Journal of Phycological Research, Vol. 2, No. 2, Sep 2018

The Effects of Physico-Chemical Parameters and Situation of Dam Reservoirs on Their Phytoplankton Population in West Azarbaijan Province (North-West Iran)

Fereidun Mohebbi[1*], **Masoud Seidgar**[1], **Ali Nekoeifard**[1], **Zhale Alizadeh**[1]

Received: 2018- 06- 20 Revised and accepted: 2018-09-14

Abstract

This study was performed to determine relationship between dam reservoir physico-chemical parameters and the phytoplankton structure in 7 reservoirs of west Azarbaijan province. Samplings were carried out during July 2016. phytoplanktons were collected, identified and enumerated then chemical parameters analysed for each sampling site. Principal component analysis (PCA), Detrended Correspondent Analysis (DCA) and two-way Unweighted Pair Group Method with Arithmetic mean (UPGMA) were performed to determine the environmental variables affecting phytoplankton community dynamics. Seventy-three species belonging to five divisions were determined during this study. The result of PCA and DCA was confirmed by UPGMA analysis, in which three main groups were clustered on the basis of their correlation with phytoplankton community changes and environmental parameters. Totally, highly disturbed reservoirs contained different phytoplankton community than undisturbed ones.

Key words: PCA, DCA, Reservoirs, Phytoplankton, West Azarbaijan

Introduction

Reservoirs are artificial lentic water bodies, generally, associated with multiple objectives for human benefits such as water supply, irrigation, fisheries, hydroelectric power and recreation. Land use patterns are changing rapidly in many parts of the world (Sala et al., 2000). The phytoplankton composition can reflect the ecological status of reservoirs and respond both qualitatively and quantitatively changes (El-Otify, 2002). The dynamics and species diversity of phytoplankton are greatly influenced by physico-chemical variables (Harris, 1986; Reynolds, 1986; Sommer, 1989). Watershed land use affects the amount of nutrients exported into lakes and reservoirs via stream inflows (Knoll et al., 2003). Phytoplankton is affected by different environmental factors such as pH, light, and temperature (Buzzi, 2002; Çelekli et al., 2007).Watersheds dominated by agricultural or urban lands typically export nutrients at higher rates than undisturbed watersheds (Beaulac and Reckhow, 1982; Puckett, 1995). However, considerable variation exists in the relationship between land use and watershed nutrient export (Mueller et al., 1995; Puckett, 1995), as well as in the relationship between

---

1- National Artemia Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization, Urmia, Iran
*email: mohebbi44@gmail.com

nutrient loading rate and nutrient concentrations, algal biomass, and algal density of different groups (Carpenter et al., 1998; Correll, 1998; Smith, 1998). Export of sediments from watersheds is also correlated with land use. Agricultural watersheds, particularly export considerable quantities of sediment as well as nutrients. Loading of sediments can reduce algal productivity by decreasing light intensity (Hoyer and Jones, 1983; Knowlton and Jones, 1995). Reservoirs can be especially influenced by inputs of nutrients and sediments because they have relatively large watersheds compared to natural lakes (Wetzel, 1990). Higher loadings of nutrients through watershed streams enhance algal blooms mainly cyanobacteria and impairment of water quality in freshwater ecosystems such as reservoirs and lakes. This may lead to change phytoplankton main groups ratios and reducing species richness and biodiversity.

At present, more than 50000 reservoirs with dams higher than 15 m exist all over the world. It was suggested that reservoirs serve as stepstones for phytoplankton, thus facilitating their dispersal (Dumont, 1999). The proliferation of cyanobacteria and the invasion of *Ceratium* hirundinella are mainly a consequence of building cascades of reservoirs on large rivers (Gil et al., 2012; Cavalcante et al., 2013).

To our knowledge, no multiple-lake studies have explicitly quantified the relationship between land use and phytoplankton primary productivity. In addition, we know of no studies explicitly relating land use to any water physical and chemical factors and eutrophication indicators in reservoirs. In this paper, we explore how agricultural land use in watersheds is related to phytoplankton primary productivity, and associatedwith water physical and chemical parameters in reservoirs.

Materials and Methods

Samplings were carried out during July 2016. One sample were taken from each reservoir, except for Aras reservoir which due to its great dimensions, three samples were picked out. Phytoplankton samplings was carried out by Ruttner model sampler from surface 0.5m water layer. Phytoplankton samples were immediately preserved with 4% formaldehyde solution for identifacetion and analysis. Phytoplankton samples were preserved in cold, dark conditions for 3-4 days before laboratory analysis for precipitation of microalgae. Additional discrete samples were collected from the same depths for chemical analysis) Greenberg et al., 1992). Water temperature, dissolved oxygen (DO), electron conductivity (EC) and pH were measured in situ at every sampling site in the superficial water layer (50 cm depth) with a WTW 320 Oxymeter, a WTW LF 320 EC meter and a Testo 320 pH meter respectively. Phytoplankton counts and identifications were made in three repeats with 5-mL settling chambers with a Nikon TS100 inverted microscope at 400× magnification by Utermöhl’s (1958) method. At least 50 fields or 100 individuals of the most abundant species were counted in each sample.

The taxonomic composition, classes, orders, family and species and density of the phytoplankton community at each site were determined. The phytoplankton taxa were identified based on Prescott (1962), Tiffany and Britton (1971) and Bellinger (1992); Cyanobacteria were identified according to the method of Komarek and Anagnostidis (1989, 2005). Dissolved total phosphorus were analyzed according to the methods described by Greenberg et al. (1992). Total phosphorus (TP(concentrations determined with a spectrophotometer model T80+ UV/VIS (PG Instruments Ltd., Leicestershire, UK). Water transparency was measured with a 30 cm diameter Secchi disc. Principal component analysis (PCA) was performed to observe sample waters on the basis of their environmental parameters and to reduce the phytoplankton data down to a few statistically significant taxa whose density distribution patterns were driving the total variance in the dataset. Two-way clustering of samples was carried out using the unweighted pair group method with arithmetic mean (UPGMA), according to the environmental parameters. The data were standardized (mean = 0, variance = 1) before running the analysis. The Euclidean distance was determined among the studied samples from standardized data. The distance matrix obtained was then used to construct the UPGMA tree. PCA and two-way clustering were performed by PAleontological STatistics (PAST) version 3.04 (Hammer et al., 2001) program.

Results

Totally, 33 phytoplankton species were recognized in studied reservoirs, belonged to 6 main phytoplankton groups including Chlorophyta (10 species), Cyanobacteria (4 species), Bacillariophyta (12 species), Pyrrhophyta (3 species), Desmidaceae (3 species) and Euglenophyta (1 species) (Table 1, Figs 1-7).

Some physico-chemical parameters of the reservoirs are indicated in Table 2. In the PCA model with all the selected environmental variables pc1, pc2 and pc3 explained 74.34, 17.27 and 6.9% of the variance in phytoplankton reservoirs communities, respectively.

The separation between the two types of reservoirs results mainly from the environmental variables correlated with the first PCA axis (Fig. 8). Reservoirs were positively correlated with component 1, mostly related to chlorophyta, EC and TDS. In general, these reservoirs presented smaller watersheds dominated by agriculture, with significant urban areas (Fig. 8). All reservoir types were clearly dominated by Bacillariophyta and Chlorophyta. *Cyclotella meneghiniana, Diatoma vulgaris, Pediastrum duplex, Navicula* sp., and *Microcystis botrys*, were positively correlated with Type 1 reservoirs and with the first PCA component (Fig. 8).

Sites on the right side of the first DCA axis lay in a fenced area. In general, these undisturbed sites were clearly dominated by non-tolerant taxa Bacillariophyta and Chlorophyta, mainly associated mesotrophic states of water bodies (Van Dam et al., 1994), Desmides and negatively correlated with axis 1 and associated with reference sites were mainly tolerant taxa, mostly *Scenedesmus* sp*., Synedra ulna* and cyanobacteria.

Analysis of loading weights of reservoirs on two first axis of DCA indicated that Ar2 and Ara reservoirs had the lowest weights on axis2 of DCA respectively. On the other hand, Zola

Table 1. phytoplankton species list determined in the reservoirs.

Phytoplankton	Reservoir						
	Aras	Aras2	Ghigaj	Ghanbari	Barun	Zola	Derik
Chlorophyta							
Oocystis crassa Wittrock	+			+			+
Coelastrum microporum Nägeli	+						
Scenedesmus quadricauda (Turpin)	+	+	+	+			+
Brébisson			+				
Scenedesmus bijuga (Turpin) Lagerheim	+						
Gleocystis vesiculosa Nägeli	+	+		+			
Tetraédran minimum (A.Braun) Hansgirg	+			+			
Pediastrum duplex Meyen	+	+					
Dictyocepharium pulchelum H.C.Wood	+	+					
Coelastrum microporum Nägeli	+						+
Chlamydomonas sp.							
Cyanobacteria							
Microcystis botrys Teiling	+		+	+	+	+	
Oscillatoria sp.	+	+	+	+			
Anabaena spiroeides Klebahn	+						
Chroococcus turgida (Kützing) Nägeli				+			+
Bacillariophyta							
Cyclotella sp.	+	+		+	+	+	+
Nitzschia sp.	+	+	+	+	+		
Nitzschia closterium (Ehrenberg) W.Smith	+		+				
Diatoma vulgaris Bory	+		+				
Navicula lanceolata (Agardh.) Kütz.	+						
Navicula sp.		+		+	+		+
Cocconeis pediculus Ehrenb	+						
Synedra ulna (Nitz.) Her.	+		+		+		
Symbella sp1.		+					
Symbella sp2.		+	+				
Amphora oralis Kiitz							
Gomphonema parvulum (Kützing) Kützing				+	+		
Pyrrhophyta							
Glenodinium quadridens (Stein) Schiller		+					+
Gymnodinium caudatum Prescott		+					
Dinobryon sp.					+		+
Desmidaceae							
Euastrum sp.		+					
Staurastrum gracille Ralfs ex ralfs		+		+			
Cosmarium subcostatum Nordst		18		+			
Euglenophyta							
Euglena proxima Dang.			+				+

and Ghigaj reservoirs had the highest weights on axis1 respectively (Fig. 9).

The result of PCA was confirmed by UPGMA analysis, in which three main groups were clustered on the basis of their correlation with phytoplankton community changes and environmental parameters (Fig. 10). The PAST software was used to determine the similarity and distance indices of reservoirs (Table 3).

Disturbed reservoirs were also dominated by tolerant taxa of Bacillariophyta namely *Navicula* sp. and Chlorophyta, mostly *Scenedesmus* sp. and species of cyanobacteria.

Discussion

The quality and availability of freshwater is one of the most essential determinants for the health of ecosystems and human societies worldwide. Human activities have exploited this resource heavily, and consequently se-

Table 2. physicochemical parameters of reservoirs in summer 2016.

Parameter Resevoir	DO (mg/L)	Water Tem (°C)	pH	EC	Turbidity (m)	Salinity	TDS	%Oxygen	TP (mg/L)
Aras	7.23	23.57	8.88	218.33	0.50	0.0	139.7	91.9	24.73
Aras-2	6.53	23.2	9.12	1576	0.75	0.6	1014	83.0	31.9
Gheigaj	6.94	23.6	8.92	1283	0.35	0.5	825	89.3	14.6
ShahidGhanbari	9.56	26.2	9.56	1200	0.50	0.4	768	135.4	35.8
Barun	11.47	26.9	8.88	507	0.48	0.0	364	172.8	35.8
Zola	10.11	24.3	9.25	315	0.95	0.0	202	145.2	6.06
Derik	10.14	23.5	8.76	465	1.00	0.0	298	144.5	29.5

Table 3. Similarity and distance indices of reservoirs.

	Ara	Ar2	Ghi	Gha	Bar	Zol	Der
Ara	0	5911.8749	1911.0264	1976.6406	1226.1343	2480.2971	1901.3162
Ar2	5911.8749	0	6357.5169	6339.7227	6170.1606	6584.2441	5885.0478
Ghi	1911.0264	6357.5169	0	425.75194	2128.6647	2664.281	3116.5337
Gha	1976.6406	6336.7227	425.75194	0	2073.5283	2383.4947	3073.5021
Bar	1226.1343	6170.1606	2128.6647	2073.5283	0	1659.516	1121.7104
Zol	2480.2971	6584.2441	2664.281	2383.497	1659.516	0	2182.8676
Der	1901.3162	5885.0478	3116.5337	3073.5021	1121.7104	2182.8676	0

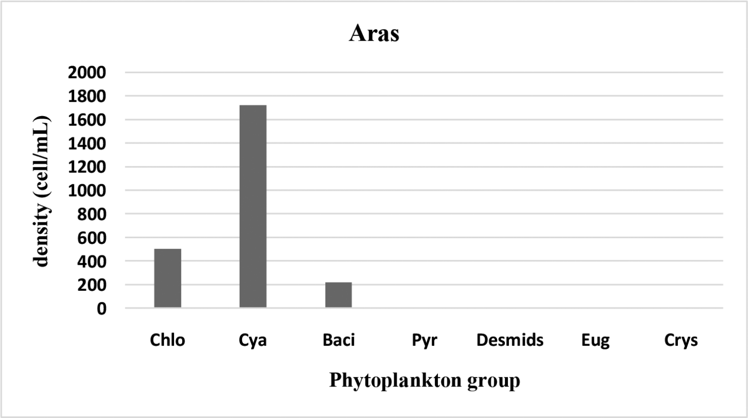

Fig. 1. Phytoplankton groups density in Aras reservoir summer 2016 (Chlo=Chlorophyta; Cya=Cyanobacteria; Baci=Bacillariophyta; Pyr=Pyrophyta; Desmids=Desmidaceae; Eug= Euglenophyta; Crys=Crysophyta).

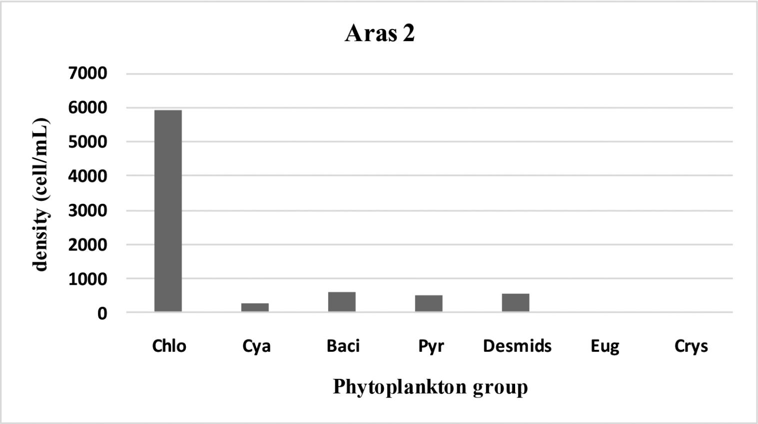

Fig. 2. Phytoplankton groups density in Aras2 reservoir in summer 2016 (Abbreviations as Fig. 1).

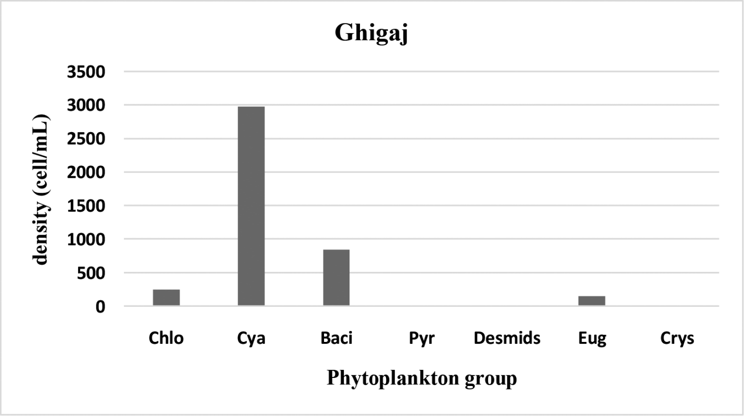

Fig. 3. Phytoplankton groups density in Ghigaj reservoir in summer 2016 (Abbreviations as Fig. 1).

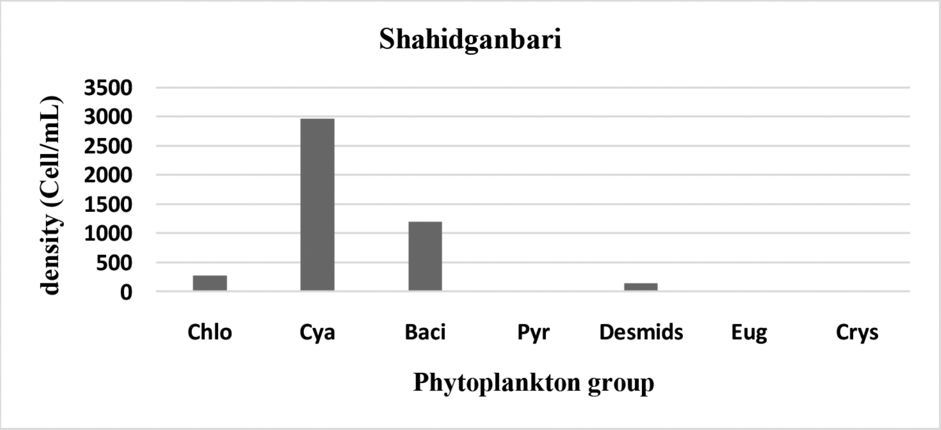

Fig. 4. Phytoplankton groups density in Shahid Ghanbari reservoir in summer 2016 (Abbreviations as Fig. 1).

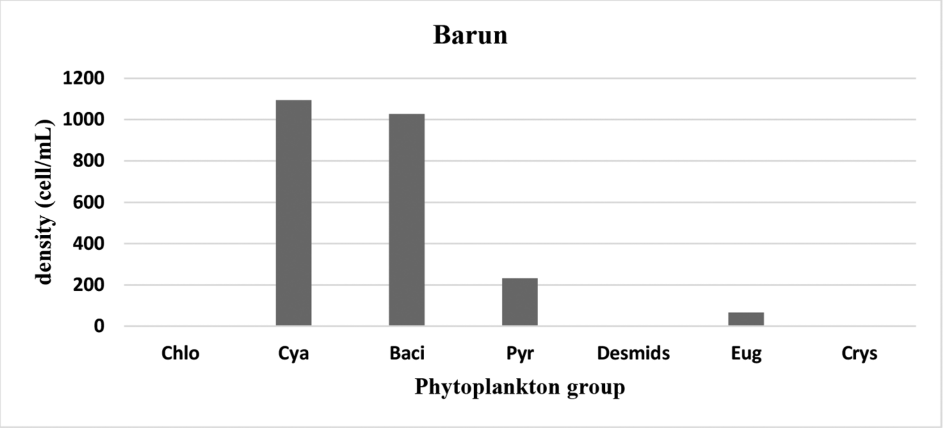

Fig. 5. Phytoplankton groups density in Barun reservoir in summer 2016 (Abbreviations as Fig. 1).

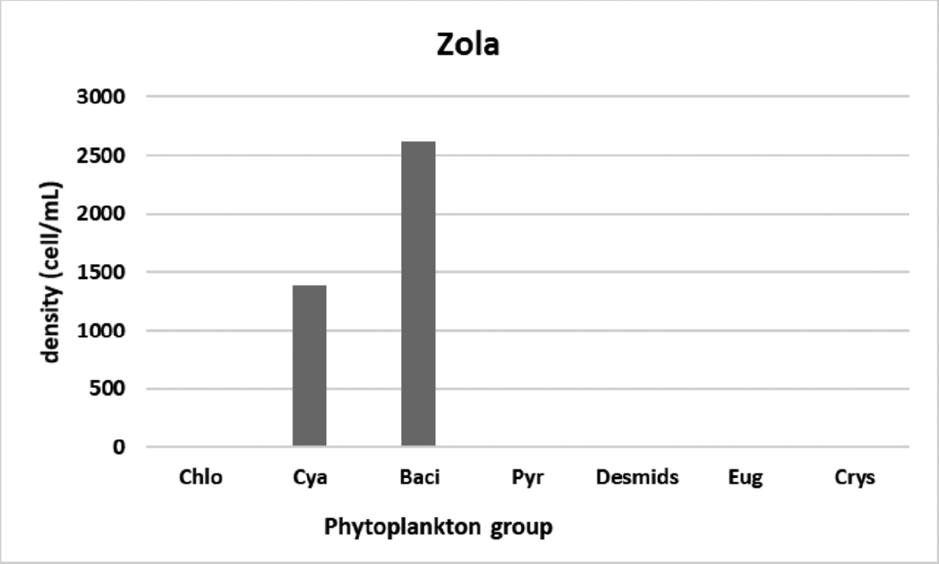

Fig. 6. Phytoplankton groups density in Zola reservoir in summer 2016 (Abbreviations as Fig. 1).