Self-purification performance of Brantas river from deoxygenation rate of carbon

by Evy Hendriarianti

PAPER • OPEN ACCESS

Self-purification performance of Brantas river from deoxygenation rate of carbon

Journal of Physics: Conference Series **1375** (2019) 012044 doi:10.1088/1742-6596/1375/1/012044

Self-purification performance of Brantas river from deoxygenation rate of carbon

E Hendriarianti[1*], S Sudiro[1], K Kustamar[2] and A Nurhayati[1]

[1]Environmental Engineering Department, National Institute of Technology, Malang, Indonesia
[2]Civil Engineering Department, National Institute of Technology, Malang, Indonesia

*evyhendriarianti@lecturer.itn.ac.id

Abstract. The Brantas River that crosses several districts and cities in East Java province receives pollutant loads from various human activities along its watershed. On the other hand, the Brantas river is also used as a source of water from various human activities along the watershed. Naturally, the river has the ability to recover through physical, chemical and biological processes. The ability of river to recover from pollution can be seen from the rate of carbon deoxygenation. Therefore, conducted research to see the performance of Brantas river self-purification starting from upstream in the Pendem Batu Bridge to the downstream at Padangan Mojokerto Bridge with 11 (eleven) locations of water sampling. Carbon deoxygenation determination method using Thomas method. The results showed varying deoxygenation rates with a range of values 0.001 / day to 0.028 / day. The highest rate of Carbon deoxygenation lies in the sampling location at Kesamben Bridge Blitar and the lowest is at the location at Dinoyo Bridge Malang. Brantas river deoxygenation rates is lower than Metro river in Malang regency, Brantas river in Malang city, Citarum upstream river, Cikapundung river and Citepus river. So it is concluded that the Brantas river self-purification performance from Carbon deoxygenation rate is lower. Brantas river management efforts should consider this factor in the handling of organic pollutant sources. The wastewater quality standard that have the same value.

1. Introduction

Dissolved oxygen become one of the parameters of river water quality which is important in maintaining the sustainability of the river as a water resource [1]. Dissolved oxygen is needed by most aquatic living. The minimum concentration is 3-4 mg / L and the desired concentration of 5 -7 mg / L is related to the need for oxygen for other purposes, such as algae respiration and biochemical oxidation processes. The kinetics of dissolved oxygen in natural water bodies are complex. The source of dissolved oxygen comes from external supply, photosynthesis and surface reaeration. While the use of dissolved oxygen for the decomposition of dissolved organic matter (BOD and COD) and in sediment (SOD), algae respiration and fish and nitrification. Most of these processes occur biologically and occur more than one-time period [2].

The kinetics process of dissolved oxygen above illustrates the source and use of dissolved oxygen. Dissolved oxygen is an important factor in the recovery of rivers from pollutants. Recovery of river water is a complex process involving physical, chemical and biological processes that occur continuously along the river flow [3]. Dissolved oxygen is used by microorganisms to decompose organic matter [4]. This rate of reduction of dissolved oxygen for the oxidation process of organic matter

Journal of Physics: Conference Series **1375** (2019) 012044 doi:10.1088/1742-6596/1375/1/012044

is known as the rate of deoxygenation [5]. The ability of the river to decompose organic matter is one element of river's self-purification. The oxidation ability of organic matter determines the value of the river's capacity to accept pollutant load [1]. The self-purification study is important for fundamental approaches to ecological problems and problem solving issues related to the sustainability of natural resource use [6].

This study aims to determine the self-purification of the Brantas river from the rate of Carbon deoxygenation. Carbon deoxygenation rates show a decrease in oxygen per day for the Carbon oxidation process [7]. The Brantas river which receives the burden of organic pollutants needs to know its oxidation ability from the rate of carbon deoxygenation. Carbon deoxygenation rates are useful in modeling river water quality and dynamic models of river dissolved oxygen kinetics. Self-purification involves several different mechanisms such as dilution, sedimentation, reaeration, adsorption, absorption and chemical and biological reactions. This complex mechanism is evaluated by a mathematical model. A mathematical model of an important tool for making water resources planning and management [3]. The study was conducted on the Brantas River starting from the Pendem Bridge in Batu City to the Mojokerto Padangan Bridge divided into 10 river segments with 11 (eleven) water quality sampling points as shown in figure 1. River water sampling is carried out in April 2018 during the dry season.

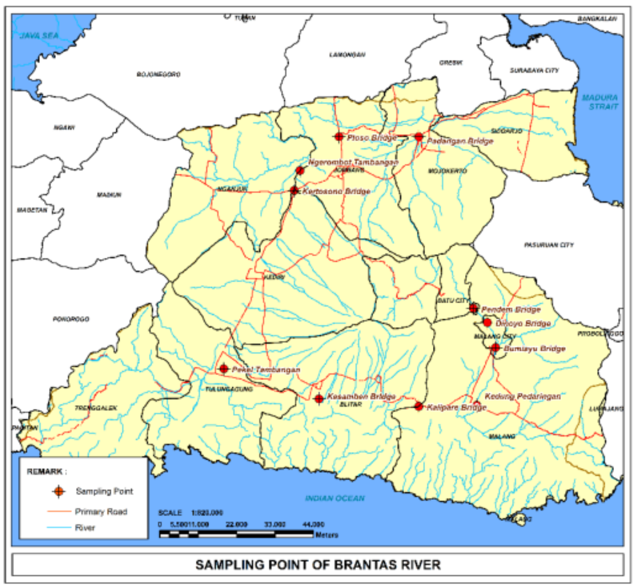

Figure 1. Sampling point.

2. Method

River water sampling method uses a method of sampling river based water on SNI 6989.57: 2008 Sampling Method of Surface Water [8]. Methods for determining the rate of carbon deoxygenation using the Thomas method with the following formula.

$$(t/y)^{1/3} = 1/(2{,}3kL_0)^{1/3} + \left[(2{,}3k)^{2/3}/6L_0^{1/3}\right]t \quad (1)$$

Plot $(t/y)^{1/3}$ with t result slope as $(2{,}3k)^{2/3}/6L_0^{1/3}$ and intercept as $1/(2{,}3kL_0)^{1/3}$.
Deoxygenation value, k and BOD_u, L_0 calculated using this following formula.

$$k = 2{,}61(\text{slope}/\text{intercept}) \quad (2)$$

$$L_0 = 1/(2{,}3k.\text{intercept}^3) \quad (3)$$

Journal of Physics: Conference Series **1375** (2019) 012044 doi:10.1088/1742-6596/1375/1/012044

In determining the deoxygenation rate, long-term BOD data are used with BOD analysis time intervals in 1, 2, 3, 4, 5, 10, 15, 20, 25 and 30 days. The term BOD analysis uses APHA Standard methods analysis method.5210 B -1998.

3. Results and discussion

The quality of the Brantas river DO shows fluctuations in value from 1.6 mg / L to 7.4 mg / L as in the following figure 2. The lowest value of DO is at the location of the Kesamben Bridge sampling point. This very low DO value indicates low river water quality. Water biota survives in DO river conditions at a minimum of 3-4 mg / L (Palmer, 2001). As for the BOD_5 value shows a range of 2.61 mg / L - 6.09 mg / L. DO and BOD_5 profiles are different, where DO profiles fluctuate more sharply than BOD_5 profiles. Dissolved oxygen is used to oxidize organic material in water quality samples, so that the initial DO difference value and the 5th day DO are obtained as BOD_5 values. From the graph below, we can see the BOD_5 value at the sampling point of the Kalipare Bridge and Kesamben Bridge above the initial DO value. This shows in the water quality sample at both sampling points, DO values on day 5 were deficit. In natural conditions, this is at risk for river sustainability if the organic pollutant load is greater than the oxygen supply from the reaeration and photosynthesis processes. The river has no self-purification. Conversely, if the oxygen supply from the reaeration and photosynthesis process is greater than the value of organic deoxygenation, SOD and respiration, the river still has the ability to recover from organic Carbon pollutants.

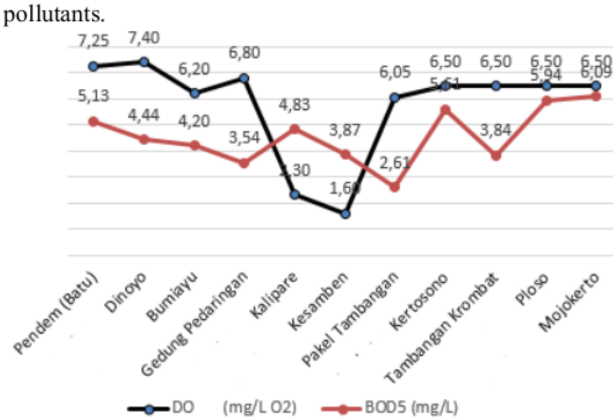

Figure 2. Determination result of DO and BOD_5.

The graph on figure 3 below shows deoxygenation rate of Carbon at Brantas river. The values are fluctuative. The range value from 0,001/day until 0,055/day. The result of carbon deoxygenation (kd) value in Brantas River is compared with other rivers in Indonesia such as Metro river, Citarum river, Cikapundung river, Citepus river in West Java and Brantas river in Malang city. The carbon deoxygenation value in Brantas River of Malang City ranged from 0.019 / day to 0.046 / day [7] The deoxygenation value of carbon (kd) Upstream Citarum River that ranges from 0.169 / day to 0.482 / day [9]. While on the Cikapundung river of 0.01 / day - 0.37 / day and river Citepus of 0.031 / day -0.48 / day [10]. Metro River in Malang Regency ranges from 0.45 / day to 0.63 / day [11]. For Cimanuk river, the value range from 0,06 /day – 0,12 /day [12]. When compared, the value of Carbon deoxygenation (kd) in the Brantas River in this research lower than in all the researches before above. The low value of carbon deoxygenation shows that the decomposition process of organic material in Brantas River has occurred slowly [10]. In addition, it also shows the lower the ability of the river to oxidize and purify naturally.

Carbon deoxygenation rate shows the ability of Carbon decomposing organisms that depend on river flow, organic matter content and temperature. From [5] the highest deoxygenation values were obtained during winter when the minimum flow and organic load were high. Low flow and low water temperature cause low water supply of oxygen from the reaeration process. This research was conducted in the summer where the river water temperature was also higher, but the value of carbon deoxygenation was low. This condition is caused by lower flow in the dry season and higher organic matter content.

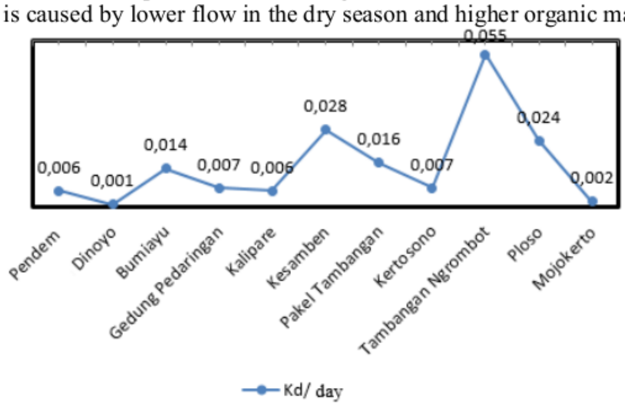

Figure 3. Determination result of deoxygenation rate of carbon (Kd).

From the graph at figure 4 can be seen the estimated BOD ultimate value by the Thomas method. The highest ultimate BOD value is found in Dinoyo Bridge (415.24 mg / L) and the lowest is in Tambangan Ngrombot (0.95 mg / L). The ultimate BOD value shows the amount of dissolved oxygen demand used by heterotropic organisms to oxidize all organic Carbon materials in river water [13]. The greater the biodegradable Carbon organic material, the greater the ultimate BOD value. Dinoyo Bridge has the most organic matter of biodegradable Carbon. This is due to organic pollutants from domestic wastewater along the Brantas river flow from the upper reaches of the river in the city of Batu. In addition, the low rate of Carbon deoxygenation on the Dinoyo Bridge causes a high content of the ultimate BOD [14]. Biodegradation of organic matter requires oxygen measured as BOD. Therefore, the ultimate BOD value is related to the rate of Carbon deoxygenation.

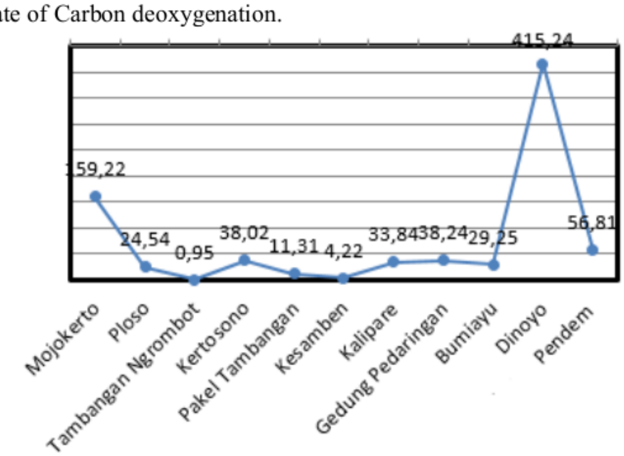

Figure 4. Determination result of BOD ultimate (Lo).

Brantas River is a strategic river for the province of East Java. Approach of capacity and carrying capacity of the Brantas river is needed in development planning in the East Java region. River capacity shows the river's self-recovery ability against river pollutants [4]. River recovery is one of them approached from the Carbon deoxygenation rate [3] So that from the Carbon deoxygenation value, it can be seen that the Brantas river's self-purification for Carbon pollutants is lower than some of the rivers reviewed above. This condition can reduce the quality of the Brantas river so that control efforts are needed to improve the ability to recover from Carbon pollutants.

4. Conclusion

The rate of Carbon deoxygenation of the Brantas River in the dry season at eleven water quality sampling locations starts from the Pendem Bridge in Batu City to the Mojokerto City Match Bridge, showing a range of 0.001 / day until 0.055 / day. The Brantas River Carbon deoxygenation rates is lower than the Malang Regency Metro river, the Citarum river upstream, Cikapundung river and Cimanuk river. The low rate of carbon deoxygenation shows the Brantas river's self-purification from Carbon pollutants.

References

[1] Tian S, Wang Z, Shang H, 2011 Study On The Self Purification Of Juma River *Procedia Environmental Science* **11** 2011 Page 1328-1333
[2] Palmer M D 2001 *Water Quality Modelling* (Washington DC: The World Bank)
[3] De Menezes J P C, Bittencourt R P, De Sá Farias M, Bello I P, De Oliveira L F C and Fia R 2015 Deoxygenation Rate, Reaeration And Potential For Self-Purification Of A Small Tropical Urban Stream *Rev. Ambient. Água* **10** N. 4 Taubaté – Oct. Page 748-757
[4] M M Devi K, E B Mano, R Geethamani and S Abinaya 2017 Self-Purification Capacity Of Bhavani River, India Purification Capacity Of Bhavani River, India *J. Engineering Sci.* **6**(3) 1-9 March Page 1-9
[5] Nancy N R, Wei-Jun C, Jacob C, Daniel J C, Brian F, Xinping H, Zoraida Q, Rutger R, Caroline P S, R E Turner, Maren V, Björn W and Jing Z 2014 Eutrophication-Driven Deoxygenation In The Coastal Ocean *Oceanography* **27** 1 Pape 172-183
[6] Ostroumov S A 2005 On The Multifunctional Role The Biota In The Self Purification Of Aquatic Ecosystem *Russian Journal Of Ecology* **36** 6 Page 414-420
[7] Hendriarianti E 2015 Deoxygenation Rate Of Carbon In Upstream Brantas River In The City Of Malang *Journal Of Applied Environmental And Biological Sciences* **5** (12): 36-41
[8] SNI 6989.57 2008 *Sampling Method Of Surface Water*
[9] Harsono E 2010 Establishment Of Organic Water Carbon From Upper Citarum River From Wastewater And Industrial Waste Water (Pencirian Karbon Organik Air Sungai Citarum Hulu Dari Masukan Air Limbah Penduduk Dan Industri *Jurnal Biologi Indonesia* **6** (2)*:* 277-288
[10] Yustani Y M 2016 Determination Of Deoxygenation Rate Of Rivers Located In The Urban Area To Characterize The Pollutant *Pollution Research Paper* **35**(3): 475-481
[11] Hendriarianti E, Wulandari, Candra D, Novitasari, Evelyn 2017 River Water Quality Performance From Carbondioxygenation Rate *International Journal Of Engineering And Management* **1** 1 P. 28-34
[12] Yonik M Y, Sri W and M R Alfian 2018 Investigation On The Deoxygenation Rate Of Water Of Cimanuk River, Indramayu, Indonesia, *Rasayan J.Chem.* **11** 2 Page 475-481
[13] J K Stamer, J P Bennett and Stuart W M 1982 Determination Of Ultimate Carbonaceous BOD And The Specific Rate Constant (K1), US Geographical Survey, Open-File Report Series Number 82-645
[14] Barros F M 2011 Balanço De Oxigênio No Rio Turvo Tujo-MG Em Diferentes Épocas Do Ano *Revista Engenharia Agrícola* **19** 1 P. 72-80

Self-purification performance of Brantas river from deoxygenation rate of carbon

ORIGINALITY REPORT

14%	12%	9%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Pendidikan Indonesia Student Paper	7%
2	textroad.com Internet Source	4%
3	Submitted to Universitas Negeri Semarang Student Paper	3%

Exclude quotes On
Exclude bibliography On
Exclude matches < 2%