Spatial and Temporal Distribution of Phytoplankton at Cirata Reservoir in Relation to Aquatic Primary Productivity

Zahidah Hasan

Program Studi Perikanan, Fakultas Perikanan dan Ilmu Kelautan
Universitas Padjadjaran (Departement of Fisheries, Faculty of Fisheries and Marine Science, Padjadjaran University)
Jl. Raya Jatinangor Km 21 Sumedang Tlp/fax : 62-22-7797763, Hp : 62-22- 70020583
Kodepos Ujungberung 40600
irahebatku@yahoo.co.id

ABSTRACT

Research on the spatial and temporal distribution of phytoplankton at Cirata Reservoir in relation to aquatic primary productivity had been conducted from March 2003 to March 2004. The aim of the research were to identify and learn spatial and temporal distribution of phytoplankton and interaction between phytoplankton and aquatic properties which affect it. Monthly sampling have been done at 5 (five) chosen stations. Two ways multivariate analysis of variance applied to identify spatial and temporal distribution of net primary productivity (NPP), biomass, orthophosphate, nitrate, ammonia, organic matter, dissolved oxygen, carbondioxide, and temperature. Multiple regression equations are applied to identify functional interrelation between net productivity and biomass with abiotic environment and interrelation between dissolved oxygen and organic matter and NPP. Result of the research showed that temporal distribution of organic matter significantly differ, but not in spatial distribution. NPP showed significant different in spatial distribution but not in temporal distribution. Biomass and NPP are higher in rainy season than dry season. Negative elimination that indicates phytoplankton development appears at the end of dry season and several months of rainy season.

Key words: Phytoplankton, Cirata, Distribution, Net Primary Productivity

Introduction

Cirata reservoir is the second reservoirs in Citarum cascade reservoirs after Saguling at the upland and before Jatiluhur in lowland. Major function of Cirata as Hydroelectric power, others function as recreational area, and Floating net cages aquaculture (FNCA) area. Cirata reservoir receive organic and anorganic material from Saguling reservoir and Citarum River and its tributaries that entered to Cirata reservoir. In the other hand FNCA activities contribute in organic material raising that tend to higher productivity and then eutrophication level.

Raising aquatic productivity initiated by changed in physicochemical characteristic which followed with others change, usually harmfull. Usually phytoplankton is the first biological variable which respon to those change. Lawrence et.al. (2000) explain that nutrient availability , light, mixing, water residence time and temperature are major factor in regulating phytoplankton growth and composition in reservoirs. Furthermore were eplained that mechanism of those factors are complicated and variable and also affected by latittude, catchment area landuse and its management, reservoir depth, drawdown morfology and condition and also climate variation. Net Primary Productivity (NPP), phytoplankton biomass and chlorofill a content are three componen in explaining phytoplankton characteristic in lentic water.

Inorganic nutrients, especially phosphorous and nitrogen have to be concern in relation to aquatic primary productivity (Henderson-Sellers dan Markland, 1987). Antrophogenic activities in terestrial ecosystem affect to nitrogen availability in aquatic ecosystem. One of those effects is erosion that brought up nitrogen from this ecosystem. Raising in nitrogen and phosphorous availability in aquatic ecosystem also affected by activities on ecosystem itself such as floating net cages aquaculture .

Nutrient ratio, especially N:P ratio is another factor that affect phytoplankton community besides its availability and concentration (Harris, 1986). N:P ratio determine phytoplankton growth rate and its dominance alteration. N:P of 9,9:1 is common in freshwater ecosystems

Methods

This research was conducted in Cirata reservoir, was filled up in February 1988 at an elevation of 221 m asl. The area of the reservoir is 6,200 ha with total volume of 2,165 million m^3 at its HWL (PT Perusahaan Listrik Negara, 1998). Monthly sampling at 5 (five) stations that represented of low BOD (2 stations) and moderate BOD (3 stations) as showed in Figure 1, was carried out and covered both two season from March 2003 to March 2004. Methods used for all physical, chemical and biological paremeters are listed in Table 1.

Table 1. Parameters were analysized, and its methods

No	Parameters	Units	Methods
1	Phytoplankton: a. biomass b. chlorofill a content c.primary productivity	 $mg.m^{-3}$ $mg.m^{-3}$ $J.m^{-2.}.hour^{-1}$	 Biovolume Spektrofotometri Dark and white bottles
2	Temperature	^oC	Potensiometric
3	Carbon dioxide	$mg.L^{-1}$	Titrimetric
4	Nitrate-N	$mg.L^{-1}$	Spektrophotometric
5	Ammonia-N	$mg.L^{-1}$	Spektrophotometric
6	Orthophosphate-P	$mg.L^{-1}$	Spektrophotometric
7	Dissolved Oxygen	$mg.L^{-1}$	Titrimetric, Winkler
8	Biochemical Oxygen Demand (BOD)	$mg.L^{-1}$	Titrimetric, Winkler

Reference: APHA (American Public Health Association, 1995)

Spatial analysis based on organic matters zonation (in this case of BOD) and temporal analisys refers to dry and rainy season. Two ways multivariate analysis of variance and multiple regresion analysis were used (Johnson dan Wichem, 1992),

Result and Discussion

Phytoplankton mean biomass in rainy season were higher than dry season and moderate zone higher than low zone as showed in Table 2. Mean NPP values higher in dry season than rainy sesaon on low BOD zone, meanwhile on moderate zone its value in rainy season is higher than in dry season as showed in Table 3. Chlorofill a content are higher in dry season than in rainy season in both zones as showed in Table 4. Phytoplankton elimination which indicate phytoplankton development showed in Figure 2.

Table 2. Spatial and temporal phytoplankton mean biomass (µg.L^{-1})

Zone	Station	Dry season	Rainy season	Dry:rainy (%)
Low	Patokbeusi	66.670	198.650	33.56
	Jatinengang	64.395	334.027	19.28
	Average	65.533	266.336	26.42
Moderate	Gandasoli	40.715	171.169	23.79
	Cicendo	43.799	222.241	19.71
	Cihea	77.437	607.105	12.76
	Average	53.984	333.505	18.75

Table 3. Spatial and temporal net primary productivity (J.m^{-2}.hari^{-1})

Zone	Station	Dry season	Rainy season	Dry:rainy (%)
Low	Patokbeusi	2.249	3.083	72.97
	Jatinengang	2.365	1.576	150.1
	Average	2.307	2.3295	99.03
Moderate	Gandasoli	2.053	2.181	94.12
	Cicendo	0.992	2.66	37.28
	Cihea	1.953	2.729	71.55
	Average	1.666	2.523	67.65

Table 4. Spatial and temporal chlorofill a content (µg.L $^{-1}$)

Zone	Station	Dry season	Rainy season	Dry:rainy (%)
Low	Patokbeusi	23.0782	20.4335	112.94
	Jatinengang	37.4405	19.2694	194.3
	Average	30.25935	19.85145	153.62
Moderate	Gandasoli	19.4658	19.6998	98.81
	Cicendo	27.6566	15.2057	181.88
	Cihea	35.2224	17.3262	203.29
	Average	27.44827	17.41057	161.3267

Negative elimination that indicates phytoplankton development appears at the end of dry season and several months of rainy season as showed in figure 2. However there are extreme high (negative and positive values) in Cihea, that is mouth of Citarum River in Cirata reservoir so that values in others station not seems markedly. This condition indicate that in riverine areas in reservoir growth and mortality fluctuation of phytoplankton tend to be incisively. Multivariate analysis resulted as showed in Table 5 and Table 6. Table 5 detailed multivariate matrix between factors and dependent variables, meanwhile Table 6 showed regresion model between phytoplankton or NPP and its determining variables.

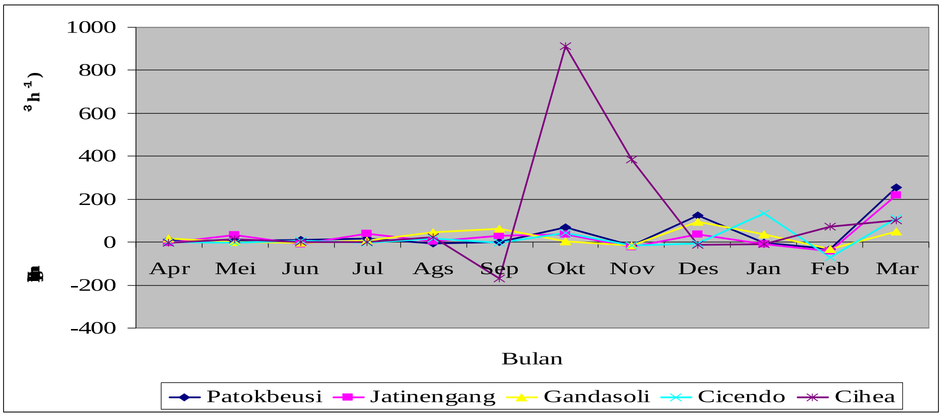

Figure 2. Phytoplankton elimination dynamic

Table 5. Multivariate Matrix between factors and dependent variables

dependent variable	Factors	
	Temporal	**Spasial**
NPP	Not affected. dry season and rainy season not significantly difference	Affected by zone. low zone higher than moderate zone.
PO_4-P	Affected. rainy season higher than dry season	Not affected. low zone and moderate zone not significantly difference
NO_3-N	Affected. rainy season higher than dry season	Affected by zone. low zone higher than moderate zone.
NH_3-N	Affected. rainy season higher than dry season	Affected by zone. low zone higher than moderate zone.
BOD	Affected. rainy season higher than dry season	Not affected. low zone and moderate zone not significantly difference
DO	Not affected. dry season and rainy season not significantly difference	Not affected. low zone and moderate zone not significantly difference
CO_2	Affected. rainy season higher than dry season	Affected by zone. low zone higher than moderate zone.

Temperature	Affected. rainy season higher than dry season	Not affected. low zone and moderate zone not significantly difference

Table 6. Regresion model between NPP or phytoplankton biomass and its determining variable

Variable	Season	Intersept	PO_4-P	NO_3-N	NH_3-N	CO_2	R^2
NPP	Dry	-1.754	-3.920	27.598	-4.880	0.002	0.08
	Rainy	1.491	-3.286	-3.267	3.445	0.039	0.14
Biomass	Dry	16.609	**-2.323***	-6.632	**-3.014***	0.008	0.18
	Rainy	15.077	0.417	-0.591	-0.170	-0.016	0.08

Note : Value with * mark showed that linier regresion model NPP or biomass variable and determining variable is significant in F test with $\alpha = 0.2$

Conclusion

In conclusion :

1. Phytoplankton growth (negative elimination values) appeared in both seasons and in all station, although in low level except in riverine areas (Station of Cihea) there are markedly growth and elimination of phytoplankton between end of dry season and early of rainy season (There is markedly growth in September with elimination negative values of – 1.7 x 10^9 mg.J.m.$^{-3}$.day^{-1}. And there is positive elimination value of 9.13 x 10^9 mg.J.m.$^{-3}$.day^{-1} in Oktober.
2. NPP values were not determined by any variables in both seasons, meanwhile biomass determined by orthophosphat-P and ammonia-N in dry season and not determined by any variables in rainy season

References

APHA (American Public Health Association). 1995. Standard Methods For Examination of Water and Waste Water 19th ed. APHA - AWWA. Washington D.C.

Harris. G. P. 1986. Phytoplankton Ecology. Chapman and Hall Ltd. New York.

Henderson-Sellers. B and H.R. Markland. 1987. Decaying Lakes. John Wiley and Sons. Chichester

Johnson. R.A. and D.W. Wichem. 1992. Applied Multivariate Statistical Analysis. Prentice Hall. Englewood Cliffs. New Jersey.

Lawrence. I.. M. Bormans. R. Oliver. G. Ransom. B. Sherman. P. Ford and N. Schofield 2000. Factors controlling Algal Growth and Composition in Reservoirs: Report of Reservoir Manager's Workshops. Cooperative Research Centre for Freshwater Ecology. http:// Freshwater.canberra.edu.au

Perusahaan Listrik Negara (PLN). PT. 1998. Cirata and Saguling Environmental Studies and Training. Final Report.