Digital Mapping of Dengue Mosquito Movement towards Weather Factors, Mosquito Density, and Cultural Factors in Jember Regency

by Cek Plagiasi

Submission date: 05-Apr-2023 08:01PM (UTC-0600)
Submission ID: 1999689858
File name: ok_Kukuh_Jalu_Prastyantoko_template_contagion_kesehatan_s3.docx (2.96M)
Word count: 7611
Character count: 41283

Digital Mapping of Dengue Mosquito Movement towards Weather Factors, Mosquito Density, and Cultural Factors in Jember Regency

Kukuh Jalu Prastyantoko[1], Dwi Wahyuni[2], Saiful Bukhori[3]

[1]Graduate Student of Public Health Postgraduate, University of Jember, Indonesia
[2] Faculty of Education and Science, University of Jember, Indonesia
[3]Faculty of Tecnology Information, University of Jember, Indonesia

Email corespondensi : anakbaiksekali@gmail.com

Track Record Article

Accepted:

Published:

Abstract

Dengue fever is a public health problem thet often accurs in all tropical and sub-tropical regions of the world. In the past 50 years according to WHO there has been a 30-fold increase in the incidence of dengue fever, with around 50-100 milion dengue fever infection worldwide each year. According to the East Java Health Office data in 2020, there have already been 5.733 dengue fever cases. In the past three years, in 2018,2019,and 2020, the Jember Regency Health Officer recorded 389 cases in 2018, 988 cases in 2019, and 945 cases in 2020, with the highest number in 2019 and the highest in the Kaliwates, Sumbersari, and Patrang sub-districts with 98,120,and 109 case respectively. This study aims to map a digital movement of the Aedes aegypti mosquito in high-risk areas for dengue fever outbreaks, taking into account the public's knowledge of dengue fever, attitude towards their environment, action towards the environment, environment conditions of the community, weather and climate factors, and mosquito density assessed through the House Index(HI). The result of the linear regression test on the cultural variable of knowledge, attitudes, and family support showed an value of α >0,05, indicating the knowledge, attitude, and family support are not important internal factors in aeradicating dengue fever. Mainwhile, the action and community leader support variable showed value α <0,05, which are important internal and external factors in reducing dengue fever levels. Then, HI value for these sub-districts is 6-7, meaning thet the mosquito density is high. The Aedes aegypti mosquito buffer zone has a flying distance 200 meters according to the CDC, so ares within that reach can be affected. This is clarified by using a digital map of the risk area of the Aedes aegypti mosquito causing dengue fever. In conclution, the digital map that includes cultural data, aera characteristics starting from weather, climate, population density, altitude, temperatue, humadity, and characteristics of mosquitoes inhabiting an area, whether they are clustered os spread, can cause the movement of dengue fever mosquitoes or Aedes aegypti to become more aggressive in their activities. So, the internal and external factors in the habitat of the Aedes aegypti mosquito can cause its movement to become more dunamic in spreading the dengue virus.

Keywords : Dengue Fever, GIS (*Geographic Information System*), *Aedes aegypti* Mosquito. Culture

INTRODUCTION

Diseases are widespread nowadays, starting from non-communicable diseases to communicable diseases that certainly pose a threat to public health (Diseases & Branch, n.d.; Gómez Gómez et al., 2022). One of the communicable diseases is dengue fever, which can affect people of all ages, as the mosquito that carries the dengue virus, particularly the female Aedes aegypti mosquito, still depends on human blood for reproduction (Abualamah, Akbar,

Banni, & Bafail, 2021; Lai, 2018). The dengue virus is released by the Aedes aegypti mosquito to prevent the blood sucked by the female mosquito from coagulating, and it is this blood that also becomes infected with the dengue virus (Sintayehu, Tassie, & De Boer, 2020). The dengue virus attacks APCs (antigen presenting cells), which are generally macrophages originating from the liver. Viremia, which occurs before clinical symptoms appear, can be seen up to 5-7 days later (Roy & Bhattacharjee, 2021).

The high-risk group for the occurrence of Dengue Fever (DF) in humans is in the age range of 5-9 years, and in Asia, it more dominantly attacks those under 15 years of age, while in the Americas, DF cases more commonly attack those over 15 years of age (Al-Tawfiq & Memish, 2018; Sanyaolu, 2017). The Aedes aegypti mosquito can live very close to humans. Dense residential environments are one of the important factors for the aggressiveness of Aedes aegypti mosquitoes. The daily flight range of Aedes aegypti mosquitoes is short, around 30-50 meters per day. (Riskesdas, 2018) However, the farthest flight range of Aedes aegypti mosquitoes is 200 meters. This distance is based on the Aedes aegypti mosquito's need to survive and reproduce. Because Aedes aegypti mosquitoes need an ideal place to breed, they can fly up to 200 meters (Diseases & Branch, n.d.).

This mosquito usually rests inside houses and buildings, such as on hanging clothes, curtains, walls, and other dark places. Its larvae are often found in bathtub drains, used tires, and other types of water containers in residential areas. This mosquito is active during the day, especially in the morning and late afternoon (Riskesdas, 2018).

The lifespan of Aedes aegypti mosquito is 3 weeks. Before 3 weeks, adult mosquitoes will look for an ideal environment to lay their eggs, which is in clean water puddles. These eggs take 1-2 days to become larvae, then the larvae take 4-9 days to become pupae, and the pupae take 2-3 days to become adult mosquitoes. Therefore, it can be concluded that from egg to adult mosquito, Aedes aegypti mosquitoes require around 15 days to live (Fátima, Carmen, & Fassiano, 2019; Roy & Bhattacharjee, 2021; Sanyaolu, 2017).

According to the data on dengue fever incidence from the Jember District Health Office, from 2018 to 2020, Jember District had the highest incidence rate of dengue fever in 2019, with 988 cases. The highest incidence rates were found in Kaliwates Sub-district, Sumbersari Sub-district, and Patrang Sub-district. Kaliwates Sub-district had 98 cases, Sumbersari Sub-district had 120 cases, and Patrang Sub-district had 102 cases (Dinas Kesehatan Kabupaten Jember, 2019).

The role of GIS (Geographic Information System) in visualizing map information is to serve as a means of communication for various people to visually see an informative map.

(Chan, Abid, Sulaiman, Nazir, & Azam, 2022; Esri, 2019; Lü et al., 2019). Within GIS, it is possible to digitize maps to describe a dengue fever occurrence in a certain area and also predict the flight distance of Aedes aegypti mosquitoes according to their environment or habitat using Buffer Zone technique. This Buffer Zone operation is necessary for spatial analysis to determine the extent of the potential spread and location of dengue fever occurrences (Couret, Dotson, & Benedict, 2014; Esri, 2019).

Furthermore, the House Index (HI) value is also an indicator commonly used to assess the density of Aedes aegypti mosquitoes in a specific area. The HI value indicates the number of houses that are positive for mosquito larvae in a particular area. (Ministry of Health of the Republic of Indonesia, 2016). Demographic characteristics of a region such as weather and climate can also affect the characteristics of an area that can become a habitat for Aedes aegypti mosquitoes. For example, these mosquitoes prefer temperatures between 25°C to 30°C (Couret et al., 2014; Jové et al., 2020; Zhao, Tian, & McBride, 2021). In addition to temperature, weather and climate factors include humidity, altitude, rainfall, and the condition of the home environment. To support the demographic characteristics of a region, researchers also add social factors such as population density and the social and cultural environment of a region.(Fernandes, Cordeiro, & Recamonde-Mendoza, 2021).

Knowledge, attitudes, practices, family support, and community leader support are social factors that can influence the high or low levels of dengue fever in an area. Social and cultural factors refer to an individual's response or reaction that is closed or open to a particular stimulus or object (Notoatmodjo, 2007).

Therefore, the objective of this research is to create a digital map with social and cultural attributes including knowledge, attitude, behavior, environmental conditions, family support, and community leader support, as well as geographic factors such as weather and climate, HI values, and spatial buffering techniques on the map to observe the movement of Aedes aegypti mosquitoes based on these five major attributes, to achieve better environmental health.

METHODS

This study is a quantitative observational analytic research with a cross-sectional design(Sugiyono, 2019). The research combines the theory of Hendrik L. Blum and the theory of Lawrence Green, where all data collection or data retrieval is done at the same time. The population and sample in this study were 177 respondents. Demographic data of the area were

obtained from the secondary data of BPS (Central Statistics Agency) Jember in 2020 and secondary data from the Department of Public Works and Water Management of Jember Regency in 2020. Culture data were obtained through direct interviews with respondents in 3 areas with high levels of dengue fever in Jember Regency, and HI data were obtained through direct observation in 3 areas with high levels of dengue fever in Jember Regency. This primary data research was conducted for 6 months from October 2021 to April 2022. The research was conducted in 3 locations in Jember Regency, namely Kaliwates District, Sumbersari District, and Patrang District, because these three districts had the highest levels of dengue fever in Jember Regency in 2019.

RESULTS

The primary data collection in this study was carried out from October 2021 to April 2022 on 177 respondents who were from an area with high DBD data in 2019, namely in Sumbersari, Patrang, and Kaliwates sub-districts in Jember Regency. Then, the researchers analyzed the data using linear regression to determine the influence of community culture on the density of Aedes aegypti mosquitoes, such as Knowledge, Attitude, Action, Family support, Community leader support, and the environmental conditions that affect the movement of Dengue Hemorrhagic Fever mosquitoes. After the data on mosquito density and culture influence were analyzed, the researchers further analyzed the spatial data using a geographic information system that displays a digital map with attributes such as the level of environmental conditions, cultural factors, demographic factors, HI value, and the Buffer Zone technique to create a digital map of the movement of Aedes aegypti mosquitoes in the surrounding area of the observed object.

a. Predisposing factors of the community to dengue hemorrhagic fever in areas with high DBD cases.

The predisposing factors in this study are Knowledge, Attitude, and Practice. Knowledge in this study refers to whether or not the community is aware of dengue fever, which functions to see how the community describes the initial symptoms when someone is infected with dengue fever before being taken to the hospital. Then the attitude of the community when there are other members of the community who are infected with dengue fever, along with the actions taken by the community to prevent dengue fever from happening again in the past. In this predisposing factor, the researcher also divided the respondents into

three age categories. This division is based on adolescence, late adolescence, and early adulthood. The description of the respondents' age will be explained as follows:

Table 1. Classification of age of respondents in 3 districts with high DBD rates in Jember Regency

Responden	Districts Sumbersari		Districts Patrang		Districts Kaliwates		Total	
	n	%	n	%	n	%	n	%
Age 15 - 23 Years	20	33,4	25	41,6	23	40,3	68	58,8
Age 24 - 35 Years	30	50	20	33,4	17	29,8	67	40,2
Age 36 - 45 Years	10	16,6	15	25	17	29,8	42	25,2

According to the research results shown in table 1, it can be seen that districts Sumbersari has the most respondents in the age range of 24-35 years, while districts Patrang has the highest number of respondents in the age range of 15-23 years. districts Kaliwates also has the highest number of respondents in the age range of 15-23 years..

Table 2. Results of linear regression analysis on the level of public knowledge about DBD in 3 districts with high DBD cases in Jember District.

Variabel	Districts Sumbersari		*P-Value*	Districts Patrang		*P-Value*	Districts Kaliwates		*P-Value*
	n	%		n	%		n	%	
Knowledge									
insufficient	13	19.4		4	7.3		7	12.9	
adequate	30	44.8	0,123	23	42.9	0,123	25	45.4	0,123
good	24	35.9		27	49.8		21	41.7	

Knowledge is something that can affect the formation of each individual's behavior (overt behavior). When these behaviors are accompanied by adequate knowledge, they can last long, but without adequate knowledge, the behavior may change and not be in line with the knowledge (Notoatmodjo, 2007). So, based on Figure 1, we can analyze that the highest level

of knowledge, which is in the good category, is found in Patrang District because Patrang District has respondents with an average age of 15-23 years. Actually, Sumbersari District is almost similar to Patrang District, but Sumbersari District, with its quantity of respondents with an average age of 15-23 years, loses to Patrang District. In this study, respondents with an age range of 0-14 years were not examined because they were not old enough to be surveyed on their knowledge of dengue fever.

Figure 1. Digital map of community knowledge level regarding Dengue Hemorrhagic Fever in Patrang, Sumbersari, and Kaliwates districts.

It can be seen from the map that the community's good knowledge about Dengue Hemorrhagic Fever in their area is in Patrang District, depicted in dark blue, while the other two districts, Kaliwates and Sumbersari, have light blue shades indicating that knowledge in these two districts is categorized as sufficient.

From the results of the research in the three districts, it can be described that knowledge is not one of the factors that increases the density of Aedes Aegypti mosquitoes. Although knowledge is one of our senses, especially the most dominant one (around 75% to 87%) perceived by our eyes, while 13-25% of human knowledge is obtained or conveyed through other senses, so the more senses are used, the clearer the knowledge gained (Jové et al., 2020). However, cultural values in a community environment will still be strong in maintaining the habits of the people in that environment. It may take a long time to change the habits of a community environment. This is because knowledge alone is not enough to change people's habits to reduce mosquito larvae. Therefore, culture will determine a person's attitude towards their environment, not just what they have as knowledge. Culture is an environment formed by norms and values that are maintained by society in their environment. These values and norms become guidelines for life that then develop into various community needs. Therefore, these values and norms are difficult to change in a community environment.

Table 3. Linear regression results on the level of community attitudes towards Dengue Hemorrhagic Fever in 3 districts with high cases of DBD in Jember Regency

Variabel	Districts Sumbersari		*P-Value*	Districts Patrang		*P-Value*	Districts Kaliwates		*P-Value*
	n	%		n	%		n	%	
attitude									
less caring attitude	9	13.4	0,286	1	1.8	0,286	5	9.1	0,286
moderately caring attitude	15	22.4		7	12.7		12	21.9	
very caring attitude	43	64.2		47	85.5		38	69.1	

In the above diagram, it can be seen that according to the research data, the three districts have a very caring attitude towards the density of Aedes aegypti mosquitoes, the cause of dengue fever in their environment. This attitude is an organization that has a settled nature from an emotional process, so this emotional state needs to be formed massively and takes a long time. This is what causes the attitude to not be able to affect the high or low level of mosquito larvae which can result in Dengue Fever (Arfan, Rizky, & Hernawan, 2022).

Therefore, it can be seen from the results of the three linear regression tests in the three districts that attitude does not affect the level of density of Aedes aegypti mosquito, the cause of Dengue Fever. This can happen because a person's attitude cannot change immediately and takes a long time to form, especially to take actions that can prevent Dengue Fever. A person's attitude can be influenced by several factors such as personal experience and the culture of others that are considered important (Azwar, 2013).

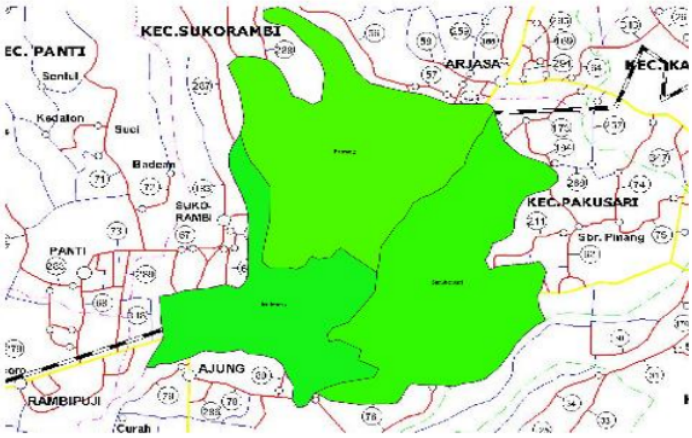

Figure 2. Digital map of Community Attitudes towards Dengue Hemorrhagic Fever in Patrang, Sumbersari, and Kaliwates districts..

The above Figure 2 shows the digital map of the Community Attitude towards Dengue Hemorrhagic Fever (DHF) in Patrang Subdistrict, Sumbersari Subdistrict, and Kaliwates Subdistrict. The map reflects that the community attitude towards the level of DHF in their surrounding area in these three sub-districts falls under the "very concerned" category. The researcher used light green color to represent these sub-districts in this digital map. The research findings indicate that the communities in these three sub-districts are very concerned about their environment. They regularly check for mosquito larvae in their bathrooms, dispose of stagnant water, and clean their drainage system every week. However, there are still some groups of people in these areas who only show concern about the level of DHF in their region. So this attitude does not have an influence because the influence of a culture or habit that originates from previous generations will be stronger than a newly formed attitude in a few months or years. Therefore, attitude is directly related to culture, and culture is formed due to the routine of a series of activities, such as how long the activity is carried out until it becomes a routine activity, so attitudes can change when the culture of a certain area also changes (West, 2013) For these reasons, attitudes cannot have a massive impact in reducing the incidence of DBD in a particular area. Because once again, attitudes take a long time to be accepted by a community in an area with a high level of cultural adherence.

Table 4 Linear regression results of community action factors on DBD in 3 districts with high DBD rates in Jember Regency.

Variabel	Districts Sumbersari		*P-Value*	Districts Patrang		*P-Value*	Districts Kaliwates		*P-Value*
	n	%		n	%		n	%	
actions									
not doing	31	46.3	0,036*	6	10.9	0,032*	4	7.3	0,046*
doing	36	53.7		49	89.1		51	92.7	

Thus, it can be seen from the three linear regression test results in the three districts that actions have a significant influence on the level of mosquito larvae density, which is the cause of Dengue Fever. This can happen because a person's action can directly cause an increase in the level of mosquito larvae, as something can happen with this action and the community can encourage an increase in the number of mosquito larvae, or conversely, can reduce the number of mosquito larvae that may occur in a certain environmental area.

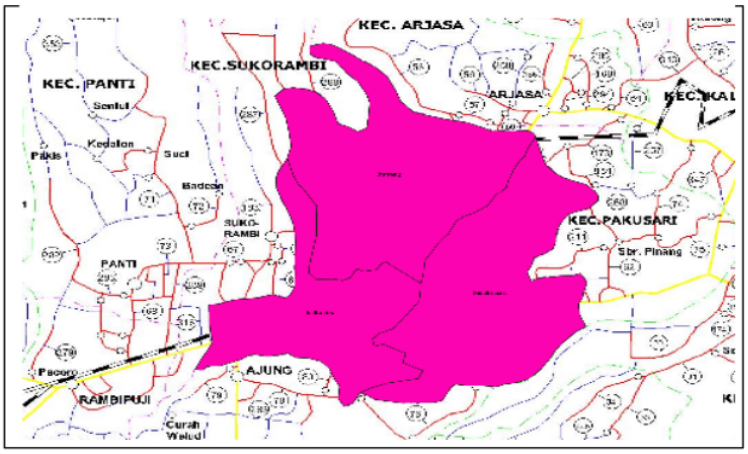

Figure 3. Digital map of Community Actions against Dengue Hemorrhagic Fever in Patrang, Sumbersari, and Kaliwates Districts.

In figure 3 above, it can be seen that the three districts are depicted with a light pink color. According to the research results, the community's actions in these three districts towards their environment are already very good, starting from always draining bath tubs, always checking for stagnant water and disposing of it, regularly disposing of trash in its place, and always cleaning the drainage channels around their homes independently or collectively every week. Although there are still some communities in these three districts that have a less good category of actions towards the level of DBD, which is indicated by the lack of awareness and laziness of the people in the area to clean up their environment, poor drainage channels around their homes, and the overcrowding of settlements in the area.

An individual's actions will be influenced by various factors, such as the availability of tools, inhibiting conditions, prevailing norms, and cultural systems in a given environment. Thus, tools, norms, and culture are one unit of an individual in taking action. When tools are not available and norms are abandoned, then a culture of neglect towards something that should be acted upon will be formed (Lai, 2018; Rezza, 2012).

b. Enabling factors of the community towards dengue hemorrhagic fever in areas with high DBD cases

In the Enabling factor, the researcher examined the respondents' environmental conditions that can trigger an increase in Aedes aegypti mosquito larvae. In this case, the researcher investigated places such as stagnant water, environmental sanitation, and whether the environment can be considered healthy or unhealthy.

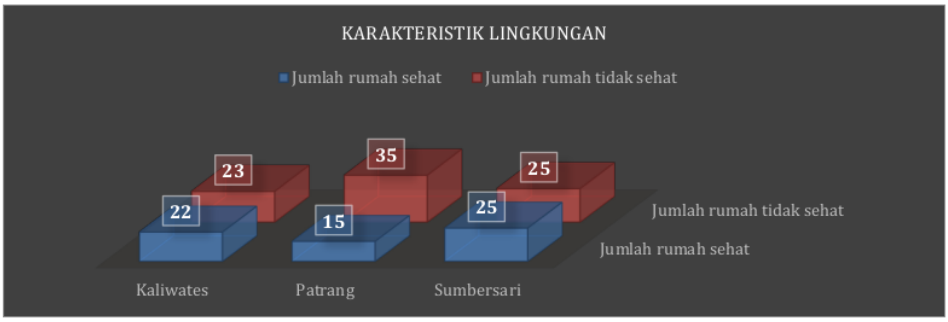

Image 4. Characteristics of the environment diagram in 3 districts with high dengue fever rates

In the above diagram, it can be seen that in Kec. Kaliwates, the conclusion is unhealthy, while in Kec.Patrang it is the same as Kec.Kaliwates, which is unhealthy because it has more unhealthy houses than healthy ones. Theoretically, it is stated that Aedes aegypti mosquitoes breed well in clean water that does not come into contact with soil. This is a good biotic environment for Aedes aegypti mosquitoes because clean water has a good pH. This is what refers to the researchers that many puddles can affect the level of DBD in a region. According to researchers, rainwater collected in containers is a good biotic environment for Aedes aegypti mosquitoes to breed. Aedes aegypti mosquitoes have a preference for clean water as a place to lay eggs and for their breeding ground. Some factors that influence female mosquitoes to choose places to lay eggs are temperature, pH, ammonia, nitrate, sulfate levels, as well as humidity, and mosquitoes usually prefer places that are not directly exposed to sunlight. Olayemi, et al. 2010)

Therefore, the environmental factors of a house are very influential in terms of its cleanliness, sanitation, and the amount of stagnant water, which can be the key to increasing the number of Aedes aegypti larvae that can develop in a certain environment.

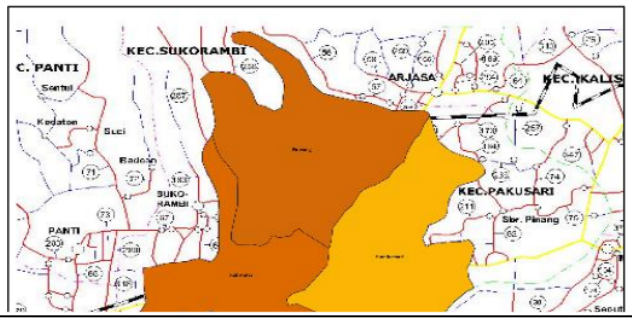

Figure 5. Digital map of community environmental characteristics related to dengue fever in Kec.Patrang, Kec.Sumbersari, and Kec. Kaliwates.

It can be seen from the map that the environmental conditions of the two districts, Kaliwates and Patrang, fall into the unhealthy category, depicted by the researcher in dark orange color. Meanwhile, Sumbersari district is categorized as less healthy because it has an equal number of healthy and unhealthy houses, 25 each, depicted by the researcher in yellow color. The unhealthy category includes a lot of stagnant water that is not cleaned or ignored, poor drainage, many unhealthy resident bathtubs, and so on. The classification is used by the researcher after conducting interviews and research in the three districts, and the results can be seen in the Results section. The environment is crucial in the increasing incidence of DBD when the surrounding environment is not properly cared for.

c. Reinforcing factors of the community towards dengue hemorrhagic fever in areas with high DBD cases

Family support refers to the attitude, actions, and acceptance of family members towards their family members, which is always supportive and ready to provide help and assistance if needed. This family is the smallest unit of society, consisting of a head of household and several people who live under the same roof in a state of mutual interdependence (Bobak, Lowdermilk, 2012)

Table 5 Linear regression test results on the factor of family support for respondents against dengue fever in 3 sub-districts in Jember Regency with high dengue fever rates.

Variabel	Districts Sumbersari		*P-Value*	Districts Patrang		*P-Value*	Districts Kaliwates		*P-Value*
	n	%		n	%		n	%	
Family support									

less supportive	23	34,3		7	12,7		9	16,4	
supportive	25	37,3	0,073	28	50,9	0,666	29	52,7	0,776
very supportive	19	28,4		20	36,4		17	30,9	

From this linear regression result, it was found that family support did not have any significant influence on the occurrence and management of dengue fever, which could be due to many people still disregarding regulations or policies issued within the family, as there is still a lack of trust among family members. Although the classification of family support in the three sub-districts supported actions in dengue fever management, the researcher found through direct interviews that there were still some actions that should have been taken to control dengue fever, even though the families supported efforts to prevent and control dengue fever in their residential areas.

Figure 6. Digital map of family support for dengue fever rates in Patrang Sub-district, Sumbersari Sub-district, and Kaliwates Sub-district.

The map shows that family support in the community in the three sub-districts falls under the supporting category, which is depicted by the researcher using a dark blue color. This category includes family support in keeping their home environment clean, taking care of the surrounding environment, and preventing mosquitoes from entering the house. This family support can be a factor that changes a person's old habits into new and better ones or simply remain as support with no change in habits.

From these results, it can be said that the respondents are very enthusiastic about dengue fever prevention and control both in their own environment and the surrounding environment, which is influenced and encouraged by their families. Some family support actions in the

community in the three sub-districts include using mosquito nets, mosquito repellent coils, and mosquito repellent devices to repel and prevent mosquitoes from entering their homes. This occurs because family support comes from the internal family or community. Family support is an attitude of action and acceptance of family members that is always supportive and ready to provide help and assistance when needed. A family is the smallest unit of society, consisting of a head of household and several people who live together and depend on each other (Bobak, Lowdermilk, 2012)

.

Table 6. Linear regression test results of community leader support factors of respondents towards DBD in 3 districts in Jember Regency that have high levels of DBD.

Variabel	Districts Sumbersari		*P-Value*	Districts Patrang		*P-Value*	Districts Kaliwates		*P-Value*
	n	%		n	%		n	%	
Support from community leaders									
less implementation	38	56,7	0,041*	13	23,6	0,047*	10	18,2	0,040*
implementing	29	43,3		42	76,4		45	81,8	

The linear regression analysis shows that the support of community leaders has an influence on the occurrence and prevention of Dengue Fever (DBD) in the high-risk areas in Kabupaten Jember. This support is a behavior influenced by community leaders in the neighborhood, such as the head of RT, head of RW, or village head. Support from community leaders is a support obtained from interpersonal relationships that refer to pleasure, peace, and beneficial assistance, which comes in the form of verbal information that is certainly accepted by individuals or communities from community leaders who bring behavioral effects. Community leaders' positions are obtained by individuals because of their knowledge, wisdom, and success in living in the community. This wisdom and knowledge possessed by community leaders usually become role models for people in their respective fields. Because of their activities, skills, and characteristics, community leaders are respected and esteemed (Porawouw, 2016)

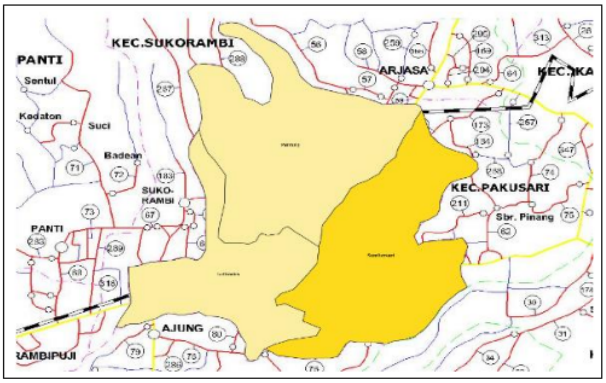

Figure 7. Digital map of community leader support for the level of dengue fever in Patrang, Sumbersari, and Kaliwates districts.

From the map, it can be seen that the support of community leaders in two districts falls into the category of "implemented," while Sumbersari district falls into the category of "less implemented." The researcher represented this with a light yellow color for the "implemented" category and a darker yellow color for the "less implemented" category. The explanation is that in the district that is less implemented, the community is less concerned about the programs issued by community leaders to tackle the DBD rate in their area. For example, the community is less active in participating in the cleaning of drains and less active in the "3M" program (draining, burying, and closing), which is initiated by local community leaders, etc. On the other hand, the communities in Patrang and Kaliwates districts are in the "implemented" category because they implement the programs initiated by local community leaders or government programs.

Thus, it can be concluded that the support of community leaders can influence the increase or decrease of Aedes aegypti mosquito larvae in an area because the community is willing to implement the policies of community leaders. This happens because the community is afraid of community leaders if a regulation or policy is not implemented. Therefore, community leaders can be the main factor in eradicating or reducing the incidence of DBD in an area by instilling policies that become a benchmark for reducing the incidence of DBD in an area.

From the results, it can be estimated that respondents are very enthusiastic about tackling DBD in their environment and external environment, which is influenced and driven by their community leaders. Community leader support is divided into emotional support, which includes expressions of empathy, concern, and attention. Recognition support includes expressions of respect and encouragement to advance. Instrumental support includes direct assistance according to the needs of the community. Finally, informative support includes advice, guidance, suggestions, and feedback (Eni et al., 2022; Wihartati, 2022).

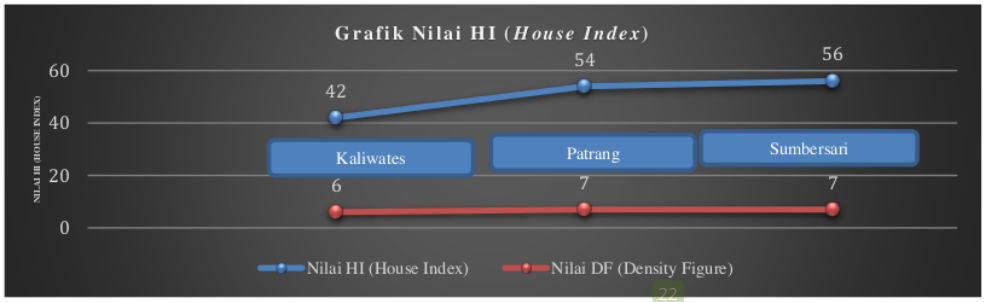

Figure 8. Graph of the HI (House Index) value in Patrang Sub-district, Sumbersari Sub-district, and Kaliwates Sub-district.

The above graph depicts the mosquito density in respondents' home environment based on the House Index (HI) values in three districts, namely Kaliwates District, Patrang District, and Sumbersari District. The Density Figure (DF) values in these districts fall under the high category, as indicated by the DF values of 6-7, which according to WHO, fall under the high-risk areas with a possibility of increasing dengue fever cases (Corbel et al., 2023; Kamande, Odufuwa, Mbuba, Hofer, & Moore, 2022).

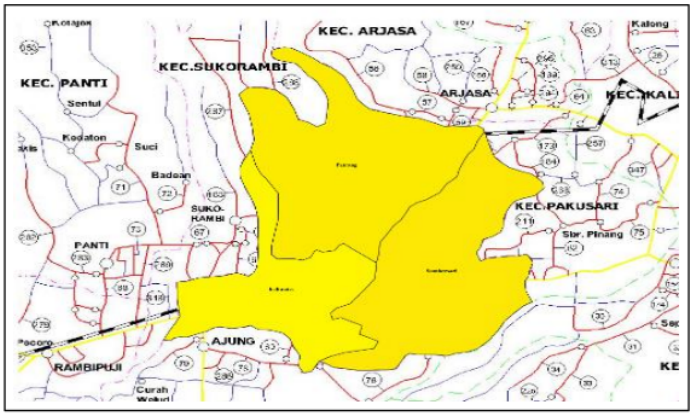

Figure 9 shows a digital map of mosquito density based on HI (House Index) values in three sub-districts.

It can be seen that the above digital map depicts strong yellow color in the areas of Kec. Patrang, Kec. Sumbersari, and Kec. Kaliwates. These three sub-districts are areas where the density of mosquitoes based on the House Index value has a Density Figure (DF) in the high category as determined by the WHO. The House Index value is one of the indicators commonly used for vector surveillance of dengue fever. The House Index value indicates the number of houses with positive larvae in a particular area. Therefore, efforts are needed to reduce the House Index value in a given area. Factors that can influence the high House Index value are community behavior and participation, which are still lacking in mosquito breeding site eradication (PSN). The PSN 3M plus program based on the Indonesian Ministry of Health is draining, closing, and utilizing/recycling used goods, conducting larviciding, biological control by maintaining larvivorous fish, and using personal protective equipment such as mosquito nets, anti-mosquito lotion, etc. (Ministry of Health, 2016). In addition, the researchers also found that some communities, especially in Kecamatan Patrang, still use cement bath tubs which make it impractical for homeowners to clean them regularly. As a result, the users of the bath tubs become lazy in cleaning them, and this leads to a situation where the water is rarely changed every 3 or 7 days, making it possible for many mosquito larvae to breed in the bath tubs. In Kecamatan Kaliwates, the community is lazier in cleaning bath tubs or water storage containers due to the dense activities of the community, making it difficult for them to find time to clean the bath tubs or water containers around their homes.

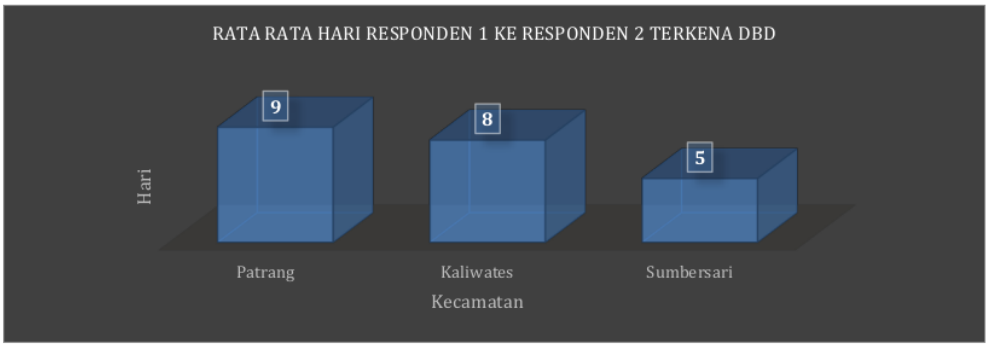

Figure 10. Graph of average days from respondent 1 to respondent 2 contracting dengue fever in three districts with high dengue fever rates in Jember Regency

According to the research results shown in the graph above, it can be seen that Sumbersari District has an average range of 5 days from the onset of DBD infection in respondent 1 to respondent 2 or other respondents, which is still within the adult Aedes aegypti mosquito's lifespan. In Patrang and Kaliwates districts, it is around 8-9 days. This is also due to the population density of the area. Sumbersari District has a population density of around 3,553 people per km2, with a very dense population and a relatively small area, resulting in high population activity, which can increase the body temperature in the area and thus increase the incidence of Aedes aegypti mosquito bites.

d. The environmental and demographic factors that can cause a high incidence of dengue fever in a particular area.

In the demographic environmental factors, there are several factors that influence the occurrence of dengue fever, namely population density factors, and the weather conditions of an area..

Figure 11. Classification diagram of population density per km2 in 3 sub-districts with high DBD rates.

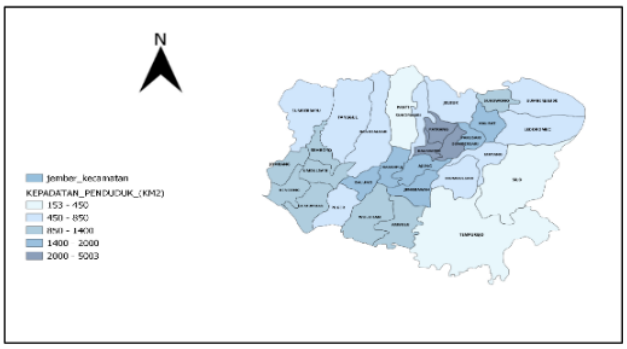

Figure 12. Digital map of mosquito density based on HI (House Index) value in 3 sub-districts.

Based on figure 12, the digital map above shows a dark blue color in the areas of Kecamatan Patrang, Kecamatan Sumbersari, and Kecamatan Kaliwates. These three districts have very high population densities compared to other areas in Jember Regency, with figures of 5003 people per km2 in Kecamatan Kaliwates, 2754 people per km2 in Kecamatan Patrang, and 3,554 people per km2 in Kecamatan Sumbersari.

Areas that are affected by dengue fever are generally densely populated areas, and the close proximity between houses also facilitates the transmission of the disease. Not only that, the behavior and culture of individuals in a certain area can also increase or decrease the vulnerability to dengue fever (WHO, 2011).

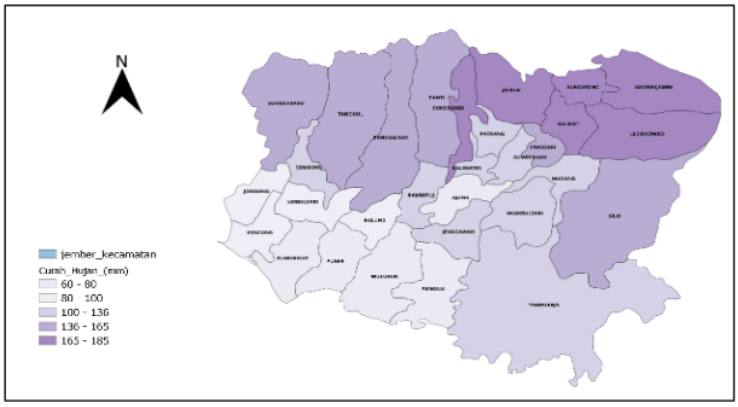

Figure 13. Digital map of rainfall in Jember Regency in 2019.

According to the Jember Regency Irrigation Department, rainfall (mm) is the amount of rainwater collected in a rain gauge on a flat, non-absorbent, and non-flowing surface. Rainfall of 1 mm means that one liter of rainwater is collected on one square meter of flat surface or that rainwater is collected to a height of one millimeter. The digital map above shows that the highest rainfall occurs in Kec. Sumberjambe, Kec. Ledokombo, Kec. Sukowono, Kec. Jelbuk, and Kec. Kalisat, which is around 165 mm3/month to 185 mm3/month, while the areas of Kec. Patrang, Kec. Sumbersari, and Kec. Kaliwates have rainfall of 100 mm3/month to 136 mm3/month, which is not a very high amount but still significant. This is due to the slightly different altitude between Kec. Sumberjambe, Kec. Ledokombo, Kec. Sukowono, Kec. Jelbuk, and Kec. Kalisat with Kec. Patrang, Kec. Sumbersari, and Kec. Kaliwates.

Extreme to moderately high rainfall is associated with 8 infectious diseases during the 2004-2008 period, one of which is dengue fever (Zhang, Wan, & Yang, 2019). The level of rainfall in an area is one of the climate elements that can affect the development of Aedes aegypti mosquitoes (Barrios, 2016). Rainfall is an ideal habitat for Aedes aegypti mosquitoes

because high rainfall results in more stagnant water in an area. However, if the altitude exceeds 500-1000 meters above sea level, Aedes aegypti mosquitoes will have difficulty breeding because the temperature is not suitable for the development of their eggs.

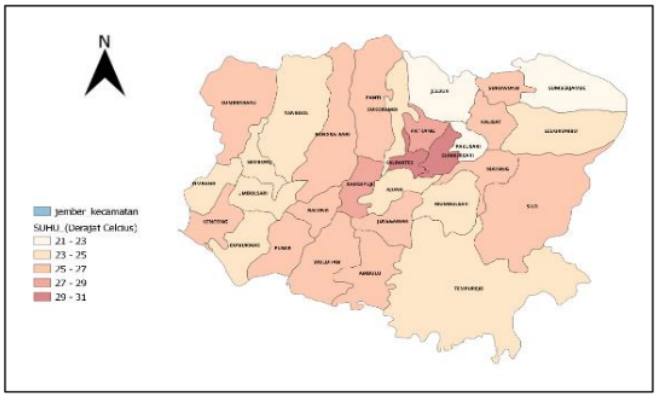

Figure 14. Digital map of the average temperature of Jember Regency in 2019.

The above digital map shows the points of the highest and lowest average temperature in Jember Regency. The highest average temperature point is located in the areas of Kec. Patrang, Kec. Sumbersari, and Kec. Kaliwates, ranging from 29°C to 31°C. This temperature range is very ideal for the habitat of Aedes aegypti mosquito larvae to develop, as their reproduction rate also becomes very fast in such an ideal temperature. Aedes aegypti mosquito requires an average temperature of around 32°C to 34°C to develop very rapidly. Thus, temperature can affect the level of development and survival of Aedes aegypti vector. The factors of food availability, larval density, and temperature have a significant effect on the development and survival of Aedes aegypti larvae (Couret et al., 2014).

Therefore, in terms of demographic factors, the three sub-districts of Kaliwates, Patrang, and Sumbersari have an ideal temperature range of 29°C to 31°C for the habitat of Aedes aegypti mosquito breeding.

Figure 15. Digital Map of Humidity in Jember Regency in 2019

Another factor that can affect the development of Aedes aegypti mosquitoes is the humidity of an area. Humidity can trigger remarkable growth in all species of mosquitoes in Indonesia. The digital map above shows the average humidity points that occurred in Jember Regency in 2019. The highest average humidity points occurred in the Patrang Sub-district, Sumbersari Sub-district, and Kaliwates Sub-district, ranging between 85% to 90%.

The ideal air humidity for the development of Aedes aegypti mosquito larvae in nature ranges between 60% to 80%. If this humidity range occurs in an area, the development and growth of Aedes aegypti mosquitoes will be very rapid (Robby Indra Wahyudi, Praba Ginanjar, 2013) Very high humidity will be directly proportional to an increase in mosquito density, while low humidity in an area will shorten the lifespan of mosquitoes to survive in that area (Epstein et al., 1998)

This humidity is difficult to avoid because different elevations can result in different humidity levels in an area. Therefore, what needs to be done to prevent dengue fever in areas with ideal humidity for the breeding of Aedes aegypti mosquitoes is to increase community behavior in limiting locations with many stagnant water sources that can become potential breeding grounds for Aedes aegypti eggs and larvae.

Figure 16. Digital map of the coverage area or buffer zone of Aedes aegypti mosquitoes based on the distribution points of dengue fever cases.

Figure 17. Digital map of the coverage area or buffer zone of Aedes aegypti mosquitoes based on the distribution points of dengue fever cases when zoomed in.

The digital map above depicts the range of Aedes aegypti mosquitoes based on the cases of dengue fever in three sub-districts, namely Patrang, Kaliwates, and Sumbersari. The researcher used a buffer zone of 200 meters from the dengue fever cases, where the yellow dots represent the cases and the red area represents the range of mosquitoes found around those dots, extending 200 meters. This is consistent with data released by the CDC, which states that Aedes aegypti mosquitoes can fly up to 200 meters. The digital map is also directly updated from Google maps, so the location of an area is more up-to-date and its coordinates are more precise.

Every day, Aedes aegypti mosquitoes can fly up to 50 meters to be active. Therefore, it can be concluded that the denser a settlement is in an area, the higher the risk of dengue fever cases in that area. Also, the denser the area, the higher the potential for mosquito range to infect humans with the dengue virus. Climate change in a place greatly affects the bionomics of Aedes aegypti mosquitoes, which are carriers of the dengue virus. Seasonal factors contribute to the increase in Aedes aegypti mosquitoes and potential outbreaks in an area. Different environmental conditions in each location can determine the number of Aedes aegypti mosquitoes found. These mosquitoes usually lay their eggs and larvae in discarded tires that become breeding sites for stagnant water. Thus, areas with many discarded tires filled with stagnant water are more likely to have a higher population of Aedes aegypti mosquitoes. (Rezza, 2012).

CONCLUSIONS

The factor of public knowledge shows that knowledge alone is not enough to increase or decrease the density of Aedes aegypti mosquitoes in Jember Regency, as it is insufficient to change people's habits in combating the mosquitoes. The factor of public attitude also shows that attitude alone cannot have a massive influence on the high or low density of mosquitoes that cause Dengue Fever. This is because a person's attitude cannot be changed quickly to take action in Jember Regency. In the factor of action, it is the most influential factor in determining the high or low density of mosquito larvae that cause Dengue Fever. This is because actions can change the human environment and have an impact on their lives in Jember Regency. The

condition of the home environment, including its cleanliness, sanitation, and the amount of stagnant water, can be the key to increasing the number of Aedes aegypti larvae that can breed in a certain environment. Family support is still not massive enough to be used to reduce the number of Dengue Fever cases in Jember Regency, as it can only be a supporting factor and cannot necessarily change a person's long-standing habits. Compared to the support of community leaders, it may have a different effect, as people tend to follow the policies or regulations set by them rather than those set by their own family. From the digital map presented, the areas with a high incidence of Dengue Fever in Jember Regency are located in three districts, namely Patrang, Kaliwates, and Sumbersari, which have higher temperatures, higher humidity, lower altitude, and the highest population density compared to the surrounding areas. Therefore, Aedes aegypti mosquitoes have an ideal habitat in these three districts, and their efficient flying range makes it easier for them to infect humans.

REFERENCE

Abualamah, W. A., Akbar, N. A., Banni, H. S., & Bafail, M. A. (2021). Forecasting the morbidity and mortality of dengue fever in KSA: A time series analysis (2006–2016). *Journal of Taibah University Medical Sciences*, *16*(3). https://doi.org/10.1016/j.jtumed.2021.02.007

Al-Tawfiq, J. A., & Memish, Z. A. (2018). Dengue Hemorrhagic Fever Virus in Saudi Arabia: A Review. *Vector-Borne and Zoonotic Diseases*, Vol. 18. https://doi.org/10.1089/vbz.2017.2209

Arfan, I., Rizky, A., & Hernawan, A. D. (2022). Factors associated with dengue fever prevention practices in endemic area. *International Journal of Public Health Science*, *11*(4). https://doi.org/10.11591/ijphs.v11i4.21784

Azwar, S. (2013). Sikap Manusia: Teori dan Pengukurannya. *Yogyakarta: Pustaka Pelajar*, *1*(69).

Barrios. (2016). Hubungan Faktor Iklim Dengan Demam Berdarah Dengue Di Kabupaten Gunung Kidul Tahun 2010. *Jurnal Ekologi Kesehatan*, *11*(3 Sep), 230–239.

Bobak, Lowdermilk, J. (2012). *Buku Ajar Keperawatan Marenitas*.

Chan, S. W., Abid, S. K., Sulaiman, N., Nazir, U., & Azam, K. (2022). A systematic review of the flood vulnerability using geographic information system. *Heliyon*, Vol. 8. https://doi.org/10.1016/j.heliyon.2022.e09075

Corbel, V., Kont, M. D., Ahumada, M. L., Andréo, L., Bayili, B., Bayili, K., … Yadav, R. S.

(2023). A new WHO bottle bioassay method to assess the susceptibility of mosquito vectors to public health insecticides: results from a WHO-coordinated multi-centre study. *Parasites and Vectors*, *16*(1). https://doi.org/10.1186/s13071-022-05554-7

Couret, J., Dotson, E., & Benedict, M. Q. (2014). Temperature, larval diet, and density effects on development rate and survival of Aedes aegypti (Diptera: Culicidae). *PLoS ONE*, *9*(2). https://doi.org/10.1371/journal.pone.0087468

Dinas Kesehatan Kabupaten Jember. (2019). *Data Kesakitan DBD tahun 2018-2020 Kabupaten Jember Berdasarkan Kecamatan*.

Diseases, Z. I., & Branch, D. (n.d.). *Dengue and the Aedes albopictus mosquito*.

Eni, R., Sari, T. H., Yunere, F., Kusuma, S. P. D. W., Orizani, C. M., Agustiningsih, N., … Riza, Y. (2022). Psikologi Kesehatan (Teori dan Penerapan). In *Media Sains Indonesia*.

Epstein, P. R., Diaz, H. F., Elias, S., Grabherr, G., Graham, N. E., Martens, W. J. M., … Susskind, J. (1998). Biological and Physical Signs of Climate Change: Focus on Mosquito-borne Diseases. *Bulletin of the American Meteorological Society*, *79*(3), 409–417. https://doi.org/10.1175/1520-0477(1998)079<0409:BAPSOC>2.0.CO;2

Esri. (2019). What is GIS? | Geographic Information System Mapping Technology. *Esriuk.Com*.

Fátima, M., Carmen, A., & Fassiano, N. (2019). A study on the epidemiology of dengue hemorrhagic fever . *Boletin de Malariologia y Salud Ambiental*, *59*(2).

Fernandes, M. S., Cordeiro, W., & Recamonde-Mendoza, M. (2021). Detecting Aedes aegypti mosquitoes through audio classification with convolutional neural networks. *Computers in Biology and Medicine*, *129*. https://doi.org/10.1016/j.compbiomed.2020.104152

Gómez Gómez, R. E., Kim, J., Hong, K., Jang, J. Y., Kisiju, T., Kim, S., & Chun, B. C. (2022). Association between Climate Factors and Dengue Fever in Asuncion, Paraguay: A Generalized Additive Model. *International Journal of Environmental Research and Public Health*, *19*(19). https://doi.org/10.3390/ijerph191912192

I.K, O., I.C.J, O., O.I, F., S.P, S., & B, I. (2010). Distribution of mosquito larvae in Relation to Physico-chemical characteristics of breeding habitats in Minna, North Centreal Nigeria. *Agriculture*, *1*(1), 49–53.

Jové, V., Gong, Z., Hol, F. J. H., Zhao, Z., Sorrells, T. R., Carroll, T. S., … Vosshall, L. B. * (2020). Sensory Discrimination of Blood and Floral Nectar by Aedes aegypti Mosquitoes. *Neuron*, *108*(6). https://doi.org/10.1016/j.neuron.2020.09.019

Kamande, D. S., Odufuwa, O. G., Mbuba, E., Hofer, L., & Moore, S. J. (2022). Modified World

Health Organization (WHO) Tunnel Test for Higher Throughput Evaluation of Insecticide-Treated Nets (ITNs) Considering the Effect of Alternative Hosts, Exposure Time, and Mosquito Density. *Insects*, *13*(7). https://doi.org/10.3390/insects13070562

Lai, Y. H. (2018). The climatic factors affecting dengue fever outbreaks in southern Taiwan: An application of symbolic data analysis. *BioMedical Engineering Online*, *17*. https://doi.org/10.1186/s12938-018-0575-4

Lü, G., Batty, M., Strobl, J., Lin, H., Zhu, A. X., & Chen, M. (2019). Reflections and speculations on the progress in Geographic Information Systems (GIS): a geographic perspective. *International Journal of Geographical Information Science*, Vol. 33. https://doi.org/10.1080/13658816.2018.1533136

Notoatmodjo, S. (2007). *Promosi Kesehatan dan Ilmu Perilaku*. 1–248.

Porawouw, R. (2016). Peran Tokoh Masyarakat dalam Meningkatkan Partisipasi Pembangunan. *Jurnal Ilmu Politik*, *3*(1), 1154.

Rezza, G. (2012). Aedes albopictus and the reemergence of Dengue. *BMC Public Health*, *12*(1). https://doi.org/10.1186/1471-2458-12-72

Riskesdas. (2018). Wilayah KLB DBD Ada di 11 Provinsi. *Kementerian Kesehatan RI*, *4247608*(021), 613–614.

Robby Indra Wahyudi, Praba Ginanjar, L. D. S. (2013). Pengamatan Keberadaan Jentik Aedes Sp Pada Tempat Perkembangbiakan dan PSN DBD di Kelurahan Ketapang. *Jurnal Kesehatan Masyarakat*, *2*(April), 14.

Roy, S. K., & Bhattacharjee, S. (2021). Dengue virus: Epidemiology, biology, and disease aetiology. *Canadian Journal of Microbiology*, Vol. 67. https://doi.org/10.1139/cjm-2020-0572

Sanyaolu, A. (2017). Global Epidemiology of Dengue Hemorrhagic Fever: An Update. *Journal of Human Virology & Retrovirology*, *5*(6). https://doi.org/10.15406/jhvrv.2017.05.00179

Sintayehu, D. W., Tassie, N., & De Boer, W. F. (2020). Present and future climatic suitability for dengue fever in Africa. *Infection Ecology and Epidemiology*, *10*(1). https://doi.org/10.1080/20008686.2020.1782042

Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D* (1st ed.). Bandung: Penerbit Alfabeta.

West, R. (2013). Pengantar teori komunikasi analisis dan aplikasi. *Journal of Chemical Information and Modeling*, *53*(9), 54.

WHO. (2011). Comprehensive guidelines for prevention and control of dengue and dengue

haemorrhagic fever. *WHO Regional Publication SEARO*, (1), 159–168.

Wihartati, W. (2022). Psikologi Kesehatan Berbasis Unity of Science. In *Lawwana*.

Zhang, Y., Wan, Q., & Yang, N. (2019). Recent Advances of Porous Graphene: Synthesis, Functionalization, and Electrochemical Applications. *Small*, Vol. 15. https://doi.org/10.1002/smll.201903780

Zhao, Z., Tian, D., & McBride, C. S. (2021). Development of a pan-neuronal genetic driver in Aedes aegypti mosquitoes. *Cell Reports Methods*, *1*(3). https://doi.org/10.1016/j.crmeth.2021.100042

Digital Mapping of Dengue Mosquito Movement towards Weather Factors, Mosquito Density, and Cultural Factors in Jember Regency

ORIGINALITY REPORT

12%	8%	4%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	jurnal.uinsu.ac.id Internet Source	3%
2	Submitted to Scotland's Rural College Student Paper	1%
3	proceedings.unimal.ac.id Internet Source	1%
4	jurnal.unimus.ac.id Internet Source	1%
5	Dessy Triana, Lala Foresta Valentine Gunasari, Helmiyetti Helmiyetti, Martini Martini et al. "Endemicity of Dengue with Density Figure and Maya Index in Bengkulu City, Indonesia", Open Access Macedonian Journal of Medical Sciences, 2021 Publication	1%
6	www.ijsht-journals.org Internet Source	1%

7	E A Nurdin, Y Wijayanto. "The distribution of green open space in Jember City area based on image landsat 8 - OLI", IOP Conference Series: Earth and Environmental Science, 2020 Publication	<1 %
8	Submitted to Universitas Muhammadiyah Yogyakarta Student Paper	<1 %
9	commons.erau.edu Internet Source	<1 %
10	www.journalcra.com Internet Source	<1 %
11	Nur Siyam, Bertakalswa Hermawati, Lukman Fauzi, Fahma Nur Fadila et al. "Eco-health survey effort to diagnose readiness for sustainability dengue prevention and control", International Journal of Public Health Science (IJPHS), 2023 Publication	<1 %
12	Mochammad Choirur Roziqin, Achmad Basuki, Tri Harsono. "A comparison of Montecarlo linear and dynamic polynomial regression in predicting dengue fever case", 2016 International Conference on Knowledge Creation and Intelligent Computing (KCIC), 2016 Publication	<1 %

13	www.earthwatch.org Internet Source	<1%
14	Sheilla Rachmania, Erma Sulistyaningsih, Anak Agung Istri Ratnadewi. "Recombinant DBL2β-PfEMP1 of the Indonesian Plasmodium falciparum induces immune responses in Wistar rats", Journal of Taibah University Medical Sciences, 2021 Publication	<1%
15	scholarworks.waldenu.edu Internet Source	<1%
16	senjop.ppj.unp.ac.id Internet Source	<1%
17	www.researchgate.net Internet Source	<1%
18	Fong-Shue Chang, Yao-Ting Tseng, Pi-Shan Hsu, Chaur-Dong Chen, Ie-Bin Lian, Day-Yu Chao. "Re-assess Vector Indices Threshold as an Early Warning Tool for Predicting Dengue Epidemic in a Dengue Non-endemic Country", PLOS Neglected Tropical Diseases, 2015 Publication	<1%
19	Submitted to The Chartered Institute of Marketing Student Paper	<1%
20	Submitted to Asian Institute of Technology Student Paper	

		<1 %
21	ijop.net Internet Source	<1 %
22	id.123dok.com Internet Source	<1 %
23	ijph.in Internet Source	<1 %
24	Submitted to saint michaels college Student Paper	<1 %
25	medcraveonline.com Internet Source	<1 %
26	midwifery.iocspublisher.org Internet Source	<1 %
27	s3-eu-west-1.amazonaws.com Internet Source	<1 %
28	Wulandari Wulandari, Al Rafni Al Rafni. "Village, Power and Local Actors: Identifying the Motivations of Village Heads Candidates and the Responses of Local Actors", MUHARRIK: Jurnal Dakwah dan Sosial, 2021 Publication	<1 %
29	archive.lstmed.ac.uk Internet Source	<1 %
	journal.um.ac.id	

30	Internet Source	<1%
31	link.springer.com Internet Source	<1%
32	s2.medicina.uady.mx Internet Source	<1%
33	K. Mitchell-Foster. "The influence of larval density, food stress, and parasitism on the bionomics of the dengue vector Aedes aegypti (Diptera: Culicidae): implications for integrated vector management", Journal of Vector Ecology, 06/2012 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		

Digital Mapping of Dengue Mosquito Movement towards Weather Factors, Mosquito Density, and Cultural Factors in Jember Regency