

# Waste Management Strategy in Lewotobi Volcanic Eruption Refugee Camp, East Flores, Indonesia

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**Abstract**—The eruption of the Lewotobi Laki-laki volcano not only had an impact on infrastructure damage so that a large number of residents were forced to evacuate. This study aims to identify the condition and quality of sanitation system services in refugee camps. Data inventory of the availability and condition of technical sanitation infrastructure at the refugee base camp was collected during the implementation of thematic real work lecture activities. In addition, interviews were also conducted with refugees and public service officers at the refugee location regarding aspects of behavior, funding support and sanitation system management. The results of this study indicate that in general the availability of technical infrastructure for waste, domestic wastewater, and clean water is quite adequate, but in the long term the existing sanitation management system has the potential to cause environmental health problems, both due to the pattern of handling solid waste and domestic waste and especially due to the pattern of disposing of feces into holes in the ground.

**Keywords**—clean water, domestic waste water, household waste, technical infrastructure.

## I. INTRODUCTION

There have been 23 recorded eruptions of Mount Lewotobi throughout history. The first event occurred around 1675. While the first eruption that was clearly recorded occurred on May 4-18, 1861. Mount Lewotobi experienced around 20 eruptions in the 19<sup>th</sup> and 20<sup>th</sup> centuries.

The Lewotobi Laki-laki eruption occurred on November 3, 2024 in East Flores Regency, East Nusa Tenggara, Indonesia. At least 10 people living near the mountain were found dead, 63 injured, and dozens of houses burned down.[1] According to the National Disaster Management Agency, more than 2,700 families or 12,200 people were displaced and affected.[2] This eruption was the most powerful volcanic event to occur in Indonesia since the 2021 Mount Semeru eruption [3].

The East Flores Regency Government, East Nusa Tenggara, has set a 58-day emergency response period for the eruption of Mount Lewotobi Laki-laki which killed 10 people. The danger radius which was originally 5 kilometers was extended to 7 kilometers. The emergency response decree was issued by the Acting Regent of East Flores Sulastri H Rasyid

on Monday (4/11/2024). The emergency response period which lasts for 58 days will end on December 31, 2024

The objectives of this study are 1) to identify existing waste management patterns in terms of technical infrastructure, institutions, community behavior, funding and regulations, in accord with [4] 2) to determine important and strategic issues in waste management aspects at evacuation sites 3) to provide recommendations for managing similar incidents in the future.

The importance of controlling public health risk aspects, including in refugee camps, is a global concern as reflected in the Water-Sanitation Healthy WaSH system model (designed for general contexts where national/international WaSH service standards are available) and in the SPHERE Standards or WaSH manual model developed by UNICEF/UNHCR (for emergency situations) [5].

## II. METHOD

Data collection on the availability and functional conditions of sanitation infrastructure in refugee camps was carried out by means of visual observation. The results of visual observation were recorded in geotagging image format. Information stored in the geotagging image includes: GIS-based location coordinates, location name, image name.

Data on the availability of technical infrastructure, funding aspects and management of activities at refugee locations were obtained through intensive interviews with task forces at each refugee location. In addition, because there are also a large number of independent refugees, namely elderly refugees and pregnant women and babies, who are accommodated in residents' houses scattered around the refugee camp location, the condition of technical infrastructure such as the type and number and functional condition of toilets and aspects of the availability of clean water containers for sanitation services and daily activities of refugees were also recorded.

### A. Field Observation

Field observations were conducted to record aspects of the availability and functional conditions of various basic sanitation infrastructure such as the type and number of toilets, the type and number of clean water storage containers, the

type of waste storage facilities, the type and number of waste transport fleets, the type and number of clean water transport fleets, the frequency of waste and domestic wastewater transport.

### B. In-Depth Interview

Regarding the waste management aspect, in-depth interview materials include: who is responsible for the logistics aspect of waste and clean water services, the location for collecting plastic bags for waste storage, the reasons for determining the location for accumulating waste bags, the schedule for transporting/disposing of waste.

The interview materials on domestic wastewater management patterns include: strategies for managing fecal sludge due to the use of emergency toilets, strategies for distributing clean water for bathing-washing-defecation services, strategies for controlling the potential for defecation in any place.

Furthermore, interviews were also conducted on the challenges and/or difficulties of sanitation management from the behavioral aspects of local communities and refugees, from the aspects of the ability to provide technical infrastructure and funding, as well as from the aspects of intra- and inter-agency coordination and parties involved in emergency response activities at evacuation sites.

## III. RESULT AND DISCUSSION

### A. The refugee locations

There are six refugee posts, including the Konga Post, Kobasoma Post (Kanada), Bokang Post, Ile Gerong Post, Lewolaga Post and Eputobi Post as can be seen in Figure 1 below.

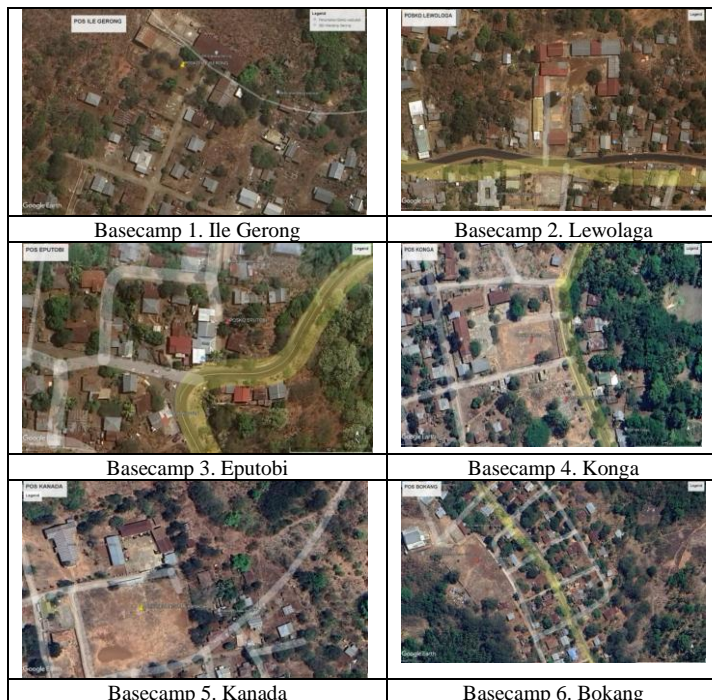


Fig. 1. Refugee Shelter Basecamp Locations

In addition, elderly refugees, children and pregnant women are willingly accommodated in a large number of local residents' homes. This has an impact on the increasingly difficult process of coordination and communication as well as the distribution of food and drink aid, blankets and pillows and various other types of logistical aid.

### B. Existing Waste Management System

1. Technical Infrastructure condition
  - a. Solid waste

Most of the waste processing that has been collected is burned, there is also assistance from the Environmental Service in the form of a garbage truck. With the assistance of a garbage truck, it can reduce the accumulation of garbage at each command post.



Fig. 2. Temporary solid waste landfill at refugee basecamp

It can be seen that solid waste is put into plastic bags to be transported and disposed of regularly. The results of observations show that daily waste production is fluctuating. The schedule for transporting and disposing of waste is set 3 times a week. Consequently, sometimes there is an unpleasant odor due to organic waste or food scraps and/or general kitchen waste.

In addition, the following image clearly shows that the solid waste is not disposed of at the final landfill but is disposed of in the nearest empty land because East Flores Regency does not have a Final Disposal Site. Furthermore, the waste is burned so that it does not cause a bad smell and/or does not become a breeding ground for disease.



Fig. 3. Illegal solid waste landfill

- b. Domestic waste water



The available domestic waste water facilities are as follow:

#### 1) Permanent toilets

There are several educations (school) as well as religious facilities (church or chapel) surrounding the basecamp so that refugee as well as volunteer may use the available toilets. The toilets were in good condition and using septic tank model.



Fig. 4. School-owned bathing-washing-toilet (BWT) facilities

#### 2) Portable toilets

There are two types of portable toilets as can be seen in Fig. 5a and 5b, respectively. Portable toilets as seen in Figure 5a can be moved from one location to another, but the opposite is true for emergency toilets as seen in Figure 5b. However, both of them do not use septic tanks but instead collect and dispose of feces into holes in the ground. In the short term, the impact of the pattern of disposing of feces into holes in the ground, instead of septic tanks, on environmental health and groundwater quality may not be too big, but in the long term this must be avoided. This is due to the potential for groundwater pollution in the surrounding shallow wells. The potential for pollution is quite large considering the geological conditions of the land which visually look quite porous (karst geology).



Fig. 5a. Portable Toilet



Fig. 5b. Emergency Toilet condition

#### 3) Other type of toilet

As previously mentioned, there are a large number of elderly refugees, pregnant women and babies who are accommodated in local housing. The condition of the technical sanitation infrastructure (bathing-washing-toilet facilities and clean water storage) is generally inadequate, both in terms of quantity (capacity) and quality.

As a result of these limitations, visual observation results show that there is a number of human feces scattered in empty areas. This strongly indicates the behavior of defecating in random places.

It is thought that the trigger is not only due to the limited number of BWT but also due to the limited capacity of clean water storage. In response to this situation, the local government helped procure water storage tanks in a large number of residents' houses that were used as shelters for the refugees, as can be seen in the following picture.



Fig. 6. Type of Local Residence's Toilets

#### 4) Laundry services

Alongside the BWT facilities, the government also provides laundry facilities as can be seen in Figure 7 to speed up the process of washing and drying clothes. This was triggered by the minimal ownership of clothes by refugees who left their homes during the eruption in a hurry. Furthermore, from the results of observations and interviews it was found that the supply of clean water by water tanker trucks to support the function of the laundry facilities was quite adequate.



Fig.7 Laundry facility

TABLE 1. Recapitulation of the characteristics of technical sanitation infrastructure in each refugee location.

Basecamp	Technical infrastructure
Ile Gerong	3 School-owned bathing-washing-toilet facilities, 2 emergency toilets
Lewolaga	4 School-owned bathing-washing-toilet facilities, laundry
Eputobi	3 School-owned bathing-washing-toilet facilities, 4 portable toilet dan 1 emergency toilet
Konga	3 School-owned bathing-washing-toilet facilities, peoples houses' toilets, 2 Portable toilet, and laundry
Kanada	2 Portable toilets dan 3 School-owned bathing-washing-toilet facilities
Bokang	3 School-owned bathing-washing-toilet facilities, 3 Church-owned bathing-washing-toilet facilities, 1 portable toilet

### c. Clean water

Clean water supply for refugees is done through aid that has been distributed using water tankers. This water tanker aid comes from various parties including the National Disaster Management Agency, the Indonesian Red Cross, the Army, the Police and other organizations such as local church youth organizations, non-governmental organizations (UNICEF, Plan International and others).



Fig.8 Temporary clean water tank

The interview results show that the role of NGOs in coordinating and providing information on aspects of water availability and supply is very helpful in meeting the need for clean water in evacuation locations (both for bathing-washing-toileting needs and for cooking needs).

### 2. Institutional Arrangement

For ease of service, 6 command posts were formed, each with 1 unit in each refugee camp. Each command post is coordinated by officers from the Indonesian national army. In addition to being volunteers, they are also tasked with securing the situation around each command post.

The results of the observation show that in addition to the Indonesian national army, there are a number of parties directly involved in the management / control of the impact of socio-economic activities in refugee locations, namely volunteers from NGOs, senior high schools, universities and individual volunteers.

Even though they come from various elements, it is apparent that daily refugee service activities, as well as trauma support activities and other basic needs services can run well due to open coordination and communication among them.

### 3. Community Behavior

#### a. Reduce-Reuse-Recycle household waste activity

One of the weaknesses of sanitation system management in refugee camps is that the pattern of waste collection and disposal is not differentiated based on the type of waste. It can be seen that both organic and inorganic waste are all put into plastic bags without being sorted first, whereas organic waste can be made into compost and inorganic waste such as plastic and the like can be recycled and/or reused. In addition, there is no apparent effort to reduce the amount of waste.

#### b. Participation in the use and maintenance of sanitation facilities

In general, the disaster-affected community was relatively active in solid waste collection activities, especially by helping to put the waste into the plastic bags given to them. In addition, they also actively and consistently provided information on the availability of clean water to officers at the command post.

### 4. Funding

Emergency response funds come from both the central and local governments. The emergency response funds are mostly used for the operational costs of garbage and domestic waste transport vehicles and clean water supply vehicles for each evacuation site.



In addition, there are also a large number of humanitarian aid funds and logistical assistance (food, blankets, mattresses, pillows, used clothing, women's and children's equipment, and other similar assistance) from donors.

#### C. Important and Strategic Issue

1. Although all the waste is put into plastic bags and thrown into the final disposal site, there is no effort to reduce or sort organic and inorganic waste.
2. A commitment to regular waste disposal is needed so that the stench from the piles of waste that have not been collected does not have a negative impact on the health of the refugees.
3. In the short term, the use of holes in the ground as a final disposal site for feces is relatively harmless to environmental health, but in the long term it can pollute shallow groundwater (dug wells) located downstream of the BWT area.

Accordingly, it is strongly recommended to: 1) prepare an education team on waste reduction and/or waste sorting patterns for refugees 2) increase the number of waste collection fleets and/or increase the number of trips by waste collection vehicles 3) The East Flores government already has a Fecal Sludge Processing Installation [6] so that if the eruption disaster is prolonged, the construction of septic tank-based toilets needs to be implemented.

#### IV. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might

elaborate on the importance of the work or suggest applications and extensions.

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