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Use of Phytoplankton Index of Biological Integrity (P-IBI) as a tool to evaluate Tigris RiverHealth

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Abstract

A multimetric Phytoplankton Index of Biological Integrity (P-IBI) was composed to assess the biotic integrity of water of Tigris River seasonally. The IBI was applied throughout Baghdad city on 3 locations in Tigris River during 2010. The P-IBI had 8 metrics: Species Richness Index, Phytoplankton Density and Relative Abundance for Blue Green Algae, Green Algae, Centrales, Pennales, Yellow Green Algae and Pyrrophyte Algae.The P-IBI scores were calculated by comparing it against historical data on phytoplankton assemblage composition. They P-IBI result ranged between good- acceptable, where the values ranged (60.5-63.3) in station 1, (60-75.5) in station 2 and (57.7-70.7) in station 3. The highest value recorded in station 2 through spring, and the lowest value observed in station 3 through summer. The P-IBI is a valuable, easily and complementary tool to assessing river ecosystem health and evaluating restoration efforts, this index appears to be an effective measure of levels of anthropogenic disturbance.

Keywords: P-IBI, Phytoplankton, Integrity, Baghdad, Tigris River.

Introduction

Multi-metric indices are increasingly used to assess the ecological status of rivers as well as resource and ecosystem management because they are often more robust than their component metrics [1], and represent different taxonomic and functional groups within the assemblage, which respond differently to various stressors and can reflect ecological status in a comprehensive manner [2,3]. As a multi-metric approach, index of biotic integrity (IBI) has become the most common

indicator of aquatic conditions in use today. The phytoplankton index of biological integrity (P-IBI) has been proved to be a management tool to assess phytoplankton community status in an ecosystem [1].

According to [4] the suitability of bio-indicators should ideally represent key information about function, composition, and structure of ecosystem.Phytoplankton conceder a good indicators of changes in pollutionover time in water because [1] they respond quickly to changes in pollutant input to any aquatic system especially nutrient, [2] can be sampled extensively in many sites [3] easily measured [4] sensitive to stresses on the system, [6] have a known response to disturbance andchanges over time (7) located in the first step of evolution process (8) have widevariety of species [5, 6].

Index of Biological Integrity (IBI) was designed by [7] and used to measure biological integrity in surface water, using fish assembling asbio-indicator. Karr's IBI index has been relying by manyenvironmental management agencies [8] and beenmodified to employ benthic macroinvertebrates as bio-indicators [9], and also been modified to assessment the ecosystems integrity of estuarine [10], Although IBIs have been applied for many purposes. Such indices are likely suited to evaluate the overall health of any aquatic system. In particular, a P-IBI developed for rivers would be of a magnificent method for testing the results of major management decisions and in annunciation the public of the ecosystem health [11]. In iraq, There are a few application of IBI where alldone on marsh only [12, 13, 14], meanwhile there are no single study are done on rivers, so this study can be considered the first one that carry out the evaluation the ecological state of Tigris river by using of Phytoplankton Index of Biological Integrity and developed of P-IBI metrics score.

Material and Methods

Study sites

Tigris Riveris one of the major rivers in Iraq.It is about 1850 km in length, rising in the Taunus Mountains of Turkey. The river flows for about 400 km through Turkey before entering Iraq. The total length of the Tigris River in Iraq is about 1418 km.River Tigris divided Baghdad City into two substantial areas, but they areconnected by a numeral of bridges which make the flow of watersdisturbed[15]. 3 sites were chosen to conduct this study as it demonstrated in "Fig. 2" with the Coordinates that are taken by Geographical Positioning System (GPS).The three sites cover Baghdad city from north to south, where site 1 near Al-Muthana Bridge in the north, site 2 near al- Sarafia Bridge at the middle, while site 3 at the end of Al-Zafranya district at south.

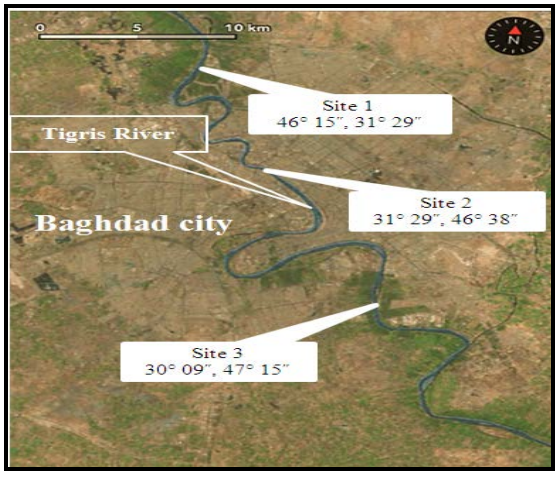

Figure 1: illustrate studied stations on Tigris River in Baghdad city, Iraq (Google earth 2015).

Sampling

Samples were collected from February to December 2010 from three sites in TigrisRiver within Baghdad city. Phytoplankton Samples were collected from subsurface according to method recommended by [16]in order to obtain a correct picture of the quantitative composition of the phytoplankton, then preservedwith Lugol's solution 250ml of water sample containing phytoplankton about five drops of this preservative is quite sufficient. Another subsample was used to identifymotile phytoflagellates).

2.3. Identification and counting of phytoplankton

All Phytoplanktonspecies were identified and counted using a light Microscopeat 400X for non-diatom and 1000X for diatom. Diatoms were identified by making permanent slidesbyacid cleaning. We used the following references for phytoplankton identification [17, 18, 19, 20, 21 , 22, 23, 24, 25, 26]. A direct estimate of phytoplankton cell wasusedto counts total Cell number, the enumeration of phytoplankton is done by various counting chambers, however. The counting cell chamber is filled with the phytoplankton sample and put on the stage of the microscope. After that the counting cell chamber is left for about half hour for sedimentation. The organisms are then counted from one corner of the counting cell to the other. The chamber is moved horizontally along the first row of squares and the organisms in each square are counted. The stage is moved to reach the second row and cell in each square here are counted. (A Few transects canalso be counted in lieu of all the squares, The total cells number is then calculated by multiplying the individuals number that's counted in transects with the ratio of the entire chamber area to the area of the counted transects.Eventually, the total number of phytoplankton presented in a liter of water [27].

Results and Discussion

The total species number of phytoplankton were recorded in this study reach to 223 in all sample, belong to 88 genera. Among them, 143 species from Bacillariophyceae, 46 species were from Chlorophyceae, 24 species from Cyanophyceae, 4 species belong toEuglenophyceaeand 2 species belong toPyrrhophyceae was found, one species from each of Rhodophyceae, Charophyeae, Xanthophyceae and Chrysophyceae.

A protocol for rating the P-IBI numeric scores was developed to assess status of water health [28]. For developing of P-IBI score for Tigris River a historical data are used [29, 30, 31] where the selected metrics analyzed and identified by comparing them with P-IBI score for each selected metric"Tab. 1". Index ratings scale is 3, 5, 10 whereThe P-IBI metrics are scored individually according to how similar they are to values that's found in reference communities; so metric values are scored high if they are very similar to reference communities (10 Good), while low value (3 poor) representing extremely degraded communities, or in the middle if they are not clearly different (5 intermediate). In this study The P-IBI were developed from 8 characteristics metrics: Phytoplankton Density and Relative Abundance (R A) for Blue Green Algae, Green Algae, Central Diatom, Pennales, Yellow Green Algae and Pyrrophyte Algae and Species Richness Index that's calculated according to [32] and the P-IBI ranked scheme were determined according to [33] as showed is"Tab. 2".

Table 1: Scoring criteria of P-IBI

metrics	Scoring		
	3	**5**	**10**
Phytoplankton Density	>2500	700 - 2500	<700
R.A. Blue Green	>4.6 %	1 – 4.6 %	<1 %
R.A. Green	<1 %	3 – 1 %	>3 %
R.A. Centrales	>65 %	40 – 65 %	<40 %
R.A. Pennales	<40 %	70 – 40 %	>70 %
R.A.Yellow Green	<0.5 %	1 – 0.5 %	>1 %
R.A. Pyrrophyte	>1 %	0.5 – 1 %	<0.5 %
Species Richness Index	<3.5	8.5 – 35	>8.5

Table2: The index ratingsscheme

P-IBI	rank
Excellent	82-100
Good	72-82
Moderate	56-72
poor	0-56

P-IBI was developed to evaluate the status of the Tigris river health conditions where biotic Indices integrity is a useful tool to measure the biological water health for aquatic life [34]. The seasonally variation of P-IBI score of all sites were shows in "Tab. 3". The higher score of P-IBI in this study was 75.5 found in station 2 during spring, and the low value 57.7 found in station 1 during autumn this manner coordinated with many studies done in Iraq were clarify the blooming of phytoplankton in spring, where the increasing of their numbers and variety follows the increasing in; nutrients conditions, ideal photoperiod, temperatureand hydrodynamic forces like stratification and mixing,etc. all this factors support good growth of the individuals [35]. On other hand, the decline of P-IBI score duringautumn are refer to degreasing in the parameter that's prior to phytoplankton communities so that eventually reflect on the P-IBI score.P-IBI like any other multi-metric indices is more sensitive to habitat conditions than its component metrics [1].

Table 3: seasonal variation of P-IBI scores for the studies sites.

Seasons	P-IBI			
	Site 1	Site 2	Site 3	rank
Winter	62.75	68.85	67.7	Moderate
Spring	61.1	75.5	67.7	Moderate- good
Summer	60.5	62.75	64.4	Moderate
Autumn	63.3	60	57.7	Moderate

Historical data that's represent the reference communitiesareused to compared it with the studied sites that areconsidered impaired sites. In general, the reason for reduction of P-IBI score go to the dominate ofCentrals group (belong to

Bacillariophyceae) which consider the Dominancegroup in Iraqi surface water and that's a fact reported by many researcher in Iraq [36 ,37], where this particular group pulse Blue Green reflect the pad condition s of water, they bloom in

un-clean water [38]. The relative Abundance of Centrals was ranged between 5.3-84.7%, the high percentage recorded during autumn in station 3which let the P-IBI score fall in to 57.7 leaving this site with lowest value, as mentioned in (2 .1) paragraph this site located in south of Baghdad citywhere have the biggest effect on the water quality of Tigris river as reported by many studies [39, 40, 41] this site not like the other sites, it have many source of pollution effluent (industrial, agricultural, Urbanactivity) [42]. Higher scoreof P-IBI referrer to Candidate metric where is not sensitive to changing that happened in ecosystem. In general, IBI focus on the structure of biological community and biological function in the aquatic system, which possesses a series of sensitive indexes to environmental change [43]. Thus, IBI consider a simple, sensitive and efficient health evaluation method for aquatic system health [44].

Conclusions

From the results that obtain form the P-IBI,it can be announced that Tigris River is still have a suitable environment conditions for livening of aquatic life, but on other handthe Iraqi government must have a comprehensive monitoring plan to raise up the quality of water to" good" and never let it fall to poor or unsuitable for organism by forcing environmental Legislation and increase the a awareness of the public audience for keeping the safety of local water.

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