The Quality of Water of the Downstream of the Siak River, Riau Province, Based on Tidal Condition

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ABSTRACT

The quality of water in a river is affected by its natural condition and pollutant input originated from activities conducted around the river. In the Siak river, however, the black water effect influences the distribution of the pollutant in general. To understand the quality of water in the black water affected by an area, a study was conducted from December 2015 to July 2016. The water was sampled during low and high tides, in 8 sampling sites that were distributed along the river, from the mouth of the river in Siak Sri Indrapura Regency to upstream in Palas Village, Kampar Regency (around 180 km from the mouth of the river). The results showed that in the downstream of the Siak river, the quality of water during the low and high tides was worse than the 3rd Class Water Quality Standard issued by the Government Regulation (GR No. 82 / 2001) except for the concentration of nitrate, total coliform, Hg, oil and fat. The BOD was 14-39.2 mg/L (the high tide) and 17-45.6 mg/L (the low tide), COD was 51.76-80.62 mg/L (the high tide) and 51.76-69.12 mg/L (the low tide), NH$_3$-N was 0.03-1.09 mg/L (the high tide) and 0.03-0.92 mg/L (the low tide), while the NO$_2$-N was 0.13-0.17 mg/L (the high tide) and 0.13-0.22 mg/L (the low tide). Based on the Storet Index, the water of the downstream in the Siak river during the low and the high tide can be categorized as heavily polluted (score -52 to -70), and it tends to decline during the high tide.

Keywords: *The quality of water, the siak river, storet index, tide*

1. Introduction

Rivers have versatile functions for human life and livelihood. Currently the condition of almost 80% of the river water in Indonesia shows a decline (MOE, 2013). The decline of the quality of river water has been characterized by increasing the parameters of Biological Oxygen Demand (BOD) (Lee and Nikraz, 2015), total ammonium, nitrite, phosphate (Dimitrovska et al., 2012; Kaur and Dua, 2016), Chemical Oxygen Demand (COD) (Ahmed et al., 2015) and the level of heavy metals (Suthar et al., 2009; Azizullah et al., 2011; Bhuiyan et al., 2013).

The Siak River is one of the main rivers in Indonesia, but its water quality has been

declining. This River is one of the four main big rivers in Riau Province, and it is the deepest river in Indonesia (DCCOES, 2015). The upstream of Siak River watershed consists of two headstreams, Tapung Kiri River and Tapung Kanan River, which unify in Palas region, at Kampar Regency in the Siak Besar River, while the downstream is the Siak Besar River in Palas Village, in Kampar Regency up to Siak estuary in Siak Sri Indrapura Regency (DOPW, 2005). Besides, the Siak river has characteristic as a black water river (Baum et al., 2007; Wit et al., 2016), its water is reddish brown (Rixen et al., 2008; Siegel et al., 2009), as it contains humic acid compound (Amri, 2007; Siegel et al., 2009) that comes from the leaching of the surrounding

peat soils (Rixen et al., 2008). Moreover, the Siak River also has other unique features, such as the high levels of dissolved organic carbon, the low dissolved oxygen levels, and under the influence of tides (Baum et al., 2007; Rixen et al., 2008; Rixen et al., 2010; Baum and Rixen, 2014; Husnah et al., 2014; Putri and Pholmann, 2014).

The Siak River is a national strategic river and serves as navigation, transportation, fishing, a source of raw water for industries and PDAM Tirta Siak in Pekanbaru. Then, it also serves as a daily source of water for most people who live along the river's flow (RBA III Sumatera, 2015). The Siak downstream watershed is a critical watershed since the quality and the quantity of the water is decreasing due to the influx of domestic and industrial waste (DCCOES, 2015), as well as the waste from oil palm plantation (Baum and Rixen, 2014). The decline of the Siak River quality adversely affects the communities around the river, for example, there are complaints of skin diseases (Ismy et al., 2012) and a decrease in fish population (Iskandar and Dahiyat, 2012).

Concerning about the condition of the Siak River, it is necessary to control the river pollution through the analysis of the quality of water based on the tides. The quality of water when the tides come can give an information in making a decision to control the pollutant in the Siak River. It is caused by the characteristics of the Siak River which are influenced by the tides, it reaches $\pm$ 200 km to the upstream of the river (Siegel et al., 2009; Putri and Pohlmann, 2014). In general, the condition of the tides affects the pollutant distribution in the Siak River as reported by Siegel et al., (2009), the pattern of waste distribution in the Siak River is affected by the tides and the high tides that reduce the conveyance capacity of the Siak River (Nurhamidah et al., 2016). According to Chihhao et al., (2009) stated that the tide patterns in the river influence the pollutant movement in the stream because of the flow fluctuation. Otherwise, the tides also cause the pollutant hardly waste to oceans (Toriman et al., 2011) which finally influences the quality of water in the river (Gasim et al., 2015; Rim-Rukeh, 2016). The poor quality of water causes the water of the river unreasonable to be used and needs efforts in management and recovery.

Although many researches have been carried out to know the water quality of the Siak River (Amri, 2007; Husnah et al., 2014; Rixen et al., 2008; Rixen et al., 2010 ; Baum and Rixen, 2014), the study on the water quality at the tides of the Siak River has been rarely reported. Some studies on the tides of the Siak River including Nedi (1999), reported about the water quality of the Siak River from the Palas village to the Buatan village. Siegel et al., (2009) reported about the tidal effects on the characteristics of chlorophyll, particle, and carbon dissolved in Siak estuary. In addition, Putri and Pohlman (2014) also reported about the particle hydrodynamic model in the Siak estuary. For serving Siak River as the Policy of Governor number 12 in 2013, it is important to do a research on some physical and chemical parameters of the quality of the Siak River on tides. Hence, the quality of downstream water of the River Siak in Riau Province becomes necessary to be studied based on tidal condition.

2. Materials and Methods

Time and place

This research was conducted in the Siak River in Riau Province (Figure.1). It was conducted in December 2015 until July 2016. And, it was located at the following coordinates: 01o 14' 06.14" north latitude- 102o 10.01' 11" East Longitude up to 00 33' 04.7'' North Latitude - 101 24' 00.8'' East Longitude. Eight sampling stations were established that was started from the mouth of the river up to 180 km upstream in Palas village, Pekanbaru City.

Sampling methods and analytical procedures

Sampling was carried out at the high and the low tides based on the tidal predictions (Pelindo 2015 - 2016). It was using Van dorn water sampler in the middle and both sides of the river banks which was subsequently composited. Samples were put into polyethylene bottles and added H2SO4 up to pH < 2, for the analysis of ammonia, nitrite and nitrate. To analyze the total coliform, the sample was placed into glasses bottles. Meanwhile to analyze total phosphate, and BOD, water samples were stored in the ice box containing ice at a temperature of 40C. The samples that intended for heavy metal analysis were filtered with 0.45 µm filter paper and were given preservative HNO3 to pH < 2 (APHA, 2012). The measurement of nitrate, nitrite, ammonia and phosphate used spectrophotometer thermo spectronic 20D+. Pb and Cd metal that were measured by using Flame Atomic Absorption Spectrophotometer. Besides, Hg metal was measured by using Hidrid Atomic Absorption Spectrophotometer (Perkin Elmer, Pin

AAcle 900H). Furthermore, samples were analyzed in triplicate to provide representative mean values. Duplicate method blanks were also processed and analyzed alongside the samples to check any loss or cross contamination. As a result, the differences of the concentrations between the determined and certified values were less than 2%. To validate the analytical methodology, recovery studies were performed that percentages were 101 % for Pb, 103 % for Cd and 102 for Hg. In addition, accuracy was determined by using Material Reference Certified Analysis (CRM).
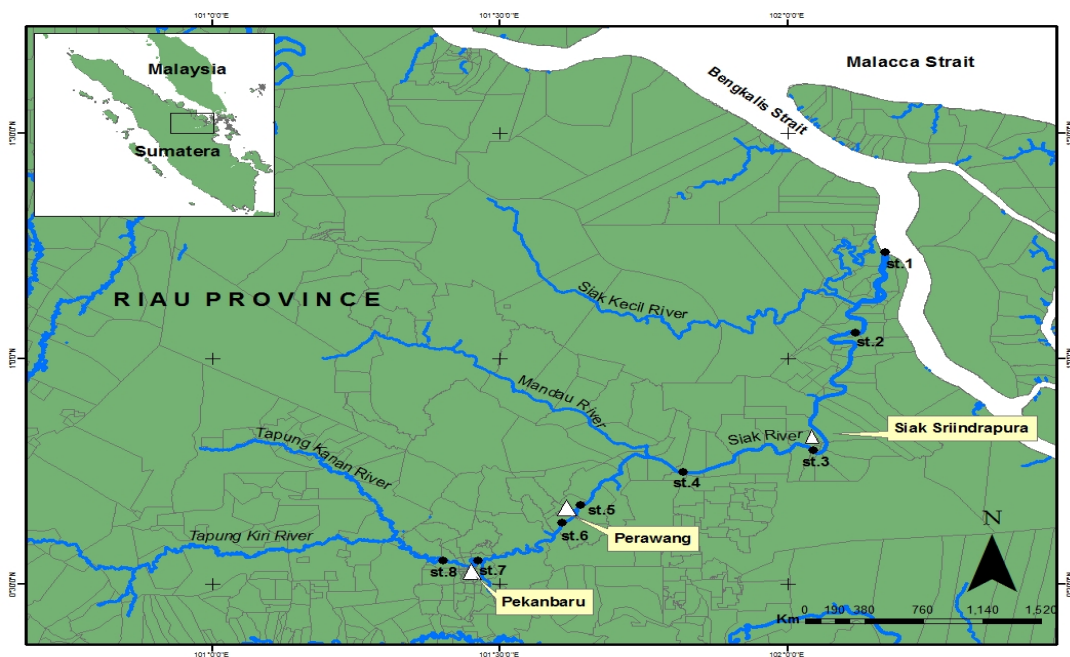

Figure1. The Map of research location

Table1. The Physical, chemical and aquatic biological parameters along with the methods used

No.	Parameter	Unit	Test Method	Method	Analysis
1.	Temperature	^0C	SNI 06-6989.23-2005	Thermometer	In situ
2.	TSS	mg/L	SNI 06-6989.27-2005	Gravimetry	Laboratory
3.	Salinity	‰		Hand Rephractometer	Laboratory
5.	DO	mg/L	SNI 06-6989.14-2004	DO Meter	In situ
6.	BOD	mg /L	APHA, 2012, 5210	Winkler Titration	Laboratory
7.	COD	mg /L	APHA, 2012, 5220-D	$K_2Cr_2O_7$ Reflux	Laboratory
8.	NO_3-N	mg /L	APHA, 2012, 4500-NO_3-N	Spectrophotometer	Laboratory
9.	NO_2-N	mg /L	APHA, 2012, 4500-NO_2-N	Spectrophotometer	Laboratory
10.	NH_3-N	mg/L	APHA, 2012, 4500-NH_3-N	Spectrophotometer	Laboratory
11.	Total Phosphate	mg/L	APHA, 2012, 4500-P	Spectrophotometer	Laboratory
12.	Oil and Fat	mg/L	APHA, 5520-B	Gravimetry	Laboratory
13.	Total Coliform	MPN/100	APHA, 2012, 9222	MPN Method	Laboratory
14.	Pb, Cd and Hg	mg/L	APHA, 2012, 3111-B, 3030-B	AAS	Laboratory

Data analysis

The data of water quality in the Siak River when the tides happened was analyzed descriptively referring to a Government Rule (GR) number 82 in 2001 Class III about the standard of water quality served to cultivate fish in fresh water, animal husbandry, to irrigate gardens and others which require the standard of water quality. It is based on the policy of Riau governor Number 12 in 2003 about the allocations and the water quality standard of the Siak River in Riau Province, which is decided that the second inter node of Siak River (from Palas to the estuary in Apit River Village) is the third class of the water quality standard.

The data analysis of the water quality in the Siak River downstream was also conducted through STORET Index approach (MOE, 2003). The STORET index has been used to determine the status of Water surface in Indonesia (Ratnaningsih, 2010). The STORET index needs a large number of water quality parameters (Tallar and Jiang-Ping, 2015). In this research, the parameters used to calculate the storet index are temperature, pH, DO, BOD_5, COD, Nitrit (NO_2-N), Nitrat (NO_3-N), ammonia (NH_3-N), total

posfat, total coliform, oil, fat and heavy metal Pb, and Cd.

STORET Index

The STORET method is a method to determine the water quality status, to determine the parameters that have met or exceeded the water quality standard (MOE, 2003). This method is always used by government agencies and non-government agencies (Sholichin et al., 2010). Determining the status of water quality by using index storet have a plus; there is a flexibility of the number and the types of water quality parameters (Saraswati et al., 2014) and more sensitive and representative (Jubaedah et al., 2015). The determination of the quality status of the water with STORET index is through the comparison between the measurement data of water quality and the water quality standard that are tailored to its purpose. If the measurement result of the water quality meets the quality standard value that has been set (measurement result ≤ quality standard) then the score given is 0; If the measurement result of water quality does not meet the water quality standard value (measurement result > quality standard), the score given is shown in Table 2.

Table 2. The determination of the score system

Number of examples*)	Score	Parameters	
		Physical	Chemical
< 10	Maximum	-1	-2
	Minimum	-1	-2
	Average	-3	-6
≥ 10	Maximum	-2	-4
	Minimum	-2	-4
	Average	-6	-12

) Number of parameters used in determining water quality status

The status of the river water quality was determined based on the number of scores obtained from the calculation of the number of the negative scores of all parameters and was compared with Table 3.

Table 3. The Determination of the water quality status based on STORET Index

No.	Score	Criteria
1.	0	Very good (standard)
2.	-1 s/d -10	Good (lightly polluted)
3.	-11 s/d -30	Medium (moderately polluted)
4.	≥ -31	Bad (heavily polluted)

3. Results and Discussion

Temperature and pH

The water temperature of the Siak River at the high and the low tides was 28.96 to 31.16 ^{0}C and 29.36 to 30.81^{0}C respectively. The lowest temperature at the high and low tides was found at the station 8 (Palas). Meanwhile, the highest temperature at the high and low tides was at the station 5. It shows that the temperature at the station 5 was higher than other stations (Table 4). In addition, the highest temperature at the station 5 was caused by the pulp and the paper mill, and at the time the pulp and paper waste was discharged into the Siak River. Based on the quality standard set out in GR No.82 / 2001 (class III), as the allowed values for temperature deviation of 30°C, the water temperature of the Siak River at the whole stations still conformed the quality standard.

Furthermore, the pH value of the Siak water at the high tides was 5.0 to 7.5 and 4.8 to 6.7 at the low tides. Almost all stations had a pH <6 except at Station 1 (Siak Estuary) and the station 5. At the high tide, the highest pH value was found at the station 1 (Siak Estuary), then the pH value decreased to the upstream except at the station 5. The pH value at the low tide tended more acid because of pH of organic acid which was produced by the organic material decomposition coming from around the turf swamp. Leaching from litter and peat soil was the major source of dissolved organic matter in the Siak River (Rixen et al., 2010). The pH value of the Siak water was categorized as the lowest value that it is a black water River. In line with the statement of Alkhatib et al., (2007) stated that the black water river had the low pH.

Table 4. The Water quality of downstream Siak River in Riau Province on tidal condition

Parameter	Unit	Quality standard	River condition	Station							
				1	2	3	4	5	6	7	8
Temperature	^{0}C	Deviation 3	High tide	30.22	31.04	30.47	29.89	31.16	30.13	30.83	28.96
			Low tide	30.42	30.33	29.41	30.13	30.81	29.89	30.43	29.36
pH	-	6-9	High tide	7.5	5.7*	5.2*	5.1*	5.9*	5.3*	5.2*	5.0*
			Low tide	6.7	5.1*	5.1*	4.9*	6.7	5.2*	4.9*	4.8*
TSS	mg/L	400	High tide	74	48	60	12	20	22	17	18
			Low tide	31	22	20	9	18	21	13	15
Salinity	‰	-	High tide	25	1.5	0.0	0.0	0.0	0.0	0.0	0.0
			Low tide	2.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
DO	mg/L	3	High tide	4.5	3.0	2.6*	1.8*	2.1*	2.6*	2.5*	3.8
			Low tide	3.0	2.8*	1.8*	1.3*	1.2*	2.9*	2.0*	3.2
BOD	mg /L	6	High tide	29*	20*	20.3*	32*	39.2*	18.5*	18.6*	14*
			Low tide	19*	17*	24.9*	41.37*	45.6*	20.2*	33.5*	23.4*
COD	mg /L	50	High tide	51.76*	61.95*	56.43*	71.28*	80.62*	61.1*	62.8*	65.34*
			Low tide	51.76*	67.47*	66.19*	56.01*	63.65*	69.16*	64.5*	52.61*
NO$_3$-N	mg /L	20	High tide	0.28	0.13	0.19	0.21	0.16	0.15	0.16	0.15
			Low tide	0.21	0.18	0.21	0.21	0.20	0.16	0.15	0.20
NO$_2$-N	mg /L	0.06	High tide	0.13*	0.14*	0.14*	0.16*	0.17*	0.15*	0.15*	0.17*
			Low tide	0.14*	0.13*	0.22*	0.15*	0.15*	0.14*	0.16*	0.15*
NH$_3$-N	mg/L	0.02	High tide	1.09*	0.12*	0.08*	0.08*	0.09*	0.06*	0.04*	0.03*
			Low tide	0.92*	0.08*	0.09*	0.07*	0.1*	0.05*	0.03*	0.04*
Total Phosphate	mg/L	1	High tide	0.25	0.35	0.29	0.23	0.45	0.5	0.52	0.47
			Low tide	0.31	0.49	0.51	0.68	0.71	0.35	0.6	0.44
Oil and Fat	mg/L	1000	High tide	270	276	270	233.2	242.3	258.1	237.2	260.8
			Low tide	233.3	252.0	213.6	233.2	312	263.2	534	264.6
Total Coliform	MPN/ 100	10000	High tide	<300	<300	<300	<300	<300	<300	<300	<300
			Low tide	<300	<300	<300	<300	<300	<300	360	<300
Pb	mg/L	0.03	High tide	0.21	0.08	0.07	0.07	0.08	0.08	0.07	0.09
			Low tide	0.17	0.06	0.09	0.09	0.10	0.08	0.07	0.06
Cd	mg/L	0.01	High tide	0.056	0.031	0.004	0.007	0.006	0.006	0.003	0.003
			Low tide	0.045	0.018	<0.002	<0.002	0.003	<0.002	0.003	<0.002
Hg	mg/L	0.001	High tide	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}
			Low tide	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}	<0.01^{-2}

Information*: not meeting class III quality standards (GR No. 82/ 2001)

1 = Estuary   5 = Perawang I
2 = Mesjid Bay   6 = Perawang II
3 = Siak Sri Indrapura   7 = Duku River
4 = Buatan   8 = Palas Village

TSS and salinity

The Siak River has value the various total suspended solid. The total suspended solids on the successive high tide and low tide were 12 to 74 mg/L and 9-31 mg/L. The highest value of suspended solids were either in the station 1 (high tide and low tide). The TSS value was high at the station 1 (the estuary of the river). It happened because there are tributaries around the estuary of the Siak; the small Siak Rivers which stream the suspended particle materials from around the turf swamps (Siegel et al., 2009). The values of the suspended solids in the Siak River water were generally still below the quality standard, <400 mg/L. Baum et al., (2007) reported that the Siak River had a low level of the total suspended matter.

The salinity values of the Siak River water at the high tide and the low tide respectively was 0 to 25 ‰ and 0 to 2.3 ‰. The highest salinity was found at the Station 1 (Siak Estuary) in both the high tides and the low tides. The salinity at the station 1 was higher than other stations because it was located at the mouth of the river and was influenced by a greater mass of sea water. At the low tides, the salinity values were lower due to the increasing mass of fresh water so that the level of salt in the water decreased. In general, the salinity between the high and low tide varies. The value tends to decrease to the upstream and the effect is not visible from the station 3 to the upstream. This is caused by turbulence water mass is strong enough so that the mass of water mixed homogenous (Siegel et al., 2009).

Dissolved Oxygen (DO), BOD and COD

The value of dissolved oxygen in the Siak water at the high tide and the low tide in a row was 1.8 to 4.5 mg/L, the value of 1.2 to 3 mg/L. The value of oxygen at the low tide was lower than at the high tide. At the low tide there was no influence of the mass of sea water. The characteristics of the Siak River contains the high dissolved organic carbon, it was subsequently decayed by microbial thereof reduced the concentration of oxygen in the water (Baum et al.,

2007; Rixen et al., 2008). Based on Table 4, the value of oxygen in the Siak water was considered low (Rixen et al., 2008; Rixen et al., 2010; Husna et al., 2014). King et al., (2012) explained that the River that had the characteristics of the Black River water contained low oxygen. The oxygen level was not in accordance with the quality standard (<3 mg/L), except at the station 1 (estuary) at the high tide and the low tide at the station 8. The lowest oxygen value was found in the station 5, because the wasting activities of pulp and paper containing organic material was found in this station (Hossain and Ismail, 2015). The oxygen is low in the water caused by micro-organisms which need oxygen to decompose organic matter (Kaur and Dua, 2016).

Biochemical Oxygen Demand (BOD) is a measure of oxygen that would be needed by the microorganism to decompose the organic and inorganic pollutants in polluted water (Uday and Anil, 2016). Pokhrel and Viraraghavan (2004); Tewari et al., (2009); Kamali and Khodapharast (2015) also reported that BOD was one of the main pollutants resulted from the production of pulp and paper in the pulping and bleaching stages. The BOD values in the water of the Siak River were from 14 to 39.2 mg/L at the high tide and 17-45.6 mg/L at the low tide. It was generally considered that the BOD value at the whole stations already far exceeded the quality standard (<6 mg/L) at the high tides and the low tides. BOD values in the Siak River water at low tides tended to be higher than at the high tides. The highest BOD value was found in the station 5, which happened at the high and the low tide. The high BOD levels indicated a decline in DO because the oxygen that was available in the water was being consumed by the bacteria leading to the inability of fish and other aquatic organisms to survive in the river (Waziri and Ogugbuaja, 2010).

The COD value in the water of the Siak River in the high tide was from 51.76 to 80.62 mg/L, whereas at the low tide was 51.76 to 69.16 mg/L. The results showed that the COD value varied during the high tides and the low tides. The COD value in the Siak River water in the whole observation stations passed the quality standard of <50 mg/L (GR No.82 / 2001 grade

III), both at the high tide and low tide. This was a presumption because along the Siak River, there were many industries that dumped waste into the Siak water (Baum and Rixen, 2014). The highest COD value was found at the station since the station had pulp and paper waste. Hossain and Ismail (2015) stated that the pulp and paper waste contained the high levels of COD. The decreasing oxygen levels and the increasing values of BOD and COD in water indicated that the water contained the high levels of dissolved organic components (Uday and Anil, 2016).

Ammonia, nitrate, nitrite and total phosphate

The level of ammonia in the Siak varied, it was about 0.03 - 1.09 mg/L at the high tide and 0.03 - 0.92 mg/L at the low tide (Tabel 4). The station 1 in the mouth of the river of both the high tide and the low tide recorded the highest values were 1.09 mg/L and 0.92 mg/L, respectively. Based on the analysis of the ammonia levels at the whole stations at the high tide and the low tide, it exceeded the standard quality boundary (0.02 mg/L) (GR No.82 / 2001 grade III). Around the Siak, there are palm plantations. Baum and Rixen (2014) reported that the fishing areas of the river were really influenced by the area conversion becoming palm plantations. In Riau Province, the width of industrial areas of palm plantations consists of approximately 16.000 km2 or 19.97 % of the width of total areas of Riau Province (Baum and Rixen, 2014). The residue of fertilizer which streamed when it was raining flowed into the Siak; as a result, it can improve the level of ammonia in the river. The higher ammonia value can be toxic for fish, but in small concentrations, it can serve as nutrients for excessive growth of algae (Corwin et al., 1999).

In general, the nitrate concentration at the high and the low tide was not extremely different. At the high tide, the nitrate concentration was 0.13 - 0.28 mg/L and at the low tide was 0.15 - 0.21 mg/l, and the highest level of nitrate was (0.28 mg/L) at the station 5 (at the high tide). While the lowest level of nitrate was found at the low tide (0.13 mg/L) at the station 2. Generally, the concentration level of nitrate was still below the standard quality (20 mg/L) (GR No.82 / 2001 grade III). A study revealed that nitrate content was lower, which might be due to its utilization by phytoplankton and macrophytes (Singh et al., 2016). Nitrate pollution in the river basin might be mainly sourced from the use of chemical fertilizer and pesticide in the agricultural area, domestic

sewage, and industrial waste water discharge (Ying et al., 2016).

Concentrations of nitrites for the whole station of the Siak River were relatively stable in the high tide and in the low tide (table 4), except in station 3 (the high tide). The nitrite concentration in present study ranged 0.13 to 0.17 mg/L (the high tide) and 0.13 to 0.22 mg/L (the low tide). The nitrite content which is allowed in rivers is not more than 0.06 mg/L, therefore, the value of nitrite content in this research at the whole observation stations exceeded the standard quality. Around the Siak, starting from Pekabaru city to Perawang and Siak Sri Indrapura, there are rubber industries, paper processing and palm plantations. The exposure and treatment of industrial sewage from rubber and paper processing industries are heavily enriched in nitrogen components (Agamuthu, 1999). Baum and Rixen, (2014) reported that the waste of rubber industries, paper processing and palm plantations improved the nitrogen component in the Siak river.

In the present study, phosphate value ranged 0.23 to 0.52 mg/L at the high tide and 0.31 to 0.71 mg/L at the low tide. Generally, the total content of phosphate is higher at the low tide than the high tide. The total content of phosphate in the Siak was still below the standard quality; 1 mg/L (GR No.82 / 2001 grade III). The higher values of phosphate were recorded at the station 5, which might be due to the anthropogenic activities. Baum and Rixen (2014) thought that the domestic waste would improve the phosphate content in the Siak about 470 %. The highly relative content of phosphate at this station was thought that it came from the wasting activities of pulp and paper. According to Cousins et al., (2014), the pulp and the paper waste contained phosphate which was high enough. The high phosphate content was caused by organic material decomposition which was leached from the turf swamp. According to Baum and Rixen (2014), one of the factors which controlled the phosphate content in the Siak was the leaching of organic material which came from the turf swamp.

Total coliform, oil and fat

Overall total coliform levels in the study area was still below the standard quality (<10000 ml) and there was no difference except at the station 7 (the low tide), which is higher (360 MPN/100). At the low tides, the sewage of the settlements was thrown into the water surface of

the Siak through the small channels. The station 7 was a dense residential area (Pekanbaru). The number of population in Pekanbaru city was one million people (CSA Riau Province, 2016). Liebezeit and Wostmann (2010) stated that the most dominant fecal contamination in the water of the Siak River in Pekanbaru was caused by the large population. Mallin et al., (2000) explained that the abundance of fecal coliform significantly correlated with the number of inhabitants in the basin, and even highly correlated with the percentage of land area developed in the watershed.

The values of oil and fat in the water of the Siak River in a row were 233.2-270 mg/L (the high tide) and 213.6-534 mg/L (the low tide). Based on the water quality standard, the amount of oil and grease in the area of research was still far below the standard of quality <1000 mg/L levels of oil and grease which was the highest at the station 7 (low tide). This was because the station 7 was a densely populated residential area. At the low tides, the domestic sewage of the settlements was thrown into the water surface through the Siak River drainage and rivers.

Pb, Cd and Hg metal

In this study, Pb concentration in the Siak River ranged 0.0 7 to 0.21 mg/L at the high tide, and 0.06 to 0.17 mg/L at the low tide. The highest concentration of Pb was recorded in the station 1 (the mouth of the river) both of tides. Pb concentration in the whole observation stations in both the high tides and low tides passed quality standard which was 0.03 mg/L (GR No. 82/2001). The Higher concentration of Pb was observed at the mouth of the river area (the station 1) compared with other stations. The sources of Pb came from industrial activities and the settlements. Arifin (2001) reported that Pb concentration was correlated to the population density in each province in Indonesia.

The concentration of Cd varied from 0.003 to 0.007 mg/L, at the high tide, and from <0.002 to 0.045 mg/L at the low tide. Cd concentration tended to be higher at the high tide. At the high tide, the Cd level in all observation stations generally was still below the quality standard except at the stations 1 and 2. The highest level of the metal cadmium was found in the station 1, which was the Siak estuary. At the low tide, the overall level of the metal cadmium in all stations was <0.002, except at the stations 1 and 2, which passed the quality standard (GR No. 82/2001 Class III). It showed that the Cd level found was higher in the Siak which was still influenced by salinity. Hg concentration in the Siak water at the whole stations in both the high tide and the low tide was <0.0001 mg/L level which was still far below the standard of quality; only 0.001 mg/L (GR No. 82/2001 Class III). It was assumed that only a few sources of heavy metal Hg contributed to the Siak water. The possible contamination of Hg might come from point sources and non-point sources of pollutants.

Evaluation on the quality of the Siak water by using STORET index on tidal conditions

Evaluation on the quality of the Siak water by using the STORET index when tides came is shown in Table 5. Based on the index STORET, the water quality of the Siak on tidal conditions was categorized as heavy polluted at the whole observation stations; the values were -52 to -70. At the high tide, the STORET index kept increasing from at the station 1 (the Siak estuary) to the station 3. This is caused by pollutants from seawater carried out along with high tide in station 3. Furthermore, the STORET index tended to decrease to the upstream. While at the low tide, the index STORET tended to increase from the upstream to the downstream and reach the peak in the station 2. It is indicated because of pollutants which from activity alongside of the river that brought at high tide then it is more increase in downstream that is in station 2. The value of STORET index at the high tide generally was higher than at the low tide. It showed that the influence of the mass of sea water (at the high tide) which streamed into the Siak could cause the pollution level of the Siak increasing.

Table 5. The scores of STORET index of the Siak River water on tidal conditions

The Stations	Indeks Storet			
	The High Tide Scores	Characteristics	The Low Tide Scores	Characteristics
1	-58		-52	
2	-60		70	
3	-70		-68	
4	-68	Heavily polluted	-64	Heavily Polluted
5	-68		-64	
6	-66		-64	
7	-66		-60	
8	-52		-58	

The scores of the STORET index in this research was lower than the result of the research done by EA (2013) (-94 to -174) and MOEAF (2015) (-52 to -89). The different from this research, the index STORET that was obtained by EA (2013) and MOEAF (2015) in the Siak River was not based on tidal conditions. Based on the result of the index STORET scores, it can be concluded that the Siak River starting from the Siak Estuary to upstream did not meet on the water quality of the class III at both the high tide and the low tide.

4. Conclusion

The quality of water in the Siak River varies greatly based on tidal condition. It shows that pollution in downstream in the Siak River influenced by the tide. The quality of water in the Siak downstream at the high tide and the low tide does not meet the standard quality of the class III Government Rule No.82/200; for the parameters of DO, BOD, COD, ammonia, nitrite and Pb metal. Based on the index STORET, the Siak River was categorized as heavily polluted at the high and low tide. At the high tide, the scores of the index STORET keep increasing to the upstream, in the contrary, at the low tide, the scores of the index STORET keep increasing to the downstream

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