International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 8, August - 2013

Potential Risks Of Manganese Through Shallow Well Water Consumption Due To The Landfill Leachate Among Community In Tamangapa Disposal Site, Makassar Indonesia

Ummu Salmah , Anwar Mallongi, Atjo Wahyu

[1]Department of Biostatistics and Demographics, Faculty of Public Health, Hasanuddin University, South Sulawesi, Indonesia 90245.
[2]Department of Environmental Health, Faculty of Public Health, Hasanuddin University, South Sulawesi, Indonesia 90245.
[3]Department of Occupational Health, Faculty of Public Health, Hasanuddin University, South Sulawesi, Indonesia 90245.

ABSTRACT

Potential adverse health impact of chemical toxics substances such as Manganese in leachate is estimated particularly the influences to the population close to the landfill due to shallow well water consumption from the leachate movement. This study aimed to investigate potential health risk associated with exposure to Manganese (Mn) in landfill leachate to the community (worker, people surround the site, and children) who live close the Tamangapa Landfill site. Sampling survey of shallow well water was collected and taken to the laboratory to be analyzed. Ten sample stations with three replicates were made to analyze manganese contaminations in well water. Then, Health Risk Assessment (HRA) was applied by using the four stages of HRA; (1) Hazard Identification, (2) Dose response measurement (3) Exposure assessment and (4) Risk characterization to evaluate the potential risk posed by community surround the site. Results revealed the acceptable daily dose (ADD) and Hazard Quotient (HQ) for workers of manganese contaminated well water consumption of 3 liters/day were 0.0064mg/l/day and 0.64, for community surround landfill 0.0043mg/l/day and 0.43, then 1 liters/day water consumption for children were 0.0021mg/L/day and 0.21, respectively. Of those results, the hazard quotient (HQ) in toxicity assessment indicated that for 3 liters for adult and 1 liter for children of Manganese consumption in water indicated no risk.

Key words: Manganese, Landfill leachate, Acceptable Daily Dose, Risk Assessment.

I. INTRODUCTION

People live surround the landfill, formal workers and particularly those scavengers who work and life at the landfill are at risk and potentially pose adverse effect of the landfill. The working conditions have the potential to cause accidents which may affect the scavengers. Moreover, those people who are living close to the landfill consume wells water which may potentially contaminated with leachate liquid movement especially in the rainy season.[1, 2]

There are some various models available for the health risk assessment for landfill within it's facilities or it's process especially for the potential adverse health impact of the chemical toxics substances in it's leachate.[3, 4] In this term of health risk assessment project, leachate as the main sources of landfill in Makassar will be assessed particularly the influences to the population close to the landfill, then the ecosystem mainly the groundwater pollution due to the landfill leachate movement. it will focuses to the Manganese and Arsenic toxic substances HRA, where the process will be undertaken in accordance with the following guidelines.

a. Indonesia Ministry of Environmental. Guidelines for Environmental and Public

Health Risk Assessment from landfill sites.[5]

b. ATSDR, Agency for Toxic Substances and Disease Registry. Guidelines for Public Health Actions in Response to Landfill Fires.
c. Environment Agency (EPA, 2004) Guidance on assessment of risks from landfill sites, External 15 consultation v1.0, May 2004, Environment Agency, Bristol, 73pp.

To comply with that guidance, the general concept of HRA approaches that consist of four stages elaborated in detail as follow:

1. *Hazard Identification or Problem Formulation*: This is the determination of whether a particular contaminant is present, and the identification of all key adverse effects (e.g. environmental persistence, toxicological effects and other health effects such as diseases and aesthetic effects)
2. Dose Response Measurement: Determination of the quantitative relationship between the magnitude of exposure and the probability of occurrence of a particular adverse effect as well as the uncertainties associated with the determination;
3. Exposure Assessment: Determination or estimation of the magnitude, frequency, duration and routes of exposure for the contaminant and assessment of the uncertainties associated with the determination;
4. Risk Characterization: Integration of the results of the exposure and dose response assessments to describe the nature and magnitude of the risk from each route of exposure, the receptors at greatest risk, and the uncertainties associated with the overall analysis from guidance documents on the application of the risk assessment process to both human health and ecological receptors.

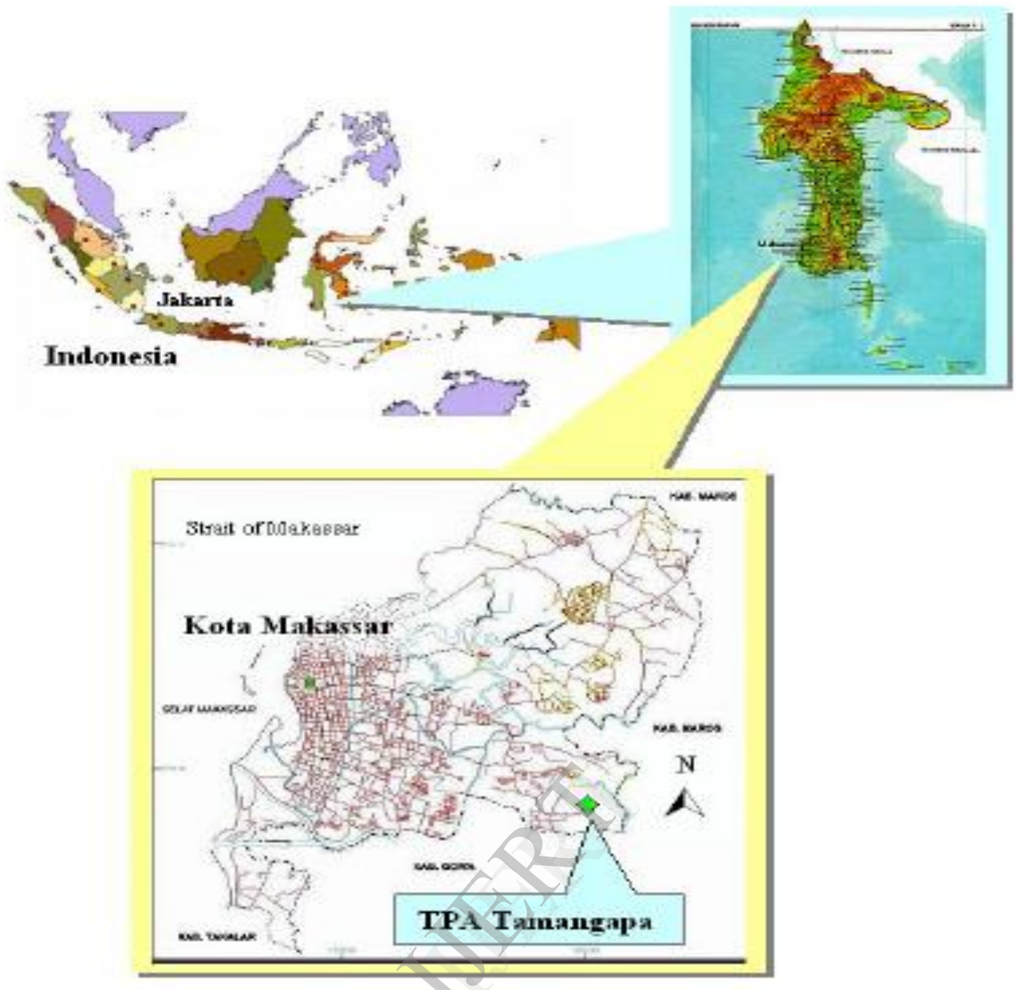
The screening level analysis focuses on leachate quality as the contaminant on ground water of potential concern, and its multi pathways exposure to the population living surround the Tamangapa landfill . The atmosphere and soil compartments play an important role in evaluation of potentially adverse effects of Manganese (Mn) both direct and indirect pathways through soil dermal contact and ingestion exposure. The assessment is based on the conceptual of risk identification, exposure scenarios and parameters, evaluation, and risk characterization.

II. MATERIAL AND METHOD

In sampling of community wells water, field water quality measurements are made at the time of sample collection or grab samples then those separated samples taken to the laboratory to be analyzed. Seven sample stations and three replicates were taken to monitor, to analyze the well water quality owned by community surround the Tamangapa Landfill, in term of Manganese (Mn) and Arsenic (As). Then, Health Risk Assessment (HRA) was applied by using the four stages of HRA that consist of (1) Hazard Identification, (2) Dose Response Measurement (3) Exposure Assessment and (4)Risk Characterization to evaluate the potential risk of Mn and As health impact whether it generates cancer or non cancer to those people.

III. RESULT AND DISCUSSION

For the purposes of this HRA study is to assess the groundwater and air pathway exposure scenario for the population living close to the Tamangapa landfill site in Makassar.



Toxic risks

- Are defined for non-carcinogenic exposure
- Think in term of a Hazard Quotient (HQ) = ADD/Rfd
- Where Rfd is reference dose and the ADD (the average daily dose) is

$$ADD = \frac{\text{Total Potential Dose}}{BW \times ET}$$

Carcinogenic risks

- Are statement of probability
- Individual excess risk is an estimate of the probability that an individual will get cancer from an exposure, Not the potentiality of dying from it.
- It is calculated from risk = SF x LADD

Although risk assessment involves the application of seemingly trivial mathematical equations, problems arise in

their parameterisation, and detailed knowledge of exposure factors is required in order to make the calculations useful. The above risk assessment was based on the following exposure factors:

a. Exposure duration. The exposure duration can be estimated by taking the difference time from the inception of the Tamangapa landfill site to the present time, assuming that the population has remained static, in this case 15 years.

b. Body weight. Body-weight data were obtained from the Provincial Public Health Office in Makassar City. For men the

average body weight is 60 kg, for women it is 55 kg and 15 Kg for Children.
c. Life expectancy. According to the Statistical Data Office life expectancy is 60 years for women and 57 for man.
d. Water ingestion rate. It is estimated that, as Makassar is a tropic region, the water consumption is about **3** litres per day per adult and **1** litres for children.

Scenario

With regard to the mix landfill use and the model also the guidelines on the exposure scenario regulation, two exposure scenarios are assumed and evaluated, considering ingestion and inhalation exposure routes.

Scenario I: Landfill Scenario – Landfill workers

Landfill worker scenario is assumed for potential exposure during work-related waste picking activities at Tamangapa Landfill. For this scenario, it is assumed that an children may be exposed to Manganese at the work place for 240 days/year for 30 years for a 70 - year lifetime. It also is assumed that this individual could have daily dermal contact to Mn in leachate (well water and air) at the work place.

Scenario II: Landfill scenario – young children 1 to 5 years old

In this scenario, it is assumed that a child may be exposed to Manganese and Arsenic at the landfill site for 365 days/year for 5 years. According to the guideline both Indonesia Minister of Environmental and ATSDR , a young child (1-5 year old) is the most sensitive group to soil ingestion as he/she would intake soil/dirt at the highest rate of up to 100 mg/day while playing at home, in a park or playground. It more risk then especially those children who work at the landfill site both for ingestion and inhalation of Mn. It is further assumed that the child would inhale at a rate of 0.36 m_3/hr for a long-term exposure.

Scenario III: residential scenario – adults

- For residential adult (either man or women) is assumed for potential exposure during normal life activities at around Tamangapa landfill site. It is assumed that the adult is exposed to Mn for 365 days/year for a 70-year lifetime. It is also assumed that the adult would ingest 25 mg of soil per day, would inhale at a rate of 0.55 m_3/hr for a long-term 227 exposure, and could have dermal daily contact to soil/dirt at the site about 2800cm_2.

Table 1. Exposure Parameter value for Scenario Specific for Tamangapa landfill

Description of Parameter Exposure	Scenario Assumption		
	Landfill Scenario		Community
	Young Children	Adult	Adult
Body weight	15	60	70
Average time	1825	1825	25550
Exposure Frequency	240	365	365
Exposure Time(h)	8	8	24
Inhalation Rate (m^3)	30	15	30
Drinking Rate (L)	1	3	3

In order to illustrate the possible health problems associated with the groundwater contamination, especially for wells owned by community around the landfill site one parameter Manganese (Mn) pollutants is considered [2]: Manganese (Mn), with evidence of neurotoxicity in miners, and a carcinogen, (2-ethylhexyl) phthalate (DEHP) which has been shown to produce liver tumours in laboratory animals. To assess the risk, a hazard quotient (HQ) has been calculated for manganese. As defined by the USEPA, it is the ratio of the average daily dose to the reference dose.

It is stated that, HQs greater than one (1) indicate that there is a risk.[6] For tested wells owned by community in table 2, it has found that the manganese concentration (0.8mg/l) exceeding both national and EPA standard.

The Exposure Factors Handbook, [7], reviews water intake in detail and suggests a mean intake rate of 3 litres per day for active adults in temperate climates increasing to 6 litres per day in a hot climate. It is evident that both uncertainty and variability in factor parameterization exist. Uncertainty refers to a lack of knowledge about specific factors whereas variability refers to factor heterogeneity attributable to natural random processes [7]

A way of dealing with the parameterization uncertainty problem is to perform a sensitivity analysis, i.e. an interactive process of changing an exposure factor within a range that encompasses the known variability to observe the effect on the dose and hence risk.[3, 8]

Table.2 Physical and Chemical Groundwater Test Results from dig wells owned by Community who are living around Tamangapa Landfill Makassar

N0	Parameters	Unit	Results Average Conct.	Method	Standard class 1	Status
A	**PHYSICS**					
	Temperatur	Degree C	30	Direct Reading	Deviasi 3	Qualified
	TDS	Mg/l	114	Gravimetri	800	Qualified
	TSS	Mg/l	12	Gravimetri	50	Qualified
	Odor	-	Less ion	Organoleptic	-	Un-Qualified
	Turbidity	NTU	5	WQ Ceker	-	Qualified
	Color	NTU	7	Hidrasin	-	Qualified
B	**CHEMICAL**					
	pH	-	8.3	Potensio meter	6.0 – 9.0	Qualified
	Fe	Mg/l	0.34	AAS	0.3	Qualified
	Mn	Mg/l	**0.8**	AAS	**0.1**	**Unqualified**
	Ba	Mg/l	0.9	AAS	1	Qualified

Base on the table above, we analyze the health risk for Manganese, since only the concentration of Mn exceeded the standard mentioned 0.1 Mg/l.[9] We collected and analyzed 10 stations or wells owned by community who life around Tamangapa landfill site base on the distance from the point source, (Landfill leachate source). Results of Manganese concentration at each station were elaborated in Table 3.

Manganese Uptake Equation (Drinking Water Route)

To assess the potential risks of Mn due to the well water consumption, we use the formulation from EPA below:

$$ADD = \frac{C_S \times IR \times F1 \times EF \times ED}{BW \times AT}$$

Where: $C_{S,}$ is Chemical Concentration in Water (mg/l), IR_S is= Drinking Rate (L/day), (3 L for worker, 2 L for community and 1 L for children). FI_S is Intake Fraction from Contaminated Source (Unitless) equal to 0.5. Ef is exposure frequency, ED is exposure duration, BW is body weight and AT time average.

Table. 3 Manganese concentration base on the distance from point source from dig wells owned by Community who are living around Tamangapa Landfill Makassar

Station	Distance (M)	Manganese mg/l	Potential Risks					
			Adults (worker)		Adult community		Children	
			ADD	HQ	ADD	HQ	ADD	HQ
St.1	25 (closest well)	2.35	0.0064	0.64	0.0043	0.43	0.0021	0.21
St.2	50	2.27	0.0062	0.62	0.0041	0.41	0.0021	0.21
St.3	75	2.33	0.0064	0.64	0.0043	0.43	0.0021	0.21
St.4	100	2.01	0.0055	0.55	0.0037	0.37	0.0018	0.18
St.5	125	1.87	0.0051	0.51	0.0034	0.34	0.0017	0.17
St.6	150	1.88	0.0052	0.52	0.0034	0.34	0.0017	0.17
St.7	175	1.92	0.0053	0.53	0.0035	0.35	0.0018	0.18
St.8	200	1.23	0.0034	0.34	0.0022	0.22	0.0011	0.11
St.9	225	0.93	0.0025	0.25	0.0017	0.17	0.0008	0.08
St.10	250	0.81	0.0022	0.22	0.0015	0.15	0.0007	0.07

The difference Manganese concentration among the stations is mostly affected by the distance of the dig well location from point source. Manganese levels concentration attained their maximum values at the closest point in station 1. With 2.35mg/L. the increased of distance the decreased the Mn concentration in water.

Then, potential risks assessment for worker, community and children were calculated based on the daily water consumption. The elevated values of Acceptable Daily Dose (ADD) for Mn contaminated water were 0.0064, 0.0043 and 0.0021, respectively. In addition, the Hazard quotient (HQ) elevated at the same stations were 0.64, 0.43 and 0.21, respectively.

Health-based levels and carcinogenic risks were derived from reference does (RfDs) and carcinogenic slope factors (CSFs) obtained from IRIS, 1997 [6, 10] (Integrated Risk Information System. U.S. Environmental Protection Agency, National Center for Environmental Assessment. For the risk calculations, RfDs were first converted to Health-Based Limits (HBLs) if the ingestion rate of 3 L/day and a body weight of 60 kg [i.e., HBL = RfD (mg/kg/day) * (60 kg/3 L/day)]. The Hazard Quotient (HQ) was then calculated by dividing the concentration in the TCLP leachate by the HBL. No correction was made for an exposure duration of 15 years because this is considered a chronic duration. (11,12) (Any human exposure of 7 years or more is considered chronic for the purposes of calculating noncancer risk). The carcinogenic risk is calculated an ingestion rate of 3 L/day, an exposure duration of 15 years for children and 35 years for adult, and a body weight of 60 kg. Accordingly, the risk was calculated using the following equation: risk = (TCLP conc. in mg/L * 3 L/day * 15 yr * CSF)/(70 kg * 60 yr).

IV. CONCLUSION

The releases of Manganese from leachate landfill give a significant contribution to groundwater, food and soil pollution which then lead to a potential adverse of health effect to community surround the landfill, plant worker, children and scavengers at the site. The exposure pathway may occur through water drinking ingestion, air inhalation, skin/dermal contact or soil ingestion. The dispersion of leachate contain of Manganese to groundwater has been increased the level of contaminant to wells water owned by community which has directly give a potential health impact due to the consumption of well water by community, worker and children. Health risk estimation for Manganese and Arsenic to workers, community and children is exceeding the allowable and recommended value. So it is unacceptable. The greatest risk is in workers and children.

REFERENCES

1. **WorldBank., *Feasibility Study of Makassar Landfill Gas Project Final report, Makassar Indonesia*. 2007.**
2. **WHO., *Guidelines for Drinking Water Quality. 2nd Ed. Geneva: World Health Organization.* . 1999.**
3. **WALHI, *A Long Way To Zero Waste Management, Country Report – Indonesia For Global Anti-Incinerator Alliance (Gaia) - Waste Not Asia Conference, Taiwan*. 2001.**
4. **(SEPA)., S.E.P.A., *Guidance for Monitoring Enclosed Landfill Gas Flares;*. 2004.**
5. **Environmental., I.M.o., *Guidelines for Environmental and Public Health Risk Assessment from landfill sites, Makassar Indonesia.* . 2009.**
6. **IRIS, *Integrated Risk Information System. U.S. Environmental Protection Agency, National Center for Environmental Assessment, Cincinnati, OH)*. 1997.**
7. **USEPA, *Turning a Liability into an Asset: A Landfill Gas-to- Energy Project Development Handbook Landfill Methane Outreach Program, U.S. Environmental Protection Agency, September 1996*. 1996.**
8. **Loranger, S. and J. Zayed, *Environmental contamination and human exposure to airborne total and respirable Manganese in Montreal. Air and waste management, 47:983-989.* 1997.**
9. **KLH., *Guidelines for Environmental and Public Health Risk Assessment from landfill sites, Makassar Indonesia.* . 2000.**
10. **Environment, A., *GasSim - landfill gas risk assessment tool. R&D roject P1-295. Environment Agency software model. See: www.gassim.co.uk*. 2002**
11. Government Regulation of the Republic of Indonesia No. 41 Year 1999, Air Pollution Control;
12. Decree of the State's Ministry of Environment No. KEP-50/MENLH/11/1996, Standard of Unpleasant Odor Levels;
13. Decree of the State's Ministry of Environment No. KEP-48/MENLH/11/1996, Noise Level Standards