A review of environmental health impact from municipal solid waste (MSW) landfill

Khoiron Khoiron[1,2,*], Ari Natalia Probandari[3], Wiwik Setyaningsih[4], Heru Subaris Kasjono[5], Roy Hendroko Setyobudi[6], Olga Anne[7]

[1]*Postgraduate Program Sebelas Maret University, Indonesia*
[2] *Faculty of Public Health, University of Jember, Indonesia*
[3]*Faculty of Medicine, Sebelas Maret University, Indonesia*
[4]*Faculty of Engineering, Sebelas Maret University, Indonesia*
[5]*Poltekkes Kemenkes Yogyakarta, Indonesia*
[6]*Waste Laboratory, University of Muhammadyah Malang, Indonesia*
[7]*Faculty of Natural Sciences, Klaipeda University, Lithuania*

***Corresponding author: (Khoiron Khoiron)**
Email : khoiron@unej.ac.id

Abstract.

.

Context: The waste of landfill produced in three phases, they were solid, liquid (example leachate), and gas. The waste had contaminated three environmental media; air, soil, and air. Operational of landfill also has an impact on the environment and public health. This review is specifically to analyze partially the impacts of the municipal solid waste (MSW) landfill, the impact on environmental pollution and the impact on public health. **Settings and Design**: This study is a literature review that discusses various literatures on environmental impact and public health caused by municipal solid waste (MSW) landfill. **Methods and Material**: The data sources of this study come from literatures obtained through the internet in the form of scientific journal articles that can be traced online. The study in this paper focuses on discussing several scientific articles in reputed international journals that carry out research related to the impact of the Municipal Solid Waste (MSW) Landfill. **Statistical analysis used**: The data were processed descriptively to describe various environmental and public health impacts arising from the landfill. **Results**: Environmental impacts are: chemical pollutants such as heavy metals (Cd, Cr, Fe, Ni, Pb, Zn, Mg), methane gas, H_2S, CO, microorganisms such as Coliform, *Clostridia perfringens* (Veillon & Zuber 1898, and Hauduroy et al. 1937), *Shygella dysenteriae* (Shiga, 1897, and Castellani & Chalmers 1919) . While the health effects are the symptoms of skin irritation, eye irritation, gastro intestinal tract disorders, allergies, nasal irritation, and other symptoms. While the risk of cancer is very low risk.

Keywords: Enviromental impact, public health impact, simple disposal procedure, sanitary landfills, waste management

How to cite this article: Khoiron et al. (2020) : A review of environmental health impact from municipal solid waste (MSW) landfill, Ann Trop & Public Health: S463 Vol. 23 Issue 3(A):60–67.
DOI: http://doi.org/10.36295/ASRO.2020.23316

Introduction

Waste is a serious problem in big cities and village, along with the growing population. Meanwhile the development of waste management is not proportional to the rate of waste generation, this is a problem that must be solved immediately. One technique of waste management is by storing the waste at the landfill.Landfill is widely applied throughout the world because it has various advantages, namely simple disposal procedures and relatively cheap[1];[2]. Some applications of the waste management method at the landfill are open dumping, controlled landfills, and sanitary landfills. Sanitary landfill is the best method among the three methods. Sanitary landfill is a method of processing waste on the ground without causing disruption or danger to the health and safety of the community, by using technical principles by isolating the garbage in the smallest place, reducing it to the smallest volume, and covering the waste with soil[3]. Sanitary landfill is one of the best methods recommended for urban waste management throughout the world[1]. However, there are still many landfill sites operated by the method of open dumping and controlled landfills, especially in some developing countries, including Indonesia.

Landfill operations also have an impact on the environment and public health. The impact that occurs is a result of the activities of stockpiling, transporting, burning, and compaction of waste, as well as the process of natural decomposition of waste. During the process of decomposition of waste, the landfill produces waste in three phases, they are solid, liquid (eg leachate), and gas[2]. The waste can pollute three environmental media: the atmosphere, lithosphere, and hydrosphere[2]. Urban waste landfill can be the source of pollution in the surrounding environment[12]. Environmental pollution can cause health impacts on humans, either directly or indirectly. This study aimed to analyze descriptively the various impacts of landfill, namely the impact on environmental pollution and the impact on public health.

Materials and Methods

This study is a literature review that discusses various literatures on environmental health impacts arising from the landfill. The data sources of this study come from literatures obtained through the internet in the form of scientific journal articles that can be traced online. The study in this paper focuses on discussing several scientific articles in reputed international journals that carry out research related to the impact of the Municipal Solid Waste (MSW) Landfill. The twenty articles were published in 1997 to 2017. The data were processed descriptively to describe various environmental and public health impacts arising from the landfill.

Results

General description of the composition of municipal solid waste

Leachate characteristics in municipal solid waste landfill are strongly influenced by the composition of waste in the landfill. In general, the composition of waste in landfill consists of organic and inorganic waste. The composition varies according to the socio–economic conditions of the local community, including the city

category whether it is a large, medium or small city. One example of the composition of waste in the landfill can be seen in Table 1.

Tabel 1. The Composition of Municipal Solid Waste[1]

Component	Percentage (%)
Organic material	40
Plastic	10
Non recycle material	30
Agricultural waste	20
Total	100

The quantity and quality of the waste found in the landfill greatly influences the impact. Most of the waste in the landfill is organic waste. Most organic waste can be decomposed biologically and can also be decomposed with aerobic and non–aerobic microorganisms. The decomposition process also causes gas and leachate. If the waste disposed in the landfill is not managed properly, it has the potential to pollute the environment physically, chemically and biologically.

The landfill impact on water quality

The landfill can also have an impact on the decreasing quality of surface and ground water. The impact is mainly due to landfill leachate. Leachate composition is influenced by several factors including waste density, waste composition, climate, and waste moisture [1]. Leachate characteristics are also influenced by the age of landfill. Young landfill is in the acidogenic phase with very high BOD and COD content. BOD and COD concentrations in leachate will decrease with increasing age of landfill (see in Table 2)[5].

Tabel 2. Leachate characteristics based on the age of landfill[5]

Parameter	Unit	Age of landfill		
		Young	Intermediate	Old
Age	year	< 5	5 to 10	>10
PH	–	6.5	6.5 to 7.5	>7.5
COD	mg L^{-1}	20 000 to 40 000	4 000 to 10 000	500 to 4 000
BOD	mg L^{-1}	10 000 to 20 000	4 000 to 10 000	50 to 100
TOC	mg L^{-1}	9 000 to 25 000	–	100 to 1 000
Volatile fatty acids	mg L^{-1}	9 000 to 25 000	–	50 to 100

High concentration of chromium was found in the leachate such in Bandung, Indonesia, Bangkok, Thailand, and in Leon, Mexico. Manganese and Zinc concentration is also high on the acetogenic leachate. It was also found Fecal coliforms, Fecal streptococcus, Clostridium, and Salmonella [5].

Table 3. Leachate quality data[5]

Parameter	Value	Parameter	Value
pH	7 to 10	COD (mg L^{-1})	500 to 38 800
BOD (mg L^{-1})	245 to 24 500	NH_4–N (mg L^{-1})	10.2 to 2 000
Alkalinity (mg L^{-1})	1 271	Chloride (mg L^{-1})	1 383
Conductivity (mS m^{-1})	670	Ammonia (mg L^{-1})	230
Nitrate (mg L^{-1})	10.25	Nitrite (mg L^{-1})	21.5
TKN (mg L^{-1})	261.8	Sulphate (mg L^{-1})	32.8
Orthophosphates (mg L^{-1})	0,2	Total Solid (mg L^{-1})	3 655
Volatile solids (mg L^{-1})	675	TSS (mg L^{-1})	77
VSS (mg L^{-1})	28	Sodium (mg L^{-1})	659
Magnesium (mg L^{-1})	65	Potassium (mg L^{-1})	371
Calcium (mg L^{-1})	91	Chromium (mg L^{-1})	0.05
Manganese (mg L^{-1})	1.2	Iron (mg L^{-1})	4.9
Copper (mg L^{-1})	0.08	Zinc (mg L^{-1})	0.2
Cadmium (mg L^{-1})	0.025	Lead (mg L^{-1})	0.075
Mercury (µg L^{-1})	12.75	Arsenic (µg L^{-1})	30.7
VFA (mg L^{-1})	11 to 1 029	TDS (mg L^{-1})	68 to 3 389
Total Nitrogen (mg L^{-1})	16.6 to 630	TOC (mg L^{-1})	30 to 800

The composition of the leachate contains many substances that can harm the environment and public health. Leachate from landfill can reduce the quality of surface water and ground water. Even leachate also contains heavy metals.Surface water around the landfill was found to contain heavy metals such as Cd, Cr, Fe, Ni, Pb, Zn, Mg[8].

The landfill impact on the decreasing of land quality

Landfill soils also contains various heavy metals, such as Al, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Zn, Hg, and Cd[6];[7];[9]. The level of heavy metal concentration in TPA are: Zn> Cu> Mn> Cr> Pb> Ni> Cd> Hg, these show that the level of contamination of Cu and Mn are higher than the others[9]. Besides being contaminated with heavy metals, the soil in the landfill is also contaminated with microorganisms such as Coliform, *Clostridia perfringens* (Veillon & Zuber 1898, and Hauduroy et al. 1937), *Shygella dysenteriae* (Shiga, 1897, and Castellani & Chalmers 1919) which can cause high level phyto–toxicity in the soils. The negative impacts of landfill can spread to surrounding agricultural land and causing eco–toxicology which degrade the soil quality [12].

The landfill impact on air quality

Landfill operational activities such as transportation, stockpiling, leveling, compaction, waste combustion, and the natural degradation process of waste can also have a negative impact on air quality in the landfill and its surroundings.Some of the gases in the landfill are methane, toluene, ammonia, xylene, carbon monoxide, hydrogen sulfide, nitrogen dioxide, formaldehyde, ethyl benzene, sulfur

dioxide, hydrogen sulfide, non methane volatile organic compounds (NMVOC), soot, benzoa pyrene, dioxin or furan, Ozone, PM 2.5, Hg[10];[11];[12];[14];[15]. Some heavy metals Pb, Cr, Cd and Mn are found in fly ash incenerator in the landfill[7]. The air quality in the landfill and its surroundings are also contaminated with microorganisms including mesophyll bacteria, fungi, Actinomycetes, Staphylococci, *Pseudomonas fluorescens* (Migula, 1895) and *Escherichia coli* (Walter Migula, 1895)[13].

The landfill impact on the surrounding public health

Various pollutants that exist in the landfill environment and its surroundings both physically, chemically, and biologically have the potential to cause health problems. Some heavy metals are toxic, and some microorganisms are pathogenic. Heavy metals Pb, Cd, Cr and Ni are toxic substances in drinking water[8]. Some studies with the topic of the landfill impact on health can be seen in Tabel 4.

Tabel 4. Research results related to the landfill impact on public health.

Researccher	Publication year	Research Location	Results
Swati, et al[6]	2017	Delhi, India	All sample results showed that the risk of cancer caused by landfill is very low
Li, et al[7]	2017	Shenzhen, China	Heavy metal content (Pb, Cr, Mn, Cd) were found in the population living near the landfill with a radius of (1 to 5) km and (5 to 10) km.
Heany, et al[15]	2011	North Carolina, USA	H_2S and bad odor had a negative impact on the public health.
De & Debnath[16]	2016	Kolkata, India	Residents living in the landfill area had health problems such as allergies, asthma, bronchitis, skin irritation, and gastro intestinal diseases.
Hung, et al[17]	2009	Northern Taiwan	Pb originating from monolithic fly ash could cause serious health risks.
Mari, et al[18]	2009	Catalonia, Spanyol	Exposure to heavy metal pollutants and polychlorinated dibenzo–p-dioxins and dibenzofurans (PCDDs / Fs) to the environment around the landfill had the potential to cause cancer disorders

(continued on next page)

Tabel 4. Continued

Researccher	Publication year	Research Location	Results
Davoli, et al[19]	2010	South Italy	The air quality in the landfill and its surroundings showed less significant results associated with negative impacts on health;
Al–Delaimy, et al[20]	2014	Los Laureles, Canyon, Tijuana, Mexico	Residents around the landfill had health complaints including: difficulty concentrating, ear disorders, nasal irritation, skin problems or irritations, extreme fatigue, stomach disorders, and eye irritation

Conclusion

Based on the results of the above study, it can be concluded that the presence of municipal solid waste landfill has a negative impact on the environment and public health. However, if the landfill management is carried out properly according to applicable regulations and standards, then the negative impact can be minimized.

Acknowledgement

The author would like to thank the Environmental Sciences Doctoral Program and the library of Universitas Sebelas Maret, which facilitated the author in obtaining the literature supporting this article.

References

[1] Bashir MJK, Aziz HA, Amr SS, Sethupathi S, Ng CA, Lim J. The competency of various applied strategies in treating tropical municipal landfill lindi. Desalination and water Treatment. 2015;54(9):2382–85. https://www.tandfonline.com/doi/abs/10.1080/19443994.2014.901189

[2] Butt ET, Lockley E, Oduyemi KOK. Risk assessment of landfill disposal sites – state of the art, Waste Management, 2008;28(6):952–64. https://www.sciencedirect.com/science/article/pii/S0956053X07001833

[3] Raghab SM, Meguid AMA, Hegazi HA. Treatment of lindi from solid waste landfill. Housing and Building National Research Center HBRC Journal. 2013;9(2):187–92. https://www.tandfonline.com/doi/full/10.1016/j.hbrcj.2013.05.007

[4] Fadel M, Findikasis AN, Leckie JO. Enviromental impacts of solid waste landfilling. Journal of Environmental Management 1997;50(1):1–25. https://www.sciencedirect.com/science/article/pii/S0301479785701314

[5] Sil A, Kumar S. Landfill leachate treatment, In: Wong JWC, Tyagi RD, Pandly A (Eds.), Current developments in biotechnology and bioengineeering solid waste management. Elsevier. 2017;391–406. https://www.sciencedirect.com/science/article/pii/B9780444636645000174

[6] Swati, Ghosh P, Thakur IS. An integrated approach to study the risk from landfill soil of Delhi: Chemical analyses, *in vitro* assays and human risk assessment. Ecotoxicology and Environmental Safety. 2017;143:120–28. http://dx.doi.org/10.1016/j.ecoenv.2017.05.019.

[7] Li T, Wan Y, Ben Y, Fan S, Hu J. Relative importance of different exposure routes of heavy metals for humans living near a municipal solid waste incenerator. Environmental Pollution. 2017;226:385–93. http://dx.doi.org/10.1016/j.envpol.2017.04.002.

[8] Biswas AK, Kumar S, Babu SS, Bhattacharyaa JK, Chakrabarti T. Studies on environmental quality in and around municipal solid waste dumpsite. Resources, Conservation and Recycling. 2010;55(2):129–34. doi:10.1016/j.resconrec.2010.08.003.

[9] Prechthai T, Parkpian P, Visvanathan C. Assessment of heavy metal contamination and mobilization from municipal solid waste open dumping site. Journal of Hazardous Materials 2008;16(1–3):86–94. Doi:10.1016/j.jhazmat.2007.11.119.

[10] Weichental S, Rijswijk DV, Kulka R, You H, Ryswyk KV, Willey J, et al. The impact of landfill fire on ambient air quality in the north: A case study in Iqaluit, Canada. Environmental Research. 2015;142:46–50. http://dx.doi.org/10.1016/j.envres.2015.06.018.

[11] Hu L, Du Y, Long Y. Relationship between H_2S emissions and migration of sulfur–containing compounds in landfill. Ecological Engineering. 2017;106:17–23. http://dx.doi.org/10.1016/j.ecoleng.2017.05.026.

[12] Makarenko N, Budak O. Waste management in Ukraine: Municipal solid waste landfills and their impact on rural areas. Annals of Agrarian Science. 2017;15(1):80–87. http://dx.doi.org/10.1016/j.aasci.2017.02.009.

[13] Breza–Boruta B. The assessment of airborne bacterial and fungal contamination emitted by a municipal landfill site in Northern Poland. Atmospheric Pollution Research. 2016;7(6):1043–52. http://dx.doi.org/10.1016/j.apr.2016.06.011.

[14] Zhu W, Li Z, Chai X, Hao Y,Lin CJ, Sommar J, et al. Emission characteristics and air–surface exchange of gas mercury at the largest active landfill in Asia. Atmospheric Environment 2013;79:188–97. http://dx.doi.org/10.1016/j.atmosenv.2013.05.083.

[15] Heany CD, Wing S, Campbell RL, Caldwell D, Hopkins B, Richardson D, et al. Relation between malodor, ambient hydrogen sulfide, and health in a community bordering a landfill. Environmental Research. 2011;111(6):847–52, doi:10.1016/j.envres.2011.05.021.

[16] De S, Debnath B. Prevalence of health hazards associated with solid waste disposal– a case study of Kolkata, India. Procedia Environmental Sciences. 2016;35:201–08. https://www.sciencedirect.com/science/article/pii/S1878029616301700

[17] Hung ML, Wu SY, Chen YC, Sih HC, Yu YH, Ma HW. The health risk assessment of Pb and Cr leachated from fly ash monolith landfill. Jounal of Hazardous Materials. 2009;172(1):316–23. doi:10.1016/j.jhazmat.2009.07.013

[18] Mari M, Nadal M, Schuhmacher M, Domingo JL. Exposure to heavy metals and PCDD/Fs by the population living in the vicinity of a hazardous waste landfill in Catalonia, Spain : Health risk assessment, Environment International. 2009;35(7):1034–39. https://www.sciencedirect.com/science/article/pii/S0160412009001111

[19] Davoli E, Fattore E, Colombo A, Palmioto M, Rossi AN,Il Grande M, et al. Waste management health risk assessment: A case study of a solid waste landfill in South Italy, Waste Management. 2010;30(8–9):1608–13. doi:10.1016/j.wasman.2009.10.013

[20] Al–Delaimy W, Larsen CW, Pezzoli K. Differences in health symptoms among residents living near illegal dump sites in Los Laureles Canyon, Tijuana, Mexico: A cross sectional survey. International Journal of Environmental research and Public Health. 2014;11(9):9532–52. doi:10.3390/ijerph110909532