



## RESEARCH ARTICLE

URL of this article: <http://heanoti.com/index.php/hn/article/view/hn1418>**Mapping of Environmental Health Risks in Bonetambung Island, Makassar****Marwah\*, Ruslan\*\*, Agus Bintara Birawida\*\*, R Azizah\***

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## ABSTRACT

Bonetambung Island is one of small islands of Spermonde Island Group that had limited access to sea transportations and unavailable environmental sanitation facilities. This study aimed to map environmental health risks to identify the areas of environmental health hazard in Bonetambung Island, Makassar. This study was observational descriptive. Respondents in this study were all households in Bonetambung Island as many as 102 households taken by exhaustive sampling method. The result showed that the environmental health hazards in Bonetambung Island were hazard related to the source of clean water (71.1%), domestic wastewater (71.2%) and the ownership of garbage (72.5%). Additionally, some unhealthy behaviors that provided an opportunity for exposure to hazards were not-washing-hand-with-soap behavior (54.2%), open defecation behavior (62.7%), not processing and managing household waste (96.1%), and not-treat-drinking-water behavior (25.5%). So that, the mapping of environmental health risks in Bonetambung Island were very high risk category located in RT 03, high risk category located in RT 02, and low risk category in RT 01.

**Keywords:** Risk mapping, Environmental health, Small island

## INTRODUCTION

**Background**

The small islands are included in environmental area that are extremely important to concern whether administrative, habitat, and environmental sanitation management. Environmental sanitation is one of the points in Sustainable Development Goals (SDGs) for the environment sector by ensuring that communities achieve universal access for clean water and sanitation specifically addressed to the sixth objective of SDGs (Ministry of Health, 2015).

Generally, sanitation referred to providing facilities and services for safe disposal of urine and faeces of human. Inadequate facilities were the main causal of infectious diseases around the world. Improved sanitation had a significant impact on health both at home and in the community. The word of 'sanitation' also referred to maintenance of hygiene conditions, such as garbage collection and waste water disposal (WHO, 2013).

Characteristics of the community, especially in remote areas, in this case was a small isolated island, lacked of understanding of the importance of sanitation for health, one of which was due to their low knowledge. So that, risk behaviors related to health were possible to occur (Asnawati, 2009). In addition, toddlers should be more concerned than the other groups of population because they were more susceptible to sanitary-related illnesses. It was related to the spread of infectious diseases, such as diarrhea, cholera, typhoid fever and paratyphoid fever, dysentery, hookworm disease, ascariasis, hepatitis A and E, dermatitis, trachoma, schistosomiasis, cryptosporidiosis, malnutrition and malnutrition-related diseases (Galal, 2011).

Nationally, basic sanitation or emerging hazards from environmental problems and hygiene risk factors and unhygienic or risky behaviors contributed about 19% of deaths in worldwide due to infectious diseases. The problem of environmental health in Indonesia notably sanitary facilities of small islands were still very alarming that were marked by high incidence of infectious diseases and communicable disease in the community (Badu, 2014). Mukherjee said that the prevalence of diseases due to poor sanitation in Indonesia were diarrhea (72%), worms (0.85%), scabies (23%), trachoma (0.14%), hepatitis A (0.57%), hepatitis E (0.02%) and malnutrition (2.5%).

A number of studies have been conducted primarily to investigate indicators and determinants of health among several countries belonging to the small island category. However only a small portion of studies focused

on countries composed of thousands of large and small islands, such as Indonesia, Japan, Malaysia and the Philippines. Some of major environmental-based diseases that have also been found as endemic diseases in the archipelago were malaria and leptospirosis. However, basically the health problems faced by island dwellers were still dominated by environmental health issues and unhealthy behaviors (Notoatmojo, 2007). Therefore, to understand the condition of the island population as well as the threat of environmental hazards and other risky behaviors on health needed an evidence-based data as a basic consideration of government in the regional development planning.

Assessment of environmental health risks as an alternative way to get data on health problems in small islands (evidence-based data). The environmental health risk assessment, in this case was also known as Environmental Health Risk Assessment (EHRA), was a study to understand the condition of sanitation facilities and behaviors that pose a risk to public health. Sanitation facilities that was studied included sources of clean water, healthy latrine facilities, household waste, and household sewerage. For behaviors that was studied were hand washing with soap behavior, behavior of sorting waste, and open defecation (ISSDP, 2007).

Bonetambung island was one of small islands of Spermonde Island Group. Administratively, this island part of Makassar city area, Ujung Tanah district, Barrangcaddi sub-district. Bonetambung island was about 18 km from Makassar that can be reached within approximately 1.5 hours by using a boat owned by residents.

This island was round with an area of  $\pm 2.8$  Ha. About 5 years ago, the area of Bonetambung island was around 5 Ha, but there has been an erosion of the island to be lost by half. Bonetambung island had only one elementary school (SD), one Junior High School (SMP), and one sub-district health center, but environmental sanitation facilities was not yet available in this island. This condition became a double burden for coastal areas and small islands, so it was necessary to do a study on environmental health risk assessment to get a description of environmental health hazards and unhealthy behaviors and to know the risk areas based on the mapping of environmental health risks using the value of Environmental Health Risk Index.

Risk mapping using Geographic Information System (GIS) was a geographically-based computer system that can be used to analyze data. Now in line with the development of technology, GIS can be utilized in the health sector to map environmental health risks and to see which areas were at high risk to facilitate decision makers in deciding priority areas in management of small island islands.

### Purpose

This study aimed to map environmental health risks to identify the areas of environmental health hazard in Bonetambung Island, Makassar city.

## METHODS

This study was observational descriptive with cross sectional design. This study was conducted in Bonetambung island, Makassar city, on March until April 2014. Unit of analysis of the this study were all households in Bonetambung Island. The sample were all households in Bonetambung island which amounts to 130 households and respondents of this study were residents of the houses, both housewives and householder were at least aged 18 years. Sampling was done by exhaustive sampling. Instruments used in this study were questionnaires, observation sheets, and Global Positioning System (GPS) for taking coordinate point of boundary study area. The data has been collected and then inputted using Epi Data 3.1 and analyzed descriptively using SPSS 20.0. Then presented in the form of tables and maps using Geographic Information System (GIS).

## RESULTS

### Distribution of household samples per RT

Bonetambung island was part of Barrangcaddi sub-district which was included in ORW 03 consisting of three RT (01, 02, and 03). Each RT had a different number of households with number of households per each RT were about 46 houses in RT 01, 37 houses in RT 03, and at least in RT 02 around 19 houses. The details were as follows:

Table 1. Distribution of Household Sample per RT in Bonetambung Island of Makassar City

No.	RT	n	%
1	01	46	45.1
2	02	19	18.6
3	03	37	36.3
Total		102	100.0

Source: Marwah et al., 2014

### Environmental health risk index

Environmental health risk index was the first step in determining environmental health risks. For each source of hazard and opportunity of hazard exposure and also the components were converted to percent based on RT. So that each source of hazard and opportunity of exposure per RT were divided by population per RT and multiplied by 100. This was done to obtain the risk index value per RT as in the table below.

Table 2. Environmental Health Risk Index in Bonetambung Island of Makassar City

Variable	Answer	RT						% Total
		01		02		03		
		n	%	n	%	n	%	
<b>Water Resources</b>								71.1%
1. Use of unprotected water resources	Yes	46	45.1	19	18.6	33	32.4	96.1%
2. Scarcity of clean water	Yes	35	34.3	17	16.7	31	30.4	83.3%
3. Access of clean water	Difficult	41	40.2	11	10.8	25	24.5	75.5%
4. Distance of water resources with pollutant sources	Yes	18	17.6	8	7.8	4	3.9	29.9%
<b>Domestic Wastewater</b>								71.2%
1. No toilet	Yes	35	34.3	15	14.7	26	25.5	74.5%
2. No sewerage	Yes	46	45.1	19	18.6	37	36.3	100%
3. Household waste was flowed into the yard	Yes	43	42.2	18	17.6	37	36.3	96.1%
<b>Household Garbages</b>								72.5%
1. No trash can	Yes	27	26.5	10	9.8	37	36.3	72.5%
<b>Unhealthy Behaviors</b>								66.9%
1. Not washing hand with soap at five important times	Yes	30	29.4	15	14.7	11	10.8	54.2%
2. Open defecation behavior	Yes	35	34.3	11	10.8	18	17.6	62.7%
3. Waste processing	No	45	44.1	16	15.7	34	33.3	93.1%
4. Waste management	No	46	45.1	18	17.6	37	36.3	99.0%
5. Not treat drinking water	Yes	19	18.6	6	5.9	1	1.0	25.5%

Source: Marwah et al., 2014

The sources of environmental health hazards found in Bonetambung Island including the hazard associated with clean water sources (71.1%) consisting of the use of unprotected water resources (96.1%), water scarcity experienced by households (83.3%), and the difficulty of access to clean water (75.5%) and the distance of source of clean water with pollutant source (29.9%). Furthermore, domestic wastewater disposal sources (71.2%), consisted of the use of unsafe latrine facilities (74.5%), ownership of sewerage (100%), and household waste was flowed into the yard (96.1%). The last source of dangers came from the ownership of garbages and from 102 households around 72.5% did not have trash bins. There were some unhealthy behaviors that provided an opportunity of exposure to hazards, namely not-hand-washing-with-soap behavior (54.2%), open defecation (62.7%), not processing and managing household waste (96.1%), and not treating drinking water behavior (25.5%).

Based on table above, so that obtained value based on the sum of each component of the variable that became the source of hazards or the possibility of hazards occurrence. The sum result was called the value of Environmental Health Risk Index which would be used to categorize environmental health risks. The complete information was presented in the table below.

Table 3. Cumulative Environmental Health Risk Index in Bonetambung Island of Makassar City

Variable	RT		
	01	02	03
Source of Water	75	77	67
Domestic Wastewater	89	90	89
Household Garbages	59	53	100
Unhealthy Behaviors	69	62	42
<b>Total</b>	<b>292</b>	<b>282</b>	<b>298</b>

Source: Marwah et al., 2014

Based on table above, the categories of environmental health risk in Bonetambung island was described in the table below.

Table 4. Environmental Health Risk Categories in Bonetambung Island, Makassar City

	Limit of Risk Scores	Description
Total of Max Risk Index	298	
Total of Min Risk Index	282	
Interval	4	
Risk Areas Categories	Lower Limit	Upper Limit
<b>Less Risk (1)</b>	282	285
<b>Medium Risk (2)</b>	286	289
<b>High Risk (3)</b>	290	293
<b>Very High Risk (4)</b>	294	298

Source: Marwah et al., 2014

Table 5. Environmental Health Risk Scoring in Bonetambung Island of Makassar City

RT	Scores of EHRI	Score
01	292	<b>3</b>
02	282	<b>1</b>
03	298	<b>4</b>

Source: Marwah et al., 2014

### Mapping of Environmental Health Risks

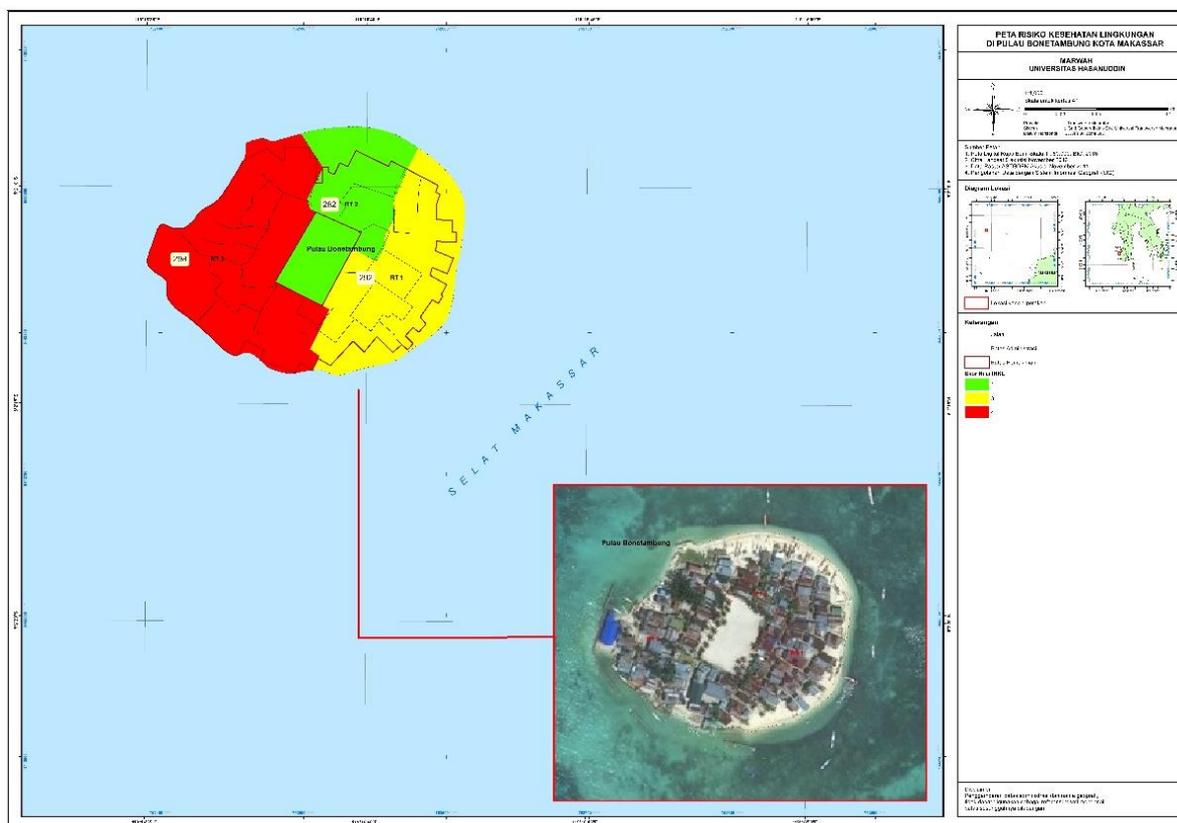


Figure 1. Mapping of Environmental Health Risks in Bonetambung Island, Makassar City

## DISCUSSION

Bonetambung island was an atoll island, most of households used draw well and septic tank for store human feces, yet still many also used the sea as an alternative for open defecation. It became crucial to observe the condition of water sources of residents who using shallow wells or dug wells. The existence of septic tanks that were unsafe and in close distance had risked contaminating residents' dug well. Environmental Health Risk Assessment (EHRA) implemented a number of indicators such as the distance between dug wells and septic tanks, whether owned by respondents or neighbors, draw wells conditions and water conditions when observed. The distance between draw well and the septic tank was measured proximity based on the respondents' explanation. Figures that were obtained do not have high precision as measurements used a special meter tool, but this figure can be at least as a rough benchmark to see health risks associated with sanitation facilities.

The data obtained showed that most of households in Bonetambung island using draw well as the main source of clean water for washing and other purposes, while for drinking water only a few used dug wells. Comparing to the use of draw wells, the use of other water sources was relatively much smaller. The source of tap water was used only around 14.7% of households only for cooking and drinking purposes, while for washing and others draw wells still dominated and the rest used rain water. The proportion of tap water usage above only applied in rainy season. Meanwhile, in dry season the proportion would be greater. Because the main sources of clean water for drinking and cooking purposes were scarcity. Such as rain water as the main water source has been exhausted in dry season. Although the community already had other alternative source of water, except rain water, such as tap water, yet the condition was still difficult. Because to get tap water must be paid around Rp4,000.00/jerry can (20 liters). Tap water was derived from the Makassar city that were brought by using fishing boats to Bonetambung island. Other sources were even much smaller that was mineral bottled water which covering only 1% of the population.

Another problem was garbage problem as the most dominant problems in small islands. Some of literated did mention that the way garbage disposal in special garbage pits, either in the yard or outside the home was a safe way too. However, in the context of the archipelago area notably including in small island category where there was no means or infrastructure for waste transportation services, the above alternative does not apply (Massie, 2013). Almost all residents say threw garbage into the sea every day because the sea as a dominating area, so it had limitations in terms of land, and this way can pose a health risk. So to reduce the burden of waste, it was very important to do waste processing at the household level. The reduction of waste volume can be achieved by separating the waste into wet/kitchen/organic waste and dry/inorganic waste and then doing something to the result of the pill. Applicable treatments may include the reuse of usable goods, reuse by forming them into other goods, or selling goods of economic value (Lahiri & Chanthaphone, 2003). This does not apply in Bonetambung Island, where more households do not perform waste processing. Meanwhile, the sorting of plastic waste also makes the sea as a final disposal. So, the waste processing they do just sorting plastic waste with kitchen waste without doing the treatment on the garbage that has been sorted. Rubbish that is thrown away will easily pollute the environment and endanger the community. Thus, the risk of pollution and the spread of disease vectors due to garbage will be higher whether it is sea water pollution or specific to water bodies used by households (Semba, 2011).

The existing latrine facility in Bonetambung Island is also a problem that needs to be identified. A survey of household respondents found that only a quarter of the total surveyed households had latrines. The rest, using neighboring latrines and public toilets. The use of a septic tank as a final disposal of feces is also relatively small and entirely never drained. The never-drained septic tank is an indication that the toilet construction used by the household is not safe for the environment. This is because the septic tank is not water-resistant as well as feces sludge can seep out and contaminate the land or water sources that exist. However, contamination of septic tanks in the environment does not only occur when a septic tank building is not impermeable seeping out, but it could also be because the stool from the septic tank is thrown haphazardly (Rahma, 2003). It increases the risk of disease occurrence due to contamination of pathogenic bacteria or other infectious diseases.

Transmission of infectious diseases associated with oral-faecal can be controlled and prevented through good sanitation, but for small islands there is no adequate fulfillment of human disposal (sanitary) disposal systems. The procurement of public toilets on the island Bonetambung only used by a small portion of the existing ladder. The existing latrine facility has been damaged by coastal abrasion. Some studies also explain that good sanitation can reduce the transmission of microbes that cause diarrhea by preventing contamination of human feces with the environment. Increased sanitation facilities can reduce the incidence of diarrhea by 36%. Other studies suggest that the use of latrines can effectively reduce the incidence of diarrheal diseases by 30% (Rahma, 2003).

A similar study was also conducted by Sembah, et al. Who mentioned that families who were open defecation and did not have latrines at risk 1.32 times their children were exposed to acute diarrhea and 1.43 times deaths in children under five years and reduce the spread of flies *Musca sorbens* as the source of trachoma disease transmission (Semba, 2011). Adisasmito (2007), said that people who do not have toilet facilities give

17.25 times the risk of diarrhea in infants and toddlers. However, basically the behavior of open defecation is influenced by various factors. A study related to the use of latrine and open defecation behaviors conducted by Sangchantr, mentions that there is a relationship between knowledge and attitudes of mothers to behavior (healthy Chapter is reaching 90% and 93.7% of toilets are ensured to function properly (Sangchantr et al, 2009).

The waste channel is also an object that needs to be included in a health risk assessment in a region or region. This is because the inadequate sewerage channels allow the development of disease-carrying animal animals. Based on the survey results, of 102 households in the data, all households do not have sewerage and most households dispose waste or water in the yard around the house. This will cause a pool of water around the house so that it can cause the risk that allows the spread of the disease. The EHRA study considers that health risks from waterlogging are closely related to the duration of the drying water. The longer, the higher the risks and most the risk is that the water is inundated within a day.

The problem of hygiene due to contamination of faeces/feces of water and other sources is the main source of viruses, bacteria, and other pathogens that cause diarrhea. Pollution paths are known so that contamination can reach the human mouth including toddlers is through 4F, i.e. fluids (water), fields (soils), flies (flies), and fingers (fingers / hands) (Curtis, 2001). This pathway demonstrates that one of the most effective and efficient means of prevention contamination is human behavior that blocks the fingers path. This can be done by practicing handwashing with soap at the right times. Meta-studies, conducted by Curtis, found that handwashing with soap can reduce the risk of diarrheal incidence by 42—47%. This simple step can save about one million children in the world. While the data obtained in this study, washing hands with soap is the most widely practiced by respondents in Bonetambung Island is in time after defecation or bowel movements, before eating food, and before preparing food and after menceboki child. So, among the five wash-time hands with essential soap, the time before feeding the child or preparing the food is the least practiced behavior. Looking at the times covered by the respondents, most do not do it at all. Only a small number apply the WHS (washing hand with soap).

The overall problem is found, then the risk assessment related to environmental health issues. Environmental health risk assessment is one way to provide hazard assessment and environmental health hazard exposure opportunity especially in Bonetambung Island of Makassar City. Assessment of environmental health risks commonly known as Environmental Health Risk Assessment (EHRA). Determination of the magnitude of the risk, carried out by means of weighting on hazard elements and opportunities of hazard exposure. The weights assigned to each component of the hazard variable and the opportunity of hazard exposure are then cumulative to obtain the value of the Environmental Health Risk Index (EHRI). Based on the calculation results, it can be mapped that RT 01 is in high risk category, RT 02 low risk / less risk category and RT 03 is in very high risk category. The unique thing in this study is that after risk categorization, RT 03 is more risky than other RTs. If it is related to the population, RT 01 should be more risky than RT 03. This is because 100% weighting on the issue of garbage ownership gives high index value on RT 03 compared to other RT, where in RT 03 there is no household has a trash can. In addition, RT 03 is a RT with geographically threatened conditions compared to RT 01 and 02.

Survey results also found that Bonetambung Island often experienced coastal abrasion and RT 03 was the target of this coastal abrasion. People say that abrasion still happens every year, some more than a year or a five year range but still in the category often happens. When the abrasion occurs the shape of the island will change, where the sand that becomes the mainland in RT 03 will move to RT 01, and vice versa when the abrasion occurs from the direction of RT 01 then the sand will return to RT 03. This incident, incidence of environment-based disease, although in this study was not discussed the effect of abrasion that often occurs. Because of the problems that exist in the small island is dominated on environmental problems.

## CONCLUSION

This study concluded that environmental health hazards existed in Bonetambung island including hazards related to clean water sources, domestic wastewater, and ownership of garbage bins. The opportunities for exposure to environmental health hazards including the behavior of not washing hands with soap, open defecation behavior, not processing and managing waste, and behavior of not treat the drinking water. So that, environmental health risks based on RT in Bonetambung island were very high risk level in RT 03, high risk level in RT 01, and low risk level in RT 03.

Suggested to the government particularly Health Office of Makassar city was necessary to strengthen the health system, especially in remote areas, such as small islands, including the fulfillment of the need for clean water either through supplying clean water from Makassar or through brackish water treatment program. In addition, the latrine facilities, especially for public that have been available should be improved so that could support the improvement of hygiene practices. Futhermore, the assessment of environmental health risks in Bonetambung island could be as basic consideration for decisions making in policy-making, service planning,

and budget allocation particularly for Bonetambung island. For students, the results of this study could be as supporting for further relevant studies.

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