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Analysis of External Environmental Design Factors on Mosquito Breeding in Sikka Regency, East Nusa Tenggara

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ABSTRACT: Factors such as environmental temperature, rainfall, location of waste disposal sites, sunlight exposure, water flow, as well as chemical, biological, and socio-cultural conditions play a crucial role in the development of malaria cases. This study specifically aims to analyze the influence of environmental elements on the number of malaria and dengue fever (DF) cases in Sikka Regency, as well as to evaluate the physical design elements of the area that can reduce DF cases in the region. The research was conducted in several locations within Sikka Regency, taking into account the differences in location and the distance between buildings in relation to thermal characteristics. The results indicate that areas located more than 500 meters above sea level did not experience malaria or DF cases, which is also influenced by the outdoor environmental design, such as building density and vegetation size, affecting light intensity. Lower light intensity increases humidity, which accelerates mosquito breeding.

KEYWORDS: Environmental Design, Mosquitoes, Sikka Regency

I. INTRODUCTION

The environment is considered a more dominant factor in influencing the development of malaria and Dengue Hemorrhagic Fever (DHF) cases compared to behavioral factors, health services, and genetics. The environmental factors in question include air temperature, rainfall, location of waste disposal sites, sufficient sunlight, water flow, and chemical, biological, and socio-cultural conditions (Yunita et al., 2012). Dinata et al. (2012) also highlighted that house density, air temperature, room humidity, the presence of mosquito nets, and the yard are variables that influence the spread of mosquitoes that cause DHF and malaria.

The environment has long been considered as one of the key elements in reducing the spread of malaria and dengue fever cases, as discussed in various previous studies (Rianasari et al., 2016; Handoyo et al., 2017; Sari et al., 2017; Ayun & Pawenang, 2017; Murwanto et al., 2019). Based on this trend, an effective environmental design approach in minimizing the spread of malaria and dengue fever can be a practical solution that needs further research. By referring to the literature review and analysis of the distribution locations of malaria and dengue fever cases, a physical environmental design standard free of malaria and dengue fever in Sikka Regency can be prepared. This standard can be an important guideline in efforts to create a healthy environment that can reduce the number of malaria and dengue fever cases, both locally and nationally.

Dengue Hemorrhagic Fever (DHF) and malaria are diseases that threaten areas in Sikka Regency every year, causing anxiety due to the high number of cases. In early 2022, the Sikka Regency Health Office reported that 40 residents were infected with DHF, one of whom died. The high number of cases, according to the explanation of the Secretary of the Sikka Health Office, Clara Francis, was caused by irregular and poorly maintained environmental conditions, which created unhealthy places and supported the development of mosquito larvae *Aedes aegypti* (Gabriel, 2022). Meanwhile, based on data from 2023, the incidence of malaria has also increased in Sikka Regency.

Data from various other sources also show that there is awareness of dengue fever. From January 1 to March 9, 2020, 1,195 dengue fever sufferers were recorded spread across several districts and cities in NTT Province. The Directorate General of Disease Prevention and Control reported a total of 31 deaths due to dengue fever from the number of sufferers (Bureau of Communication and Public Services, 2020). In 2020, the Ministry of Health of the Republic of Indonesia announced that there were 25,693 cases of dengue fever in 30 provinces. In the data, Sikka Regency recorded the most cases with a total of 1,292 cases (Figure 1). Antara

reported that dirty and untidy environmental conditions were the main causes of the high spike in cases in Sikka. Poor drainage problems and ineffective waste management also contributed to unhealthy environmental conditions (Yosepha, 2020).

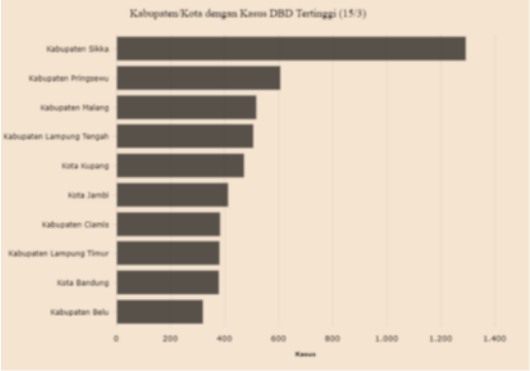

Figure 1. Districts/Cities with the Highest Dengue Fever Cases
Source: Ministry of Health, 2020

A well-maintained, healthy, and orderly environment is a key factor in reducing, or even eliminating, the possibility of dengue fever cases. Didik Budijanto, Director of Prevention and Control of Vector-Borne and Zoonotic Diseases at the Directorate General of Disease Prevention and Control, Ministry of Health, revealed that there are various causes of the spike in dengue fever cases in the last five years, and the community and environmental conditions are the main factors in efforts to suppress the spread of this disease. He explained that an unhealthy environment supports the development of the mosquito vector *Aedes aegypti* (Ananda, 2021).

The high number of spikes in dengue fever cases and various references showing the importance of the role of the environment indicate the need for research into the form of a physical environment that is free from dengue fever.

According to Sains et al. (2005) and Suyasa et al. (2008), housing quality, including the distance between houses, lighting, building shape, and materials used, can affect the rate of dengue fever transmission. Zulfikar (2019) also explained that the condition of water reservoirs, as well as humidity and rainfall, can affect the growth and lifespan of *Aedes aegypti* mosquitoes. This is in line with research by Ayumi et al. (2016) which shows that rainfall, temperature, and humidity are related to the incidence of dengue fever in various seasonal zones. In addition, Sari et al. (2017) added that there is a significant relationship between the intensity of light entering an area and the incidence of dengue fever.

II. METHOLODOGY

This study was conducted in several villages located in Sikka Regency, based on data on DHF and malaria cases sorted from the highest to the lowest or without cases. Observations were differentiated based on the height of the area and the distance between buildings in the area. Several specific characteristics of the area were also recorded as additional findings in the study, related to the external environment, such as the position of the bathroom, the location and condition of the animal pen, and the condition of the drainage.

The steps taken in this research include:

1. Literature Review: Previous studies focusing on the environment related to dengue cases were analyzed to formulate appropriate design standards. The field of public health plays a major role in research examining the relationship between the environment and dengue cases, and has produced several conclusions regarding environmental settings that influence dengue cases.
2. Field Observation: Based on available data, the focus of field observation is to compare the physical environment between areas with the lowest and highest distribution of DHF cases in Sikka Regency. Measurements taken include air temperature and humidity (using a thermo hygrometer), wind speed (using an anemometer), and light intensity (using a lux meter) installed at several points outside the building.
3. Analysis of Research Results: The results obtained are analyzed based on the similarities and differences in environmental conditions in each region. These findings are then compared with theories that have been proposed by previous experts.

III. RESULTS AND DISCUSSION

The study was conducted in three sub-districts located in Sikka Regency. This study is based on data obtained from the Sikka Regency Health Office, where the three sub-districts recorded the highest incidence of DHF in the Sikka Regency area.

Waigete District

Waigete District is one of the districts in Sikka Regency, East Nusa Tenggara, located about 27 kilometers east of the capital of Sikka Regency. To the north, this district borders directly on Maumere Bay. The topography of the villages in this area consists of mountains, plains, and beaches, with an altitude of about 750 meters above sea level (Wikipedia, 2022). Based on data from the Sikka Regency Health Office in 2022, there were 58 cases of dengue fever distributed across eight villages in this district, with Hoder Village recording the highest number of cases and having an altitude of 22 meters above sea level.

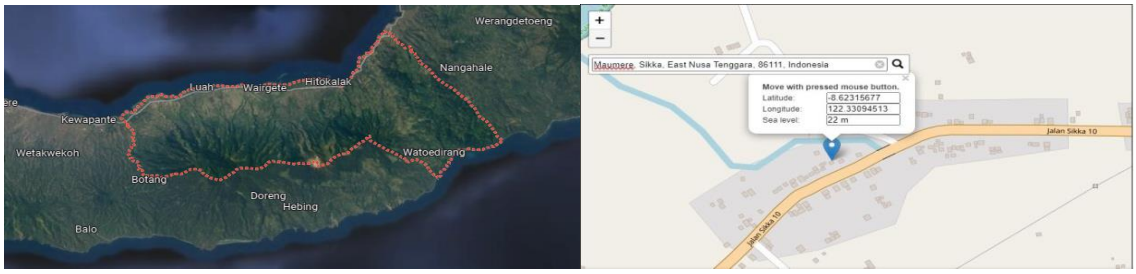

Figure 2. Administrative map of Waigete District (top) and the height of the research location (bottom)

Source: googlemap, 2022

Based on the research that has been conducted, it was found that there are external environmental design conditions that encourage an increase in DHF cases. The research conducted in Hoder Village focused on areas experiencing DHF cases, which are located close to the coastal area. These conditions can be seen in Table 1.

Table 1. External Environmental Conditions in Hoder Village

External environmental conditions	Information
Thermal characteristics (average)	Temperature 31.05oC, humidity 67.1%, wind speed 1.24 m/s, light intensity 200-250 lux
Distance between houses	The distance between houses is 72.8% more than 4 meters
Types of vegetation	Mango and coconut
Vegetation Location	Located in front of the residence and used as shade
Vegetation distance	1-2 meters
Bathroom location	56.4% are outside the building at a distance of 1-2 meters
Location of the well	75% are at the front of the building in open conditions
Location of animal cages	Located at the back of the house. Distance 1-3 meters
Garbage dump	It is not a permanent place but a collection of rubbish that can be burned.
Drainage conditions	Generally there is no drainage from the waste. In the bathroom or from the well (left dry in the yard).

Source: personal research, 2023

Waiblama District

Waiblama District is a district in Sikka Regency, which is approximately 57 kilometers from the capital of Sikka Regency, namely Maumere City. This district directly borders Talibura District. This area is recorded as an area with no cases of DHF.

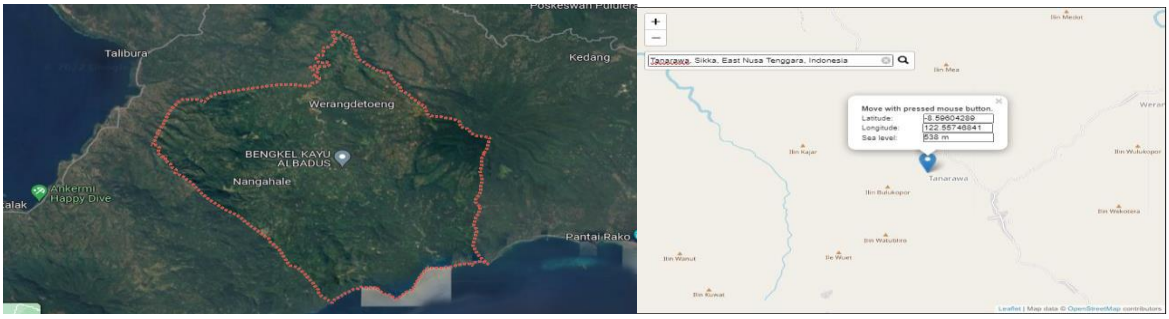

Figure 3. Administrative map of Waiblama District (top) and the height of the studied location (bottom)

Source: Googlemap, 2023

The research conducted in Tuabao Village, is a representative of Waiblama District, considering that in this area there are no DHF incidents and it is far from the coastal area so that it can be used as a comparison with other areas. Environmental conditions in the area can be described in table 2.

Table 2. External Environmental Conditions in Tuabao Village

External environmental conditions	Information
Thermal characteristics (average)	Temperature 29.4oC, humidity 67.05%, wind speed 1.36 m/s, light intensity 260 lux
Distance between houses	The distance between houses is 72.8% more than 4 meters
Types of vegetation	Sour, and mango
Vegetation Location	1-2 meters from the house
Bathroom location	Located behind the house 2-3 meters away
Location of the well	-
Location of animal cages	2-3 meters from the residence, dry conditions at the disposal
Drainage conditions	There are no drainage channels for rain or dirty water disposal

Source: personal research, 2023

East Alok District

East Alok is a sub-district in Sikka Regency, East Nusa Tenggara, Indonesia. This sub-district is about 5 kilometers from the capital of Sikka Regency to the east. The center of government is in Waioti Village. East Alok District is part of Maumere City. In this sub-district, the Sikka Police dormitory is the location with the highest number of dengue fever cases in 2022.

Figure 4. Map of the police dormitory (top) and the height of the location studied (bottom)

Source: Googlemap, 2023

The research conducted at the Sikka Police Dormitory is not much different from the research conducted in the two previous areas, where this area is the area with the highest number of cases. The following are the environmental conditions in the area which can be described in table 3.

Table 3. External environmental conditions at the Sikka Police dormitory

External environmental conditions	Information
Thermal characteristics (average)	Temperature 28.4oC, humidity 73.55%, wind speed 0.1 m/s, light intensity 120-200 lux
Distance between houses	1-1.5 meters
Types of vegetation	Mango functions as a protector
Vegetation Location	1-2 meters from the house
Bathroom location	Being in a residence
Location of the well	-
Location of animal cages	-
Drainage conditions	Damp, there are 40% drainage conditions that are not smooth/clogged for more than 1 day.

Source: personal research, 2023

Measurement of tools and observations in the field are then separated based on areas affected by DHF cases (Hoder and Polres Dormitory) that are not affected by DHF cases (Waiblama/Tuabao). Where the analysis begins by finding differences and similarities from each location. The results of the research from these three areas, namely:

Table 4. Similarities and differences in external environmental conditions in each research area

	Aspol and Hoder	Old man
Location	22-24 m above sea level	538 m above sea level
Thermal characteristics	Humidity ranges from 67-73.55%, light intensity 120-250 lux	humidity 67.05%, wind speed 1.36 m/s, light intensity 260 lux
Distance between houses	1-4 meters	More than 4 meters
Types of vegetation	Functions as a shade	Functions as a shade
Vegetation Location	1-2 meters from the house	1-3 meters from the house
Bathroom location	Mixture (outer and inner)	Mixture (outer and inner)
Location of the well	Generally located in the residential yard (front)	-
Location of animal cages	1-3 of the dwelling (hoder)	
Drainage conditions	Damp, drainage conditions that are not smooth/clogged for more than 1 day and open.	There is no drainage channel

Based onThe findings in table 4, can be explained that the influence of the location's height on sea level, can have an influence on the high incidence of DHF. This is in line with research conductedTamengkel, Sumampouw, and Pinontoan (2019)in Minahasa, which explains that the spread of mosquitoes is influenced by the height of the location, especially those close to coastal areas because vegetation is rarely found and air humidity is high.

While the distance of the dwelling, as well as the location of vegetation is known to have an effect on the thermal characteristics that occur in the environment, where the closer the distance of the dwelling, supported by vegetation that functions as shade is within a distance of less than 2 (two) meters, it can have an impact on humidity and light intensity. Where humidity will increase and light intensity will decrease. This is in line with research conductedHerawati and Utomo (2014), which explains that the higher the humidity in an area, the longer the life of mosquitoes.

The location of the bathroom and the location of the cage towards the occurrence of DHF is more influenced by the condition of the drainage. Where areas that do not have drainage but the absorption of water into the soil is not more than 1 (one day) / not flooded, can minimize mosquito breeding. According toNasution and Naria (2012), there is a significant relationship between the Wastewater Disposal System, lighting in the environment and mosquito breeding.

IV. CONCLUSION AND SUGGESTIONS

A. Conclusion

Based on the discussion that has been carried out, the following results were obtained:

1. Air humidity and light intensity affect mosquito breeding.
2. The height of the location to sea level, the distance between residences, the type and distance of vegetation and drainage conditions are factors in the external environment that influence mosquito breeding. This can be seen from the development of data from the Sikka Regency Health Office which shows that the incidence of malaria and dengue fever in 2024 is more common in coastal areas than in hilly areas.

B. SUGGESTIONS/RECOMMENDATIONS

There needs to be a standard design for healthy, dengue-free homes that is specific to local conditions or areas such as Sikka Regency.

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