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Water Quality Monitoring Using Wqi Method In Cemara Sewu Shrimp Farm Jetis Cilacap Regency

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Abstract. The problem and decilining of water quality shrimp farm is important to be observed. It's make the study of monitoring and water quality status have to carried out. The aim of this study is to investigate of water quality in Cemara Sewu Shrimp Farm using Water Quality Index (WQI) method. The research was conducted at October 2018. The survey method and Purposive random sampling were applied in this research. Sampling location was divided into 6 location with 3 repeat. The data was analyzed using One Way Anova and Water Quality Index to categorized the water quality of Cemara Sewu Shrimp Farm. The result show that WQI result between range 54,46 – 71,84. Station VI was the highest WQI result and the lowest WQI result was station I, respectively. Generally, water quality parameters show significantly different ($p < 0,05$) except temperature. According WQI status, Cemara Sewu Shrimp Farm classified into medium category.

Key Words: *water quality, WQI, Cemara Sewu*

1.   Introduction

CV. Cemara Sewu Sumber Rejeki is the Vaname shrimp farming which located in Jetis, Cilacap Regency. The shrimp farm is the super intensive farming with density 130 individu/m^2. The shrimp farm has a large area 18 ha and divided into two location. Block A is the area in Cemara Sewu that borders with Ijo River Estuary. While Block B is the area in Cemara Sewu that border with Jetis Coastal. Cemara Sewu Shrimp Farming using both water sources, that are Ijo River and sea water of Jetis Coastal. Jetis Coastal is located in the south of Java Island and borders with the Indian Ocean. Meanwhile the Ijo River is a river that passes through Rowokele, Cilacap Regency and Ayah, Kebumen Regency.

Human activities along the river has given pollution of domestic waste [1]. The waste contained in Ijo River water then enter to the Cemara Sewu shrimp ponds. It has caused on decreasing water quality of shrimp ponds.

Shrimp farming is hihgly dependent on the water quality. The success of shrimp farming have to supported by water quality consisted of physical, chemical and biological parameters. Water quality plays a role in supporting growth of shrimp. The low of water quality can cause declining growth rate and also cause growth of bacteria and pahtogenic organisms [2].

On of the method commonly used for water quality monitoring was Water Quality Index (WQI). The Water Quality Index represents a numerical expression that is used in the flowing water quality assessment [3]. WQI used to determine the status of water quality singly. Monitoring and determine the status of water quality and in Cemara Sewu using WQI method to be important. Therefore, study on water quality monitoring using WQI method is needed. The aim of this study is to determine water quality differences between stationsin Cemara Sewu Shrimp Farm and determine water quality status using WQI method.

2.   Material and Method

Sampling were conducted in Cemara Sewu Shrimp Farm, Jetis, Cilacap Regency (Figure 1). Survey method and purposive random sampling were applied in this study. Sampling location were divided into 6 stations. Both station I and station II were location of source water for shrimp ponds. The station in Block A consisted of station III and IV, station in Block B consisted of station V and VI.

Figure 1. Sampling location in Cemara Sewu Shrimp Farm, Jetis, Cilacap Regency (Source: google earth)

Table 1. Sampling location with coordinate

Station	Location	Coordinate
I	Source water of Ijo estuary	S 7° 43' 2" E 109° 23' 12"
II	Source water of Jetis coastal	S 7°43'13" E 109° 22' 55"
III	Block A 1	S 7°43'12" E 109°23'11"
IV	Block A 2	S 7°43'9" E 109°23'3"
V	Block B 1	S 7°43'15" E 109°23'7"
VI	Block B 2	S 7°43'20" E 109°23'18"

Water quality parameters were measured according National Sanitation Foundation-Water Quality Index (NSF-WQI) consisted of temperature, turbidity, Total Suspended Solid (TSS), pH, dissolved oxygen (DO), biological oxygen demand (BOD), nitrate, phosphate and total coliform. Water samples were collected at October, 2018. In situ measure sample consisted of temperature and DO. While the ex situ sample were analyzed in Faculty of Fisheries and Marine Jenderal Soedirman University, Laboratory consisted of turbidity, TSS, pH, BOD, nitrate, phosphate andtotalcoliform.

Table 2. Parameters were measured with method

Parameters	Method/tool
Temperature (°C)	Expansion/termometer [4]
Turbidity (NTU)	Nephelometri/turbiditimeter [4]
Total Suspended Solid (TSS) (mg/L)	Distillation [5]
pH	Electrometric/pH meter [4]
Dissolved Oxygen (mg/L)	Winkler [4]
Biological Oxygen Demand (BOD) (mg/L)	Winkler [4]
Nitrate (mg/L)	Spectofotometry [4]
Phosphate (mg/L)	Askorbat acid [6]
Total Coliform (Koloni/ 100 Ml)	Total plate count [7]

The data obtained were analyzed using One way anova was use for analyze water quality significantly different (0,05) between stations. If the data significance, the mean value afterwards were analyzed use post hoc Tukey's. The Water Quality Index was calculated according to the method by National Sanitation Foundation-Water Quality Index (NSF-WQI) [8].

$$\text{WQI} = \sum_{i=1}^{!} ¤¤¤¤$$

Information:
WQI   = *Water Quality Index*
Qi   = sub index for variabel i
Wi   = weight factor for variabel i
n   = number variabel.

Table 3. Weight of each parameters factor

Parameters	Wight
Dissolved Oxygen	0,17
Total coliform	0,16
pH	0,11
Biological Oxygen Demand	0,11
Temperature	0,10
Phospate	0,10
Nitrate	0,10
Turbidity	0,08
Total Dissolved Solid	0,07

WQI values have obtained afterwards classified into water quality status according water quality index.

Table 4. water quality criteria according WQI status.

WQI Range	Category
90-100	Very good
70-89	Good
50-69	Medium
25-49	Bad
0-24	Very Bad

3.   Result and Discussion

Sampling and parameters measured has been carried out in Cemara Sewu Shrimp Farm, Jetis, Cilacap Regency. Parameters were measured consisted of temperature, turbidity, TSS, pH, dissolved oxygen (DO), BOD, nitrate, phosphate, and total coliform. The result of water quality parameters ($\bar{x}$ + Stdv) presented in table 5.

Table 5. Data of water quality were measured in Cemara Sewu Shrimp Farm each station.

Parameter	Station					
	I	II	III	IV	V	VI
Temperature	27,50 ± 0,50	25,83 ± 0,29	27,17 ± 0,29	27,00 ± 0,50	27,17 ± 1,15	26,83 ± 0,29
Turbidity	63,30 ± 16,2	8,353 ± 1,883	50,773 ± 4,344	53,60 ± 7,62	34,687 ± 7,379	38,663 ± 11,936
TSS	264,270 ± 35,661	117,873 ± 5,109	198,410 ± 3,875	217,617 ± 4,290	187,857 ± 2,347	132,363 ± 11,413
pH	6,807 ± 0,234	7,743 ± 0,060	6,990 ± 0,120	7,130 ± 0,046	7,177 ± 0,032	7,167 ± 0,035
DO	4,20 ± 0,53	3,37 ± 0,70	6,27 ± 0,46	6,53 ± 1,01	6,27 ± 0,92	6,80 ± 0,40
BOD	16,90 ± 9,53	1,873 ± 2,042	4,643 ± 1,802	5,30 ± 1,28	5,57 ± 1,04	4,07 ± 1,33
Nitrate	1,1360 ± 0,0410	0,4087 ± 0,0167	1,2537 ± 0,0150	1,3090 ± 0,0250	0,5910 ± 0,5925	0,3530 ± 0,0115
Phosphate	0,3840 ± 0,0079	0,0810 ± 0,0082	0,2183 ± 0,0156	0,1497 ± 0,0384	0,1517 ± 0,0075	0,0907 ± 0,0059
Total coliform (10^8 coloni/100 mL)	6,97 ± 0,15	5,57 ± 0,45	6,70 ± 0,40	5,83 ± 0,46	5,10 ± 0,36	6,03 ± 0,31

In this study, temperature parameter show that there was no significant difference between stations ($p > 0,05$). It might be caused by rain which cause temperature be the homogen. In addition, distance between stations not to far away so that the temperature was no difference significantly.

There was significant difference between stations in turbidity parameter ($p < 0,05$). According post hoc Tukey's test, Station II had significant difference between another stations. It due to sea water thinning which cause turbidity in station II was the lowest. Station in shrimp ponds (III, IV, V and VI) showed there was no significant difference. Turbidity in shrimp ponds can caused by mud substrate in the pond. In addition feeding residue can also influence turbidity in shrimp pond.

TSS value was obtained show that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station I had significant difference between another stations. It might be caused by input of matter suspension in river [9]. Mean of TSS value in shrimp ponds (III, IV, V and VI) between range $132,363 \pm 11,413 - 217,617 \pm 4,290$. TSS value in shrimp ponds might be influenced by shrimp feces and feeding residue [10].

Results obtained for pH showed that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station II had significant difference between another stations. Station II was the coastal water and have higher salinity which cause high pH. Mean of pH value in shrimp ponds (station III, IV, V and VI) between range $6,990 \pm 0,120 - 7,177 \pm 0,032$. Value of pH in shrimp ponds might be caused by liming treatment.

DO value was obtained show that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station I and II had significant difference between another stations. Station II was the coastal water which have higher salinity than station in shrimp ponds. Dissolved oxygen decrease with increasing of salintiy [11]. Range of DO in shrimp ponds (station III, IV, V and VI) between $6,27 \pm 0,46 - 6,80 \pm 0,40$ mg/L. The value of DO in shrimp ponds can caused by aeration mecanism and photosyntesis by phytoplankton [12].

BOD value was obtained show that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station I had significant difference between another stations. It might due to the decomposition organic matter in station I. Range of BOD in shrimp ponds (station III, IV, V and VI) between $4,07 \pm 1,33 - 5,57 \pm 1,04$ mg/L. BOD value in shrimp ponds can caused by feeding activity [13]

Results obtained for nitrate showed that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station IV had significant difference between another stations. It might be caused by decomposion organic matter which increase nitrate concentration in culture pond. The increase of organic matter from decomposition can cause nitrate concentration increased [14].

Results obtained for phosphate showed that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station I had significant difference between another stations. It might be caused by run off river that contain phosphate in the waste [15]. Mean of phosphate value in shrimp ponds (station III, IV, V and VI) between range $0,0907 \pm 0,0059 - 0,2183 \pm 0,0156$. Application of liming materials to increase pH could also be associated with elevated phosphate concentration in the culture ponds [16].

Total coliform was obtained show that there was significant difference between stations ($p < 0,05$). According post hoc Tukey's test, Station V had the lowest total coliform containing and significant difference between another stations. It might due to the least input bacteria through river water. While station I was the lowest total coliform due to high input river water thath containing bacteria. Total of coliform bacteria due to domestic waste which into the shrimp pond [16]. In addition, culture activity can also increase total coliform through nutrien containing [17]

Parameter value were obtained afterward analyzed by WQI method. The each value parameter imported to Water Quality Index calcuation and result in sub index (Qi). The sub index after that multiplied by weight factor (Wi) which are then summed to obtain WQI value (table 6).

Table 6. Water Quality Index calcuation in each station in Cemara Sewu Shrimp Farm.

No	Parameter	Wi	Station I	Station II	Station III	Station IV	Station V	Station VI

|		Wi	Qi	Wi x Qi	Qi	Wi x Qi	Qi	Wi x Qi	Qi	Wi x Qi	Qi	Wi x Qi	Qi	Wi x Qi
1	Δ Temperature	0,11	88	9,63	89	9,79	94	10,31	94	10,31	93	10,24	92	10,10
2	Turbidity	0,08	30	2,40	80	6,37	38	3,04	37	2,93	48	3,82	45	3,60
3	TSS	0,07	63	4,42	83	5,78	72	5,03	69	4,84	73	5,13	81	5,65
4	pH	0,11	82	9,05	89	9,79	87	9,58	90	9,93	91	10,03	91	10,01
5	DO saturation	0,17	47	8,03	31	5,32	86	14,55	90	15,23	86	14,55	92	15,57
6	BOD	0,11	17	1,84	78	8,54	58	6,43	55	6,02	53	5,85	62	6,82
7	Nitrate	0,10	87	8,70	92	9,17	86	8,63	86	8,59	90	9,05	92	9,21
8	Phosphate	0,10	57	5,73	84	8,37	67	6,69	73	7,33	73	7,31	82	8,18
9	Total coliform	0,16	2	0,32	2	0,32	2	0,32	2	0,32	2	0,32	2	0,32
	WQI			50,13		63,44		64,57		65,49		66,30		69,45
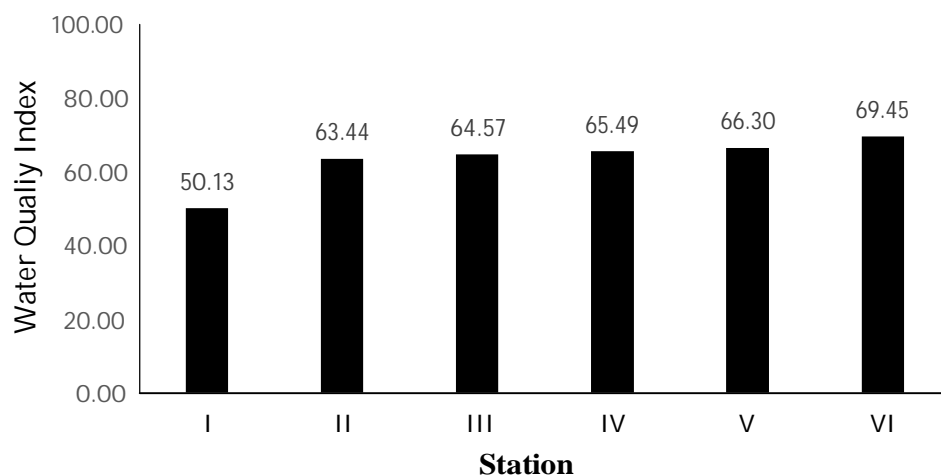
Figure 2. Water Quality Index value on each stations in Cemara Sewu Shrimp Farm.

Figure 2 show that station VI was the highest WQI value in Cemara Sewu Shrimp Farm. The high of WQI value might be caused by some parameters which have good range. This parameters consisted of pH (7,167 ± 0,035), dissloved oxygen (6,80 ± 0,40 mg/L) and nitrate (0,3530 ± 0,0115 mg/L). The third parameters in station VI gives the value sub index (Qi) of the high. While the lowest WQI value in Cemara Sewu Shrimp Farm was station I as source water of the shrimp farm. Some parameters in Station I have not better range than another stations. This parameters consisted of turbidity (63,30 ± 16,2), TSS (264,270 ± 35,661 mg/L), pH (6,807 ± 0,234), BOD (16,90 ± 9,53 mg/L) and phosphate (0,3840 ± 0,0079 mg/L). The parameters in station I gives the value sub index (Qi) of the lowest. According WQI status, water source of Cemara Sewu Shrimp Farm (station I and

II) were categorized medium. While the WQI status in Cemara Sewu Shrim Farm (Station III, IV, V and VI) also categorized medium.

4.   Conclusion

There was significant difference on parameters water quality between stations except, temperature, while the status of water quality in Cemara Sewu Shrimp Farm categorized medium.

References

[1] Nuraina Andriyani, Arif Mahdiana, Rose Dewi, Yusuf Subagyo, Asrul sahri siregar, Teuku Junaidi, Taufan harisam. 2018. Biodiversity of algae potentially HABS (Harmfull Algae Blooms) in reservoir Mrica, Banjarnegara. E3S Web of Conferences 47, 03001 .

[2] Arsad, S., Afandy, A., Purwadhi, A.P., Betrina, M.V., Saputra, D.K., Buwono, N.R. 2017. Studi Kegiatan Budidaya Pembesaran Udang Vaname (*Litopenaeus vannamei*) dengan Penerapan Sistem Pemeliharaan Berbeda. *Jurnal Ilmiah Perikanan dan Kelautan.* **9 (1)**: 1-14.

[3] Ionus, O. 2010. Water Quality Index-Assessment Mehtod of the Motru River Water Quality (Oltenia, Romania). *University of Craiova.* **13:** 74-83.

[4] APHA. 2012. *Standard Methods for the Examination of Water and Wastewater, 22nd Edition.* American Public Health Association (APHA). Washington D.C.

[5] Alaerts, G. Santika, S. S. 1984. *Metode Penelitian Air*. Usaha Nasional. Surabaya.

[6] Badan Standarisasi Nasional. 2005. *SNI 06-6989.31-2005 Cara Uji Kadar Fosfat dengan Spektrofotometer secara Asam Askorbat*. Badan Standarisasi Nasional. Jakarta.

[7] World Health Organization. 1982. Bacteriological Examination. *Examination of Water Pollution Control*. **3**: 273-531.

[8] Tyagi, S., Sharma, B., Singh, P., Dobhal, R. 2013. Water Quality Assessment in Terms of Water Quality Index. *American Journal of Water Resources.* **1 (3)**: 34-38.

[9] Tarigan, M.S., Edward. 2003. Kandungan Total Zat Padat Tersuspensi (*Total Suspended Solid*) di Perairan Raha, Sulawesi Tenggara. *Makara Sains.* **7 (3)**: 109 – 120.

[10] Timmons, M.B., Losordo ,T.M. 2000. *Aquaculture Water Reuse Systems: Engineering Design and Management.* Elsevier. New York.

[11] Effendi, H. 2003. *Telaah Kualitas Air*. PT Kanisius. Yogyakarta.

[12] Mateka, H.A., Tamatamah, R., Kyewalyanga, M., 2015. Study on the Water Quality Parameters in Semi-Intensive Coastal Shrimp Culture System in Mafia Island, Tanzania. *Journal of Environment and Earth Science*. **5 (1)**: 142-150.

[13] Kordi, K.M.G.H., Tancung, A.B. 2010. *Pengelolaan Kualitas Ai dalam Budidaya Perairan.* Rineka Cipta. Jakarta.

[14] Santosa, M.B., Wiharyanto, D. 2013. Studi Kualitas Air di Lingkungan Perairan Tambak Adopsi *Better Management Practices* (BMP) pada Siklus Budidaya I, Kelurahan Karang Anyar Pantai Kota Tarakan Propinsi Kalimantan Utara. *Jurnal Hardopon Borneo.* **6 (1)**: 49-56.

[15] Purwiyanto, A.I.S., Agustraini, F. 2014. Effect of Silvofishery on Ponds Nutrient Levels. *Ilmu Kelautan.* **19 (2)**: 81-87.

[16] Sutiknowati, L.I. Kualitas Perairan Tambak Udang berdasar Parameter Mikrobiologi. *Jurnal Ilmu dan Teknologi Kelautan Tropis.* **6 (1)**: 157-170.

[17] Sutapa, I.D.A., Widiyanto, T. 2014. Kualitas Mikrobiologis Air Sungai dan Pipa Distribusi di Kabupaten Aceh Besar dan Kota Banda Aceh. *Limnotek.* **21 (2)**: 135-144.