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The Impact Analysis of Fire Disaster at Tamangapa, Makassar

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ABSTRACT
Fires that often occur in the dry season, are not only capable of burning residential locations, shops, warehouses and forest areas, but also burning landfill areas. A landfill fire is not something that is impossible to report. This is because every year, landfill fires often occur not only in developing countries, but also in developed countries. Landfill fires can be caused by hot spots, which can be found on the surface of the garbage in landfills or in the inside of landfills. This research is a type of qualitative research using a descriptive phenomenological approach. This research aims to determine the impact of the fire disaster of the Tamangapa garbage dumpsite, Makassar. The results of the analysis showed that the health impacts that people felt were coughing, shortness of breath, dizziness, headaches and sore eyes. The environmental impact felt by the community is the presence of smoke, smog and foul odors. The social impact felt by the community is reduced income and schools are closed. Fire disasters for landfills have resulted in environmental damage which also has an impact on health and social issues, especially for people who live ≤ 500 meters from the landfill, experiencing the heaviest impact.

Keywords : Environment, Health, Impact, Landfill Fire, Social

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BACKGROUND

Fires that often occur in the dry season are not only capable of burning residential locations, shops, warehouses and forest areas, but also burning landfill areas. Each year, landfill fires that occur in the United States are quite intense, as many as 8,300 times (Copping et al., 2007). A landfill fire occurred in Dallas, Texas, in August 2000 where this incident occurred spontaneously. The pile of garbage continued to burn until July 2001 (Moqbel, 2009). In addition, a landfill fire also occurred in Vancouver, Canada on October 18, 2000. This was known because smoke was found in the landfill (Moqbel, 2009).

From 1995 to 1999, it was found that there were 10 landfill sites in the United States, Mexico and Canada that experienced fires. Landfill fires that occur originate from under the pile of garbage (Moqbel, 2009; US Fire Administration, 2001; Tridata, 2002). The incidence of fires at landfill, not only occurred in the countries of the American continent, countries on the European continent also experienced landfill fire disasters. In 1994, 200 to 250 landfill fires were reported in Sweden. Between 1990-1992, the average fire incidence in Finland was 380 landfill fires in 633 landfills in Finland (Ettala et al., 1996). There were 78 landfill fires in the UK in 2007 (Copping et al, 2007).The number of landfill fires in Nisava, Serbia from 2009-2016 was 576 incidents (Milosevic, et. Al., 2018). Landfill fires that occur in Ghana generally occur in Aboboki and Nkanfoa landfills (Kusi, et.al. 2016). The incidence of landfill fires in the continent of Australia, in the New South Wales, was reported as many as 197 fire incidents from the beginning of 2014 to April 2016 (Fattal, et.al, 2016).

Data on the incidence of landfill fires in Indonesia have not been clearly identified, both from the frequency of their occurrence, the type of fire, the cause of the fire, and the impact caused by the landfill fire (Wahyono, 2015). This results in difficulty finding scientific information about landfill fires in Indonesia. Thus, data and information regarding landfill fires in Indonesia can be obtained from search results through online media news portals. The tracing results obtained in the vulnerable period of 2004-2019, the incidence of landfill fire disasters in Indonesia was as many as 37 incidents in 25 landfills located in the territory of Indonesia. This is based on searches in online news media, where the only large landfill fires were reported (Antara East Java; Antara Lampung; Antara News; Antara Sulsel; Malang Times; Banyumas News; Elshinta; Kompas; Liputan 6; Media Pelangi; Metro Bali; Metro Semarang; Nusa Bali; Pikiran Rakyat; Republika; RMOL Banten; Sindo News; Solo Pos; Suara Merdeka; Tempo; Tribun Aceh; Tribun Batam; Wahyono, 2015; Waste 4 Change).

One of the 25 landfills that experienced a fire is Tamangapa Landfill in Makassar city. Tamangapa Landfill, which accommodates the garbage of Makassar residents, has experienced fire incidents four (4) times, namely on June 29, 2009, October 3, 2014 (Antara Sulsel; Rahim, 2018; Rakyatku News), October 10, 2018 and most recently on September 15 2019. Fires at Tamangapa landfill often occur in the dry season, which is when the weather is hot. Thus, resulting in sparks from the bottom pile of garbage. The fire incident that occurred at Tamangapa landfill on September 15, 2019 had an impact with the presence of smog in the city of Makassar for 4 days. Thus, resulting in a reduction in visibility in the community.

Given the lack of information related to landfill fire disasters to the Indonesian public. So it is necessary to conduct a study of landfill fire disasters in Indonesia, especially in terms of the impact caused by the landfill fires in Indonesia, not only from the environmental impact, but also from the health and social aspects. Therefore, researchers are interested in

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conducting research related to the "The Impact Analysis of Fire Disaster at Tamangapa Landfill, Makassar".

METHODS

This research is a type of qualitative research using a descriptive phenomenological approach. This study aims to determine the impact of the fire disaster at Tamangapa Landfill, Makassar. This research was conducted in January - February 2020 in Tamangapa Landfill, Makassar. The main informants in this study were the people in the Tamangapa Landfill area who were affected by the landfill fire disaster on September 15, 2019. The research location will be carried out in the area around the Tamangapa Landfill. Tamangapa Landfill is located in Makassar City. This research has passed the ethical test with letter number: 10 / UN4.6.4.5.31 / PP36 / 2019.

RESULTS

Table 1. Health Impact of Tamangapa Landfill Fires

Health Impact of Tamangapa Landfill Fires					
While Tamangapa Landfill Fires			After Tamangapa Landfill Fires		
≤ 500 meters	> 500 meters - ≤ 1 kilometers	> 1 kilometers - ≤ 2 kilometers	≤ 500 meters	> 500 meters - ≤ 1 kilometers	> 1 kilometers - ≤ 2 kilometers
Cough	Cough	Cough	Headache	There are no symptoms	Cough
Breathless	Breathless	Dizzy	Breathless		Dizzy
Dizzy	Dizzy	Headache			Breathless
Headache	Headache				There are no symptoms
Sore Eyes					

Table 2. Health Impact for Children under 5 years of Tamangapa Landfill Fires

Health Impact for Children under 5 years of Tamangapa Landfill Fires					
While Tamangapa Landfill Fires			After Tamangapa Landfill Fires		
≤ 500 meters	> 500 meters - ≤ 1 kilometers	> 1 kilometers - ≤ 2 kilometers	≤ 500 meters	> 500 meters - ≤ 1 kilometers	> 1 kilometers - ≤ 2 kilometers
Cough	Cough	There are no symptoms	There are no symptoms	There are no symptoms	There are no symptoms
Breathless	Breathless				

Table 3. Environmental Impact of Tamangapa Landfill Fires

Environmental Impact of Tamangapa Landfill Fires					
While Tamangapa Landfill Fires			After Tamangapa Landfill Fires		
≤ 500 meters	> 500 meters - ≤ 1 kilometers	≤ 500 meters	> 500 meters - ≤ 1 kilometers	≤ 500 meters	> 1 kilometer - ≤ 2 kilometer
Fire Smoke	Fire Smoke	Fire Smoke	Contaminated Water	Bad Odor	Smog
Contaminated Water	Bad Odor	Bad Odor			Bad Odor

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Table 4. Social Impact of Tamangapa Landfill Fires

Social Impact of Tamangapa Landfill Fires					
While Tamangapa Landfill Fires			After Tamangapa Landfill Fires		
≤ 500 meters	> 500 meters - ≤ 1 kilometers	> 1 kilometers - ≤ 2 kilometers	≤ 500 meters	> 500 meters - ≤ 1 kilometers	> 1 kilometers - ≤ 2 kilometers
Decreased Income	School Closed	No Social Impact	Decreased Income	No Social Impact	No Social Impact
School Closed	Decreased Income	[redacted]			
[redacted]	No Social Impact				

DISCUSSION

1. Health Impact

The health impacts of this landfill fire disaster are caused by the smoke produced by the landfill fire. It is not only the side effects of smoke that cause health problems in the community. The presence of a bad smell also has the potential to seek other sources of health complaints that are felt by the people who live around the landfill. Interviews were conducted with 21 informants spread across 3 areas around the landfill. The results showed that the community during the fire incident experienced health complaints, namely coughing, shortness of breath, headaches, dizziness and disturbing visual conditions that were irritated by smoke or smog.

There are health problems due to landfill fires caused by the poisonous gas contained in the smoke, which triggers symptoms in the community. This smoke is very dangerous for human health, because it contains various substances and substances that are harmful to the human body when it enters the body. The impact is especially felt on the people who live very close to the landfill. Fires can occur under anoxic conditions. Hydrocarbons, chlorinated substances and pesticides produce various toxic gases under anoxic conditions, which may contain dioxins or furans, polynuclear aromatic hydrocarbons, inhaled particulates (PM) and *heavy metals* (HM) and other hazardous compounds. The smoke produced during landfill fires can contain harmful toxic gases such as CO, H_2S, CH_4, as well as carcinogenic substances such as dioxins. The smell and smoke emitted disturb the environment and even endanger human health, especially in vulnerable populations such as the elderly, children, pregnant women and /or people with a history of chronic respiratory conditions (Vaverkova, 2019).

People who live <500 meters from the landfill revealed that the health problems they felt during the fire were coughing, shortness of breath, dizziness, headaches and sore eyes. This is because people who live near the location of the landfill fire will breathe in fumes that contain more toxic gases than people who live at more distances than that. Research shows that people who live closer to landfill sites are more susceptible to respiratory disease. Respiratory diseases and respiratory disorders can be caused by bioaerosol and biological agents released from the landfill site. These emissions have been reported to be harmful to human health (Njoku, Edokpayi & John, 2019).

In addition, people living in areas > 500 m - 2 km from the landfill also experience coughing, shortness of breath, dizziness and headaches. This can be caused

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because the smoke from the landfill fires contains poisonous gas that flies in the direction of the wind so that people who still live around the landfill will experience problems with their respiratory system.

The combustion of biomass releases particles (PM 10 and PM 2,5) and various volatile organic compounds which are involved in respiratory diseases. In addition, diseases such as flu, eye irritation and body weakness are often reported by people who live closer to the landfill than by people who live further away from the landfill. Some diseases such as back pain, skin disorders, hearing loss and asthma are shown by most people who live closer to landfill (Njoku, Edokpayi & John, 2019).

In addition to the explosion hazard caused by landfill fires, smoke and other by-products from landfill fires also present a health risk for people who not only live closer to the landfill, but people who live in other areas. Smoke from landfill fires generally contains *particulate matter* / PM (the product of incomplete combustion from a fuel source), which can exacerbate pre-existing lung conditions or cause respiratory problems. Like all fires, landfills produce smoke and poisonous gases. The dangers and levels of toxicity of these gases depend on how long they are exposed to and the type of material burned (US Report, 2012).

Turbulence of air and oxygen supply greatly affect the final product in the combustion process. If turbulence occurs and the oxygen supply is insufficient, there will be an incomplete combustion process which will cause CO gas as the final product. The formation of CO gas can occur 10 times that of the CO_2 formation process . High temperatures can also trigger the formation of CO gas. High temperatures will make CO_2 gas which should be the final product of complete combustion will dissociate into CO and O gases. The higher the temperature, the more CO gas is formed (Octavia, et al, 2016).

In the fire process, domestic waste which tends to be organic and wet, will result in incomplete combustion. This incomplete combustion will produce carbon monoxide gas (CO) instead of carbon dioxide gas (CO_2), where CO_2 gas comes from complete combustion. CO gas can be formed when all carbon components in the waste are not oxidized to CO_2 gas . The high level of CO indicates that the combustion gas is not formed at a high enough temperature in the presence of oxygen gas (O_2) for a long time to convert CO gas to CO_2 (Bestar, 2012).

Carbon monoxide gas can be formed whenever carbon or substances containing carbon are burned with insufficient air supply (Ferronato & Vincenzo, 2019). Fires that occur underground can produce Carbon Monoxide (CO) levels in excess of 50,000 ppm (parts per million) - the *Occupational Safety & Health Administration* (OSHA) allowable exposure limit for CO is 50 ppm. OSHA standards prohibit workers from being exposed to more than 50 gases per million averaged over 8 hours. Carbon monoxide is very dangerous for the human body because when the CO gas that is inhaled enters the human respiratory tract to enter the lungs. So in the lungs it will bind to Hemoglobin (Hb) and participate in human blood circulation, which results in blocking the entry of oxygen gas (O_2) into the body (Ministry of Health, 2018). Where when this happens it will cause the body's organs to experience a condition of lack of oxygen (hypoxia) which can cause permanent damage to vital organs in the body which can lead to death (US Report, 2012).

This can occur because CO gas is an unbalanced competitor of O_2 , where the binding of CO to hemoglobin (Hb) is much higher than the binding of O_2 to hemoglobin. WHO (1977, in the Indonesian Ministry of Health, 2018) states that

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Carbon Monoxide (CO) has the ability to bind to hemoglobn (Hb) 240 times stronger than oxygen (O_2). As a result, people who are poisoned with CO will experience lack of oxygen (*hypoxia*) which is caused by the role of Hb to distribute oxygen throughout the body is disturbed by the presence of CO. This is of course dangerous for the body (Prabowo and Burhan, 2018).

Apart from methane gas (CH_4) and carbon monoxide (CO), a concern in the event of a landfill fire is the presence of Dioxin emissions. Accidental fires at landfills and uncontrolled burning of residential waste are considered to be the largest sources of dioxin emissions in the United States. The term 'dioxin' refers to a group of chemical compounds with similar chemical and biological characteristics that are released into the air during the combustion process. Dioxins are toxic compounds and they can cause mutagenic and teratogenic effects (Reports US, 2002; Aderemi & Adebayo, 2012; Rivera, 2016).

Dioxins also occur naturally and exist throughout the environment. Burning chlorine and chlorinated compounds produces dioxins. Burning tires at low temperatures produces dioxins and furans. These toxins are biomagnified, meaning that when dioxins move up the food chain, their concentration is repeatedly doubled. However, exposure to high levels of dioxins has been linked to cancer, liver damage, skin rashes, and reproductive and developmental disorders (Reports US, 2002; Aderemi & Adebayo, 2012; Rivera, 2016).

Children can face a much greater risk. Because of their size, they breathe in more air per pound of body mass than adults, and can absorb proportionately larger doses of toxins. Also, children's bodies are more susceptible to damage from lead, cadmium and other heavy metals found in tire fumes because their nervous systems are not fully developed (Aderemi & Adebayo, 2012).

An increased risk of severe health implications such as birth defects, low birth weight, and certain cancers has been reported in individuals living next to landfill areas in various studies. For example, TCE is an elemental carcinogen that often comes from landfill leachate. Other discomfort and self-reported symptoms for people living next to the landfill include drowsiness, headaches and fatigue. The effect is related to the toxic action of chemicals present in landfill waste. Contamination of air with harmful gases to water pollution, the result will have detrimental effects on human health. Landfill toxic gases release and water pollution are also linked to lung and heart disease.

Apart from short-term impacts, there are health problems that have long-term impacts on the people living in the area around the landfill, especially those who live 500 meters from the landfill, most of whose livelihoods are as scavengers at the landfill . This is related to research conducted by Andhika et al (2015) which revealed that 13 scavengers at the landfill did not experience complaints of respiratory problems (40.6%). This is possible because the people who live and work in the landfill have already experienced adaptations (adjusting to the conditions of the surrounding environment). This adaptation can occur in several ways, one of which is through a physiological process.

The scavengers who work every day in the landfill already feel that their immunity to upper respiratory infections (complaints of respiratory problems) will develop by itself in the scavenger's body. So, they are no longer able to feel complaints of respiratory problems such as coughing, chest pain and shortness of breath. However, some scavengers who do not feel any complaints of respiratory

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problems at all (in Andhika's study, et al., 2016) said that at the beginning they worked as scavengers, they did experience complaints of respiratory problems (cough, chest pain or shortness of breath) with the main complaints being cough with severe nausea. The scavenger said that the smell from the landfill was the main factor causing the nausea they experienced.

2. Environmental Impact

Landfill fires can have a significant impact on local air quality through odors and the presence of smoke. Fires can occur at the surface or underground. Fires can have detrimental impacts on the environment as well as on the communities around the landfill area. The incidence of underground fires in the landfill can be determined through the level of carbon monoxide in the *landfill gas* (LFG) which will give an indication of whether there is or has been a fire under the surface of the landfill. Carbon monoxide is produced when there is not enough oxygen to fuel fully combustion. Carbon monoxide levels of more than 1,000 ppm will indicate a fire has occurred underground in the landfill.

Generally, a complete fire reaction of hydrocarbons with sufficient oxygen will produce CO_2 and H_2O gases. It can be explained that the oxygen supply greatly affects the exhaust gases produced. Waste that contains carbon if in the combustion process it cannot be completely oxidized, generally there will be an open combustion process. This will prevent methane gas from decomposing into CO_2 and H_2O, but will be released into the air as pollutants.

When methane gas causes a fire at the landfill, a lot of smoke will appear from the landfill. This smoke will be scattered out of the landfill environment and will move towards settlements of residents who live around the landfill area to areas far from the landfill location. As the results of this study, the results of interviews with 21 informants who live in 3 zone around the Tamangapa landfill, namely that the community feels the impact in the form of smoke due to the fire process, foul odors and for people living around the landfill will experience water conditions for daily activities. will be polluted. Apart from the environmental impacts of the incident, smog also appeared.

This haze is not only about the people living around the Tamangapa landfill, but also on almost the entire city of Makassar for 4 days. People who live close to the landfill, which is 500 m from the landfill, said that they had difficulty distinguishing between smoke and smog during a fire. This is due to the thick smoke coming from the landfill itself. In this study, 7 informants in this study who lived> 500 m - 1 km from the landfill stated that smog appeared in their home environment for 4-7 days. Based on the results of interviews with 7 informants, it was found that the smog only appeared at dawn until 10 am, after which there was no smog in the environment around the informant's house. 4 informants who live > 1 km - 2 km from the landfill stated that the smog appeared in their home environment for 4-5 days, but 3 informants in this neighborhood stated that they did not see smog in their home environment. These 3 informants said that at that time, the direction of the wind was coming from their house towards the landfill, so that the smoke or smog coming from the landfill did not reach their neighborhood.

The emergence of smog is caused by the presence of volatile compounds or so-called *Volatile Organic Compounds (VOCs)* which will contribute to the emergence of ozone pollution on the ground. The ease with which these compounds evaporate will

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eventually cause the air environment around the materials containing these compounds to be toxic because VOC compounds do have these properties (Prabowo and Burhan, 2018).

After the fire at landfill Tamangapa has been extinguished, the environmental problems felt by the people who live around the landfill cannot immediately disappear. The people who live 500 m from the landfill reveal that there is still smoke coming from the landfill and that the water conditions for people's daily lives are still polluted due to the fire-fighting process at the landfill. Meanwhile, people who live > 500 m - 1 km from the landfill said that after the incident, the environmental impact they felt was a foul smell coming from the landfill. On the other hand, for people who live > 1 km - 2 km from the landfill, the community stated that there was still a smog after the incident which sometimes gave off a foul odor.

This foul odor is caused by the presence of hydrogen sulfide (H_2S) gas produced in the garbage heap at the landfill. The smell of garbage from landfill is included in the medium - small risk zone, because the smell of garbage spreads in all directions depending on the direction of the wind and the altitude of the place. Exposure to combustion smoke disturbs the respiratory system and sense of sight of the residents around the landfill (Sukrorini, et al., 2014).

3. Social Impact

Landfill fires do not only have an impact on the environment and health. From a social perspective, this includes community activities in the area around the landfill, school conditions and economic problems caused by the landfill fires. The impact of the landfill fires is very pronounced for the people who make a living in the landfill. So that has an impact on their productivity. As previously explained, the result of a garbage fire in the landfill is an increase in smoke production. The result is a reduction in the efficiency of the community to be able to work or do activities as before, without the smoke from the landfill fire.

This is because when a large scale landfill fire occurs, schools and community activities are hampered. Schools that are in a neighborhood close to the landfill are the ones most affected by the waste fire disaster in this landfill. The temporary stopping of the teaching and learning process as a result of the fire, namely the smog. World Bank Group (2016), found several cases of schools being closed for weeks due to forest fires and the presence of haze, resulting in teachers having an obligation to accommodate homework assignments for students. If the school is closed for a prolonged period of time it will contribute to a lower graduate level. This resulted in a very large loss of IDR 540 billion (school closure for 34 days).

If this is seen from an economic perspective, there will be a decrease in people's income as a result of the burning of the landfill (Suryani, 2012). This can be seen from the point of view of declining community sales due to the decrease in buyers who come to shops or stalls to carry out buying and selling activities. This of course is related to the smog produced from the landfill fire, which makes people afraid to go outside their homes. This condition will occur until the smog disappears.

Apart from the people who live around the landfill area, the people who live in the closest distance from the landfill, the majority work as scavengers at the landfill. Every day these scavengers will make a living by picking and utilizing used goods (such as cigarette butts, plastic, used cardboard, etc.) then selling them to entrepreneurs who will process them back into commodity goods (Khadijah, 2019). In this group of scavengers the decrease in income is very pronounced. The income they

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get to meet their daily needs has decreased due to this fire. The main factor that causes this, of course, is the limited working area of scavengers to find waste that can be resold to collectors. This certainly has an impact on the income of scavengers, which has decreased due to the landfill fire.

In addition, the presence of smoke caused by the process of spraying the fire in the landfill area made them unable to stay in the landfill for long to find and collect the garbage. The longer they stay in the landfill which is burning, besides making them short of breath, dizzy and coughing from inhaling gas due to burning garbage at the landfill, it also causes their eyes to become red and watery. This makes their vision blurry and again has an impact on the condition of the trash they manage to collect. The less trash they collect, the less money they will get.

However, not all people who live in the area around the landfill are socially affected by the landfill fire disaster. In the research, the 7 informants said that the people who were > 1 km to ≤2 km from the landfill said they were not socially affected. This is based on information from the informant that at the time of the incident it was Sunday afternoon which was a holiday. So, people who live in this area do not go to their offices and go to school.

After the landfill fire incident, based on the research results, social impacts such as schools that were closed for 2 days, reopened and teaching and learning activities were carried out in schools. In terms of the economy of the community, those who sell are also back in normal conditions like before the landfill fire incident. Meanwhile, the people who live 500 meters from the landfill still feel the impact after the landfill fire incident, namely the problem of reduced income. Based on the accounts of the seven informants, it was found that the reduced income was due to the fact that there was not much land to look for garbage in the landfill. Because there are 8 out of 16 mountains of garbage burned in the landfill. Thus, causing them to still search the 8 piles of garbage that were not hit by the fire during the fire and that too must be done together with scavengers.

CONCLUSION

1. The health impact felt by the people who live around the landfill is influenced by the location where they live near the landfill. The closer the distance to where the community lives, the greater the health impact that will be felt by the community. Not to mention, the impact that will be felt in the long term as a result of exposure to various kinds of gases originating from the landfill.
2. The environmental impact felt by the community both during the fire and after the landfill fire is on local air quality through the smell and presence of smoke, which can have a negative impact on the health of the community around the landfill area. Besides, the impact is in the form of smoke that appears during the landfill fire. The long-term environmental impact that can be caused is the release of unpleasant odors from the landfill caused by waste decomposition activity in the garbage pile at the bottom.
3. The social impact when the fire occurs includes the activities of the people who live around the landfill area. Especially in the community who act as waste collector laborers who earn a living from the landfill. This will also create new social problems in the future for the increasing number of garbage collector workers who will reside near the landfill site.

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