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The Larvae Project Application as a Digital Image for monitoring the Larvae Free Index in DHF endemic areas in Tebing Tinggi city

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Abstract— The number of dengue cases in Tebing Tinggi, North Sumatra province has fluctuated. The number of DHF cases in 2021 was 87 cases, then it was increase in 2022 to 175 cases. This number is still relatively high considering that the indicator for DHF morbidity is 20/100,000 population. Efforts to control the DHF vector have been carried out but have not been maximal in reducing cases. One House One The Larvae Observer Movement as the effort to optimizing Mosquito Nest Eradication (MNE) and 3M Plus in the Community has been carried out but determining the larvae free index (LFI) and larval density using a house survey requires time and The Larvae Observer's accuracy in seeing the type and presence of mosquitoes. Utilization of technology with digital images can address this imbalance in The Larvae Observer's tasks. LFI data can be directly reported along with a map of the location of the house with positive larvae so that time is more efficient and the presentation of information is more accurate. This study aims to determine the zoning of potential DHF areas using digital images technology in monitoring the presence of larvae. This type of research was an analytic survey with a cross-sectional design. The population of this study were all houses located in endemic areas, a sample of 500 houses representing 5 districts was taken by purposive sampling. Data collection uses the kobotoolbox which contains questions about the condition of the house, TPA and its type. Larvae application with digital image to identify the presence of larvae and map positive larvae houses. Spatial analysis was used to map the zoning for the presence of Aedes aegypti larvae and larvae free index (LFI), HI, CI and BI. The results showed that the maps of 5 sub-districts representing 5 sub-districts in the city of Tebing Tinggi, all of them have potential risks because LFI <95%, HI 13-35%, Ci 6.5 -13.4%, BI 20-50%, LFI 65-87% .

Keywords: density of larvae, digital image, potential risk

I. INTRODUCTION

Dengue hemorrhagic fever (DHF) is an endemic disease in more than 100 countries around the world, especially tropical and sub-tropical areas. The first DHF cases in Indonesia were reported in Jakarta and Surabaya in 1968, and in 2015 there were 126,675 cases recorded in 34 provinces in Indonesia, and 1,229 of them passed away.[1] Data from the Directorate General of Disease Prevention and Control, Indonesian Ministry of Health, the Incidence Rate of dengue in Indonesia was 51.5 per 100,000 population in 2019 and in 2020 it was 40 per 100,000 population.[2]

Based on health profile data for North Sumatra Province, 7,584 cases of DHF were found with a total of 37 deaths in 2019.[3] The discovery of DHF cases for the city of Tebing Tinggi fluctuated, where in 2019 there were 515 cases reported, in 2020 it decreased by 42 cases and in 2021 it increased a total of 87 cases and in 2022 a total of 175 cases were found.[4,5] This condition illustrates an increase in cases per year, therefore it needs more serious handling.

The number of DHF cases in Tebing Tinggi City is still high considering that the indicator for DHF morbidity is 2/100,000 of the population and it has not been prevented even though all cases found have received serious treatment from the Health Office. Various efforts to control the DHF vector have been carried out, spraying, larvicides, 3 M Plus, the Dengue Hemorrhagic Fever Operational Working Group and the activities of the Larvae Observer have not optimally reduced cases.[6] The Ministry of Health has launched the The Larvae Observer One House One Movement in order to optimize the Eradication of 3M Plus Mosquito Nests in the Community.[3,6]

Determining the density index of larvae using a house survey requires more time and the accuracy of The Larvae Observer in seeing the type and presence of mosquitoes.[7] Utilization of technology is needed so that the larva density index data is updated along with the location, and can predict the potential

for DHF. It is necessary to use sophisticated and efficient technology to present information, especially about DHF and be analyzed spatially.[8] Utilization of artificial intelligence technology can be used to monitor and identify larvae.[9,10] Besides that, it can minimize The Larvae Observer's work time in determining Larva Free Index. This research is a bridge of information and technology transfer from manual larva monitors towards digitalization so that information constraints in implementing DHF control programs can be overcome. This study aims to determine the zoning of potential DHF areas using digital images technology in monitoring the presence of larvae and mapping the Larva free index, House index (HI), Container Index (CI), house index (HI), Container Index (CI), and Breteau Index (BI).

II. METHOD

This type of research was an analytic survey with a cross-sectional research design,[11] carried out in Tebing Tinggi. The research ethics were obtained from the Health Research Ethics Commission, Ministry of Education and Culture Research and Technology, University of North Sumatra, Faculty of Nursing Health Research Ethics Commission (Number 2767/SP/2022). The criteria for research locations were based on the highest DHF case finding for three consecutive years from each sub-district stated by one kelurahan. The population was all houses in Tebing Tinggi with a total of 36,285 households. Sample of 500 houses was selected from 5 urban village representing 5 sub-districts in Tebing Tinggi. The sample was taken using purposive sampling. The larvae survey was carried out in 100 of these houses. A collection of digital images of Aedes aegypti larvae obtained from a survey of water storage containers classified as Controllable Containers (CC) such as bathtubs, dispensers, jars, drums, flower vases, bird water containers and Disposable Containers (DC) abandoned places outside the house such as cans, plastic, and used tires which have the potential to become breeding grounds for the Aedes aegypti mosquito. The results of the survey on the presence of larvae are used to calculate measures of larval density, namely the house index (HI), Container Index (CI), Breteau Index (BI) and Larvae Free Index (LFI).[8]

Stages of data collection:

1. Collection of primary data including the number, type of landfills and presence of larvae and location points were collected using a questionnaire with the kobotoolbox software.
2. Monitoring the presence of larvae with digital image tools that use cellphones and Dino-Lite Microscope Digital Basic software with the help of a camera can get photos of Aedes aegypti mosquito larvae / larvae. The software used was called the Larvae project.

Data Analysis :

1. A digital image is a numerical representation of a two-dimensional image.[12] A digital image can be classified as Vector or Raster depending on whether the resolution of the digital image is fixed or not. Vector images come from mathematical geometry. Mathematically, a vector consists of a point that has a direction and a length. Whereas bitmap images have a limited number of pixels that are represented as in a matrix. The number of pixels in the rows and columns of a bitmap image cannot change. This Digital Image principle will be applied in this research.
2. Digital image is a classification model that is able to distinguish Aedes aegypti larvae from non-Aedes aegypti larvae.[13] The first digital image stage was training on dataset collection which is carried out to produce a classification model.[12] The second part was evaluating the classification model that has been formed from a testing dataset that is different from the dataset forming the classification model and then determining the type of larvae/larvae. The result was a map of the location of larvae from containers in residents' homes.
3. Data on the presence of larvae and the number of landfills were further analyzed by spatial analysis

The following is the formula for the density index size of larvae, as follows:

Density figure of DHF vector[14,15]

1. *House Index* (HI)

$$HI = \frac{\text{Number of houses that are positive for larvae X 100\%}}{\text{Number of Houses Inspected}}$$

HI shows the distribution area of the vector. A House Index value higher than 10% means that the area has a high risk of contracting Dengue Hemorrhagic Fever (DHF). There are many mosquito larvae in people's homes which are feared to transmit dengue fever from one person to another.

2. *Container Index* (CI)

$$CI = \frac{\text{Number of houses that are positive for larvae X 100\%}}{\text{Number of Containers Inspected}}$$

CI shows vector's density

3. *Breteau Index* (BI)

$$BI = \frac{\text{Number of houses that are positive for larvae X 100\%}}{\text{100 Inspected Houses}}$$

BI shows the density and distribution of vectors in an area

4. Larvae Free Index (LFI)

$$\frac{\text{Number of houses that are not positive for larvae X 100\%}}{\text{Number of Houses Inspected}}$$

The national indicator is 95%, if the LFI value is <95% then the risk of DHF transmission is said to be high.

III. RESULT AND DISCUSSION

The survey results show that the output based on digital image software for positive larvae containers can be seen in the following figure:

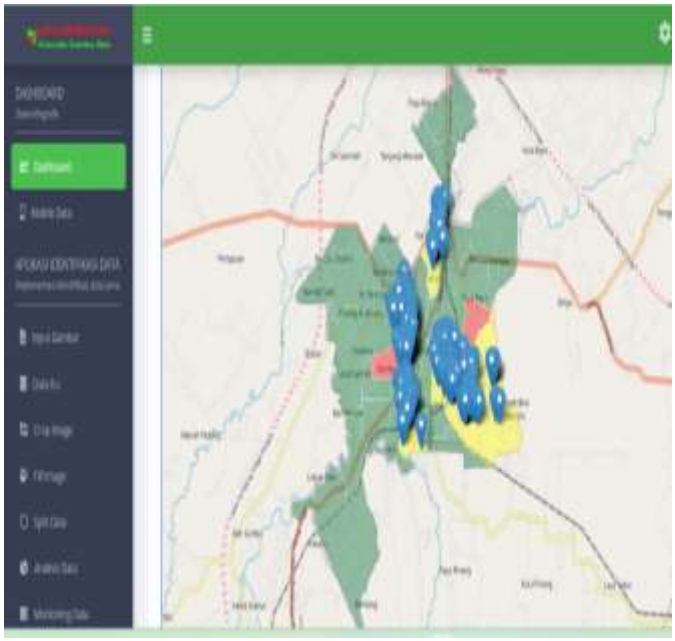

Fig. 1 Home zoning map with positive larvae in the Larvae Project

The map image above showed areas marked with indicators that determine the risk of transmission based on the density figure (DF). In all locations, larvae were found in 158 houses from the 500 houses examined. Based on these values, the larva density index can be calculated in table 1 below.

TABLE I

DENSITY OF DENGUE VECTOR LARVAE IN 5 SUB-DISTRICTS IN TEBING TINGGI CITY IN 2022

Areas	House Index (HI)	Container Index (CI)	Breteau Index (BI)	Larva Free Index (LFI)
Tebing Tinggi	34%	13,4%	50%	66%
Rambung	35%	10,8%	49%	65%
Bandar Sakti	32%	13,1%	49%	68%
Tanjung Marulak	13%	6,5%	20%	87%
Persiakan	34%	11,8%	40%	66%

From the results of the analysis, it was obtained from the five regions in Tebing Tinggi City that the largest House Index was in the Rambung Sub-District as much as 35%, the largest Container Index was in Tebing Tinggi Sub-district as much as 13.4%, the largest Breteau Index was in Tebing Tinggi as much as 50% and Larvae Free The largest index is in the Tanjung Marulak Village with 87%.

Density figure of Ae. Aegypti can be measured with the parameter Larvae Free Index (LFI) along with parameters using the HI, CI, BI index.[16,17]

Density figures for the 5 locations in the moderate risk category, can be seen from the highest larval density index values in the Tebing Tinggi subdistrict with HI 35% (DF=5), CI=13.4% (Df=4), BI=50% (Df=6) the DF value of this location is 4.6. It means that there is a medium risk of DHF transmission. Then larval indices were compared to the WHO standard to determine the density figure (DF) of larvae as shown in Table 2. The amount of HI, CI and BI scores divided by 3 and expressed on a scale of 1 -9 and categorized into DF = 1: low density, DF = 2-5: medium density and DF = 6 -9: high density.

TABLE II

DENSITY FIGURE OF MASQUTTO LARVAE

Density Figure	House Index (HI)	Container Index (CI)	Breteau Index (BI)
1	1-3	1-2	1-4
2	4-7	3-5	5-9
3	8-17	6-9	10-19
4	18-28	10-14	20-34
5	29-37	15-20	35-49
6	38-49	21-27	50-74
7	50-59	28-31	75-99
8	60-76	32-40	100-199
9	77+	41+	200

Source: Queensland Government[18]

Density of mosquito larvae is a risk factor for DHF transmission in the community.[19] The higher the density of larvae will increase the number of dengue cases in an area, the density of larvae occurs because the number of houses with positive containers or water reservoirs as mosquito breeding places increases in number.[20,21]

Based on the results of direct field observations using the larvae project application, out of the 500 houses examined, 158 community houses in Tebing Tinggi City tested positive for larvae from the 885 containers examined.

The House Index (HI) in the five areas of Tebing Tinggi City is in the range of 13% -35%, based on the indicator of larva density classified as moderate larva density because the value of DF = 5 20, where this figure has exceeded the standard set by WHO, namely HI <10% . The number of house index (HI) better describes the extent of the spread of mosquitoes in an area marked by the discovery of positive containers of Ae. aegypti.[7,14]

The Container Index (CI) number is the percentage of positive containers found by Ae. Aegypti mosquito larvae.[22] The CI value of Tebing Tinggi City is above the standard according to WHO <5%, which is around CI 6.5 -13.4%. CI numbers in all areas of Tebing Tinggi City have exceeded the standard recommended by WHO, this condition will be a risk factor for DHF transmission in Tebing Tinggi.[22] This is in accordance with research conducted by Fatin Mawaddah in 2022, Several

studies in Penajam Paser Regency, Surabaya show that the presence, type, and condition of containers are related to the presence of Ae. Aegypti.[23]

Houses that have water reservoirs that did not meet the requirements have a 7.48 times the risk of getting DHF in the presence of mosquito larvae.[23,24]

The BI value was calculated according to WHO <50%, the BI value from 5 sub-districts in the city of Tebing Tinggi is in the range of 20% -50%.[25] This means that it still meets WHO standards.[24]

The following is a map (figure 1) of the density figures of the 5 sub-districts in yellow, indicating that all locations are in the moderate transmission risk zone.

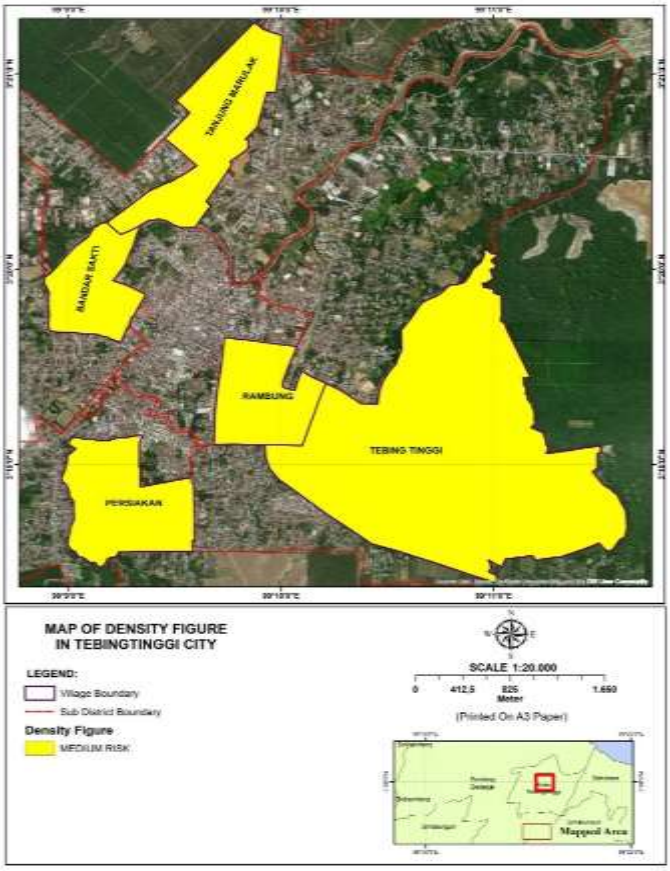

Fig. 2 Zoning map of DHF distribution based on moderate DF values.

According to research conducted by Tri Wahono in 2022 on the characteristics of mosquito larvae habitat, the Aedes Aegypti mosquito as the main vector that transmits dengue fever can live in stagnant water with a neutral pH value and normal water temperature (24–28 °C), and not come into contact with land. While the potential vector is Aedes Albopictus, this type of Aedes mosquito tends to prefer bushes around the house.[26] Aedes Aegypti mosquitoes can breed inside and outside the house, where the preferred habitat characteristics of these mosquitoes are the location of clear standing water that is accommodated in a places or vessels in or around the house usually not more than 500m from the house.[27,28]

The following figure is the result of spatial analysis

Fig. 3 Spatial Map of Larvae Free Index in Tebing Tinggi

The spatial map of the transmission risk based on the LFI value showed that the Tebing Tinggi, Rambung, Bandar Sakti, and Persiakan Sub-districts are in the red zone so that these four areas were at high risk of DHF. Where the LFI value was below 95%. The lowest risk zone for DHF transmission based on the LFI value was the Tanjung Marulak Village area which was in the green zone where the LFI value is 88% or close to 95%.[8,19]

TABLE III

DISTRIBUTION OF POSITIVE AMOUNT OF LARVAE PRESENCE BY LANDFILLS TYPE

No	Type of Landfill	Number of Positive Larvae	Percentage (%)
1	Water storage drum	11	4.3
2	Bucket	84	33.1
3	Basin	2	0.8
4	Bathtub	102	40.2
5	Water dispenser reservoir	24	9.4
6	Used tires	7	2.8
7	Trash can	2	0.8
8	Glass jar	1	0.4
9	Flower vase/pot	4	1.6

10	Pool	7	2.8
11	Used bottle	3	1.2
12	Pet drinkers	3	1.2
13	Rain gutters	2	0.8
14	Water barrel	1	0.4
15	Used gallons	1	0.4
Total		254	100

The results of the study found 15 types of TPA with a positive number of larvae present in 254 TPA from 500 house samples. The type of TPA that was most commonly found positive for the presence of mosquito larvae was the bathtub, namely 102 houses (40.2%). Followed by bucket totaling 84 houses (33.1%) and water dispenser reservoir with total 24 houses (9.8%).

Based on the results of direct field observations, the majority of respondents had more or equal to four water reservoirs on the grounds that storing more water would make it easier to carry out daily needs. Especially housewives who do a lot of activities in the kitchen such as cooking and washing. In addition, the habit of storing water is one step that is used when water availability is limited. The majority of people in Tebing Tinggi leave a water reservoir outside the house to collect rainwater for their daily needs, such as watering plants, yards and washing vehicles. Water reservoirs that did not meet the requirements and open will be an opportunity to become a habitat for Aedes Aegypti mosquito larvae. This was very reasonable because three quarters of the mosquito's life cycle is in water. Therefore the number of landfills greatly influences the presence of Aedes larvae.[19,20]

The more water reservoirs, the denser the mosquito population and the higher the risk of transmission of the Dengue Hemorrhagic Fever (DHF) virus.[19,24] Based on the Breteau Index (BI) figure in the City of Tebing Tinggi, the majority of areas have a BI value of <50% so that the Kota Tinggi area is still not a potential area for DHF Extraordinary Incident. The status of an area declared free of DHF can be seen through the Larvae Free Index (LFI) indicator. The LFI value is concluded as good if the value is >95% of the total houses inspected. Based on the results obtained that the average LFI value in Tebing Tinggi was below 95% so that the Tebing Tinggi area still has the potential for DHF to occur with moderate larvae density.[29,30] Public awareness is really needed in cleaning containers and the home environment and actively participating in supporting government programs in efforts to eradicate Aedes Aegypti mosquito larvae in Tebing Tinggi.[20,31]

CONCLUSIONS

The results of the study found that the zoning of DHF cases in 5 sub-districts (Tebing Tinggi, Rambung, Bandar Sakti, Tanjung Marulak and Persiakan) representing 5 sub-districts in Tebing Tinggi city, all of which have the potential risk of spreading DHF in the moderate category with HI: 13-35%, CI: 6.5 -13.4%, BI:20-50%, LFI : 65-87%. A total of 158 houses found larvae and the most commonly found positive larvae container was a bathtub (40.2%).

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