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Impact of Illegal Gold Mining Activities Toward River and Water Pollution in Kuantan Singingi Region, Indonesia

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Abstract: ***Illegal gold mining activities have been conducted by illegal workers since 10 years ago in Kuantan Singingi using mercury (Hg) resulted river water pollution and disruption of river biota. This study aims to determine the impact of illegal gold mining toward water pollution of Singingi and Kuantan river and also irrigation dam in Kuantan Singingi. The research method consists of quantitative and qualitative research. Quantitative research was conducted to determine pollution level (Hg levels and turbidity) of river water through survey methods and laboratory testing. Qualitative research conducted to gather information from informants and strengthen the results of quantitative research, focusing on social phenomena representation to get stakeholders and public perception about river environmental condition before and after illegal gold mining activity through questionnaires and in-depth interviews. The results showed that illegal gold mining activity had a negative impact on river water quality and water irrigation dam in terms of turbidity levels, Hg levels, DO, BOD and COD parameters has exceeded the threshold (polluted), resulting in disruption and death of various types of fish, shrimp, shellfishes in the river. Communities around the watersheds are feeling the effects of river pollution because the river water can no longer be used for daily necessities and fish hard to come by. Expected that perpetrators of illegal gold mining, the public and policymakers to realize that illegal gold mining activity in streams and irrigation dams to be terminated with a shared commitment. To the Government of Kuantan Singingi and stakeholders to formulate policy on illegal gold mining integrated and protect the river environment, also setting up a social-control program post-closure illegal gold mining by providing jobs for local people in agriculture and plantations, community empowerment, improving skills and people's incomes. To other researcher needed a comprehensive study about Hg content in river sediment, fish, and snail, paddy or rice in downstream of illegal gold mining activities, also health symptoms to the community around the watershed.***

Keywords: impact, illegal gold mining, pollution, river, Kuantan Singingi.

1. Introduction

Environmental pollution caused by heavy metals, such as arsenic, lead, cadmium, and mercury is very harmful to human health, animals, plants and continuity of life in the surrounding environment [1]. At low concentrations, effects of heavy metals have a direct effect and accumulate in the food chain, disrupting environmental biota resulting an impact on human health despite on relatively long time and far from pollution sources [2].

Since industrial era, mercury becomes excavation contaminants material, because mercury can be utilized as much as possible. One of environmental pollution due to mercury is excretion of waste products (tailings) on gold processing by amalgamation [3]. Gold mining activities, in general, using amalgamation process will produce a positive impact that is served the gold for the needs of human life but also has a negative impact in form of environmental pollution by Hg vapor. A total of 10% - 30% Hg which used to be lost or released into the environment [4].

Environmental pollution by mercury found in many places in the world. For example, in areas of Indian settlement in Quebec province (Canada), along Amazon River (Brazil) and Songhua River in Jilian province (China) contamination has reached the threshold. Mercury pollution also occurs in the vicinity of Victoria Lake (Africa), Mindanao island (Philippines), also in Indonesia, and in some other places [5-7].

According to United State-Food Drug Administration (US-FDA), maximum mercury content limit is 0.005 ppm 0.005 mg / kg of water and 0.5 ppm = 0.5 mg / kg for fish, while the WHO set a lower maximum limit , ie 0.0001 ppm = 0.0001 mg / l for water and 0.50 ppm = 0.50 mg / kg for fish [8].

According to Mahmud [9], the negative impact of Illegal Gold Mining is mercury pollution. As the occurrence of changes in water quality, sediment, aquatic animals, and vegetation resulting from used of mercury in gold extraction. Methyl-Hg very persistent, estimated to be left in the river or water sediment until reach 70 years. When methyl Hg entry the food chain, it will bioconcentration because in those organisms body methyl Hg tends to survive and only slightly removed. Relatively high levels of mercury in fish tissue are highly dependent on many factors, including species, age, and where they live [10].

The illegal gold mining activity is often referred to small-scale gold mining, traditional, small scale because it is done by people, not by a company, using simple equipment and its existence does not get permission from the local government [11]. The illegal gold mining activities are found in various regions in Indonesia, among others; in Pongkor-Bogor-West Java, Kulo-North Sulawesi, Landak-West Kalimantan, Gunung Mas-Central Kalimantan, Jambi, Sijunjung-West Sumatra. In Riau province is also found in Kampar, Indragiri Hulu, but are most numerous in Kuantan Singingi

(Kuansing), which flows along Kuantan River, Singingi River, irrigation dams, creeks and plantation area[12].

Kuansing area is known contain a lot of gold (alluvial), thus attracting the interest of small-scale illegal gold miners who come from outside of the area. Illegal gold miners activity is conducted since 2006, initially by migrants and followed by local villagers. Illegal gold miners number has increased very rapidly from year to year and spread almost in every district and villages close to the river flow. In January 2014 there were approximately 2,103 units and in January 2015 is estimated at more than 3,000 units of illegal miners raft and machinery (Dongfeng) equipped with a vacuum, and every unit run by 3 to 4 workers. It is estimated that approximately 9,000 to 12,000 gold miners who actively operate every day, both migrants from outside the region and the local community. There are even some illegal gold miners were using heavy equipment (excavator) to dredge the land optimally [12].

According to Bintal Amin (2014), Illegal gold miners activity in this Kuansing will be "a timer bomb" that have an impact on the environment, so this should be a common concern, particularly the use of mercury to the environment. Mercury used should not directly discharge into river environment and must be managed well[13].

The study purpose is to determine the impact of illegal gold mining activities toward water pollution and irrigation dam in Kuantan Singingi.

2. Method

This research method consists of quantitative and qualitative research. Quantitative research was conducted to determine pollution level (Hg levels and turbidity) by survey methods and laboratory testing. Then exploratory qualitative research conducted to gather information from informants and strengthen results of quantitative research, focusing on the representation of social phenomena to get stakeholders and public perception about the environmental condition of the river before and after illegal gold mining activity through questionnaires and in-depth interviews.

This research was conducted in seven districts from 15 districts in Kuantan Singingi. Those seven district are location with the most illegal gold mining activity and dispersed in Kuantan River, Singingi River, Kukok River and irrigation dam that had previously been conducted enforcement efforts by the regional government officers and the Police, that are Singingi Hilir District, Singingi, Kuantan Mudik, Gunung Toar, Hulu Kuantan, Kuantan Tengah, and Sentajo Raya. The research was carried out two years, starting on February 15, 2014, until February 15, 2016.

River and dam water sampling conducted in 19 research locations, which is around 50-100 meters upstream and downstream from the raft of illegal gold mining operating in Kuantan river flow, Singingi river, Kukok river and irrigation dams. Those water samples were taken directly from the surface of the river where citizens usually used for daily necessities without being processed first, to measure mercury (Hg) and water turbidity level at the specified location.

Determination of respondents based on cluster conducted through quota and accidental sampling, each district was taken 30 respondents which dispersed in 7 districts. Number of the sample determined using Rapid Assessment Procedure (RAP) method which has been the jurisprudence by the World Health Organization (WHO), that was 30 respondents for each district, so the sample size becomes 210 illegal gold miners from 7 district. As much 210 respondents consists of the community around the watershed who not involved as the illegal gold miners also took as samples.

Further qualitative research, informants are selected by purposive sampling. The selected informants are Head of Energy and Natural Resources Department, Environmental Agency, Health Department, Plantation Department, Fisheries Department, Agriculture Department, Chief of Police, environmental expert, Chairman of Parliament, head of the local district, chief of villages, community leaders, and illegal gold mines. The Number of informants is determined according to the adequacy of data required. Data collection was discontinued if no longer found the variation information.

3. Result

3.1 Measurement Result of Mercury Level(Mercury/Hg) and Water Turbidity

In table 1 is known one location that have been contaminated with Hg (0.0034 mg/L) or has exceeded the water quality standard for Class I, II, III according to criteria of water quality standards based on the class (Government Decree No.82/2001) [14], that was Kuantan river-Toar Village, Gunung Toar district (No.10). In addition, there are two locations that have reached the threshold value or water quality standard for class I (0.001 mg/L), that was Singingi River, Petai Village, Singingi Hilir subdistrict, and Kuantan River, Lubuk Ambacang Village, District of Hulu Kuantan, as follows:

Table 1: Measurement Result of Mercury level on Water of Kuantan, Singingi River and Irrigation Dam in Kuansing Region, October 2014

No	*No. Lab*	*Description of Water Sampling Location*	*Result and Parameter*			*Category*
			Mercury APHA 3030 B, 3111 B 2012 (mg/L)	*Water Quality Standard*		
				Kls I	*Kls II, III*	
1	3927 / 3069 BA.K	Singingi River, Koto Baru	0,0007	0,001	0,002	Not Polluted
2	3927 / 3070 BA.K	Creek, Petai Village	0,0005	0,001	0,002	Not Polluted
3	3927 / 3071 BA.K	Singingi River, Petai Village	0,001	0,001	0,002	Not Polluted
4	3927 / 3072 BA.K	Singingi River, Muara Lembu	0,0005	0,001	0,002	Not Polluted
5	3927 / 3073 BA.K	Kuantan River, Tepian Narosa	0,0006	0,001	0,002	Not Polluted
6	3927 / 3074 BA.K	Downstream Kukok River	0,0004	0,001	0,002	Not Polluted
7	3927 / 3075 BA.K	Kukok River (in gold mining location)	0,0004	0,001	0,002	Not Polluted
8	3927 / 3076 BA.K	Kopah Dam water (K.Tengah)	0,0004	0,001	0,002	Not Polluted
9	3927 / 3077 BA.K	Kuantan River, Pulau Aro village	0,0004	0,001	0,002	Not Polluted
10	3927 / 3078 BA.K	Kuantan River, Toar village (1)	0,0034	0,001	0,002	Polluted
11	3927 / 3079 BA.K	Kuantan River, Toar village (2)	0,0006	0,001	0,002	Not Polluted
12	3927 / 3080 BA.K	Kuantan River, Lubuk Jambi	0,0007	0,001	0,002	Not Polluted
13	3927 / 3081 BA.K	Kuantan River, L.Ambacang (1)	0,0003	0,001	0,002	Not Polluted
14	3927 / 3082 BA.K	Kuantan River, L. Ambacang (2)	0,001	0,001	0,002	Not Polluted
15	3927 / 3083 BA.K	Kuantan Sentajo River (1)	0,0003	0,001	0,002	Not Polluted
16	3927 / 3084 BA.K	Kuantan Sentajo River(2)	0,0005	0,001	0,002	Not Polluted
17	3927 / 3085 BA.K	Kuantan River Sentajo-Benai boundary	0,0001	0,001	0,002	Not Polluted
18	3927 / 3086 BA.K	WK Sentajo Dam water (1)	0,0003	0,001	0,002	Not Polluted
19	3927 / 3087 BA.K	WK Sentajo Dam water (2)	0,0001	0,001	0,002	Not Polluted

Source: Test Results in Environmental Health Laboratory, Riau Province, October 2014

In Table 2 below known that river water turbidity (TSS) measurement results at all locations of the sample (19 points) have exceeded the threshold of water quality standard for class I and II. Then also found 7 point of sample locations were already far exceeded the threshold of water quality standard for class I, II, III and IV, that are: Singingi River in Muara Lembu Village, Downstream of Kukok River, Kukok River in the illegal gold mining location, Kuantan River Sentajo and Benai boundaries, the irrigation water in Jaya Kopah Village-Kuantan Tengah District, irrigation and dam water WK Sentajo district in upstream and downstream of illegal gold mining activities.

Table 2 : Measurement Result of Turbidity in Kuantan, Singingi River and Irrigation Dam in Kuantan Singingi District, October 2014

No	*No. Lab*	*Description of Water Sampling Location*	*Result and Parameters*			*Category*
			Turbidity(TSS) SNI 06-6989. 25-2005	*Water Quality Standard (Class)*		
				I, II	*III, IV*	
1	3927 / 3069 BA.K	Singingi River, Koto Baru	146,75	50	400	Polluted
2	3927 / 3070 BA.K	Anak Sungai, Petai Village	237,02	50	400	Polluted
3	3927 / 3071 BA.K	Singingi River, Petai Village	261,41	50	400	Polluted
4	3927 / 3072 BA.K	Singingi River, Muara Lembu	1086,30	50	400	Polluted
5	3927 / 3073 BA.K	Kuantan River, Tepian Narosa	72,35	50	400	Polluted
6	3927 / 3074 BA.K	Downstream Kukok River	6970,50	50	400	Polluted
7	3927 / 3075 BA.K	Kukok River (in illegal gold mining location)	14088,00	50	400	Polluted
8	3927 / 3076 BA.K	Kopah Dam Water (K.Tengah)	4210,25	50	400	Polluted
9	3927 / 3077 BA.K	Kuantan River, Pulau Aro Village	169,35	50	400	Polluted
10	3927 / 3078 BA.K	Kuantan River, Toar Village (1)	104,76	50	400	Polluted
11	3927 / 3079 BA.K	Kuantan River, Toar Village (2)	119,36	50	400	Polluted
12	3927 / 3080 BA.K	Kuantan River, Lubuk Jambi	107,38	50	400	Polluted
13	3927 / 3081 BA.K	Kuantan River, L.Ambacang (1)	93,70	50	400	Polluted
14	3927 / 3082 BA.K	Kuantan River, L. Ambacang (2)	142,72	50	400	Polluted
15	3927 / 3083 BA.K	Kuantan Sentajo River (1)	142,72	50	400	Polluted
16	3927 / 3084 BA.K	Kuantan Sentajo River(2)	324,20	50	400	Polluted
17	3927 / 3085 BA.K	Kuantan RIver Sentajo-Benai	1360,70	50	400	Polluted
18	3927 / 3086 BA.K	WK Sentajo Dam Water (1)	779,31	50	400	Polluted
19	3927 / 3087 BA.K	WK Sentajo Dam Water (2)	812,50	50	400	Polluted

Source: Test Results in Environmental Health Laboratory, Riau Province, October 2014

3.2 Water Quality Based BOD, COD and DO Parameters

Water quality monitoring based BOD, COD, DO parameters were analyzed using secondary data from Environmental Agency, Riau Province in 2009 until 2013 with reference to Regulation No.82/2001[14]. Based on Table 3 are known that dissolved oxygen (DO) in Kuantan River (Lubuk Ambacang Village, Banjar Padang Lubuk Jambi Village, Koto Gunung Toar Village, Pasar Teluk Kuantan Village) Kuansing in 2010 until 2013 has been decline. Biochemical oxygen demand (BOD) in Kuantan River (Lubuk Ambacang Village, Banjar Padang Lubuk Jambi Village, Koto Gunung Toar Village, Pasar Teluk Kuantan Village) Kuansing District in 2009 until 2013 has been exceeded the threshold. Measurements results of COD are known to have exceeded the threshold (20 mg/L) or polluted in Kuantan River (Lubuk Ambacang Village, Banjar Padang Lubuk Jambi Village, Koto Gunung Toar Village) Kuansing District in 2009 until 2013.

Table 3 : Laboratory Result Analysis of DO, COD, BOD in Kuantan Kuantan River, Kuantan Singingi Region, 2009 until 2013

No.	Location and Parameters	Measurement Result (mg/Liter) Time (date/month/year)					Water Quality Standar (mg/L)					Category
		03/12/ 2009	08/11/ 2010	01/11/ 2011	01/11/ 2012	03/11/ 2013	Treshold	Class I	Class II	Class III	Class IV	
1	Kuantan River (Lubuk Ambacang Village)											
	DO	5,17	4,78	4,03	3,54	3,88	> 5	6	4	3	0	Polluted
	COD	4,69	13,53	4,02	14,11	6,88	< 4	2	3	6	12	Polluted
	BOD	24,15	49,26	22,22	48,00	22,47	< 20	10	25	50	100	Polluted
2	Kuantan River (Banjar Padang Lubuk Jambi Village)											
	DO	5,08	2,98	3,81	4,02	4,06	> 5	6	4	3	0	Polluted
	COD	10,11	9,31	4,01	4,49	7,48	< 4	2	3	6	12	Polluted
	BOD	43,47	39,41	19,04	32,90	24,14	< 20	10	25	50	100	Polluted
3	Kuantan River (Koto Gunung Toar Village)											
	DO	5,37	3,20	4,28	-	-	> 5	6	4	3	0	Polluted
	COD	8,05	12,40	1,02	-	-	< 4	2	3	6	12	Polluted
	BOD	33,81	39,41	12,70	-	-	< 20	10	25	50	100	Polluted
4	Kuantan River (Pasar Teluk Kuantan Village)											
	DO	5,54	3,15	3,86	3,56	3,87	> 5	6	6	3	0	Polluted
	COD	1,07	4,63	2,17	1,42	5,98	< 4	2	2	6	12	Polluted
	BOD	9,66	15,00	12,70	16,00	18,12	< 20	10	10	50	100	Not Polluted

Source : Secondary Data (Environmental Department, Riau Province), 2014

3.3 Public and Informants Perception Toward River Pollution

Public perception in the surrounding of watersheds area toward river water condition due illegal gold mining activities in Kuansing can be seen in Figure 1, which is the result of the questionnaire and supported in-depth interviews with informants. It is known that illegal gold mining activity has an impact on environment and water pollution of Kuantan River, Singingi River, Kukok River and irrigation dams. The water of the river is very turbid so not worth longer used for everyday purposes, such as for bathing, washing clothes and disrupt lives of fish and another biota. During this time the people who live in the watershed is very dependent on those river water.

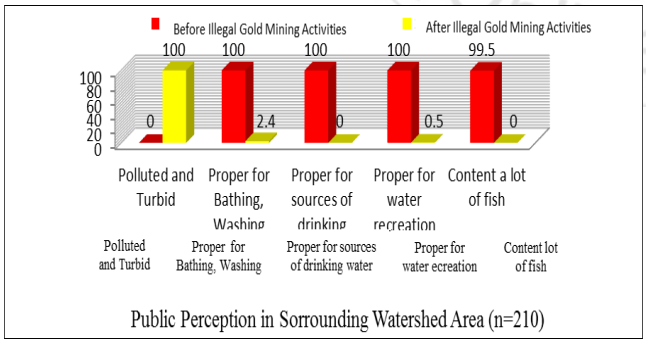

Figure 1: Public Perception in the Surrounding Watershed Area Toward River Water Condition Due The Illegal Gold Mining Activities in Kuantan Singingi District, 2015

4. Result

4.1 Mercury (Hg) Level and River Water Turbidity Levels

The results showed that is an indication of mercury pollution in Kuantan River water due illegal gold mining activities in Toar Village, Gunung Toar subdistrict, Kuansing district, with levels of Hg (0,0034 mg/L) has exceeded the threshold of water quality standard for class I, II & III for raw sources of drinking water , infrastructure/facilities water recreation, freshwater fish farming, livestock, and for irrigating crops, according to criteria of water quality standards by the class[14]. It also found two (2) locations of river water samples that have reached the threshold value water quality standard class I (0,001 mg/L) for raw sources materials of drinking water in Singingi River-Petai Village-Singingi Hilir subdistrict and Kuantan River-Lubuk Ambacang Village-Hulu Kuantan subdistrict, Kuantan Singingi District. The results of this research were supported by the opinion of Kasry[15], which states that allegedly presence of mercury in Kuantan and Singingiriver water are derived from activities of illegal gold miners who use mercury.

Out the 19 locations of water samples that being examined, found one point of sample locations that have exceeded the threshold of water quality standard for class I, II, III, and also found two sample points that have reached the threshold of water quality standard for class I. It is strongly believed that mercury levels are found more on sediment or silt along the river because Hg density heavier than water. This assumption is supported by Adventus research[16] in Kahayan River-Central Kalimantan, said that from the sample being measured, the highest mercury accumulated are in river sediments (0,336 g), then mercury accumulation in flesh of Baung fish (*Mytus nemurus*), ie 0,303-0,342 mg/g, and next

is water of river (0,058 mg-1). Mercury has a tendency to rise toward downstream. This is caused by sediment texture dominated by silt. Thus threatening population consuming water and fish from the river.

According to Mahmud[9], that the greater the distance, the lower of mercury concentration. The highest mercury concentrations in the effluent (sewage), tend increasingly to smaller downstream. Elevation at a certain point because of movement of particles riverbed, also due to another mining activities in the surrounding. As well as results of research Subanri [8] which state that there is a significant relationship between distance to Hg content in river water, the greater the distance, the smaller the Hg content in the water. Average levels of Hg in Menyuke River water- West Kalimantan is 0,532 ppb, already highly polluted when compared to Hg content in Kuantan and Singingi River Water[14]. However, if the illegal gold mining activity continues to occur in Kuantan and Singingi River, it is predicted that 10-20 years later have potential polluted as happened in Kahayan River-Central Kalimantan and Menyuke River in West Kalimantan.

The results of this research are similar with Inswiasri [11,17], that show the illegal gold mining activities in various regions using Hg for amalgamation process. The impact from that amalgamation, often appearing Hg contamination in the environment at the time of amalgamation and annealed so that contaminate sources of drinking water and fish that are needed by people around the gold mining. Gold amalgamation process performed by the traditional community can be released into the environment. When this washing process, waste which may contain mercury discharged directly into water bodies. Making mercury mixed, fragmented intangible fine granules, which of nature are difficult to separate. The milling process which performed at the same time with amalgamation process resulting mercury leaching process carry the dregs over into the river.

The results of this research also similar with Orathinkal, et al[18], about concentration of mercury and its impact on river water environment in Watut River in Morobe Province, Papua New Guinea, states that mercury concentration level 0,001 mg/L, is already quite high when compared to drinking water quality standard recommended in Papua New Guinea and Australia. Explained that mercury can affect aquatic environment, many changes occurred or are found in rivers, many plants dead, levels of mercury (Hg) lots in sediment and fish are found defective. This study provides basic information on effects of toxic mercury toward river water environment. This study focused on Hg levels and turbidity level of the river water which has been used for everyday purposes as a source of clean water by villagers, both for material drinking, bathing, washing clothes, drinking livestock, fish farming and other.

This study uses same water samples to measure Hg levels and turbidity level of river water and irrigation dam on research location that is instantaneous (one-time measurement). From measurement result of turbidity (Total Suspended Solid = TSS) Kuantan River, Singingi River and irrigation dams can be seen that all locations of water samples (19 points) have exceeded the threshold of water quality standard for the class I and II. Found 7-point location of water sample that has far exceeded threshold of water quality standard for class III and IV, that are Singingi River in the Muara Lembu Village, Kukok Hilir River, Kukok River in the illegal gold mining location, Kuantan River-Sentajo and Benai boundary district, Irrigation Dam water in Jaya Kopah Village- Kuantan Tengah Subdistrict, WK Irrigation water- Sentajo on upstream the illegal gold mining, WK Irrigation water-Sentajo on downstream the illegal gold mining. Meaning that it has far exceeded quality standards for drinking water sources, infrastructure / water recreation facilities, for freshwater fish farming, animal husbandry and for watering plants or farms [14,19], so can disrupt life and growth of aquatic organisms. It is also supported by perception from people that living in Kuantan and Singingi River flow area who have trouble getting fish from the river, and the catch has decreased.

The results are support by Johan and Ediwarman's research[20], which states that high-value of Singingi River water turbidity due to activities of illegal gold miners operating at the time of taking water samples. Believed that soil, sand, silt and clay aspirated Dongfeng engine the illegal gold mining directly discharged into the river so these solids suspended in form of small particles and fine resulting turbidity of river water, then these particles floating in river flow resulting in lower light intensity to water contained in phytoplankton, zooplankton, and others. The particles that are suspended in these river water will flow away and settles somewhere, will cover the benthos and fish eggs that are around grass so that fish eggs can not hatch, bento and some types of fish will also die. Even if there are some benthic and fish surviving remains unsafe, because the fine mud containing organic and will decay, resulting in unaerobik process and conditions in the water will cause toxic H_2S or multiple effects.

The statement above is supported by Wardhana's opinion[21] and Salmin's [22] which states that the river which becomes waste dumps and containing organic matter, mostly dissolved oxygen used by aerobic bacteria to oxidize carbon and nitrogen in the organic compound matter into carbon dioxide and water. So that dissolved oxygen levels will decrease rapidly and consequently fish, shrimp and shellfish will die. The stench of polluted water comes from NH_3 and H_2S gas resulting from advanced organic materials decomposition process by anaerobic bacteria. Low polluting waters and which can be categorized as good waters as either having dissolved oxygen (DO)> 5 ppm.

4.2 River Water Quality Based BOD, COD and DO Parameters

The quality of river water viewed under DO, BOD and COD parameters measurements carried out by the Environment Agency of Riau Province in 2009 until 2013, which was included in the study location. It is known that dissolved oxygen (DO) in Kuantan River-Lubuk Ambacang Village, Kuansing District in 2010 until 2013 has been a decline. DO parameters based on Regulation No.82/2001 [14] for water

quality standard are ; Class I (6 mg/L), class II (4 mg/L), class III (3 mg/L). According to Wardhana[21] and Salmin [22], water must contain oxygen (DO) at least 5 mg/L as a place that fish can life. An aquatic environment with low pollution levels and are categorized as good if the waters had DO levels> 5 ppm (parts per million). This means that measurement of DO in Kuantan River-Lubuk Ambacang Village-Kuansing District in 2010 until 2013, is under the threshold (5 mg/L) and categorized as polluted so that it can result fish, shrimp, shellfish in this river will die.

Biochemical Oxygen Demand (BOD) in Kuantan River-Lubuk Ambacang Village-Kuansing District in 2009 until 2013 has been exceeded the threshold. BOD parameter[14] for water quality standard are; Class I (2 mg/L), Class II (3 mg/L), Class III (6 mg/L). According to Wardhana[21], clean waters are waters that BOD is less than 1 mg/L or 1 ppm if BOD was above 4 ppm, the water is said as contaminated. The raising higher levels of BOD then show strongly increasing indication that the water is contaminated. This means that measurement results of BOD in 2009 until 2013 has exceeded the threshold value (4 mg/L) and water quality standards for drinking water, infrastructure/water recreation facilities, and for freshwater fish farming.

COD measurement results indicate the amount of oxygen used in chemical reactions by bacteria in Kuantan River-Lubuk Ambacang Village-Kuansing District in 2009 until 2013 has exceeded the threshold (20 mg/L) or polluted. COD parameter (Government Decree No.82/2001) to the water quality standard are; Class I (10 mg/L), Class II (25 mg/L), Class III (50 mg/L). According to UNESCO, WHO/UNEP (1992) in Warlina [23], not polluted waters usually less than 20 mg/L.This means that COD results measurements in Kuantan River-Lubuk Ambacang Village-Kuansing District in 2009 untill 2013, has exceeded the threshold and water quality standards for drinking water, and infrastructure/water recreation facilities.

The measurement result of Dissolved Oxygen (DO) in Kuantan River-Banjar Padang Lubuk Jambi-Kuansing Regency in 2010 until 2013, does not correspond to threshold (5 mg/L) and water quality standard for class I, II and III, which would cause fish, shrimp, scallops in the river will die. Measurement result of Biochemical Oxygen Demand (BOD) in Kuantan River-Banjar Padang Lubuk Jambi-KuansingRegency in 2009 till 2013 has exceeded the threshold (4 mg/L) and water quality standard for class I, II, and III, as raw sources for drinking water, infrastructure / water recreation facilities, and cultivation of freshwater fish [14,21,22]. Measurement results of COD indicates amount of oxygen used in chemical reactions by bacteria in Kuantan River-Banjar Padang Lubuk Jambi-Kuansing Regency in 2009 till 2012 has exceeded the threshold (20 mg/L) and water quality standard for class I and II, to raw sources of drinking water, and infrastructure/water recreation facilities (UNESCO/WHO, 1992 in Warlina [23].

The measurement result of dissolved oxygen (DO) in the Kuantan River-Koto Gunung Toar Village-KuansingDistrict only measured in the year 2009 to 2011, known that DO in 2010 and 2011 showed a decrease, not suitable with the threshold (5 mg/L) and below of water quality standards for class I and II, which would cause fish, shrimp, shellfish in the river will die. Biochemical Oxygen Demand (BOD) in the Kuantan River-Koto Gunung Toar Village-Kuansing District in 2009 and 2010 has exceeded the threshold (4 mg/L) and water quality standards for drinking water, infrastructure/facilities water recreation, and for the cultivation of freshwater fish [14, 21,22]. COD measurement results indicate the amount of oxygen used in chemical reactions by bacteria in Kuantan River- Koto Gunung Toar Village-Kuansing District in 2009 and 2010 has exceeded the threshold (20 mg/L) (UNESCO / WHO, 1992 in Warlina [23].

The measurement result of Dissolved Oxygen (DO) in Kuantan River-Pasar Teluk Kuantan Village-Kuansing District in 2010 till 2013 did not correspond with the threshold (5 mg/L) and water quality standard for class I and II or have been contaminated so as to result in the fish, shrimp, shellfish in the river will die. Measurement results of Biochemical Oxygen Demand (BOD) in 2009 to 2013 there is a fluctuation, only in 2010 and 2013 that exceeds the threshold (4 mg / L) and water quality standards for drinking water, infrastructure/water recreation facilities [14,21,22]. While measurements result of COD in Kuantan River-Pasar Teluk Kuantan Village-District Kuansing in 2009 until 2013 is still below the threshold (20 mg/L) or not contaminated, it is assumed for this location is a dense residential population and number of people doing activity there, so it is very easily monitored, supervised and river water pollution can still be controlled by local government and security forces.

Mahmud's research results [9], showed that negative impact of small-scale gold mining in Tulabolo River-Gorontalo province is mercury pollution. There were changes in water quality (BOD, COD and DO), sediment, aquatic animals, and vegetation resulting from the use of mercury in gold extraction. But in this study did not measure mercury levels in sediments and aquatic animals such as fish, shellfish. This study only measured levels of mercury and turbidity of water which has a direct impact on communities surrounding watershed (DAS) on the utilization of river water.

The results are similar with Johan and Ediwarman's research[10] which states that general condition of Singingi waters are in unstable ecosystem conditions and are at worrisome condition because it has been contaminated. Analysis result based physic and chemical parameters have exceeded the threshold accordance to Regulation No. 82 of 2001 [14] concerning to management of water quality and water pollution control, among others such as turbidity, TSS, DO, BOD and COD.

According Warlina [23] water quality impaired can mark by changes in smell, taste, and color. An indicator water polluted is observed by changes or signs of physical, chemical and biological, and water contamination by microorganisms present in water, especially the presence or absence of pathogenic bacteria. All of the indicators, it can be stated that Kuantan River water, Singingi and Kukok River, and irrigation Dam has been polluted by illegal gold miners activities.

Pollution and decreased of water quality seen based BOD, COD and DO parameters. Biochemical Oxygen Demand (BOD) indicates the amount of oxygen used in oxidation reaction by bacteria. The higher levels of BOD, more indicate those waters are polluted. Then COD indicates the amount of oxygen used in chemical reactions by bacteria. Oxygen is needed by all creatures that live in water like fish, shrimp, shellfish and other animals, including microorganisms such as bacteria, in order fish can live, the river water must contain oxygen for at least 5 mg/liter or> 5 ppm (parts per million), But reality of dissolved oxygen in those river flow had dropped below water quality standards or become corrupted, so can cause fish, shrimp, shellfish in the river will die. Therefore, river pollution should be prevented from the pollutant sources and controlled by the Environment Department (BLH), curbing illegal gold mining activities should be carried out by police, local government, and community support.

4.3 Public and Informants Perception Toward River Pollution

Traditional small-scale gold mining in Kuantan Singingi has actually been done decades by locals and visitors. Initially, some of the miners only do by way of panning in certain locations, such as in small rivers (tributaries) where the water is fairly quiet and does not cause pollution along Kuantan and Singingi River as is the case today, but gold results were obtained from the pan relative a little. Then, about last ten years (since 2006) has become a popular method of gold mining alluvial deposits in the river with rafts and machinery (Dongpeng) the illegal gold mining, as is done in West Kalimantan and some other areas.

The results of this study indicate that since increasing of illegal gold mining activities in Kuantan Singingi which use rafts unit, Dongfeng machine even heavy equipment (excavators) has an impact on the water environment pollution Kuantan River, Singingi River, Kukok River and irrigation Dam. According to perceptions of respondents and informants in this study, the river water is very turbid so not worth longer used for everyday purposes, such as for bathing, washing, as a source of drinking and cooking water, recreational water, freshwater fish farming, animal husbandry and also to irrigate crops, people have trouble getting clean water, fish and other biota life to be disrupted and die, and people more difficult to get fish in Kuansing. Whereas this long before a lot of illegal gold mining activities, people living in the watershed is highly dependent on river water for their daily needs and not contaminated.

According to Robbins and Judge[24] and Hanggraeni[25], that perception is defined as the way people analyze and interpret their observations with aim of giving meaning to their surroundings. An individual will view everything with their own perceptions that may differ from the perception of the other. According to McShane and Von Glinow [26] and Wibowo [27], one of the ways that can be done to improve individual perception is helping others become more concerned (improving self-awareness).

Local government and their staffs also the polices have been making efforts curbing illegal gold mining, but it has not been effective. Public and stakeholders have a negative perception toward illegal gold mining which has polluted river water, but most of them are apathetic and unable to do much to resist illegal gold mining, illegal gold mining activity that persists, even the increasing number and expanded. Therefore it is a very necessary concern of all parties, as the perpetrators of illegal gold mining and the surrounding communities also policy makers (stakeholders) to establish, maintain, preserve and save the environment of the river and the biota therein.

Based on Kohlberg's theory of moral development, then the attitude of illegal gold mining perpetrators, the local communities and stakeholders are still at the pre-conventional level 1 and 2. In stage 1 (obedience and punishment orientation) means an act regarded as morally wrong if person who did it punished, more increasingly harsh sentence given is considered one of the actions [28]; at level 2 (orientation personal interests), they still think "what's the benefit for me", show little interest in the environment and other people, only at the stage when the need was influential on his own needs, attention to others not based on loyalty or the intrinsic factor ,

It takes values of local wisdom that has started to disappear in increasing knowledge, understanding and habits that drive human behavior in society to preserve environment [29,30]. Saam [31] mentions local wisdom was developed in daily life through the teachings directly from parent to child or from *"niniak mamak"* to grandchildren and "*kemenakan*" (nephews). Another way in the delivery of this wisdom can also be through-proverb adage, *"pantang larang"* or some rules to forbid any action and other literature.

The surrounding communities actually have the right to express objections and report to the police and local government as impaired due to illegal gold mining activities which have been polluting the river, as regulated in Environmental Law No. 32 of 2009 clause 26 and clause 70. The communities also has the same rights and opportunities and broadest to play an active role in the protection and management of environment.

5 Conclusion

Illegal gold mining has a negative impact on river water quality and irrigation Dam water in terms of turbidity level, Hg level, DO, BOD, and COD parameter has exceeded the threshold (polluted), disturbed the life of various types of fish, shrimp, shellfish and leading to those biota die. The communities around the watersheds are feeling the effects of river pollution because the river water can no longer be used for their daily needs.

6 Suggestions

The illegal gold miners (workers/investors), communities and policy makers to realize that illegal gold mining activities have an impact on environmental pollution and river biota.

Illegal gold mining activity in streams and irrigation dams should be terminated through mutual commitment, the necessary dissemination of information, required publication and education, cooperation and coordination between curbing illegal gold mining sustainably. To the Government of Kuantan Singingi and stakeholders should use results of this study as materials to formulate policy on illegal gold mining and protect river environment from pollution, also setting up a social control program post-closure illegal gold mining by providing jobs for local people in agriculture and plantations, community empowerment, efforts to improve skills and people's incomes, diversification, and the provision of subsidies. Local governments can also use village funds budget for rural development and help provide land, seed, fertilizer, livestock, and other efforts for rural communities welfare. To other researcher needed a comprehensive study about Hg content on river sediment, fish and snail, paddy or rice in downstream of illegal gold mining activities, also health symptom to community around the watershed.

References

[1] Widowati.W, Sastiono.A, R.Jusuf Raymond. *Impact of Metals Toxic "Prevention and Polllution Controlled".* Andi Publisher: Yogyakarta, 2008.
[2] Lestarisa.T. *Factors Related Poisoned of Mercury (Hg) on Illegal Gold Miners in Kurun district, Gunung Mas Region, Central Kalimantan*. PS MKL, PPS, Diponegoro University, Semarang, 2010.
[3] International Agency for Research on Cancer World Health Organization, *Berrillium, Cadmium, Mercury, and exposures in the glass manufacturing* in Monographs on The Evalution of Carcinogenic Risk to Humans. Vol.58. 1993.
[4] Alpers.N, Charles and Michael P, Hunerlach. *Mercury Contamination from Historic Gold Mining in California*. USGS Fact Sheet FS-061-00 (Rev. 4/05) 2006 [Online]. Available : http://ca.water.usgs.gov/ mercury/ fs06100.htpl. [Accessed : April 2 , 2013]
[5] Aspinall.C. *Small-scale Mining in Indonesia*. Report of Mining Minerals and Sustainable Development (MMSD) Project, IIED. No. 79, September,2001.
[6] Doreo.G, Jose. *Mercury in Hair and Fish Consumed by Riparian Woman of the Rio Negro, Amazon, Brazil*. International Journal of Environment Health Research, Vol. 13(3), 239-248, September, 2003.
[7] Spiegel.SJ, Ribeiro.CA, Sousa.R, Veiga.MM. *Mapping Spaces of Environmental Dispute: GIS, Mining, and Surveillance In the Amazon*. Ann Assoc Am Geogr, Vol. 102(2):320–349, 2012.
[8] Subanri. *Studi of Pollutant Contain of Mercury (Hg) Toward Menyuke River Water and Health Impaired on Minners as Result of Illegal Gold Minners Activites in Menyuke district, Landak region, West Kalimantan*. PS MKL Diponegoro University, Semarang, 2008.
[9] Mahmud.M. *Spasial Temporal Distribution Model of Mercury Consentration as result of Traditional Gold Mining as basic of pollution Monitoring and Evaluation*. Disertation, PPS UGM Yogyakarta. 2012. [Accesed : 03 Mei 2014]
[10] Darmono. *Environmental and Pollution:The Relationship with Metal Toxicology*.Indonesia University Publisher (UI-Press). Jakarta, 2008.
[11] Inswiasri. *Health Risk Analysis Mercury on People Gold Mining Activities in Gunung Mas, Central Kalimantan*. Disertation. Public Health Faculty, Indonesia University. Depok, 2010.
[12] Nopriadi. *The Influence of Illegal Gold Mining Activities toward Health of Workers in Kuantan Singingi, Indonesia*. International Journal of Science and Research (IJSR), Volume 4 Issue 8, August, 2015 www.ijsr.net. Paper ID: SUB157856.
[13] Kasim. *Will becoming a bom timer*. Article, Pekanbaru Riau, 2014.
[14] Republic Indonesia Government Regulation Number 82 / 2001 concerned to *"Water Quality Management and Water Pollution Controlled"*
[15] Kasry.A. *Organic Mercury and Minamata Disease.* Article, PSIL Riau University, Pekanbaru Riau, 2014.
[16] Adventus.P, K.Handoyo, Nitimulyo, Tjut S. Djohan. *Mercury accumulation on Baung fish (Mytus nemurus) in Kahayan River, Central Kalimantan*. Jurnal Manusia dan Lingkungan, Volume X, No. 3, November. ISSN 0854-5510, 2003
[17] Inswiasri, Hendro Martono. *Study of Pollution in People Gold Mining Area.* Media Litbang Kesehatan, Vol.XVII No.3; 42-50, 2007.
[18] Orathinkal.J, Abbeygail.T, Joanne, M. Kilip. *Mercury Concentration and its Effect on the Aquatic Environment of the Lower Watut River, Morobe Province, Papua New Guinea*. Contemporary PNG Studies: DWU Research Journal, Volume 14, May, 2011.
[19] Sunu.P. *Protect Environment with Implemented ISO 14001*, Gramedia Widia Sarana Indonesia Publisher. Jakarta, 2001.
[20] Johan.TI , Ediwarman. *Impact of Gold Mining Toward Singingi river water quality in Kuantan region, Riau Province*. Jurnal Ilmu Lingkungan. ISSN 1978-5283. Environmental Sciences Department PPS University of Riau,2011.
[21] Wardhana. W.A. *Impact of Environmental Pollution*. Andi Offset, Yogyakarta, 2004.
[22] Salmin. *Dissolved Oxygen (DO) and Biology OxygenDemand (BOD) as An Indicator for Determine Waters Quality*. Oseana, Volume XXX, Nomor 3: 21-26, 2005.
[23] Warlina.L. *Water Pollution : Sources, Impact and Controlled*. Sains Philosophy IPB, Bogor, 2004.
[24] Robbins.S.P, TimothY,A, Judge. *Organizational Behavior 13th edition*. Pearson Education, 2013
[25] Hanggraeni.D. *Organizational Behaviour : Theory, Cases and Analysis.* Economic Faculty Publisher University of Indonesia, 2013.
[26] McShane.S.L. & Mary Ann Von Glinow. *Organization Behavior*. New York: McGraw-Hill, 2010.
[27] Wibowo.A. *Practical Research Methodology in Health Issues*.PT RajaGrafindo Persada. Jakarta, 2014.
[28] Shaffer, David R. *Social and Personality Development*. (5th Ed ed). Wadsworth Publishing. ISBN 0-534-60700-4, 2004
[29] Hamidy. *Puak Melayu Riau Wisdom to Maintain Environmental.* UIR Press. Pekanbaru, 2001.
[30] Amri.F, Zulfan Saam, Thamrin. *Local Wisdom of Lubuk Larangan as Force to Waters Resources Preservation in Pangkalan Indarung, Kuantan Singingi Region.* Riau University Environmental Research Center, 2013.
[31] Saam.Z, Arlizon. "*Perkandangan" Local Wisdom in Sentajo District.* Jurnal Ilmu Lingkungan. 5(1): 10-17, 2011.

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