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Determination of Water Quality Parameters-Case Study Punduh and Blongkeng Rivers, Magelang

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Abstract

Determination of water quality parameters for temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solid (TSS), total dissolved solid (TDS), ammonia and nitrite on Punduh and Blongkeng Rivers, Magelang, Central Java, Indonesia have been conducted. Sampling test carried out on three points in the upstream, midstream and downstream. The testing methods were performed using volumetric, gravimetric, and UV-Vis spectrophotometer.
The results showed that the water quality parameters River Blongkeng which include temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Suspended Solid (TSS), Total Dissolved Solid (TDS), ammonia and nitrite appropriate water quality standards. Based on the results of the case study, Punduh River water quality parameters that are in accordance raw river water quality for the temperature, pH, DO, TDS, TSS at upstream and downstream and BOD at upstream and midstream. Different from Blongkeng River, the parameter of nitrite at a point upstream, midstream and downstream in Punduh River showed higher results than the standard. The concentration of nitrite in Punduh River approached 0.1 mg / L. Furthermore, the concentration of ammonia in the upstream region exceeding the threshold value with a concentration just over 1 mg / L and an increase to obove 3 mg / L in the midstream and downstream.

Keywords : temperature, pH, DO, BOD, TSS, TDS, ammonia, nitrite, water quality

Introduction

Water is a natural resource that is necessary for the livelihood of many people, even by all living things. Use of water for various purposes should be done wisely by taking into account the interests of present and future generations (Nugroho, 2008). One of the many sources of water used to meet the needs of human life is a river. Changes in water quality can be determined by monitoring water quality. Therefore, water quality monitoring can be used to address specific issues related to watershed management (Asdak,1995).

Magelang is one of regencies in Central Java province. Magelang is an area crossing the path of economic activity-Magelang, Semarang-Yogyakarta-Solo and there are rivers that serve as the lifeblood for the life of the surrounding community, including Punduh and Blongkeng rivers. The water quality of Blongkeng and Punduh Rivers can be determined by monitoring and

testing. This meant that the quality remains at its natural condition and appropriate quality standards as the Government Regulation No. 82 of 2001 on water quality management and water pollution control. The parameters that are commonly used for the determination of water quality is the physical and chemical parameters. Physical parameters include temperature, Total Suspended Solid (TSS) and Total Dissolved Solid (TDS). Chemical parameters include the degree of acidity (pH), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and nitrogen compounds. Testing of these parameters is important because it becomes the size of the pollution load in water, especially contamination of organic material (Moenir, 2007). It is very dangerous if the value exceeds a predetermined quality standards. The test results obtained were compared with river water quality grade II as the Government Regulation No. 82 of 2001.

Materials and Methods

Materials

Whatman filter paper series 934-AH; $MnSO_4 \cdot 4H_2O$ (Merck), amylum indicator, alkali iodide azide, H_2SO_4 98% (Merck), $Na_2S_2O_3$ (Merck), NH_4Cl (Merck), phenol (C_6H_5OH) 89% (Merck), sodium nitro prusside ($C_5FeN_6Na_2O$) (Merck), alkaline citrate ($C_6H_5Na_3O_7$) (Merck), sodium hypochlorite (NaClO) 5% (Merck), sulfanilamide ($H_2NC_6H_4SO_2NH_2$) (Merck), NED di-hydro chloride (Merck), *Certified Reference Material* of nitrite (NO_2) 1000 mg/L (Merck), and distillated water.

Instrument

Thermometer, pH meter (Hanna), Oven (Memmert), analytical balance (Mettler Toledo), porcelain cup, bottle Winkler, heating reflux (CR 2200), spectrophotometer (UVD series Labomed Inc. - 2950) and the laboratory glass ware.

Sampling area

Test sampling carried out on all three points Punduh and Blongkeng rivers are upstream, midstream and downstream. The sample code for Punduh River is 041 (upstream,Hu), 042 (midstream, Tg) and 043 (downstream, Hi). The sample code for Blongkeng River is 044 (upstream, Hu), 045 (midstream, Tg) and 046 (downstream, Hi). Sampling technique using the technique of grab samples. Sampling sites Punduh and Blongkeng rivers shown in Table 1.

Table 1. The water sampling area from sites Punduh and Blongkeng rivers

River	Segment	Location	Coordinates	Land Use
Punduh	Upstream	Jl. Punduh-Kebon Agung Kulon, Tempuran	S: 07º31.879' E: 110º09.611'	settlement and agriculture
	Midstream	Jl Magelang-Purworejo, Punduhsari, Tempuran	S: 07º32.410' E: 110º10.114'	textile industry, livestock, and settlement
	Downstream	Desa Punduh Kidul, Tempuran	S: 07º32.922' E: 110º09.981'	settlement
Blongkeng	Upstream	Desa Pucanganom, Srumbung	S: 07º34.258' E: 110º19.009'	agriculture
	Midstream	Dusun Dangean, Gulon, Salam	S: 07º35.557' E: 110º17.628'	settlement
	Downstream	Desa Blongkeng, Ngluwar	S: 07º37.999' E: 110º15.421'	settlement, livestock, agriculture, and mining of sand

Determination of water quality

Determination of water quality parameters for temperature, pH, dissolved oxygen, biochemical oxygen demand, total suspended solid, total dissolved solid, ammonia and nitrite on Punduh and Blongkeng Rivers, Magelang, Central Java, Indonesia have been conducted. The testing methods were performed using volumetric, gravimetric, and UV-Vis spectrophotometer. Determination of total suspended solid and total dissolved were conducted by gravimetric methods. The value of dissolved oxygen and biochemical oxygen demand were performance by Winkler titration methods. And than, the concentration of ammonia and nitrate were determined by UV-Vis spectrophotometry methods.

Result and Discussion

The parameter of temperature and pH

Figure 1. shows that Punduh River water temperature value in the upstream, midstream and downstream about 27 - 28ºC, whereas Blongkeng River about 26 - 28ºC. Based on Government Regulation 82 of 2001 which requires the temperature of the river water class II have 3ºC

deviation from the state of the natural temperature of the local environment, the condition of the Blongkeng and Punduhriver still in the water quality standard. Temperature measurement results from upstream to downstream increases. This is consistent with the statement of Sandy (1985) is the headwaters of the river water is relatively cold, while in the midstream and lower reaches of the higher temperature. The water temperature from upstream to downstream higher because the downstream increasingly rare vegetation or trees along the river.

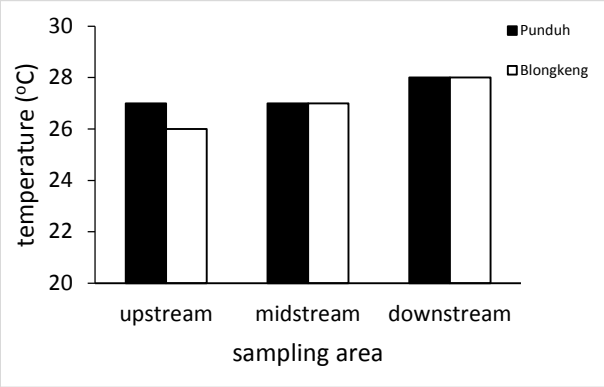


Figure 1. The water temperature

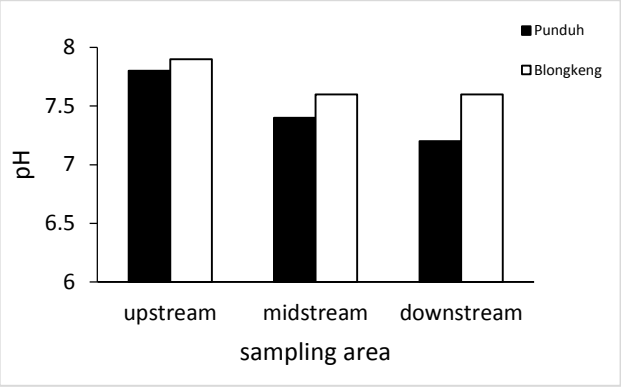


Figure 2. The pH value

Base on Figure 2. the measurement results show a pH value at Blongkeng and Punduh river from upstream to downstream tends to decrease. The value of pH in Punduh river from upstream to downstream are 7.8, 7.4 and 7.2, while the pH value in Blongkeng are 7.9, 7.6 and 7.6. Based on Government Regulation 82 of 2001 which requires the pH of river water class II ranged from 6 to 9, the pH of the water in Blongkeng and Punduh is appropriate quality standards. Decrease in the pH value can be affected by various causes such as organic waste, inorganic and acid rain due to exhaust emissions. A decrease in the pH value of the water of the river from upstream to downstream due to the content of organic materials that produce more organic acids through a process of aerobic decomposition of organic material. The content of organic acids can lower the pH value (Ghazali et al, 2013). The content of organic matter in the River Punduh and Blongkeng derived from residential areas which are often dispose of waste into water.

Total Suspended Solid (TSS) and Total Dissolve Solid (TDS) Parameters

Figure 3. shows that the value of TSS in river Punduh and Blongkeng ranged between 18 to 54 mg/L. The TSS values at the location midpoint Punduh River has exceeded the quality standard that is equal to 54 mg/L, while the upstream and downstream are still in line with the quality standard that is equal to 14 mg/L and 41 mg/L. According to Government Regulation 82 of 2001,

TSS parameters for class II river water is 50 mg/L. TSS measurement results Blongkeng River at all points have met quality standards, namely the upstream, midstream and downstream are respectively 23, 27 and 18 mg/L. TSS values of the two rivers tend to fluctuate. TSS values from the upstream to the center have increased and decreased downstream. Similar results have been reported by Trofisa (2011) on the determination of water quality Ciliwung River. TSS values increased because it is caused by the input of pollution load of waste such as household / domestic, industrial and livestock. It is also appropriate to Blongkeng and Punduh River which has many land uses such as development of land for residential, industrial and livestock thereby increasing the value of TSS. TSS values of the midstream to downstream decreased due to the decomposition that occurs in water bodies due to high rainfall and discharge of water. At the time of sampling Punduh and Blongkeng is the rainy season is in February 2015 with a fairly high rainfall.

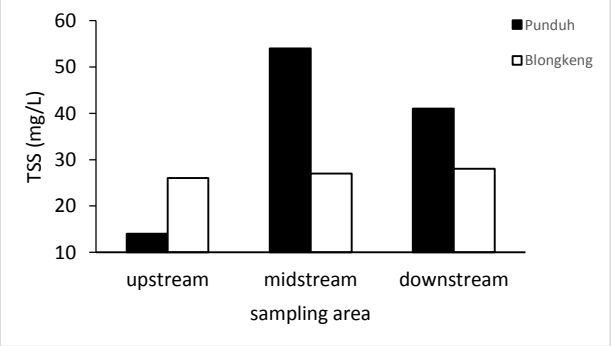


Figure 3. The Data of Total Suspended Solid

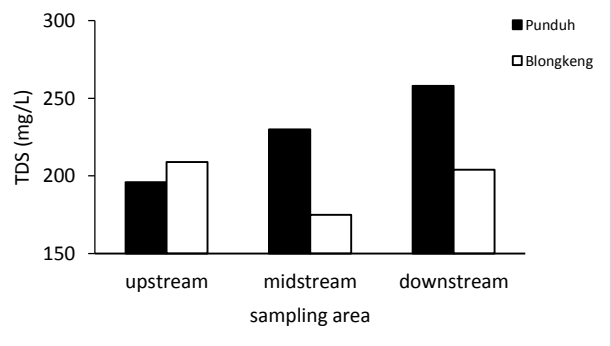


Figure 4. The Data of Total Dissolve Solid

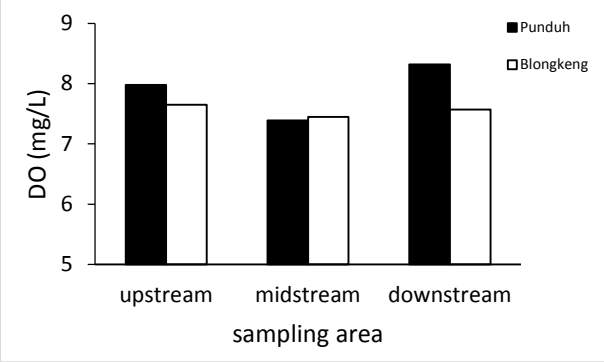
Figure 4. presents that the value of TDS in the river or Blongkeng Punduh ranged from 196 to 258 mg/L. These results have appropriate water quality standards in accordance with Government Regulation 82 of 2001 to the river water class II is 1000 mg/L. TDS values in Punduh river from upstream to downstream are likely to experience an increase in the amount of 196, 230, and 258 mg/L. Blongkeng River TDS value has decreased from the upstream to the midstream of that of 209 mg/L to 175 mg/L, but at downstream of the river increased to 204 mg/L.

The TDS values from upstream to downstream river Punduh always increase. According Supiyati et al (2012), an increase in the value of TDS may occur because of all the dissolved

gases, waste water disposal of household or industrial waste from upstream will be carried away by water currents and deposited downstream. The different results occurred in Blongkeng River. Impairment TDS from the upstream to the middle can be caused by the deposition process / deposition ions - ions dissolved in water bodies (Osibanjo et al, 2011). In addition, TDS values may decline due to high rainfall and large water discharge (Trofisa, 2011). TDS value increased downstream allegedly occurred due to a buildup of waste water containing molecules of soap, detergents and surfactants that are water soluble and industrial activity. This is in accordance with the opinion of Effendi (2003) that the value of TDS waters is strongly influenced by the weathering of rocks, runoff from the land and the influence of domestic waste containing molecules soaps, detergents and surfactants are water soluble as well as industrial waste.

Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)

Figure 5 shows that dissolved Oxygen (DO) on Punduh river from upstream to downstream is 7.976, 7.385 and 8.323, while the river Blongkeng of 7.650, 7.446 and 7.568. The test results of water samples in Blongkeng and Punduh River at all points have appropriate quality standard based on Government Regulation 82 of 2001 which states that the dissolved oxygen in the river water class II was more than 4 mg/L. Dissolved Oxygen (DO) value from upstream to downstream tend to fluctuate. Impairment DO from the upstream to the midstream due to the incoming waste such as domestic wastewater from residential, industrial and livestock. The higher organic matter content in the water of dissolved oxygen requirement in the process of decomposition by bacteria also increased so that it will lower the dissolved oxygen content in water (Effendi, 2003). The DO value increase occurs in the lower reaches of the river and Blongkeng Punduh. DO in the downstream value can be increased due to the flow velocity increases so that the aeration process that helps the process of diffusion of oxygen from the atmosphere into the water (Fisesa et al, 2014). In addition, the condition of the river waters in Blongkeng and Punduh relatively shallow with a depth of less than 5 meters and rocky (BLH, 2014). According to Odum (1971) rivers are relatively shallow and the turbulence by the movement of water will have a high dissolved oxygen content.



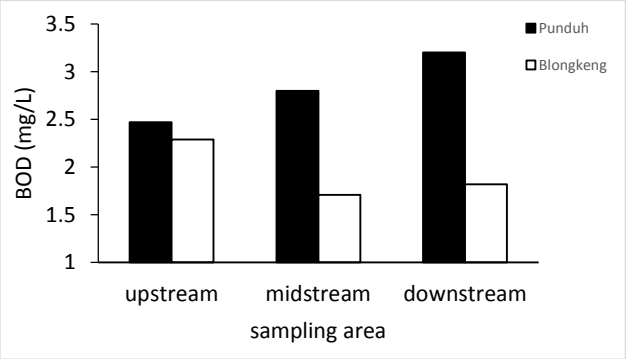


Figure 5. The value of dissolved oxygen

Figure 6. The value of Biochemical Oxygen Demand

Value of BOD in Punduh River from upstream to downstream are likely to rise and at the downstream value exceeds water quality class II which is equal to 3.203 mg/L. Value of BOD in Punduh River upstream and midstream have met the standard that is equal to 2.469 and 2.795. Based on Government Regulation 82 of 2001, BOD of the river water class II maximum of 3 mg/L. The BOD values in Blongkeng river in the upstream, midstream and downstream has met class II water quality standard that is successively equal to 2.285, 1.714 and 1.816 mg/L. The BOD values in different Punduh River to River Blongkeng. This difference is due in Punduh River textile industries. Liquid waste textile industry average contains 500 mg / L BOD contributor of organic matter (Pratama, 2010). Increasing the value of BOD from upstream to downstream is also caused by the accumulation of household waste (Walakira and Okumu,2011). The different results shown by the value of BOD in River Blongkeng. The value of BOD decreases from the upstream to the midstream and the increase in BOD downstream. During the rainy season, the river flow increases can cause organic waste decomposes more quickly (Rahman and Bakrie, 2010). The value of BOD from the middle to downstream have increased due to the fact that land use in the lower reaches of the more include residential, agricultural and mining of sand.

The concentration of amonia and nitrate

Base on Figure 7. The concentration of ammonia in Punduh from upstream to downstream is quite high and exceeds the water quality grade II as the Government Regulation 82 of 2001 which states that the maximum ammonia concentration was 0.5 mg/L. The highest value of the ammonia contained in the midstream of the River Punduh is equal to 3.800 mg / L, while at the point of the upstream and downstream of 1,091 mg / L and 3,560 mg/L. Ammonia in Blongkeng

at all points have appropriate quality standards. Value ammonia from upstream to downstream is between 0.115, 0.157 and 0.172 mg/L. Differences in ammonia values were highly significant between Punduh River and Blongkeng allegedly because of the amount of land use in the river Punduh more than Blongkeng River. One of them is the textile industry which is in a liquid Punduh. Limbah River textile contains a good number of organic compounds which easily degraded biologically and difficult degraded (non-biodegradable). Liquid waste that has long accommodated contain high ammonia concentrations and can cause ammonia to increase after discharged into water bodies (Pratama, 2010). Low levels of ammonia in the river Blongkeng comes from a small number of household organic wastes are broken down by bacteria into ammonia.

The concentration of ammonia in the river from upstream to the middle tends to rise and fall as downstream. Increased ammonia from the upstream to the middle can be caused by industrial waste and manure waste streams from agricultural activities to a body of water (Mullai, 2013). Ammonia values decreased in the lower reaches of the river due to the high water flow. Organic material will decompose rapidly flowing into water bodies due to turbulence / water upheaval. According to Effendi (2003), amonia also can be decreased with decreasing pH value. Ammonia reacts faster to nitrite and nitrate at pH ± 7. The pH value in the downstream in Blongkeng and Punduh decreases and approaches the value of 7 compared to the upstream and central regions, namely by 7.2 and 7.6. This allows the ammonia levels quickly react to form nitrite.

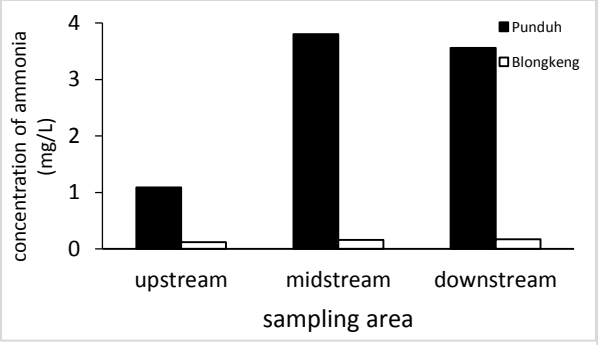


Figure 7. The concentration of ammonia

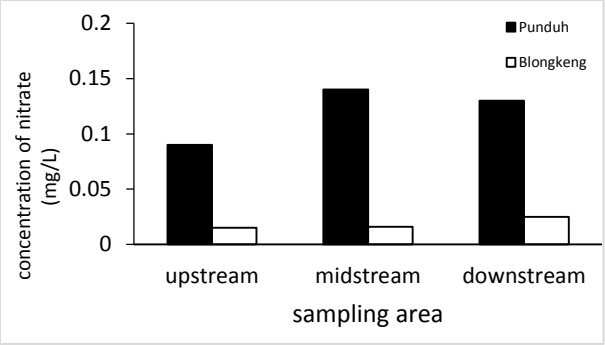


Figure 8. The concentration of nitrate

Figure 8. presents the concentration of nitrite in Punduh River in the upstream, midstream and downstream is high at 0.0912, 0.1396 and 0.1291 mg/L. These results have exceeded nitrit for class II river water based on Government Regulation 82 of 2001 is a maximum of 0.06 mg/L.

Nitrite levels in the river Blongkeng lower than the river Punduh and compliance with quality standards. Nitrite levels from upstream to downstream Blongkeng are of 0.0148, 0.0157 and 0.0252 mg/L. Nitrites are found in natural waters in very small amounts compared to ammonia because it is unstable in the presence of oxygen and immediately oxidized to nitrate. Trends Punduh River nitrite test results together with ammonia levels. This is because ammonia in water is oxidized to nitrite. Organic materials that went into the water to experience the reaction produces ammonia, subsequent oxidation process will convert ammonia to nitrite (Aswadi, 2006). The different results occurred in Blongkeng River. Nitrite levels from upstream to downstream has increased. This is caused by water discharge and rainfall. The higher the rainfall, the nitrite greater because of soil containing nutrients nitrogen carried away by water (Aswadi, 2006). In addition, nitrite from waste agricultural activities carried out by the community. The use of nitrogen fertilizers can lead to increased levels of nitrite. Punduh river have nitrite levels exceeding 0.06 mg/L. For aquatic organisms are very sensitive, nitrite levels were more than 0.05 mg/L can be toxic (Effendi, 2003). This indicates that Punduh river is not too good to aquatic organisms.

Conclusion

The results showed that the water quality parameters River Blongkeng which include temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Suspended Solid (TSS), Total Dissolved Solid (TDS), ammonia and nitrite appropriate water quality standards. Based on the results of the case study, Punduh River water quality parameters that are in accordance raw river water quality for the temperature, pH, DO, TDS, TSS at upstream and downstream and BOD at upstream and midstream. Different from Blongkeng River, the parameter of nitrite at a point upstream, midstream and downstream in Punduh River showed higher results than the standard. The concentration of nitrite in Punduh River approached 0.1 mg/L. Furthermore, the concentration of ammonia in the upstream region exceeding the threshold value with a concentration just over 1 mg/L and an increase to obove 3 mg/L in the midstream and downstream.

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