GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(Research Article)

Diagnosis of ecological quality of Dohou Lake on the basis of environmental parameters and phytoplankton community, Western Côte d'Ivoire

Martin Kouamé Kouamé [1], Séverin Kouakou Attoungbre [1, *], Julie Estelle Niamien Ebrottié [2], Charles Koffi Boussou [1], Nicole Ahou Yoboué [1] and Sanogo Abiba Tidou [1]

[1] *Laboratory of Biology and Tropical Ecology, Jean Lorougnon Guédé University, Daloa (Côte d'Ivoire).*

[2] *Laboratory of Environment and Aquatic Biology, Nangui Abrogoua University, Abidjan (Côte d'Ivoire).*

GSC Advanced Research and Reviews, 2021, 09(02), 073–082

Publication history: Received on 03 October 2021; revised on 09 November 2021; accepted on 11 November 2021

Article DOI: https://doi.org/10.30574/gscarr.2021.9.2.0265

Abstract

The ecological quality of Dohou Lake in Duékoué was determined from the phytoplankton community and physico-chemical parameters. All of the stations in Dohou Lake are dominated by Cyanobacteria and Bacillariophyta individuals, with high monthly proportions observed during the study period. Ecological indicators such as total phosphorus, transparency and chlorophyll made it possible to assess the physico-chemical quality of the environment. Thus, mean total phosphorus values ranged from 970 to 1150 µg/L from station D7 to station D6. Minimum transparency values ranged from 0.1 to 0.5 m from station D7 to D3, and mean values ranged from 0.3 m (station D7) to 0.69 m (station D1). For chlorophyll a, mean values ranged from 3.52 µg/L to 12.98 µg/L from station D7 to station D2, with maximum values for this parameter ranging from 13.4 µg/L (station D7) to 46.73 µg/L (station D2). All of the stations on Dohou lake are therefore in an eutrophic state. The monthly variations in the different proportions of phytoplankton groups observed indicate a clear predominance of Cyanobacteria followed by Bacillariophyta. The values of the Planktonic Index (PI) indicate that the stations are in average ecological condition, except for station D7, which is in poor ecological condition. These ecological qualities are reflected by the spatial and temporal dominance of 4 functional groups which are C, LM, K, and S1.

Keywords: Functional groups; Ecological status; Trophic status; Ecological indicators

1. Introduction

Freshwater is unevenly distributed and indispensable to the life of human populations as well as to most living organisms [1]. Indeed, as a natural resource, human populations use it for domestic, agricultural, fishing and industrial purposes, but also many animal or plant species use it as exclusive or temporary habitats. Despite this great importance of water resources, they are increasingly subject to pollution and/or eutrophication as well as to the modification of physico-chemical characteristics. This is the case in most lakes and reservoirs in the tropics that are more or less permanently damaged [2]. This state very often results in poor transparency of these waters and excessive development of aquatic plants (microalgae, water lilies, freshwater salad). Today, one of the methods for diagnosing the ecological status of water bodies is the use of phytoplankton as a biological indicator. It is a complementary method to the measurement of environmental parameters in the environment. In fact, the sensitivity of phytoplankton and its relatively short development cycle makes it possible to integrate changes in the environment in a relatively short time. According to Talita [3], human activities are one of the major causes of the degradation of aquatic environments. Faced with such an observation, the use of water resources is called into question. Hence the need for a water resource management policy [4, 5] in order to preserve the ecological balance of aquatic ecosystems. Consequently, the

* Corresponding author: Séverin Kouakou Attoungbre

Laboratory of Biology and Tropical Ecology, Jean Lorougnon Guédé University, Daloa (Côte d'Ivoire).

assessment of water quality and the conservation of aquatic ecosystems are therefore a priority for the coming decades. In Côte d'Ivoire, Dohou lake in Duékoué located in the Sassandra basin is no exception to this reality. Dohou lake is used to supply drinking water to the city of Duékoué. Urbanization has increased the number of human activities carried out on this lake (housing, agriculture, transport, fishing, livestock). It receives enormous quantities of nutrients from urban, domestic and agricultural effluent discharges. These inputs cause the progressive invasion of aquatic macrophytes and phytoplankton blooms. However, despite this considerable pressure on the lake, its ecological status is unknown. Scientific data on this lake are scarce and limited to a few works [6, 7]. The first works focused on the physico-chemical and bacteriological characterization in order to highlight the vulnerability of the lake as a drinking water resource. In the results obtained, the abundance of fecal germs was well above the standards for water intended for the production of drinking water, especially the presence of the pathogenic agent salmonella [6]. The second works carried out on the typology of the phytoplankton community showed a dominance of Cyanobacteria in the composition of the phytoplankton as well as low diversity index values reflecting a disturbed and unstable environment [7]. In the light of the previous work, it therefore seems judicious to know the trophic and ecological state of Dohou lake.

The general objective of this study is to assess the ecological quality of Dohou lake in Duékoué based on the phytoplankton community and physico-chemical parameters.

2. Methods

2.1. Area

Dohou lake is located in the commune of Duékoué in western Côte d'Ivoire. It is located 450 km from Abidjan between latitudes 6.7520 and 6.7622 N and longitudes 7.353 and 7.367 W. Dohou lake is an artificial water reservoir in the sub-basin of the Sassandra river, built to supply drinking water to the population of the town of Duékoué by the Côte d'Ivoire water distribution company (SO.DE.CI). It covers an area of about 1 km^2, near which several activities are developed. Agriculture remains the main income-generating activity. The banks of the lake are occupied by market gardening, maize fields and rubber plantations. But there are also chicken farms, cars mechanicals garages, quarries and houses. The lake also receives waste from runoff and sewage from nearby homes and the city [6].

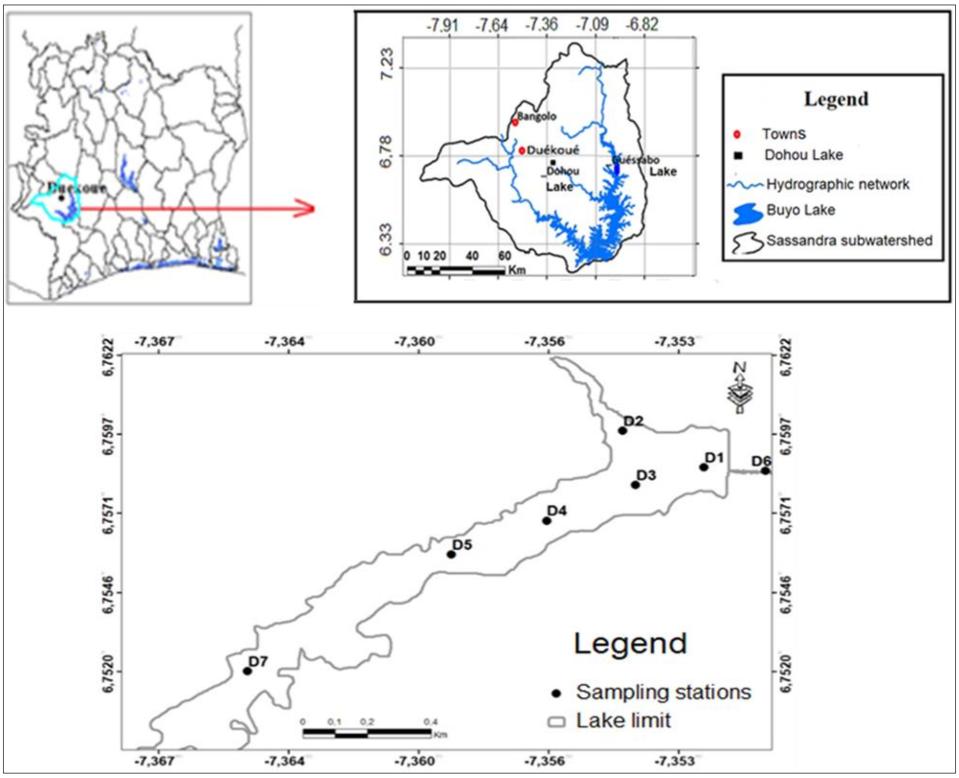

Figure 1 Map of Dohou Lake and sampling stations in Sassandra subwatershed

2.2. Sampling, assaying and enumeration

Twelve monthly sampling campaigns at seven stations in Dohou Lake were carried out between October 2017 and September 2018. In the field, water transparency was assessed from the depth of appearance of the Secchi disk after its immersion and its complete disappearance in the water column. For phytoplankton, organisms were sampled with an integrated sampler, fixed and preserved in pillboxes using drops of 90% alcohol and 5% formaldehyde. Water samples for chlorophyll a and total phosphorus were collected under the same conditions as before and stored in dark tubes (350 ml) at a cold temperature (4°C). Once in the laboratory, phytoplankton organisms were observed under an inverted microscope and identified from a set of literature [8, 9, 10, 11, 12,13, 14]. Phytoplankton cells were counted using a counting cell with a capacity of 10 ml according to the method of Utermöhl [15]. For the chlorophyll biomass, the method of Lorenzen [16] was used for quantification. For this purpose, the water samples were filtered through Whatman GF/F paper (0.7 µm porosity and 47 mm diameter). The filtrates obtained were kept in 90% acetone for the extraction of chlorophyll *a*. The contents were obtained from spectrophotometer readings at different wavelengths (665 and 750 nm before and after acidification). The results are given by the following formula.

$$\text{Chl } a\ (\mu g/l) = \frac{26.7\ .\ [A1.\ (DO\ (665 - 750)) - A2\ .\ (DO\ (665 - DO\ 750))]\ .\ Va}{Ve\ .\ L}$$

A1 (DO (665 - 750)) : absorbance before acidification at 665 nm et 750 nm ; A2 (DO (665 - 750)) : absorbance after acidification at 665 nm et 750 nm ; Va : acetone volume (ml) ; Ve : filtered water volume (L) ; L : distance from the optical path of the cell used (cm).

The determination of total phosphorus consisted in the hot mineralization of a test sample in the presence of sulfuric acid and sodium persulfate followed by the spectrometric determination of ortho-phosphates obtained according to French Standard T90-023.

2.3. Data Analysis

Data were collected from phytoplankton counts, chlorophyll *a*, total phosphorus and transparency to assess the physico-chemical and ecological quality of Dohou lake based on Trophic Index, Planktonic Index and functional groups according to Reynolds [17].

2.4. Trophy index

To determine the trophy of Dohou lake, the trophic classification of the waters recommended by the O.C.D.E [18] (Table 1) was adopted. This system takes into account the following parameters: total phosphorus (TP), water transparency and chlorophyll *a* (Chl *a*). The information acquired allows for international exchange and comparison.

Table 1 Limit values of the trophic water classification system [18]

Trophic status	Pt mean (µg/L)	Secchi mean (m)	Secchi min (m)	Chl *a* mean (µg/L)	Chl *a* max (µg/L)
Oligotrophic	4-10	6-12	3-6	1-2,5	2,5-8
Mesotrophic	10-35	6-3	3-1,5	2,5-8	8-25
Eutrophic	35-100	3-1,5	1,5-0,7	8-25	25-75
Hyper-Eutrophic	100≤	1,5≥	0,7≥	25≤	75≤

max: maximum value; min: minimum value, Pt: total phosphorus, Chl *a*: chlorophyll *a*

2.5. Planktonic Index (PI)

The calculation of Planktonic Index was carried out on the abundance data during periods of phytoplankton production [19]. The relative abundances of the different groups of algae were assessed. The index is based on quality coefficients (Qi) assigned to each algal group (Table 2) and on relative abundance classes (Aj) (Table 3). Relative abundance is the ratio of the abundance of each of the different groups to the total abundance of all groups expressed as a percentage. The expression of Planktonic Index is the average of the sum of the quality scores multiplied by the relative abundance (in percentage) obtained during the surveys as follows:

$$PI = \text{Mean} \sum Qi \times Aj$$

Qi: quality coefficients assigned to each algal group and Aj: relative abundance classes recorded in tables IV and V.

Table 2 Coefficients assigned to the reference algae groups

Algal groups	**Qi**
Desmids	1
Bacillariophyceae	3
Chrysophyceae	5
Dinophyceae et Cryptophyceae	9
Chlorophyceae (except Desmids)	12
Cyanophyceae	16
Euglenophyceae	20

Qi: Assigned coefficients

Table 3 Relative abundance classes

Relative abundance	**Aj**
0-10	0
10-30	1
30-50	2
50-70	3
70-90	4
90-100	5

Aj: relative abundance classes

Score out of 100 is thus obtained (Table 4), making it possible to classify the ecological status of the water bodies on a quality scale ranging from very good to poor with corresponding color codes

Table 4 Values of Planktonic Index (PI) classification limits for water bodies [20]

Ecological Status Classification	**Note/100 and color coding**
Very good	0-25
Good	26-40
Moderate	41-60
Poor	61-80
Bad	>80

2.6. Functional groups: ecological indicators

Functional groups (FGs) are based on those established by Reynolds [17], grouping species frequently found together in the same environment with the same ecological requirements and similarities. Phytoplanktonic taxa with a contribution ≥3% of the total density were used to constitute the different functional groups. The ratio of the abundance of each group to the total abundance of the groups was estimated as a percentage. Functional groups reflect the characteristics of a habitat type.

3. Results

3.1. Trophic status

Ecological indicators such as total phosphorus, transparency and chlorophyll a were used to assess the physico-chemical quality of the environment. Total phosphorus values ranged from 970 to 1150 µg/L between stations D2 and D6. Concerning transparency, the minimum values varied from 0.1 to 0.5 m between station D7 and D3 and the average values from 0.3 m to 0.69 m between station D7 and station D1. For chlorophyll a, mean values fluctuated from 3.52 µg/L to 12.98 µg/L between station D7 and station D2. The maximum values for this parameter varied from 13.4 µg/L to 46.73 µg/L between stations D7 and D2. The trophic status of the different stations, obtained by using the limit values of the OECD water trophic classification system [18], is presented in table 5. Thus, all the stations of Dohou lake are in a eutrophic state.

Table 5 Limit values of the trophic classification system for Dohou lake stations

	Stations						
Indicators	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
Pt mean (µg/L)	1040	960	1070	1090	1050	1150	970
Secchi mean (m)	0.69	0.64	0.68	0.67	0.55	0.37	0.3
Secchi min (m)	0.3	0.45	0.5	0.4	0.35	0.17	0.1
Chl *a* mean (µg/L)	8.79	12.98	9.64	8.53	7.68	8.89	3.52
Chl *a* max (µg/L)	24.48	46.73	20.03	22.25	15.58	17.8	13.4
Trophic status	E	E	E	E	E	E	E

Max: maximum value; min: minimum value; Pt: total phosphorus; Chl *a*: chlorophyll a.
D1 to D7: sampling stations; E: Eutrophic

3.2. Ecological quality

The ecological quality of the area study was estimated using the planktonic index (Table 6). The planktonic index (PI) values ranged from 49 to 73 between station D5 and station D7. These index values show that all stations have a moderate ecological status except station D7 with a poor ecological status.

Table 6 Ecological status of the various stations on Dohou Lake according to the planktonic Index (PI) parameter.

	Stations						
Index	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
Planktonic Index (PI)	60	53	51	57	49	52	73
Ecological status	Mo	Mo	Mo	Mo	Mo	Mo	Po

Mo: Moderate. Po: Poor. D1 to D7: sampling stations

3.3. Functional groups

The contribution of taxa within the phytoplankton community allowed us to note a set of 11 dominant species (contribution ≥3% of the total density) in Dohou lake (Table 7). These species belong to Cyanobacteria (5 taxa), Bacillariophyta (3 taxa), Euglenophyta (2 taxa) and Chlorophyta (1 taxa). These are *Aphanocapsa conferta*, *Microcystis aeruginosa*, *Planktolyngbya limnectica*, *Chroococcus minutus*, *Asterionella formosa*, *Aulacoseira ambigua, Aulacoseira ambigua* var*. japanica*, *Phormidium articulatum, Trachelomonas volvocina, Trachelomonas cylindrica* and *Dictyophaerium pulchellum*. The structure of phytoplankton species assemblages from the dominant species is characterized by 7 functional groups (Table 7). Among these functional groups, 4 groups represented cyanobacteria (S1, X2, LM and K), 1 group for the dominant diatom (C), 1 group for Euglenophyta (W2) and 1 group for Chlorophyta (F).

Table 7 Phytoplanktonic functional groups **based on** dominant species of Dohou lake

Taxa	functional groups	Habitat templates/Tolerances
Cyanobacteria		
Aphanocapsa conferta	K	Short nutrient rich columns
Chroococcus minutus	X2	mesotrophic, clear and mixed / Stratification
Microcystis aeruginosa	LM	Summer epilimnia in eutrophic lakes / very low carbon
Planktolyngbya limnectica	S1	Turbid mixed layers / highly light deficient
Phormidium articulatum		
Bacillariophyta		
Asterionella formosa	C	Mixed, eutrophic small-medium lakes / Light, C deficiencies
Aulacoseira ambigua		
Aulacoseira ambigua var. *japanica*		
Euglenophyta		
Trachelomonas cylindrica	W2	Meso-eutrophic shallow lakes and ponds
Trachelomonas volvocina		
Chlorophyta		
Dictyophaerium pulchellum	F	Clear superficial layers/low nutrients, high turbidity

3.4. Spatio-temporal dynamics of functional groups

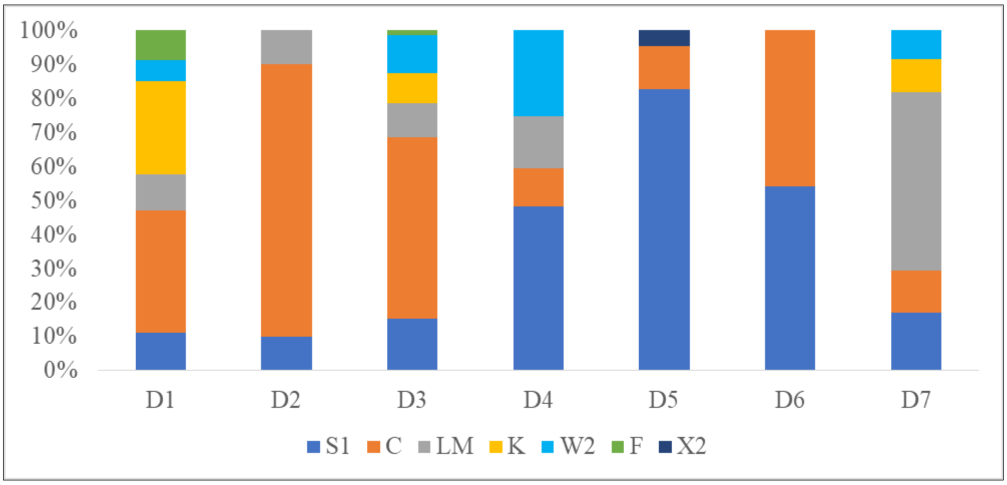

Figure 2 Spatial variations in the average relative abundance of functional groups in Dohou lake. D1 to D7: sampling stations; K, LM, S1, X2, W2, F: Functional groups. C: *Asterionella formosa* and/or *Aulacoseira ambigua,* and/or *Aulacoseira ambigua* var. *japonica;* K: *Aphanocapsa conferta;* LM: *Microcystis aeruginosa;* S1: *Planktolyngbya limnectica* and/or *Phormidium articulatum;* X2: *Chroococcus minutus;* W2: *Trachelomonas cylindrica* and/or *Trachelomonas volvocina;* F: *Dictyophaerium pulchellum.*

An average of abundances per station and per month was used to monitor the evolution of functional groups (Figure 2 and 3). Among the 7 groups identified, 4 groups had an average individual contribution greater than 5%. These are S1 group (32 %), C group (31 %), LM group (14 %) and K group (10 %). These functional groups dominated the phytoplankton assemblages with 87% at station level. No significant difference in abundance exists between stations in these functional groups. Figure 2 shows the variation in functional groups at the sampled stations. The proportions of dominance of S1 group with *Planktolyngbya limnectica* varied from 10% at station D2 to 85% at station D5. As for C group represented by *Asterionella formosa*, the proportions fluctuated from 10% to 79% from station D4 to station D2. However, LM group (Microcystis aeruginosa) and K group (*Aphanocapsa conferta*) were more represented at stations D7 (53%) and D1 (10%) respectively. Similarly, there was little variation in the contribution of each group over time (t-test, $p > 0.05$). The monthly proportions of the different functional groups are presented in Figure 3. For S1 group, the proportions varied from 1% in June to 75% in April. For C group, the proportions varied from 0.06% in June to 70% in November. LM Group is most represented between June (97%) and July (72%) in the rainy season, while K is most represented in October (49%) and February (37%). The first two groups (S1 and C) were more represented in the dry season than in the wet season, while the second (LM and K) were more represented in the wet season than in the dry season (Table 8). No significant difference was recorded between seasons (t test, p > 0, 05) in the abundance of these functional groups.

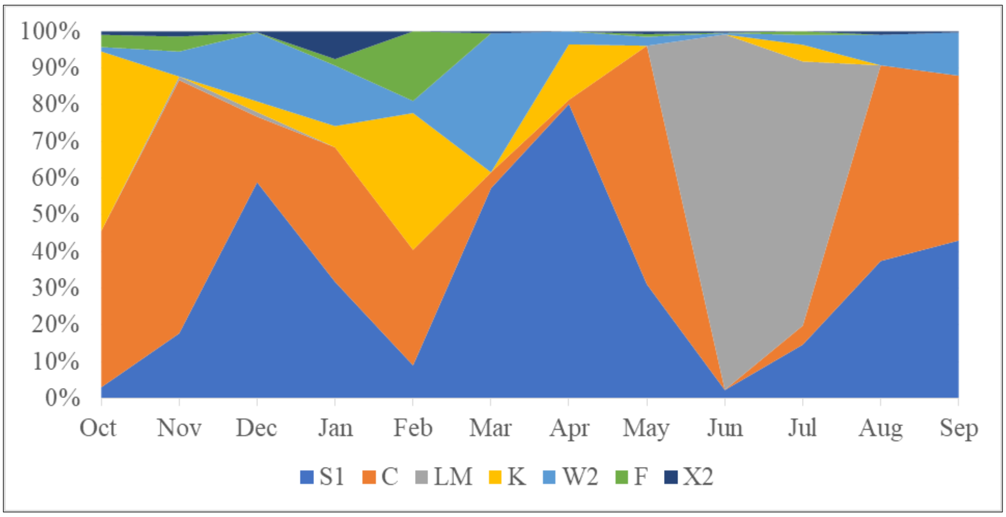

Figure 3 Monthly variations in the average relative abundance of functional groups during the sampling period. C, K, LM, S1, X2, W2, F: Functional groups. C: *Asterionella formosa* and/or *Aulacoseira ambigua,* and/or *Aulacoseira ambigua* var*. japonica;* K: *Aphanocapsa conferta;* LM: *Microcystis aeruginosa;* S1: *Planktolyngbya limnectica* and/or *Phormidium articulatum;* X2: *Chroococcus minutus;* W2: *Trachelomonas cylindrica* and/or *Trachelomonas volvocina;* F: *Dictyophaerium pulchellum.*. Oct: octobre, Nov: november, Dec: December, Jan: January, Feb: February, Mar: march, Apr: april, Jul: july, Aug: august, Sep: september

Table 8 Seasonal average of the proportions of functional groups in Dohou Lake

	Seasons		
Functional Groups	**dry season**	**rainy season**	***p-value***
S1	35%	30%	$p > 0.05$
C	32%	30%	$p > 0.05$
LM	0%	24%	$p > 0.05$
K	9%	10%	$p > 0.05$
W2	17%	5%	$p > 0.05$
F	5%	1%	$p > 0.05$
X2	2%	0%	$p > 0.05$

C: *Asterionella formosa* and/or *Aulacoseira ambigua* and/or *Aulacoseira ambigua var*. japonica; K: *Aphanocapsa conferta,*; LM: *Microcystis aeruginosa*; S1: *Planktolyngbya limnectica* and/or *Phormidium articulatum*; X2: *Chroococcus minutus*; W2: *Trachelomonas cylindrica* and/or *Trachelomonas volvocina*; F: *Dictyophaerium pulchellum*. $p > 0.05$: non-significant test (t-test).

4. Discussion

The results obtained from the OECD trophic classification System [18] and the Lake Phytoplankton Index (PI) give relatively similar information on the overall trophic level and ecological status of Dohou lake. Thus, all stations in lake are characterized by a eutrophic state. It should be remembered that the lake, due to its proximity to the city and the anthropic activities (agriculture, fishing, etc.) to which it is subject, receives excessive exogenous and endogenous nutrient inputs. These inputs would therefore be responsible for the eutrophication of the lake waters, leading to an increase in the density of particles in suspension, hence the low transparency of the stations. Indeed, under the action of nutrient salts (nitrogen and phosphorus) from cultivated land and urban effluents, algae proliferate and accumulate after their death in the lake bottom. The silt thus enriched in organic matter and its release would also contribute to the availability of nutrients in the lake. The trophic status of lake Dohou is consistent with that of Adzopé lake [21] and Taabo lake [22]. Concerning ecological states, the Plankton Index (PI) used showed average ecological states of the lake waters. These ecological states would be due to the high relative proportions of phytoplankton groups considered as indicator groups of eutrophication to which high quality coefficients are assigned. The relative number of individuals representing the different taxonomic groups in a phytoplankton sample could reflect the ecological conditions of the environment. This ecological state would be derived from the trophic level of the lake. According to E.C [20], in eutrophic lakes, the number of individuals belonging to groups linked to eutrophication is greater than the number of individuals belonging to groups linked to oligotrophic conditions. The structure of phytoplanktonic species assemblages from the dominants species is characterized by 7 functional groups (S1, X2, LM, C, W2, F and K). Of these functional groups, 04 groups (C, S1, LM and K) were the most dominant. Examination of the functional diversity of the phytoplankton community revealed that most of the taxa characteristic of the functional groups are associated with eutrophic conditions. The most dominant groups (C, S1, LM and K) contain taxa that are tolerant of low nutrient and carbon levels, with the majority of species characterized by low light levels. The S1 functional group with *Planktolyngbya limnetica* was strongly represented at station D7 during the wet season (April). The high density of S1 (*Planktolyngbya limnetica*) is mainly associated with low total phosphorus values. This main species of the group is a filamentous Cyanobacteria well adapted to high turbidity conditions [23]. Although frequently found in mesotrophic to hyper-eutrophic environments [24, 25], *Planktolygbya limnetica* is often competitive in conditions of low phosphorus values [26, 27]. The functional groups K and LM, represented by *Aphanocapsa conferta* and *Microcystis aeruginosa* respectively, are also dominant in the Cyanobacteria with their growth optima in October and June. The taxa in this group include small colonial non-nitrogen fixing cyanobacteria. However, they can dominate phytoplankton when ammonium is still present in the water [28]. Members of this group are favoured by the conditions under which these taxa could benefit from the nutrient reserve of the gelatinous structures, as well as by the rebound against sedimentation by good floating regulation [17]. Functional group C, strongly represented by *Asterionella formosa*, dominated the assemblages in November, with strong colonisation at station D2. Members of this group are fast-growing species linked to high phosphorus concentrations in the lakes [29]. These diatoms are good competitors even under conditions of low nutrient concentrations and light with the presence of silica [30, 31]. This would justify the representativeness of C group.

5. Conclusion

In this study, the ecological indicators used made it possible to assess the ecological quality of the environment. Thus, stations of lake have presented eutrophics states based on the limit values of the trophic classification system according to OECD. The Planktonic Index (PI) values of the stations indicated moderate ecological conditions to except station D7. This station showed a poor ecological condition. 7 functional groups were determined from the dominant species. Of these, 4 groups characterize the phytoplankton with an average individual contribution of more than 5%. These are groups S1, C, LM and K with strong contributions from the first two groups. These groups by their characteristics testify the trophy state of the lake with strong contributions from the species *Planktolygbya limnectica* and *Asterionella Formosa*.

Compliance with ethical standards

Acknowledgments

we would like to thank the hydrobiology and ecological engineering research group / Jean Lorougnon Guédé university for funding this study and all the anonymous individuals who helped us during our research work.

Disclosure of conflict of interest

The authors declare they have no competing interest.

References

[1] Lacroix G, Danger M. From food webs to functioning of lake ecosystems: toward an integration of heterogeneity and complexity. J. Wat. Sci. 2008; 21 (2): 155-172

[2] Mambo V, Tidou AS, Yapo OB, Ohouenou P. Assessment of the trophic state of Buyo (Côte d'Ivoire): physico-chemical and biological aspects. J. *West*-Afr. Chim. Soc. 2001; 011: 95-135.

[3] Talita S. Monitoring and modeling of cyanobacteria dynamics in urban lakes within their watershed [Ph.D dissertation]. Paris, France: Paris-East University; 2014.

[4] Dziock F, Henle K, Foeckler F, Follner K, Scholz M. Biological indicator systems in floodplains-a review. Int. Rev. Hydrobiol. 2006; 91(4): 271 - 291.

[5] Cabecinha E, Cortes R, Cabral JA, Ferreira T, Lourenco M, Pardal AP. Multi-scale approach using phytoplankton as a first step towards the definition of the ecological status of reservoirs. Ecol. Indic. 2009; 9: 240 - 255.

[6] Kouamé KB, Konan KS, Attoungbre KS, Konan KF, Boussou KC, Kouamé KM. Qualitative assessment and typology of the water resource used for the production of drinking water in Duékoué, western Côte d'Ivoire. J. geosci. Environ. prot. 2019; 7: 212 - 231.

[7] Attoungbre KS, Niamien-Ebrottie JE, Kouame KM, Boussou KC, Aliko NG, Konan KF. Typology of the Phytoplankton Community of Dohou Lake, Drinking Water Supply Source in Duékoué Town (Western Côte d'Ivoire). J. Environ. and Ecol. 2020; 11 (1): 1-18.

[8] Förster K. Desmidiaceae from Brazil, 2th part: Bahia, Goyaz, Piauhy and Northern Brazil. Hydrobiol. Acta Hydrobiol, Hydrogr. Protistol. 1964; 22 (3 - 4): 321-505.

[9] Philipose MT. Chlorococcales. New Delhi (Indian): I.C.A.R; 1967.

[10] Compère P. Algae from the lake Chad region. VII: Chlorophytes (3rd part: Desrnideae). ORSTOM Notebooks. Hydrobiol. Ser. 1977; 11 (2): 77 - 177.

[11] Couté A, Iltis A. Ultrastructure of the Trachelomonas cubicle (Algae, Euglenophyta) collected in Côte d'Ivoire. Trop. Hydrobiol. J. 1981; 14 (2): 115-133.

[12] Komárek J, Fott B. Chlorophyceae (Green algae) order: Chroococcales. *In*: Huber-Pestalozzi G, Heynig H, & Mollenhauer D, eds. The phytoplankton of the fresh water: systematics and biology. Stuttgart, 7th part: Schweizerbart, 1983. p. 1-1044.

[13] Uherkovich GA. Green algae of the genus Scenedesmus (Chlorococcales, Chlorophyceae) with special regard to Hungary, Budapest: Hung. Algol. Soc; 1995

[14] Wołowski k, hindák F. Atlas of euglenophytes. 1e éd. Bratislava: VEDA Slovak Academy of Sciences. 2005.

[15] Utermöhl, H. To perfect the quantitative phytoplankton methodology. Int. Assoc. Theor. Appl. Limnol. 1958; 9: 1-39.

[16] Lorenzen CJ. Determination of chlorophyll and pheopigments: Spectrophotometric equations. Limnol. Oceanogr. 1967; 12: 343-346..

[17] Reynolds CS, Huszar VLM., Kruk C, Nasseli-Flores L, Melo S. Towards a functional classification of the freshwater phytoplankton. J. Plankton Res. 2002; 24(5): 417 - 428.

[18] OECD (Organization for Economic Cooperation and Development). Eutrophication of Waters. Monitoring, Assessment and Control. Paris: OECD & Washington DC; 1982.

[19] Barbe J, Lafont M, Mouthon M, Philippe M. Protocole actualisé de la diagnose rapide des plans d'eau. Lyon (France) : CEMAGREF. 2003.

[20] E.C. Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy. 2000.

[21] Adon M.P. Trophie status of the drinking water supply reservoir in the city of Adzopé (Côte d'Ivoire) [Diploma of Advanced Studies]. Abidjan: Nangui Abrogoua University; 2006.

[22] Groga N. Structure, functioning and dynamics of phytoplankton in lake Taabo (Ivory Coast) [Ph.D dissertation]. Toulouse: University of Toulouse; 2012.

[23] Padisak J, Crossetti LO, Naselli-Flores L. Use and misuse in the application of the phytoplankton functional classification: a critical review with updates. Hydrobiol, 2009; 621: 1-19.

[24] Delazari-Barroso A, Sant'anna CL, Senna PAC. Phytoplankton from Duas Bocas Reservoir, Espírito Santo State, Brazil (except diatoms). Hoehnea. 2007; 34: 211 - 229.

[25] Silva APC, Costa IAS. Biomonitoring ecological status of two reservoirs of the Brazilian semi-arid using phytoplankton assemblages (Q index). Acta Limnol. Bras. 2015; 27: 1 - 14.

[26] Villena M-J, Romo S. Phytoplankton changes in a shallow Mediterranean lake (Albufera of Valencia, Spain) after sewage diversion. Hydrobiol. 2003; 506: 281 - 287.

[27] Pinto TDS, Becker V. Diel dynamic of phytoplankton functional groups in a tropical water supply, Extremoz Lake, northeastern Brazil. Acta Limnol. Bras. 2014; 26(4): 356 - 366.

[28] Blomqvist P, Peterson A, Hyenstrand P. Ammonium-nitrogen: a key regulatory factor causing dominance of non-nitrogenfixing Cyanobacteria in aquatic systems. Arch. Hydrobiol. 1994; 132: 141 – 164.

[29] Anneville O, Ginot V, Druart JC, Angeli N. Long-term study (1974-1998) of seasonal changes in the phytoplankton in Lake Geneva: a multi-table approach. J. Plankton Res. 2002; 24: 993 - 1007.

[30] Chisholm SW. Phytoplankton size. In: Falkowski PG, Woodhead AD. & Vivirito K, eds: Primary production and biogeochemical cycles in the sea. Boston: Springer. 1992; 213 -.237.

[31] Riegman R., Flameling IA, Noordeloos AAM. Size-fractionated uptake of ammonium, nitrate and urea and phytoplankton growth in the North Sea during spring 1994. Mar. Ecol. Prog. Ser. 1998; 173: 94 - 85.