ENVIRONMENTAL QUALITY ON SURROUNDING COMMUNITY OF COAL MINING AREA IN SAMARINDA, EAST KALIMANTAN, INDONESIA

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Public Health of Indonesia
Anggraeni, I et al. Public Health of Indonesia. 2019 December;5(4): 91-98
http://stikbar.org/ycabpublisher/index.php/PHI/index
ISSN: 2477-1570

Original Research

ENVIRONMENTAL QUALITY ON SURROUNDING COMMUNITY OF COAL MINING AREA IN SAMARINDA, EAST KALIMANTAN, INDONESIA

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Received: 15 July 2019 | **Revised:** 2 September 2019 | **Accepted:** 14 November 2019
DOI: http://dx.doi.org/10.36685/phi.v5i4.270
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ABSTRACT
Background: The massive exploration of coal in Samarinda could lead to various environmental consequences, such as metal contamination of soil, toxic materials and sediments in rivers and air pollution. Scanning and exploring the impact of mining on environmental quality will strategic to develop and carry out rehabilitation on damaged ecosystems and as a preventive and adaptive action of the community in responding the threat of global environmental change.
Objective: This paper mainly focused on determining environmental quality based on water and air quality parameters (sulfur dioxide/SO_2, Nitrogen dioxide/NO_2, Carbon monoxide CO and TSP/dust) also determining community perception about the environment.
Methods: Water sample taken from Betapus river (upstream and downstream) and well. Air sample taken around residential in coal mining area. Household survey of 305 respondents conducted in five community neighborhoods in area that affected by mining activities. In general, the air quality parameters such as SO_2, NO_2, CO and TSP at normal condition.
Result: The measurement result of wells water revealed that only the pH (power of hydrogen) at normal condition, while BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), Iron (Fe) exceed the threshold and almost all water sample exceeds the threshold in Manganese (Mn). The results of river quality in pH and COD showed that both in the upstream, midstream and downstream on normal condition, while Fe, COD exceeds the threshold. The BOD in the upper, middle parts of the river exceed the threshold.
Conclusion: This study found that there had been anomaly in water environment compounds. These indicate that mining has led to the occurrence of water pollution. Therefore, needs reevaluation analysis of environmental impacts document of the mining companies in Bayur Village. It is also important to treating Mn and Fe of well or river water, especially if the water use for drinking.

Keywords: water quality, air quality, coal mining, environmental quality

BACKGROUND

Mining has become a vital industry and one of the economic central in East Kalimantan. The mining sector contributes the highest domestic income, approximately about 47.98 percent of Gross Regional Domestic Product (GRDP) compared to other sectors (Central Statistics Agency of East Kalimantan Province, 2016).

The contribution of mining and natural resources excavation, especially coals in Samarinda as the capital of East Kalimantan to Regional Original Revenue was 588,267,538,947 rupiahs or around 23.76 percent (Central Statistics Agency of Samarinda, 2018). The fact strengthens that mining is essential for the region because as source of energy supply and domestic income that sustains the economy.

The high contribution of mining to economic sector tends to be inversely proportional to the damage caused. The consequences for environmental damage are always found in every step in the mine production cycle. Starting from land clearing (excavation, landscape alteration, making road access) to land cover in the form of unused waste products such as waste rock, water logging, open holes, slags and worse impacts if abandoned mine is not reclaimed (Coelho, Teixeira, & Gonçalves, 2011).

Some of the environmental damage caused by mining had been investigated, including heavy metal contamination in the soil, water contamination such as toxic materials and sediments in rivers and air pollution (Coelho et al., 2011). Study in Kuantan Singigi District revealed that wastewater of coal and resident wells surrounding mining area had a heavy metal contamination (Fe and Pb), nitrate, sulfide, pH and Total Suspended Solids/TSS (Kurniawan, Hanifah, & Bali, 2015).

The human body is also susceptible to contamination exposure through various materials continued consumed for instance water, food (especially fish and biota that live in polluted water) and air. The physical environment like climate, geology, air, water are external factors that given large influence on disease exposure that affects human health (as an agent) (Thacker, Qualters, Lee, Control, & Prevention, 2012). The study in South Sumatra showed that there were health problems in the community around the mine area, namely Upper Respiratory Tractus Infection, Skin Disorders, Diarrhea, Nausea, Dizziness (Juniah, Dalimi, Suparmoko, & Moersidik, 2012). Long-term impacts due to environmental contamination that occurred in coal mining industry in Appalachia United States found that toxins in coal have strong carcinogenic substances (zinc, cadmium, nickel, arsenic and others) that caused lung cancer (Hendryx, O'Donnell, & Horn, 2008) further if there was heavy metal exposure could impact on women's reproductive health (infertility and miscarriage) and infant mortality (Kuyek, 2003).

Samarinda is the only provincial capital in Indonesia that has become a mining area. More than 71 percent of the area has been designated as a Mining Business License Area of a total area of 718 km^2.Until now there are 16 mining companies that are still active (having permits) in Samarinda with coal production of 4.9 million tons per year (Central Statistics Agency of Samarinda, 2018). It was also known that 63 mining permits had been given by the Government of Samarinda (Sefriani, 2018).

Various environmental impacts now occur quite large as a result of the sedimentation process due to the stripping of land in the upper of the river (5,000 cubic per meter) which causes flood. There are 24 flood points scattered in 15 zones in Samarinda that always occur when heavy rain. The flood point is considered expand due to the massive dredging of coal and a lot of ex-mining land left by the company without reclaimed or restored (Ghofar M, 2017).

The contribution of the mining sector to the economy is very high but also give a lot of impact. The cyclical nature of mining and the uncertainty of the age of its activities can have serious implications for the surrounding community. This raises a challenge for the government to respond efficiently and effectively according to the needs of the community. For this reason, a deeper understanding of the health and the welfare context of the people who settle around the mining area is needed. This understanding will enable communities and health services to prepare for social, environmental and economic impacts due to mining activities (Mactaggart, McDermott, Tynan, & Gericke, 2018).

Without a comprehensive understanding there will be unpreparedness in preventing and overcoming the impact of mining activities. As a result, handling environmental impacts will require big budget. In 2008-2010, Samarinda government spent 107.9 billion rupiah to overcome the impact of flooding. This amount increasing in 2017, budget for flood control is 375 billion rupiah (Regional Planning and Development Agency of Samarinda, 2017). The results of various studies related to the health impacts on the area around the mining industry were known but empirical evidence of the impact of mining, especially in East Kalimantan still limited. Furthermore, this research important to do, because changing in environmental conditions due to the widespread expansion of mining in East Kalimantan still happening. Scanning and exploration of mining impacts on environmental quality and public health is strategically carried out in order to develop and implement measures to rehabilitate damaged ecosystems and as a preventive and adaptive community in response to the threat of global environmental change.

Based on background above, it is necessary to conduct a study to obtain an accurate assumption so it can provide more complete and comprehensive information to find out how the environmental quality around mining areas in Samarinda.

METHODS

Study Setting and Study Design

The study was conducted in Bayur Village, North Samarinda located up to 3 kilometers away from the mining site. The mining site itself has existed in the last 10 years ago. This study is part of mixed method study which has aimed to know the impact of mining on the environment, health and social affairs in Samarinda that used mixed method design. The following figure is a flowchart as an illustration of the research activities.

Seven stages of research activities of this study as the following: Stage 1: Arranging study permit at sub-district where location of the study conducted and propose ethical clearance. Stage 2: Listing sample frame, choose sample and start survey in the community. Stage 3: Measuring water and air quality in the environment. Stage 4: Perform qualitative data collection through in-depth interviews and focus group discussion. Stage 5: Perform data reduction, conclusions and data presentation. Stage 6: Conduct data analysis, and then choose respondents with criteria that represent groups of different characteristics. Stage 7: Triangulate the data to confirm the results of the survey interviewing informants at this stage are community leaders

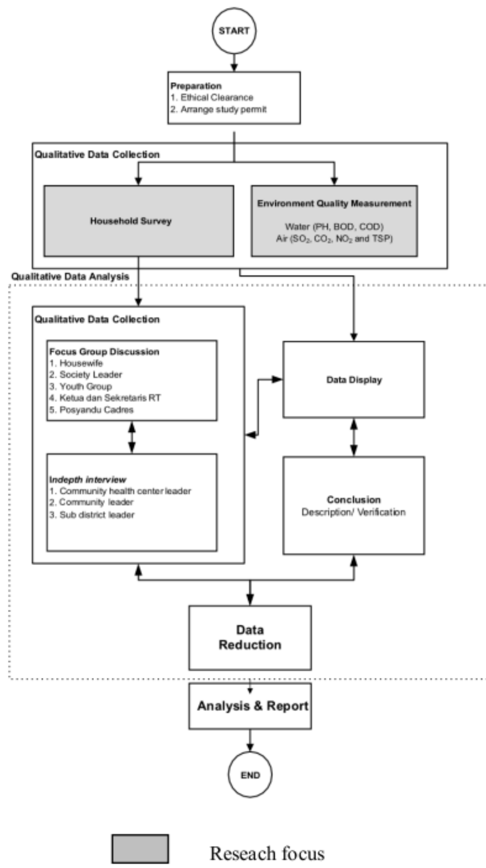

Figure 1 Research Activities

Part of study presented in this paper was focused on stage 2 and 3. The stage 2 is a household survey with a cross-sectional approach, researchers collected all data at one point of time. Stage 3 conducted to measure environmental quality that includes water and air to determine the concentration of pollutants.

Sampling Size Determination and Sampling Procedure

Participants selected were heads of households/wives, more than 18 age years who lived in selected area. The selection of samples was limited to the criteria set by the researcher. The inclusion criteria: (1) living in the area around the mining area for more than 5 years; (2) being at the study location when the survey conducted; (3) able to communicate. Sample size calculated using sample size formula and obtain 305 samples (Lemeshow, Hosmer Jr, Klar, & Lwanga, 1993). Sampling was taken by multistage random sampling.

At the first stage, 1 sub district or village was chosen out of 2 that were known to have a residential area close to the mining area. Next stage is selected randomly 4 from 8 neighborhood in village. As much as 305 respondents were randomly and proportionally selected based on the number of residents in those 4 neighborhoods. These neighborhoods located around 200 meters until 3 kilometers away from the mining site. The neighborhood or called, "*Rukun Tetangga*" (RT) where location that covered the study area. RT is the lowest administrative unit or governmental hierarchy in a sub district or village. A village usually has between 10 to 15 RT and each RT consist of minimum 50 household.

Data Collection, Quality and Analysis

Data were collected using a structured questionnaire that have been tested for validity and reliability test to ensure that the variables being observed that used valid and accurate. Data were collected and checked for completeness and consistency. Descriptive statistics analysis used to measure the different characteristics of samples.

Data of water samples were taken from the Betapus river (upstream, middle and downstream) with 1 point each, wells water taken from 2 neighborhood with 2 points each. Air samples were taken at 2 points, 1 at mining site and 1 in the middle of settlement in neighborhood.

Ethical Considerations

Ethical clearance was obtained from the Mulawarman University ethics committee. Furthermore, informed consent is made verbally. If the informant agrees and agrees to be the subject of the research after receiving an explanation and information about the purpose and process of the research, information retrieval is carried out.

RESULTS

In this study the ambient air sampling was used as a basic characteristic of air around coal mines. The study sample was examined by the Industrial Waste Research and Standardization Agency of Samarinda. The results can be seen in Table 1.

Table 1 The Ambient Air Quality of Open Coal Mining

Pollutant	Unit	Standard	Result	
			X	Z
Sulfur dioxide (SO_2)	µg/Nm^3	365/24 hour	< 0.012	< 0.012
Nitrogen dioxide (NO_2)	µg/Nm^3	150/24 hour	10.43	8.38
Carbon monoxide (CO)	µg/Nm^3	10.000/24 hour	435	172
TSP (Dust)	µg/Nm^3	230/24 hour	127	5,00

Based on the results of air quality measurements, the ambient air quality in two locations was measured for 24 hours <0.012 µg / Nm^3 at X and Z location while the standard of sulfur dioxide is 365 µg / Nm^3. The carbon monoxide (CO) level at location X (435 µg/Nm^3) is higher than location Z (172 µg/Nm^3) whilst standard level by Indonesian quality standard according to Environmental Ministry Regulation Number 12/ 2010.

Table 2 The Chemical Water Quality in Surrounding Open Coal Mining

Location Categories	Parameter	Unit	Standard	Result			
Dug well				**X (1)**	**X (2)**	**Y (1)**	**Y (2)**
	pH	6	6 – 9	6.66	6.57	6.54	6.83
	BOD	mg/L	2	2.390	2.930	3.130	2.090
	COD	mg/L	10	28.57	39.33	97.22	24.49
	Ferrum (Fe)	mg/L	0.3	1.1772	1.440	0.749	0.672
	Mangan (Mn)	mg/L	0.1	0.951	0.072	0.136	0.904
River				**R(1)**	**R(2)**		**R(3)**
	pH	6	6 – 9	7.13	6.89		7.12
	BOD	mg/L	2	2.168	2.168		1.243
	COD	mg/L	10	19.29	14.84		14.84
	Ferrum (Fe)	mg/L	0.3	0.484	1.304		2.491
	Mangan (Mn)	mg/L	0.1	0.024	0.022		0.023

Based on the results of chemical water quality test around coal mines, the level of COD at X location were 28.57 mg/L and 39.33 mg/L even higher than at Y location were 97.22 mg/L and 24.49 mg/L. This showed that chemical oxygen demand (COD) is higher than standard (10mg/L). The complete result of this could be seen in Table 2. In addition, other than testing air and water quality objectively in the laboratory, we also conduct surveys to measure people's perceptions to find out their assessment of environmental conditions. As much as 85.9 percent of households in Bayur Village use well water as a source of clean water showed the well is main water source. Since illegal mining has operated 47.5 percent respondents reported a decrease in the quality of well water.

Table 3 Community Perception About Environment Quality

Community Perception	n	%
Perception of well water quality		
Reduced volume of ground water (wells)	145	47.5
Well water became cloudy	145	47.5
Well water had bad odor	79	25.9
Well water has chemical like taste	67	22
Perception on river water quality		
reduced river water discharge	192	63
the river water becomes cloudy	233	76.4
the river becomes shallow	216	70.8
Perception on air quality		
Dusty air	202	66.2
Air pollution	108	59
Rising heat temperature	212	69.5
Environmental impact cause by illegal mining		
Flooding in residential areas		67.2
flooding in agriculture land	187	61.31
River became silting		
Health impacts cause by air and water pollution		
Prolonged cough	41	13.4
woke up and suddenly coughed	42	13.8
Itchy after use well water	61	20
Eye irritation	79	25.9

Survey showed the community complains because they are no longer free to use this well water for daily consumption because of the smell of well water that resembles foul odor. Meanwhile there are still 10.2 percent of households using the river as a source of clean water, and 76.4 percent respondents reported that river water has turned cloudy. General concerned to polluted air and polluted water is they may suffer a disease as impact of environmental nuisance. At that time of survey, from polluted air they complain of eyes irritation, while from polluted water they complain of itching of the skin. The various causes of complaints are shown in Table 3.

DISCUSSIONS

This study found that the air quality measured by Sulfur Dioxide (SO_2) parameters still in the normal threshold value, Nitrogen dioxide (NO_2), Carbon monoxide (CO) and TSP (Dust) are also still in normal below the threshold. This result nevertheless does not indicate air pollution has occurred, but still could be the useful information to increase health awareness. Even though pollutant levels still match the threshold value, it has raised a number of complaints from the local community. This study found that the majority of respondents complained about the decline in river water quality, river siltation and reduced discharge of clean water in rivers and in wells belonging to residents. Their perception accuse river siltation occurs due to open mining. The community also complains of hot and dusty air. Air and water pollution are thought to have caused mild disease, although not fatal, these conditions have reduced the comfort of living in the neighborhood.

Opencast mines have directly or indirectly been contributing to the air and water pollution. In this study it is observed that in the mining affected locality fugitive dust from mining activities such as mines transport contributing to uncomfortable living condition due to dusty environment. Earlier study showed that surface mines generate air pollution, primarily particulate matter, through blasting, wind erosion of exposed areas, and handling of coal at the mines, during transportation and at processing plants (Aneja, Isherwood, & Morgan, 2012).

This coherent with Pandey (2014) who explained that air pollution also occurs as a result of dust fall-out. Significant amounts of dust are emitted during surface mining operations and associated operations including drilling, blasting, and transportation of coal and equipment. According study in India, 80.2% of total dust emissions are from the transport roads of mines (Mandal et al., 2012). Screening is the next largest source of dust emission (8.1%) followed by overburden removal (2.8%), top soil handling (2.6%), coal extraction (2.2%), drilling and blasting (1.3%), and coal handling or stockpiling (1.1%).

In this study those who lived closest to mining sites complained of hot and dusty air. Community complaints could be a sign of air pollution even though it cannot ensure illegal mining as a main source of pollution. In their study to explore the health and environmental concerns associated with open-cast mining, Other study found that the factors related mainly to the proximity of the mine to housing and farmland, and the length of operation (Colagiuri, Cochrane, & Girgis, 2012)

Different with air quality measurement result, water quality parameters showed that n BOD, COD, and Iron (Fe) exceed the threshold while only the pH parameters in normal value at all points sampling, also found that manganese (Mn) parameter exceeds the threshold. This condition could happen due to open mining process. The dumping of waste during mining operations affects the land in the vicinity of the operations and this land is prone to surface erosion which may increase sediment loading to surface waters (Mangena & Brent, 2006).

The literatures study states the need to waken the concerns of various professional associations of expertise such as environmentalists, engineering, regional planning to improve environmental improvement efforts (Mancini & Sala, 2018). In addition, another important thing that cannot be ignored in improving water quality is the existence of pollution control policies from law enforcers accompanied by guidance and supervision of river water quality. The main responsibility for overcoming environmental damage that has occurred is in mining companies. Research in Colombia revealed that mining companies had socio-environmental obligations (Diaz, 2015). This obligation arises because mining processes create pollution, damage to local health, reduce groundwater reserves, loss of land and ecosystem services, damage due to transportation and shipping, and loss of coal reserves.

CONCLUSION

Small scale coal mining could play a transformative role in a rural development because of the economic benefit, although mining comes with environmental and health impacts if not managed properly. A key challenge for all stakeholder is finding ways to manage these impacts and create a solid foundation for controlling environmental impacts which respects and supports the livelihoods and healthy environment for community.

Declaration of Conflicting Interest

All authors have declared that there is no conflict of interest for this study.

Funding

Funded by Indonesia One Health University Network (INDOHUN).

Acknowledgment

The authors acknowledge Prof. drh. Wiku Adisasmito, MSc., PhD as Indonesia One Health University Network (INDOHUN) Coordinator, and Prof. Enos Tangke Arung, Ph.D, Research and Community Services Board Secretary of Mulawarman University

Authorship Contribution

All authors contributed in conceiving and designing the analysis, collecting data, performing analysis, and drafting the manuscript.

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Cite this article as: Anggraeni, K., Nurrachmawati, A., Ifroh, R.H., Anwar, A., Siswanto. Environmental quality on surrounding community of coal mining area in Samarinda, East Kalimantan, Indonesia. *Public Health of Indonesia.* 5(4). 91-98. http://dx.doi.org/10.36685/phi.v5i4.270

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