100; Polytrophic 100-500; Hypertrophic > 500

Table 5. Values of solids in the water of sampling stations across the section of Khreisan River from Baquba city

Sampling stations	Values of Solids		
	Total Volatile Solid (%)T.V.S.	Total Dissolved Solid ppm (T.D.S.)	Total Suspended Solid ppm (T.S.S.)
S1: before river entry in Baquba	1.7	652	163
S2: beginning entry in Baquba	1.2	790	261
S3: before entry in popular Baquba's market	1.8	528	114
S4:beginning entry in popularBaquba's market	0.8	822	288
S5: after exit from popular Baquba's market	1.0	810	271
S6: before entry in popularBuhriz's market	1.4	714	212
S7: beginning entry in popularBuhriz's market	1.7	572	130
S8: after exit from popularBuhriz's market	1.4	776	218
S9: after exit from Baquba	1.5	681	182
Mean ± SD (Confidence Interval)	(1.4 ± 0.3)	(705 ± 105.7)	(204 ± 62)

includes sampling stations from S5 till S8 along the study section of Khreisan River. Similar observation where tallied by Cholonky (1968), he gave detailed account of dominant species of diatoms being used as indicators of water quality, It was also supported by Verma and Mohanty (1994) and Jafari and Gunale (2006), from the other hand Figure 2., showed the high average of total score of pollution index in Old Baquba's region especially at sampling stations (S3, S7 ,and S1) which were recorded very high grade points, like *Euglena viridis* and *Oscillatorialimosa*. (Patrick, 1965; Sanap, 2007) concluded that *Euglena* and *Oscillatoria*are highly pollution tolerant genera and, therefore, reliable indicators of Eutrophication supported by (Kshirsagar *et al.,* 2012).

Nygaard's (1949) index which was modified by Felföldy (1987) for trophic state indices for water sampling stations across the section of Khreisan River were represented in (Table4.), Nygaard's indices of different groups of algae viz Myxophycean, Chlorophycean, Bacillariophycean and Euglenophycean were used to get a meaningful evaluation of the extent of pollution in the water. According to Nygaard's biotic indices, Eutrophic nature has indicated from water sampling stations (S3 and S7) which are represented respectively (before river entry in popular Baquba's market and at beginning river entry in popular Buhriz's market), Meso-eutrophic nature has indicated from water sampling stations (S1,S4 and S5) which are represented respectively (before river entry in Baquba city , beginning river entry in popular Baquba's market and after river exit from popular Baquba's market), While the remaining sampling stations were indicated Mesotrophic nature. Meso-eutrophic nature was obtained only by Chlorophycean at water sampling station (S3) and it wasn't recorded by the remaining groups of algae in the current study.

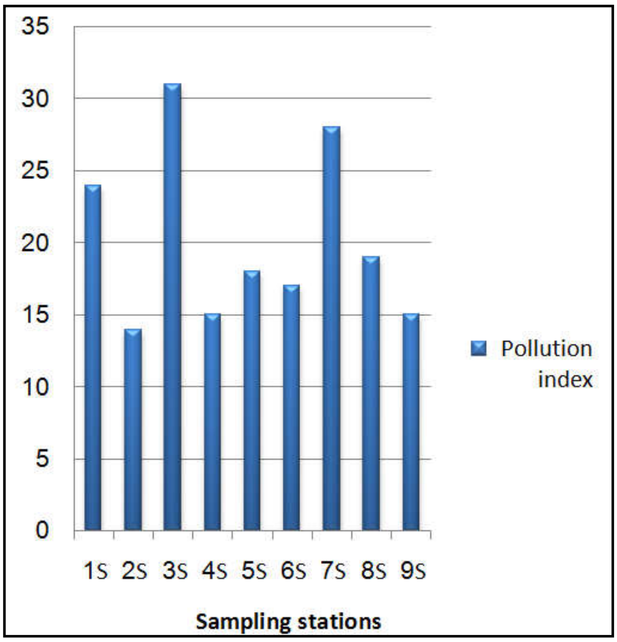

Figure 2. Total score of pollution index for algal tolerant group according (Palmer, 1969) in the water of sampling stations across the section of Khreisan River from Baquba city

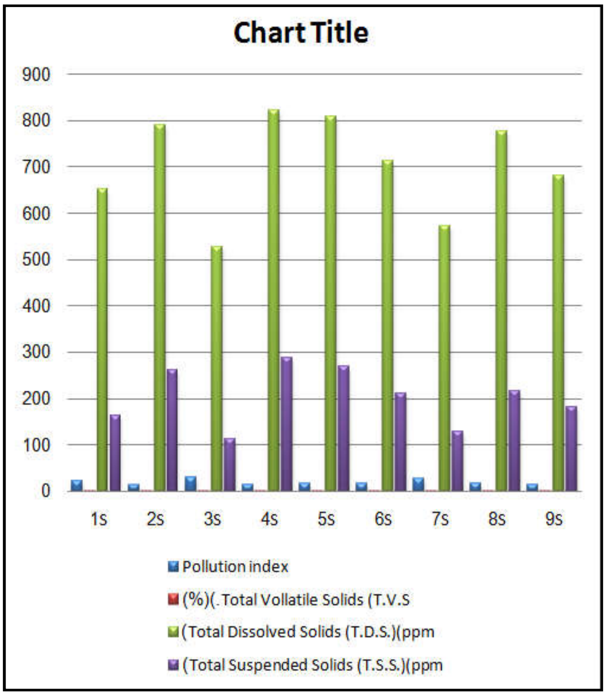

Figure 3. Variation of solids in the water of sampling stations across the section of Khreisan River from Baquba city

Bacillariophycean wasn't recorded Olig-mesotrophic or Ultra-oligotrophic nature at any sampling stations. Chlorophycean wasn't recorded Oligotrophic and Ultra-oligotrophic nature at any sampling stations. Jafari and Gunale (2006) stated that the increasing urbanization and industrialization in this area is posing a very serious threat in that it is creating an ever increasing quantity of effluents of all types being added to river fresh waters which twining to eutrophicated. As showed in (Table 4), Dominance of Chlorophycean at sampling stations (S3 and S7) with respectively numerical account approximately (0.63 and 0.38) million/liter has indicated Eutrophic nature according to Nygaard's biotic indices , Frequent *Scenedesmusquadricauda* has recorded in present investigation at sampling station (S3) this is consistent with Palmer, (1980) who stated the genus *Scenedesmus* which is belong to Chlorophycean indicate eutrophic water**.** Also Frequent *Stigeocloniumtenue* has recorded in present investigation at sampling stations (S4,S7 and S8) this is consistent with (Mclean 1974; Gunale and Balakrishnan, 1981; Dokulil, 2003) have shown that *Stigeocloniumtenue*is an indicator of Meso-eutrophicnature of fresh water.Common of Myxophycean at sampling stations (S3 and S7) with respectively numerical account approximately (0.26 and 0.17) million/liter associated with Common of Euglenophycean at sampling stations (S3 and S7) with respectively numerical account approximately (0.32and 0.26) million/literthis is consistent with Patrick, (1965) who concluded that *Euglena* and *Oscillatoria*are highly pollution tolerant genera and therefore, reliable indicators of Eutrophication, In present investigation common of *Euglena viridis* and *Oscillatorialimosa* were recorded in sampling stations (S3 and S7) which has indicated Eutrophic nature according to Nygaard's biotic indices. Uncoated by concrete and the zigzag path of Khreisan River in some regions especially those are located at sampling stations (S1, S2, S7 and S3) may effect on the flow rate of the river (Yacoubi, 2000).

Steinberg and Hartmann, 1988 stated that reduced flow rates of river enable Cyanobacteria to grow and sometimes produced short- lived blooms because of improved light conditions and less turbulence. As showed in (Table 5), Old Baquba's region recorded increase values of Total Volatile Solids (T.V.S.) in water sampling station (S3) approximately (1.8)% followed by sampling station (S1) about (1.7)% which is located before river entry in Baquba district. This has clearly associated with decreased values of Total Dissolved Solids (T.D.S.) about (528 and 652) ppm and Total Suspended Solids(T.S.S.)about (114 and 163) ppm at sampling stations respectively (S3 and S1),As it showed in (Figure 3). Also it recorded decrease of (T.V.S.) values in waters of Khreisan River at the beginning entry in popular Baquba's market (S4) with approximately (0.8)% followed by sampling station (S5) about (1.0)% which is located after river exit from popular Baquba's market. This was associated with increased values of (T.D.S.) about (822 and 810)ppm and (T.S.S.) about (288 and 271)ppm at sampling stations respectively (S4 and S5). Coated by concrete and the straight path of Khreisan River as well as low population density (Yacoubi, 2000), in nearby regions from sampling stations S2 (beginning entry in Baquba), S4 (beginning entry in popular Baquba's market) and S5 (after exit from Baquba's market) caused increase the flow rate of the river which is reflected directly in reduce of pollution levels due to increase of dissolved oxygen and decreased sedimentation rates as well as high solubility of pollutants, Perhaps this explains the relatively low levels of organic pollution in those sampling stations across that section of Khreisan River (Ribolzi *et al*., 2002). Buhriz's region recorded increase values of (T.V.S.) in waters at the beginning of river entry in popular Buhriz's market (S7) approximately (1.7) % and this was associated with decreased value of (T.D.S.) about (572) ppm and (T.S.S.) about (130) ppm at the same sampling station. Also it recorded decrease values of (T.V.S.) in river waters before entry in popular Buhriz's market and after exit from it at sampling stations respectively (S6 and S8) approximately (1.4)% for both of them followed by sampling station (S9) about (1.5)%. This was associated with increased values of (T.D.S.) about (714, 776 and 681) ppm and (T.S.S.) about (212,281 and 182)ppm at sampling stations respectively (S6, S8 and S9). Uncoated by concrete and the zigzag path may effect on the flow rate of Khreisan River as well as high population density (Yacoubi, 2000) in some regions which is reflect directly on pollution levels due to decrease of dissolved oxygen and increased sedimentation rates as well as low solubility of pollutants, Perhaps this explains the high levels of organic pollution in those sampling stations across that section of river (Ribolzi *et al*., 2002; Jord˜ao *et al.,* 2007).

REFERENCES

APHA – American Public Health Association, 1998. Standard Methods for the Examination of Water and Wastewater. (20th ed.).Washington, DC.

APHA (American public Health Association), 2003. Standard Methods for Examination of Water and Wastewater, 16thed., Washington DC. , USA.

Bhatt, L R., Lacoul, P., Lekhal, H. D. and Jha, P. K. 1999. Physico-chemical Characteristic andPhytoplanktons for Taudha Lake, *Kathmandu. Poll. Res*., 18 (4): 353-358.

Cholonoky, B. J.1968. Die Okologie der Diatomeen in. Binery Ewassera. J. Cramex, Germany: pp.699.

Cohn, F. 1853. Ber Lebende Organismenim Trinkwasser. Z.klein. Medizin, 4:227-239.

Cohn, F. 1870. ÜberDen Brunnenfaden (*Crenothrixpolyspora*) Met Bemerkungen Über die Mikroskopische Analyse des Brunnenwassers. Cohn'sBeiträgezur Biologie de Pflanzen, 3:1-108.

December, Chennai: Department of Geography, University of Madras and Faculty of Environmental Studies, York University: 374 – 385.

Dokulil, M.T. 2003. Algae as Ecological Bio- Indicator. In: Markert, B.A., Breuer, A.M., Zechmeister, H.G. (Eds). Bioidicators and Biomonitors. Elsevier Science Ltd. pp.285-327.

Dwivedi, B. K. and Pandey, G. C. 2002. Physicochemical Factors and Algal Dversity of Two Ponds (GirijaKund and Maqubara Pond), *Faizabad, India. Poll. Res*., 21 (3):361-369.

Felföldy, L.1987. A Biológiai Vízminősítés (Biological Water Quality Evaluation). *Vízügyi Hidrobiológia*, 16. VGI. Budapest.

Furet, J. E. and Benson – Evans, K. 1982.AnEvalution of the Time Required to Obtain Complet Sedimentation of Fixed Algal Particles Prior to Enumeration . *Br. Phycol. J.*, 17: 253 – 258.

Germani, H. 1981. Flora dus Diatom PhyceasScandouce at. SanmatersDumass of Armoricien Codes Contrecs Voisinesd. Europe Occidentals". Paris. Soc. Nour, Ed. Boubee.

Gunale, V. R., and Balakrishnan, M.S. 1981. Biomonitoring of Eutrophication in thePavana, Mula and Mutharivers Flowing Through Poona. *Indian Journal of Environmental Health.,* 23: 316-322.

Hosmani, S. P. and Bharti, S.G. 1980. Algae asIndicators of Organic Pollution. *Phykos*., 19(1):23-26.

Hustedt, F.1985.The pinnate Distoms 2-An English Translation of Husted Dickiselgal Genteilz with Supplement by Jensen IV. Kocwingstein Gylcoeltz, Sci., Books.

Jafari, N .G. andGunale, V. R. 2006. Hydrobiological Study of Algae of an Urban Freshwater River. *J.Appl.Sci.Environ*., 10 (2): 153 – 158.

Jord˜ao, C.P., Ribeiro, P. R. S., Matos, A.T., Bastos R. K. X., Fernandes, R. B. A. and Fontes, R. L.F. 2007. Environmental Assessment of Water-Courses of the Turvo Limpo River Basin at the Minas Gerais State, Brazil. *Environ Monit Assess*., 127:315 –326.

Joubert, G. 1980. A bioassay Application for Quantitative Toxicity Management Using the Green Algae, *Selenastrum Capricornutum. Water Res*., 14:1759-1763

Kolkwitz, R. and Marsson, M. 1902. Grundsätze Für die Biologische Burteilung des Wassers Nach Seiner Floraund Fauna Mitteilungender Prüfungsanstalt Für. Wasserver sorgung und AbWasserreinigung,1:33-72.

Kolkwitz, R. and Marsson, M. 1908. Ökologie der. Pflanzlichen Saprobien. Berichte der Deutschen *Botanischen Gesellschaft*. 26A:505- 519.

Kshirsagar, A.D. and Gunale, V.R. 2011. Pollution Status of River Mula (Pune City) Maharashtra, India. *Journal of Eco-physiolog Occupational Health*.,11: 81-90.

Kshirsagar, A.D., Ahire, M.L. and Gunale, V.R. 2012. Phytoplankton Diversity Related toPollution from Mula River at Pune City. *Terrestrial & Aquatic environmental Toxicology,* 6(2):136-142.

Liebmann, H. 1962. Handbuch der Frischwasser- und Abwassere Biologie. (Handbook of the Biology of Fresh Water and Waste water)., 2ndedn. Verlag R. Oldenbourg, München.

McGeoch, M.A. 1998. The Selection, Testing & application of Terrestrial Insects as Bioindicators. *Biol. Rev.*, 73: 18- 201.

Mclean, R. O. 1974. Tolerance of *Stigeocloniumtenue* Kuetz.to Heavy Metals in SouthWales. *Bri. Phycol*. 9: 91-98.

Mez, C. 1898. MikroskopischeWasseranalyse.Springer Velarge, Berlin.

More, Y. S. and Nandan, S.N. 2000. Hydrobiological study of algae of Panzara Dam (Maharashtra). *Ecology Environmental Conservation.*, 9(3):367-369.

Nygaard, G. 1949. Hydrobiological Studies on Some Danish Ponds and Lakes II. The Quotient Hypothesis and Some New or Little Known Phytoplankton Organisms. Dat. *Kurge. Danske.Vid. Sel. Biol Skr*.,7: 1-293.

Olsson, J.1.,Shabiimam M.A.1.,Nehrenheim E.1.and. Thorin, E1. 2013. Co-Digestion of Cultivated Microalgae and Sewage Sludge From Municipal Waste Water Treatment. *International Conference on Applied Energy,* ICAE, Jul 1-4, Pretoria, South Africa.

Palmer, C.M. 1969. Composite Rating of Algae Tolerating Organic Pollution. *Journal of Phycology*., 5: 78-82.

Palmer, C.M. 1980. Algae & Water Pollution. Castle House Publishers Ltd., England.

Patrick, R,. 1965. Algae as Indicator of Pollution.In Biological Problems in Water Pollution. 3rd Seminar Bot. A. Tuft. Sanitory Eng. CentreCincinati Ohio.: 223-232.

Patrick, R. andRiemer, C. W. 1975. The Diatoms of United states . *Monographs Acad.Nat. Sci. Philadelphia*., Vol. 13: 1 – 213.

Plafkin, J.L.M.T., Barbour, K.D., Porter, S.K., Gross, R.M. and Hughes, 1989. Rapid Assessment Protocols for Use in Streams and Rivers: Benthic Macro Invertebrates & Fish. EPA: Washington, D.C. Rosenberg, D.M., V.H.Resh (eds). 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman &Hall: New York, NY.

Prescott, G. W. 1973. Algae of the Western Great lake Area William , C. , Brow , Co. Publishers , Dubuque , Lowa.

Rai, U.N., Dubey, S., Shukla, O.P.,Dwivedi.S. and Tripathi, R.D. 2008. Screening andIdentification of Early Warning Algal Species for Metal Contamination in .Fresh Water Bodies Polluted From Point andNon-Point Sources. *Environmental Monitoring Assessment*, 144:469-481.

Ramakrishnan, N. 2003. Bio-Monitoring Approaches For Water Quality Assessment In Two Water bodies At Tiruvannamalai, Tamil Nadu India. in Martin J. Bunch, V. Madha Suresh and T. Vasantha Kumaran, eds., *Proceedings of the Third International Conference on Environment and Health, Chennai, India, 15-17*

Ribolzi, O., Valles, V., Gomez, L., and Voltz, M. 2002. Speciation and Origin of Particulate Copper in Runoff Water From a Mediterranean Vineyard Catchment. *Environmental Polluttion*, *117*:261– 271.

Saha, S. B., Bhattacharya, S. B. and Choudhury, A. 2000. Diversity of Phytoplankton of Sewage Pollution Brakish Water Tdal Ecosystems. *Environ. Biol.*, 21 (1): 9-14.

Sanap, R.R. 2007. Hydrobiological Studies of Godavari River up to Nandur-Madhmeshwar Dam, Dist Nashik, Maharashtra. Ph. D. thesis, University of Pune, Pune, India.

Sonneman, J.A., Walsh Breen P.F. and Sharpe, S.K. 2001. Effects of Urbanization on Streams of the Melbourne Region, Victoria, Australia. II. Benthic diatom communities. *Freshwater Biology*, 46(4):553-565.

Steinberg, C. and Hartmann, H. 1988. Planktische blütenbildende Cyanobakterien (Blaualgen) und die Eutrophierung von Seen und Flüssen.Vom wasser.70:1- 10.

Sudhaker, G., Joyothi, B. and Venkateswarlu, V. 1994. Role of Diatom as Indicator of PollutedGradients. *Environ. Moni. and Assessment*., 33:85-99.

Trivedy, R. K.1986. Role of Algae inBiomonitoring of Water Pollution. *Asian Environ*., 8 (3): 31-42.

Trivedy, R.K.1988. Ecology and Pollution of Indian Rivers. Ashish Publishing House, New Delhi.

Verma, J. P. and Mohanty, R. C. 1994. Evaluation of Water Quality on the St. Joseph River (Michigan and Indiana U. S. A.) by 3 methods of Algal Analysis. *Hydrobiolo*., 48:145-173.

Yacoubi, S. Y. 2000. Preparation of Agricultural Land use Maps Using Remote Sensing Techniques for Space Baquba. Master Thesis. College of Education, Ibn- Rushd, Baghdad University.

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