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The Effect of Batik Waste Disposal into the River To The Level of Cadmium in the Dug Well Water

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Abstract- The process of batik production is indicated to use synthetic chemicals. Synthetic dyes used in the process contain heavy metals, one of which is the heavy metal, Cadmium. This research aims to analyze the effect of the disposal of Batik waste into the river to the level of cadmium in the dug well water. This research was conducted in 2016. This type of research is observational research with cross sectional study as the design. The population of the research are exposed and controlled group with a total of 16 samples for each group. The result showed average level of Cadmium in the river water is 0.009 mg/L, 0.0029 mg/L in the dug well. The result of processing the data showed that there is river pollution as the effect of Batik waste in the level of cadmium (Cd) of dug well water (b = 28.3; p = 0,004); there is an effect of soil porosity to the level of cadmium (Cd) of the dug well water (b = -66,6; p = 0.000); there is also an effect based on the distance of the river and the dug well to the level of cadmium (Cd) of the dug well water (b = -14.2; p = 0.025). The research result concluded that the level of cadmium of the dug well is affected by the cadmium level in the river water, the porosity of the soil, and the distance of the river as well.

Keywords- Cadmium, Batik Waste, River Water, Dug Well Water

1. INTRODUCTION

Batik is one of the cultural wealth of Indonesia. Batik can be defined as a cloth whose process uses the technique of *membatik*. *Membatik* is one of the techniques of textile background maker using the method of *celup-rintang* (resist-dye), i.e. by using wax as a medium to resist the dye color. The wax can be painted on top of the fabric using a special tool called *canting* or block that is stamped to bind the cloth basic color pigment substance or the result color from the first dying process before the fabric is dipped back repeatedly into the textile dye. The next process is *nglorot*, to get rid of the wax, so that the shape of the patterns and color will be visible as a result of the dipping process [2].

Batik production is spread throughout the territory of Indonesia, mainly in Java and Sumatra. Batik is one industry whose process of production uses synthetic dyes which is indicated to use chemicals containing heavy metals. Liquid waste of Batik industry is also indicated to still contain the elements of heavy metal. Some of the heavy metals contained in the waste of Batik are cadmium (Cd), lead (Pb), chromium (Cr), copper (Cu), iron (Fe) and zinc (Zn). If Batik waste containing heavy metals is not processed properly, it will cause pollution of heavy metals in river water and groundwater [8].

Heavy metals typically give rise to special effects on living things; can be toxic or an essential metal substance to the body. Heavy metals can be toxic to living things, such as, mercury (Hg), cadmium (Cd), lead (Pb), and chromium (Cr) (Palar., 2008). Cadmium (Cd) is a white metal, easily shaped, soft, and has bluish color. Having relatively low boiling point (767˚C) makes it flammable, forming cadmium oxide fume. Exposure to cadmium in the long time can cause malfunction to the body's internal organs, especially kidneys. Chronic cadmium poisoning can cause cardiovascular disorders and hypertension [10].

Pekalongan is a city in Central Java province, Indonesia that has become one of the country's industrial centers of Batik in Indonesia. The majority of the population in Pekalongan works in the industrial sector of Batik, both as workers and as Batik makers. Batik industry in Pekalongan is a household-scale industry. Most of Batik industry liquid waste in Pekalongan has not been managed properly. Batik waste is usually streamed to rain water channel that flows towards the river.

Based on research by Tuty and Herni (2009), it is stated that the waste of Batik Cap Palembang contains cadmium around 0.0063 mg/L. Result of a preliminary survey conducted by the researchers obtained that the waste of Batik in Pekalongan contains cadmium about 0.0171 mg/L. After some physical quality observations, the water of some dug well near the river flow used as a place for Batik waste disposal, obtained result that it was turbid and smelly.

This indicated that there had been water pollution in the dug well due to water seepage from the river. It was presumed that the water in the dug well also contained cadmium as did in the waste of Batik.

This research aims to analyze the effect of the disposal of Batik waste into the river to the level of cadmium in the dug well water.

2. RESEARCH METHODS

This research is a quantitative research, uses dug well water as a research subject, and undergone by laboratory tests. The study was observational with cross sectional design. Simple random sampling technique is used to gather samples. The total sample for each exposed and controlled group are 16. Sample of the exposed group was the dug well on the riverbank of Jenggot Village,

$$n = \frac{2.\sigma^2.(Z_\alpha + Z_\beta)^2}{(\mu_1 - \mu_2)^2}$$

while the controlled group got the dug well on the riverbank of Kertoharjo Village. The calculation of the sample uses mean formula [5]:

Information :

n : sample size of each group

Zα : Adjusted standard deviation for α 1 way test (1,96).

Zβ : Adjusted standard deviation for β (0,84).

σ : SD response to the comparison group (0,02)

μ_1 : The average of blood lead levels in the sample group (0,05)

μ_2 : The average of blood lead levels in the comparison group (0,03) [1]

Samples taken were those that met the inclusion criteria that were the well located on the riverbank, within ≤ 10 meters from the river, and used for drinking and cooking need by the people. Sampling was done by researchers and referring to ISO 6989. 58: 2008.

Data collection techniques was done by taking samples from the river water and the well water, and then the samples were analyzed using Atomic Absorption Spectophotometry (AAS) to determine the level of cadmium in those water. Soil porosity data was obtained by measurement using percolation test, while the data of the distance between the river and the dug well was obtained by measurement using a roll meter. The data in this research is the primary data. To analyze the data, multiple linear regression using the data processing program was used.

The quality standard of cadmium level in river water refers to the Indonesian Government Regulation No. 82 in 2001 about the Management of Water Quality and Water Pollution Control. The quality standard of cadmium level in dug well water refers to the Regulation of Minister of Health of Indonesian Republic number 492 in 2010 about Drinking Water Quality Requirements.

3. RESULTS AND DISCUSSION

Analysis of Cadmium level in river water, dug well water, soil porosity and distance between the river and the well can be seen in Table 1, 2, 3, and 4.

Table 1. The Cadmium Level in the river water in Jenggot Village, Pekalongan 2016

Parameter	Mean±SD	Min	Max
Cd level of the River Water (mg/L)	0.009±0.0017	0.0069	0.0112
Cd level of the Well Water (mg/L)	0.0029±0.0009	0.0019	0.0056

Source : The primary data source

The river used as a Batik waste disposal site had average cadmium level about 0.009 mg/L. According to the Indonesian Government Regulation No. 82 in 2001, the quality standard of cadmium in the body of water is 0.01 mg/L. The results of the analysis of the average level of cadmium in river water was still below the quality standard and can be indicated that the river contained cadmium as a result of batik waste disposal. This could be evidenced by the results of a preliminary survey which stated that the level of cadmium of Batik waste in Jenggot Village was about 0.0171 mg/L. Based on the Regulation of the Minister of Environment of Indonesian Republic No. 5 in 2014 concerning Wastewater Quality Standard states that it is not required for textile industrial wastewater to contain heavy metal cadmium. The content of heavy metal cadmium in batik industry wastewater clearly violates the rules set by the government.

River water will seep into the groundwater. The content of cadmium in river water will be absorbed into the ground water, in this case dug well water. The results of the analysis of dug well water near the river showed that the average cadmium level was about 0.0029 mg/L. Dug well water is used as drinking water by the community. Standard quality of the cadmium content of drinking water in accordance with Regulation of the Minister of Health of the Republic of Indonesia No. 492 in 2010 is 0.003 mg/L. The results of analysis of cadmium dug well water is still below the standard set, but consuming water containing heavy metal cadmium accumulated in the body in the long term can cause health problems such as impaired kidneys, liver, reproductive system, hemopoitic system, and bones.

Table 2. The Results of the Measurement of Soil Porosity and the Distance between the River and the Well in Jenggot Village, Pekalongan 2016

Parameter	Mean±SD	Min	Max
Soil Porosity (Inch/minute)	2.99±0.274	2.82	3.17
The Distance between the Well and the River (Meter)	3.82±1.059	1.5	6.5

Source : The primary data source

Soil porosity in Jenggot Village, Pekalongan was 2.99 inches/minute whose soil type has medium porosity. Soil porosity is a proportion of the total pore space contained in unit volume of soil that can be occupied by water and air, so it is an indicator of the condition of drainage and soil aeration. Porous soil means having adequate pore space for air and water movement in and out of the soil freely. The amount of water moving through soil pore closely related to the size and number of pores present in the soil [3].

The distance between the river and the well that became the subject in the study had an average distance of 3.82 m, indicating that the distance of the river to the well did not meet the health requirements for wells located in a location that is vulnerable to contamination. According to Sugiharto (1987), the pollution caused by the chemicals can reach a distance of 95 meters, thus the water source used by society to be located more than 95 meters from the source of chemical disposal [11].

The effect of Batik wastewater disposal into the river, soil porosity, and the distance of the river to dug wells to the cadmium level analyzed using multiple linear regression obtained the following results.

Table 3. The Analysis of the Effect of the Cadmium Level in the river Water, Soil Porosity, and the Distance of the River to the Well to the Cadmium Level in the Dug Well Water in Jenggot Village Pekalongan 2016.

Variable	Cd Dug Well Water	
	b	p
Cd River Water	28.3	0.004*
Soil Porosity	-66.6	0.000*
The Distance between the River and the Well	-14.2	0.025*

*ρ < 0,05= significant

Based on Table 3, it showed that there was an effect of the cadmium level in the river water to which in the well water, b positive value indicated that the higher cadmium level of river water, the higher the cadmium level of dug well water. Soil porosity also affected the cadmium level of dug well water, with negative value of b indicated the higher porosity of the soil, the lower the cadmium level of the dug well water. The distance between the river and the well also affected the cadmium level of dug well water, with negative value of b indicated the higher the distance between the river and the well, the lower the cadmium level of the dug well water.

In line with the research conducted by Tika A. P (2009), indicated that the wells located on the edge of the river of Porong Sidoarjo used as a place to dispose Lapindo mud also contained heavy metals in the sludge and the river. The farther the distance of the river to the wells, the smaller the level of heavy metals would be. It showed that the level of heavy metals in the river affected the level of heavy metals in water wells located near the river [13].

4. CONCLUSION

Results showed that there was river pollution as an effect of Batik wastewater disposal to the level of cadmium (Cd) of the dug well water (b = 28.3; p = 0.004), b positive value indicated that the higher cadmium level in the river water, the higher the content of cadmium in the dug well water. Soil porosity also affected the cadmium level of dug well water, with negative value of b indicated the higher porosity of the soil, the lower the cadmium level of the dug well water. Distance to the river with the well also affected the cadmium level of dug well water, with negative value of b indicated the higher porosity of the soil, the lower the cadmium level of the dug well water. The conclusion of the study is that cadmium level of the water in the dug well is affected by cadmium level of the river water, soil porosity, and the distance of the river to the well.

The average of cadmium level of river water is 0.009 mg/L. This indicates that the cadmium level of river water is still below the quality standards stipulated in the Indonesian Government Regulation No. 82 of 2001, in which the quality standard of cadmium in the body of water is 0.01 mg/L. The average cadmium level of dug well water is 0.0029 mg/L. That is still below the quality standards established in the Regulation of the Minister of Health of Indonesia Republic Number 492 in 2010 that is about 0.003 mg/L.

Good Batik wastewater management and treatment is needed so that it does not pollute the river water and ground water. Adding the capacity of communal Wastewater Treatment Plant (WWTP) in Jenggot Village needs to be done. Monitoring the quality of river water and groundwater should be conducted periodically to serve as a reference for the follow-up control of pollution.

People who still use dug well water as a source of drinking water should be given an alternative source of drinking water to prevent exposure to heavy metals. Alternative source of community drinking water is for example by making an inner pumped drilled well that can penetrate layers of aquifer rocks to avoid contaminants. Besides that, the need for communication with Batik entrepreneurs to participate

in preserving the environment by using natural dyes for fabrics to be easily parsed by nature is necessary.

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