IMPACT OF LAPINDO MUD DUMPING WATER IN MADURA STRAIT EAST JAVA

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ABSTRACTS

Warm water mud has sprayed out from craked of the earth surroundings gasses drilling by Lapindo Brantas Inc in village of Siring, Porong Subdistrict, Sidoarjo Regency, a large industrial zone and the economic backbone of East Java Province, at May 29 2006. The mud water created problems in the environment, relocation of people, conflicts, and controversies on the issue of dumping warm mud water into Porong River and Madura Strait, East Java. In this paper, I reviewed secondary literature to analyze and examine the impacts of dumping mud water in Madura Strait East Java to provide recommendations in the proper management of mud water. Literature provides that the quality of mud water was beyond the standards provided by the State Ministry of Environment Republic Indonesia and International Environment Quality Standard. Temperature is 38 - 56 ^{0}C, Hg (Mercury) is 2.5 ppm, H_2S Fenol is 3.37-4.25 ppm, BOD is 38.40 mg/L, Manganese is 0.806 ppm, Pb is 0.104 ppm, Selenia is 0.0071 ppm.

Water mud of Lapindo drained into the sea endangers biotic organisms. The recommendation are: Spray out of mud water should be stopped and mud water doesn't thrown to sea, Lapindo must make a permanent giant lake to keep mud water in the origin of place, If the previous recommendation cannot done, than for keep the live of man surrounding the area, the water may be trown to the river or sea after the water processing, but the mud must still remaining in the ground, not to thrown in the sea.

Keywords: Mud water of Lapindo, Dumping.

INTRODUCTION

The Indonesian listed oil and gas company, PT. Energi Mega Persada Tbk (ENRG), the prime company of Lapindo Brantas Inc, reported at May 29, 2006, the company observed steam, water and minor amount of gas bubbles to the surface adjacent to its Banjarpanji-1 exploration well (PT ENRG, May 30, 2006). The mud water content of : temperature is 38 - 56 ^{0}C, Hg (mercury) is 2.5 ppm, H_2S Fenol is 3.37-4.25 ppm, BOD is 38.40 mg/L, Manganese is 0.806 ppm, Pb is 0.104 ppm, Selenia is 0.0071 ppm, (Tempo, June 15, 2006). Warm mud water mixed by gasses has soaked 3 villages (400 hectares). Warm mud has soaked agricultures, residences, and make traffic jammed, and disturb economics.

Problem of warm mud water have problem with environment, relocation of people, conflict, and controvention about planning to dumping water from warm mud water to Porong river and Madura Strait, East Java. Treated water from hot toxic mud into Madura Strait East Java, posed a threat of pollution.

In this paper we will investigate the impact of dumping mud water in Madura Strait East Java, as basic properly management to cope with dumping mud water of Lapindo.

The aims of this paper are:

1. To determine the quality of Lapindo mud water
2. To determine the effect of mud water dumping in sea water
3. To examine legislation related to mud water dumping in the sea
4. To recommend actions from government and other institutions to address the problems

METHODS

For the study of the impact of mud water dumping in sea water in Madura Strait, East Java, I collected secondary data and study of literatures. I investigate the contain of warm mud water of Lapindo and compare with standard quality guideline from Ministry of Environment, Republic of Indonesia (2004), and compare with International Environment Quality Standard : from Environmental Protection Agency (USEPA, 1986 and 2006) and also from other Environment agency in the world. I also predicted the impact of toxic contained in the mud water to marine ecosystem. With the result of the investigation, I will give recommendation as alternative to cope dumping mud in sea water of East Java.

RESULTS AND DISCUSSION

Sidoarjo Regency is one of Regency in East Java. At May 29th 2006, there has gushed warm mud at 05.00 am in Porong Subdistrict, exactly in 100-500 m from drilling well Banjarpanji-1 (Picture. 1) in gasses drilling area of Lapindo Brantas Inc. Warm mud water have soaked 4 village : Siring, Jatirejo, Renokenongo in Porong subdistrict, and 1 village in Tanggulangin subdistrict. Porong Subdistrict and Tanggulangin Subdistrict are industrial area, and economic backbone of East Java Province (Picture. 2). There are 17,013 people live in Porong and 22,717 in Tanggulangin. People relocation more than 4,000 peoples until June 26, 2006 (Bureau of Research and Development of Health Department of Health Republic of Indonesia, 2006).

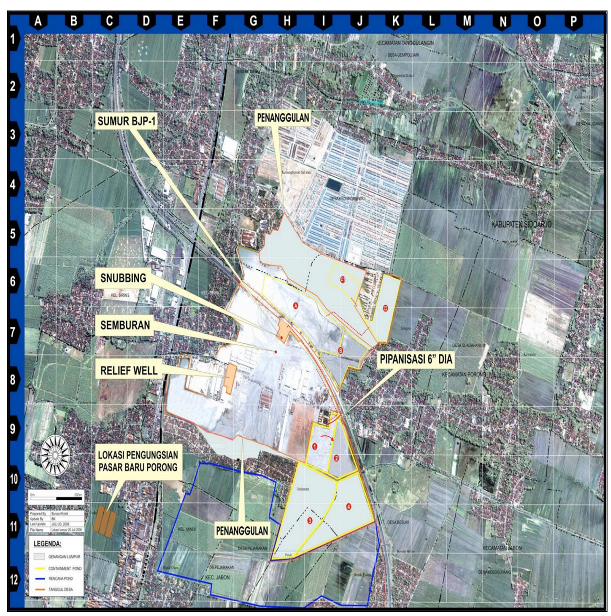

Figure 1. The satellite imaging of mud water location

Figure 2. The aerial picture of mud water

Content of Warm Mud Water

Warm water mud has sprayed out 70% waters and 30% warm mud to the main land, 6 meters height and about 25,000 m^3 per day, About 1.8 cubic meters of this mud gushes out of the earth every second (Jakarta Post, August 25, 2006). Nowadays, the wide of hot mud water reached 400 hectare, with depth of the mud reservoir exceed 7 meter high (Tempo, September 3, 2006).

Gashing warm mud from 2.000-6.000 feet (608 meter - 1,824 km) is not surface layers. Composition of mud is from animal that live at Pleosin period (1.5 millon – 5 million years). Content of mud water of Lapindo can be shown in Appendix 1.

Temperature

In order to assure protection of the characteristic of a water body segment from adverse indigenous marine community thermal effects by USEPA (1986):

a. The maximum acceptable increase in the weekly average temperature resulting from artificial sources is 1^0 C (1.8 F) during all seasons of the year, providing the summer maxima are not exceeded; and

b. Daily temperature cycles characteristic of the water body segment should not be altered in either amplitude or frequency.

Temperature of mud water of Lapindo is 38 ^{0}C - 56 ^{0}C, means has gone beyond normal temperature average of Madura strait is 28 ^{0}C - 30 ^{0}C (Nugraha and Insafitri, 2006). If water from Lapindo mud exhaust to river or to sea, this would be increase the normal average temperature of Madura strait. This phenomenon would be hardly endangers biotic organisms, because biochemical reaction rates, metabolic rates, and other rates of biological activity increase exponentially with temperature.

Raymont and Shields (1994) indicated that trace metals are uptaken more rapidly at high temperatures by marine organisms. In unicellular algae and polychaete worms approximate doubling rate of uptake of copper was found at a 10^{o}C rise in temperature. The mechanism whereby heavy metal toxicity increases with higher temperature to elevated respiratory activity.

Biological Oxygen Demand (BOD)

All animal need oxygen for the metabolism in their cells. Oxygen takes apart in oxydation and reduction process of chemical matter to be the simple compound. Atmosphere and photosynthesis by product are the main source of oxygen in waters. Dissolved oxygen (DO) and biological oxygen demand (BOD) are the most important parameter of water quality. Biodegradable substances cause a decrease in the concentration of dissolved oxygen

BOD from mud water of Lapindo is 38.40 mg/L by is very high that is mean very dangereous for ecosystem. The standard water quality for BOD is 20 mg/L by State Ministry of Environment of

Republic of Indonesia (2004).

The oxygen concentration in the water is reduced with an increase in BOD. This can starve aquatic life of the oxygen it needs and anaerobic decomposition of organic matters lead to the breakdown of proteins and other nitrogenous compounds, releasing hydrogen sulphide, ammonia and methane, all of which are potentially hazardous to the ecosystem and toxic to marine organisms in low concentrations. Nutrients resulting from decaying organic matter enhance plant growth and excessive plant growth together with oxygen depletion can lead to alterations in ecosystem structure and these are both features of eutrophication (Islam, *et al.*, 2004).

Also, nutrient levels increase so does the chance of algal bloom development, toxin production and a corresponding decrease in dissolved oxygen. Long-term effects include phytoplankton biomass increases and large scale decreases in species diversity with benthic and fish communities (Bonsdorff, *et al.*, 1997).

Mercury

Mercury is commonly called liquid silver or quicksilver because it is metallic silver in colour and a liquid at room temperature. Mercury bonds to other elements in the environment to form compounds that “dissolve” in water, much like the way table salt dissolves when added to a pot of water. Mercury can form both inorganic and organic compounds. In general, chemical compounds that contain carbon atoms are “organic”, while those without carbon atoms are “inorganic” (Water Policy and Coordination Directorate, Canada, 2003).

Concentration of mercury in mud water of Lapindo is 2.5 ppm, means have been far go beyond standard quality of sea organism what specified by State Ministry of Environment of Republic of Indonesia (2004) and International Environment Quality Standard: 1.8×10^{-6} ppm by USEPA (2006), 0.00212 by Texas, Washington, Louisiana, Maryland (Hunaiko and Green, 2000), and 0.0004 mg/l by California (Hunaiko and Green, 2000).

Mercury (in particular, methyl mercury) is toxic to a large number of marine organisms. Mercury can enter the human body by ingestion of contaminated food such as tuna and other fish. Agusa *et all* (2005) reported that Mercury contamination in human hair caused by fish from Cambodia.

Aquatic plants take up mercury compounds directly from the surrounding water, while aquatic animals, such as fish and shellfish, get mercury from water and from eating food contaminated with mercury. For large fish and for wildlife, essentially all of the mercury in their bodies comes from the food they eat. Animals accumulate mercury over time because they take it in faster than they can eliminate it from their bodies. Methylmercury accumulates in animal tissues more easily than other types of mercury compounds because it can bind to body proteins and pass through the digestive tract wall. The increase in the body burden of mercury as fish get longer and older. As Ciesielski, *et al.,* (2006) reported that bioaccumulation of mercury is correlated with age. Increased Hg concentrations with high size and age of the fish bioaccumulation (Holsbeek et al., 1997). The proportion of total mercury that is methylmercury also gets bigger in larger and older predators.

As mercury elimination rates by organisms are very low, its concentration through food chains tends to increase (Pinho *et al.*, 2002). Bioaccumulation in food webs of mercury is thus a concern. Predatory organisms at the top of aquatic food webs generally have higher methyl mercury concentrations. Nearly all of the mercury that bioaccumulates in upper trophic level tissue is methyl mercury (Bloom, 1992).

Aquatic plants and animals that live in water polluted with mercury are more likely to be smaller (length and weight), have physical deformities, have problems reproducing, and die sooner than plants and animals not exposed to toxic levels of mercury. Kontas (2006) also reported that There is a correlation between fish length and Hg (muscle tissue) concentrations in *Mullus barbatus* and *Merluccius merluccius*.

Phenol

Concentration of Phenol in Lapindo mud water is 3.37-4.25 ppm. This concentration exceed the standard water quality by State Ministry of Environment of Republic of Indonesia (2004) is 0.002 mg/l and International Environment Quality Standard is 0.17 ppm (USEPA, 1986).

The available data for phenol indicate that toxicity to saltwater aquatic life occurs at concentrations as low as 5,800 ug/L and would occur at lower concentrations among species that no data are available are more sensitive than those tested, concerning the chronic toxicity of phenol to sensitive saltwater aquatic life (USEPA, 1986).

There is correlation between ammonia and transaminases points towards phenol-induced consumption of protein. Hepatic glycogen and glucose contents were lower followed exposure to phenol. The same was observed for muscle glucose, suggesting considerable use of carbohydrate stores. The activity of hepatic lactate dehydrogenase increased with negative correlation with muscle lactate. This suggests that hepatic gluconeogenesis supplies tissues like muscle and brain with glucose. These results indicate that phenol intoxication demands metabolic energy and leads to significant changes of the metabolic profile of the fish, inducing to a certain extent a shift from carbohydrate catabolism to protein catabolism and the activation of gluconeogenesis. (Hori, *et al.* 2006). Phenol reduction in growth in marine organism (Haglund, *et al.* 1996). Phenol also Inhibited development of female reproductive organ, Inhibited fertilisation and maturation marine organism and reduced fertilisation by 50% in number of cystocarps, Inhibited functioning of male reproductive organ (Eklund, 1998) .

Manganese

Concentration of manganese in Lapindo mud water is 0,806 ppm. The standard of manganese concentration is 1 x 10^{-4} ppm by USEPA (1986), while the standard of manganese concentration from US EPA (1986) are:

- 50 ug/L for domestic water supplies (welfare):
- 100 ug/L for protection of consumers of marine molluscs.

This mean that the concentration of manganese in Lapindo mud water is exceed the standard water quality by USEPA (1986).

Manganese is an essential micronutrient which serves as an important cofactor in general body mechanisms

(Drown, *et al.,* 1986). Exposure to high concentrations of manganese in the atmosphere can lead to neurological and respiratory health problems for humans especially (Roels, *et al.,* 1992). Exposure to manganese in laboratory studies can cause mortality and decreased fertility, particularly of male rodents (Laskey et al., 1982), decreases in motor activity (Ingersoll, *et al.*, 1995), learning disabilities (Senturk and Oner, 1996), and nervous system dysfunction and convulsions (Mergler, 1986). In birds, manganese can cause neurobehavioral defects (Burger and Gochfeld, 1995). Much less has been done with effects in fish, although manganese at high doses reduces leukocytes (Al-Akel *et al.,* 1998), impairs growth, and increases mortality (Stubblefield, *et al.,* 1997).

Lead (Pb)

Concentration of Pb in mud water of Lapindo is 0.104 ppm which has gone beyond standard quality of 0.008 ppm by State Ministry of Environment of Republic of Indonesia (2004) and International Environment Quality Standard : 210 x 10^{-6} ppm (USEPA, 1986), and 0.02 mg/l by California (Hunaiko and Green, 2000), 0.133 mg/l by Texas (Hunaiko and Green, 2000), and 0.14 mg/l by British, Columbia, and Canada (Hunaiko and Green, 2000).

Copper is toxic to a large number of marine organisms. Ingesting sea food that has been contaminated with lead is harmful to humans. Organic lead compounds are more toxic than inorganic compounds. Lead also Accumulates in marine organisms (Hunaiko and Grenn, 2000). The LC50 values of Pb for E. olivii, S. serratum and P. elegans were 0.62, 4.61 and 5.88 mg/l, respectively. (Bat, L. *et al*, 1998).

Lead is a neurotoxin that causes behavioral deficits in fish within days of exposure to sublethal concentrations, and these effects can persist after removal from the contaminant (Weber and Dingel, 1997). Lead also causes deficits or decreases in survival, growth rates, development, behavior, learning, and metabolism, in addition to increased mucus formation in fish (Eisler, 1988). Calcium can reduce the uptake and therefore the efects of lead in fish (Varanasi and Gmur, 1978).

Little information on the levels of lead in muscle that are associated with impairments in the fish themselves is available, but levels of 50 mg/g in the diet (i.e., forage fish) are associated with reproductive effects in some carnivorous fish, and dietary levels as low as 0.1 to 0.5 mg/g are associated with learning deficits and abnormal social behavior in some mammals (Eisler, 1988).

Selenium

Concentration of Selenium in mud water of Lapindo is 0.0078 ppm. This concentration is exceed the standard water quality by International Environment Quality Standard : 290 x 10^{-6} ppm by (USEPA, 1986), 0.15 mg/l by California (Hunaiko and Green, 2000), 0.564 by Texas (Hunaiko and Green, 2000), and 0.01 mg/l by New Jersey (Hunaiko and Green, 2000).

Selenium can accumulates in marine organism, minimum concentration that has a negative impact on marine organisms is 0.1 mg/L (Hunaiko and Grenn, 2000).

There has been a lack of consistency of adverse effects from selenium exposure on either growth or survival of fish, especially early life stages. Some fish studies with selenium exposure in the water, diet, or both have reported inconsistent results: (1) reduced growth occurred in the same treatments (exposure concentration and duration) where reductions in survival occur (Klauda, 1986); (2) reduced survival occurred before reduced growth (Cleveland et al., 1993); (3) reduced growth occurred before reduced survival (Hamilton et al., 1990); or (4) no effects on growth or survival, but other pathological or reproductive effects occurred (Coyle et al., 1993). The inconsistency between these studies was probably due to differences in species, age, exposure route and duration, selenium form and other factors.

Dumping of Mud Water

Based on Government Regulation of Republic of Indonesia (Peraturan Pemerintah/PP) No. 19 year 1999 about control of contamination and/or sea damage, dumping is waste disposal as residue of a business and/or other activity and/or object of which is not used or expire to sea. While according to LDC (London Dumping Convention) 1972, dumping is defined, marginally, as waste disposal to a location on the sea designedly at certain depth.

Indonesia is not ratify LDC 1972. To ratify LDC 1972 Indonesia will need more budget because have to make annual report, attend some conferences, but many case in Indonesia do not appropriate LDC 1972, because the meaning of dumping according PP no. 19 year 1999 is different from LDC 1972.

Dumping according to PP no. 19 year 1999 and dumping according to London Convention there are a few basic difference. In PP RI no. 19 The year 1999, is not differentiated waste type which may thrown to sea however tending to enables all types waste in exhaust to sea of it is of course fulfills standard quality procedures as according to guide from the State Ministry of Environment and enables dismissal in sea level. However according to LDC 1972, there is demarcation of waste type which may in exhaust to sea. Waste containing Hg and Cadmium, for example, may not thrown to sea at all. And so do, the dismissal must at certain depth below (under) sea, may not in surface.

Though dumping has been arranged in PP no. 19 Years 1999, however procedures of dumping and its permit has not been born (in the form of Ministrial decree). Indonesia can adopt LDC 1972 to make Ministrial decree on dumping. According to correct order is before doing dredging of port pool, beforehand is done identification of pollutant type consisting in in sediment of dredger, if containing heavy metal like Hg and Cd, hence the sediment must be done treatment in continent to eliminate metal and may not thrown to sea. Location of dumping shall minimize below depth thermocline layer because under this layer no happened mixing of water mass vertically which will bring water mass below up to surface.

Site selection considerations

Proper selection of a dumpsite at sea for the reception of waste is of paramount importance. With sewage sludge, it is important to consider the proximity of site(s) to recreational and shellfish areas with special consideration being given to human exposures to pathogens.

Information required to select a dump-site shall include:

1. Physical, chemical and biological

characteristics of the water-column and the seabed;

2. Location of amenities, values and other uses of the sea in the area under consideration;
3. Assessment of the constituent fluxes associated with dumping in relation to existing fluxes of substances in the marine environment. Particular consideration should be given to the organic matter flux and associated changes in oxygen demand. Particular consideration should also be given to nutrient fluxes and potential eutrophication; and
4. Economic and operational feasibility.

Prior to selecting a dump-site, it is essential that data be available on the oceanographic characteristics of the general area in which the site is to be located. This information can be obtained from the literature but fieldwork should be undertaken to fill the gaps. Required information includes:

1. The nature of the seabed, including its topography, geo-chemical and geological characteristics, its biological composition and activity, and prior dumping activities affecting the area;
2. The physical nature of the water column, including temperature, depth, possible existence of a thermocline/pycnocline and how it varies in depth with season and weather conditions, tidal period and orientation of the tidal ellipse, mean direction and velocity of the surface and bottom drifts, velocities of storm-wave induced bottom currents, general wind and wave characteristics, and the average number of storm days per year, suspended matter; and
3. The chemical and biological nature of the water column, including pH, salinity, dissolved oxygen at surface and bottom, chemical and biochemical oxygen demand, nutrients and their various forms and primary productivity.

Some of the important amenities, biological features and uses of the sea to be considered in determining the specific location of the dump-site are:

1. The shoreline and bathing beaches;
2. Areas of beauty or significant cultural or historical importance;
3. Areas of special scientific or biological importance, such as sanctuaries;
4. Fishing areas;
5. Spawning, nursery and recruitment areas;
6. Migration routes;
7. Seasonal and critical habitats;
8. Shipping lanes;
9. Military exclusion zones; and
10. Engineering uses of the seafloor, including mining, undersea cables, desalination or energy conversion sites.

CONCLUSIONS AND RECOMMENDATIONS

Parameter of temperature, biochemical oxygen demand (BOD), mercury, Phenol, Pb, Manganese, and Selenium from mud water Lapindo, altogether has gone beyond quality standard which has been specified by State Ministry of Environment of Republic of Indonesia (2004) and International Environment Quality Standard. If water from mud water of Lapindo is exhaust to Madura strait ecosystem, it will very dangerous. Treated water from hot toxic mud into Madura Strait East Java, posed a threat of pollution that could hurt the local fishing industry. Madura Strait becomes polluted, that will harm not only its own ecosystem, but also the livelihoods of communities nine surrounding regency in East Java. Based on the province's economic statistics, the nine coastal regency produce about 183,000 tons of fish per capita worth some Rp 1.2 trillion (US$133 million). That does not include other fishery activities, such as open water fisheries and fish ponds. The East Java fishing industry annually produced up to 490,000 tons of products valued at around Rp 3.4 trillion.

Because of this matter, the fact that the chemichal content of the mud water is gone beyond the limit of the sea water standard quality decree, the State Ministry of Environtment still not give permittion to dump the mud water to the river and sea. But we afraid that the government will make the political move than the scientific result to dump the mud water to the sea.

We recommended that the mud water of lapindo must be:

1. If Possible, spray out of mud water should be stopped and mud water doesn't thrown to river or to sea, since it will damage the ecosystem and there for the livelihood of surrounding communities will also affected. Lapindo must make a permanent giant lake to keep mud water in the origin of place.
3. If the previous recommendation cannot done, than for keep the live of man surrounding the area, the water may be trown to the river or sea after the water processing, but the mud must still remaining in the ground, not to thrown in the sea. And trown in depth water (under thermokline layer).

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Appendix 1. Content of warm mud water of Lapindo surrounding Porong-Sidoarjo that are over than quality standard for marine animal

No	Parameter	Result	International Marine EQS (Environmental Quality Standard)	State Ministry of Environment of Republic Indonesia
1.	Temperature	38-56^{0}C (1)	The maximum acceptable increase in the weekly average temperature resulting from artificial sources is 1^0 C (4)	Normal temperature , average change not over than 2^{0}C 2)
2.	BOD	38.40 mg/l (1)	Effluent discharge restrictions – Open sea (5): – 40-55 mg/L (Italy) – 400 mg/L (Denmark) – MAP Maximum: 600 mg/L Effluent discharge restrictions: – closed bay (5): – MAP Maximum: 250 mg/L	20 mg/l (2))
3.	Hg (mercury)	2.5 ppm (1)	1.8 x 10^{-6} ppm (3) Maximum 0.00212 mg/L (Texas, Washington, Louisiana and Maryland) (5) Maximum 0.0004 mg/L (California) (5)	0.001mg/l (2))
4.	H_2S (Phenol)	3.37-4.25 ppm (1)	0.17 ppm (4)	0.002 mg/l (2))
5.	Manganese	0,806 ppm 1)	1 x 10^{-4} ppm (5)	

6.	Pb	0.104 ppm (1)	210 x 10^{-6} ppm (4) Maximum 0.020 mg/L (California) (5) Maximum 0.133 mg/L (Texas) (5) Maximum 0.140 mg/L (British, Columbia, Canada) (5)	0.008 mg/l (2)
7	Selenium	0.0071 ppm (1)	290 x 10^{-6} ppm (4) Maximum 0.150 mg/L (California) (5) Maximum 0.564 mg/L (Texas) (5) Average 0.136 mg/L (Texas) (5) Maximum 0.010 mg/L (New Jersey) (5)	

Source :
(1) Tempo (6/15/06)
(2) State Ministry Of Environment of Republic Indonesia (2004)
(3) USEPA (2006)
(4) USEPA (1986)
(5) Hunaiko and Grenn (2000)