JOURNAL OF PUBLIC HEALTH FOR TROPICAL AND COASTAL REGION (JPHTCR)
Journal homepage: http:/ejournal2.undip.ac.id/index.php/jphtr/index
ISSN : 2597-438

Spatial Analysis of Environmental Factors in the Dengue Hemorrhagic Fever Incident at Soe City District

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Abstract

Introduction: In 2022, there was a large increase in cases resulting in extraordinary events cases in the TTS district with the number 226 cases. Half of the percentage of outbreak cases that occurred in the Soe City with a number of case is 134 cases. Spatial analysis can be used to see patterns of disease distribution in certain areas.

Methods : This research is a type of descriptive research with a case study approach. This descriptive research was carried out using a survey method where there was no intervention on variables but simply observing natural phenomena or looking for relationships between these phenomena and other variables.

Results: The research of dengue case data is divided into univariate analysis and spatial analysis, for example classification, buffering and Moran index. Environmental factors in the form of the existence and condition of water reservoirs with dengue fever incidents can be seen in data related to the number of water reservoirs used by the community which are left open and the number is >3, making it easier for mosquitoes to breed. In the Spatial Classification Analysis, Nonohonis Village has the highest level of risk, but Autocorrelation Analysis states that the Oekefan area has larger cluster points than Nonohonis Village. Furthermore, environmental factors include the existence and condition of dug wells. at a depth of ≤15m with open conditions makes it easier for mosquitoes to breed. Apart from that, based on the buffer data above, it can be seen that at a radius of <100m it is 3 times larger than a radius of 100 to 300m and 2.7 times larger than a radius of 300m to 500m. Environmental factors include the existence and condition of waste water drainage channels (SPAL) with dengue fever incidents. Based on the buffer data above, it can be seen that at a radius of <100m it is 0.6 times greater than the radius from 100 to 300m and 0.8 times greater than the radius from 300m to 500m.

Conclusion: It is necessary to control mosquito breeding in water reservoirs and dug wells through education regarding malaria risk factors in the Soe City.

Keywords: dengue hemorrhagic fever (DHF), spatial analysis, environmental factors

Article History: Received: September 28, 2023 , Revised: January 29, 2024, Accepted: April 17, 2024

Introduction

Dengue Hemorrhagic Fever (DHF) is a disease caused by the bite of the Aedes Aegypti mosquito which contains the dengue virus. DHF is generally characterized by clinical symptoms in the form of high fever, bleeding manifestations, hepatomegaly, and signs of circulatory failure leading to shock (dengue shock syndrome) which can cause death (1). According to the NTT Health profile, in the TTS district area in the 2020, the number of dengue fever cases in TTS district was 105 cases with an IR (Incidence Rate) of 19.8 and in 2021 it will have an IR of 9.2.

Even though in 2021 there was a decrease in IR, in 2022 there was a large increase in cases resulting in extraordinary events cases in TTS district with the number in 2022 being 226 cases. There were no cases of death during the outbreak, but according to Minister of Health Regulation Number 1501 year 2010, this condition is caused by an increase in the incidence of pain two times or more compared to the previous period within hours, days or weeks according to the type of disease. DHF data in Soe City based on the TTS health service in 2022 is 134 cases. The number that occurred in the Soe City sub-district contributed more than half of the percentage of outbreak cases that occurred in TTS district in 2022. In addition, data on dengue fever in the Soe City sub-district based on the Central Statistics Agency (BPS) has tended to increase in the last few years, namely, 2017 was 1 case, 2018 was 16 cases, and 2019 was 111 cases.

The environment that influences the spread and transmission of agents becomes easier, namely the existence of puddles of water as a resting place for Aedes Aegypty. Aedes aegypti mosquito larvae usually breed in puddles of water with a non-soil base (containers), clear water that is still and protected from direct sunlight such as waste water drains, water reservoirs and wells.(2)

The existence of wastewater channels can become a breeding ground for mosquitoes, especially Culex sp. However, based on research by Jacob et al. (2014), Aedes sp mosquitoes can not only live in clear water, but can also survive and reproduce in normally drained water that is calm and clear. Soe City sub-district has many waste water drainage channels in community housing and roadsides. The condition of waste water drainage channels that are uneven and have holes tend to cause stagnant water which can become a nest for mosquitoes during the rainy season.(3,4)

Water reservoirs are breeding grounds for Aedes aegypti larvae. The more water reservoirs that are used, the more it can become a breeding ground for larvae. According to Oktavianus et al. (2021), the effect of water storage on the incidence of dengue fever shows that the presence of open water storage places increases the risk of dengue infection. People in Kota Soe Regency usually use water for their daily needs from the regional drinking water company which routinely distributes water to the community every four days. Because of these conditions, people often have water storage places for long-term needs and for daily needs such as bathing. This condition could have the potential to breed mosquitoes.(5)

Apart from that, the type of clean water installation used can be a risk factor for the spread of dengue fever. The research results of Jacobi et al (2014) show that the Aedes aegypti mosquito can survive in dug well water. This is supported by research by Miftakhul Janah (2015) that dug wells which are breeding grounds for Aedes aegypti larvae are indoor, open, made of cement, pH 6.9-8 with lighting < 50 Lux. In Soe Regency, people who do not get water through regional drinking water companies usually use dug wells as an alternative source of clean water. This condition places them at a high potential risk of dengue fever.(6,7)

Control efforts are needed by creating risk area maps/spatial analysis of dengue cases as a preventive measure to increase public awareness of dengue-vulnerable areas.(8) Spatial analysis can be used to see patterns of disease distribution in certain areas. Farahhiyah's (2014) study on spatial analysis of dengue fever incidents in Demak Regency was obtained from distribution patterns in the Mranggen area. Spatial analysis is an important method in monitoring and surveillance of public health.(9)

Methods

This research is a type of descriptive research on dengue fever cases that occurred in the Soe City District (case study). This descriptive research was carried out using a survey method where there is no intervention on variables but simply observing natural phenomena or looking for relationships between these phenomena and other variables. Descriptive surveys in the field of public health are used to describe health problems and matters related to the health of a group of people living in a particular community. A survey was conducted on several environmental factors and they were linked to the incidence of dengue hemorrhagic fever (DHF) in the Soe City District research using a spatial approach.

Results

The frequency distribution of the water storage and dug well variables studied was seen using univariate analysis. The factors of clean water source, type of water storage place, existence of water storage place, number of water storage place, type of well, and depth of well were evaluated univariately.

Table 1 Distribution of cases based on the type of Clean Water source used by respondents in 2023

No	Types of Clean Water Sources	n	Persentage (%)
1	Local water company	92	89.3
2	Dig well	4	3.9
3	River	1	1.0
4	Water springs	1	1.0
5	Water tank	5	4.9
Total		**103**	**100**

Based on Table 1, the type of clean water source most used by respondents in the Kota Soe sub-district is regional drinking water companies, namely 92 (89.3%) residences, followed by water tanks, namely 5 (4.9%) residences and wells in 4 (3.9%) residences.

Table 2 Distribution of water storage places based on the type used by the community in 2023

No	Water Storage Type	n	Persentage (%)
1	Closed	1	1.0
2	Open	27	26.2
3	Open and Closed	75	72.8
Total		**103**	**100**

Based on Table 2, the types of water storage places commonly used by respondents in the Kota Soe sub-district are open and closed, namely 75 (72.8%) residences, followed by the open type of water storage places, namely 27 (26.2%) residence and closed as much as 1 (1.0%) residence.

Table 3 Distribution of water storage places based on presence in people's homes in 2023

No	Existence of water storage places	n	Persentage (%)
1	In the	7	6.8
2	Outside	0	0.0
3	Inside and Outside	96	93.2
Total		**103**	**100**

Based on Table 3, the existence of water storage places most frequently used by respondents in the Kota Soe sub-district are inside and outside the house, namely 96 (93.2%) residences, followed by the existence of water storage places only inside the house, namely 7 (6.8%) residence.

Table 4 Distribution of water storage places based on presence in people's homes in 2023

No	number of water storage places	n	Persentage (%)
1	<3	0	0
2	≥3	103	100
Total		**103**	**100**

Based on table 4, the number of water reservoirs in one house observed <3 is 0 (0%), while the number of water reservoirs ≥3 is 103 (100%) people. This condition is related to the frequency of water flow in Soe.

Table 5 Distribution based on well type in Kota Soe District in 2023

No	Well Type	n	Persentage (%)
1	Open	30	96.8
2	Closed	1	3.2
Total		**31**	**100**

Table 6 Distribution based on Well Depth in Kota Soe District in 2023

No	Well Depth	n	Persentage (%)
1	<15m	27	87.1
2	≥15m	4	12.9
Total		**31**	**100**

Based on table 5, the open well type is 30 (96.8%) while the closed well type is 1 (3.2%). Based on table 6, the depth of wells ≥15m is 27 (87.1%) of them, while the depth of wells >15m is 4 (12.9%) of them. Furthermore, the distribution of the results using spatial analysis was carried out on the variables of water reservoirs, dug wells and wastewater drainage channels. This distribution categorizes dengue fever cases based on several analyses namely classification, autocorrelation, and buffering.

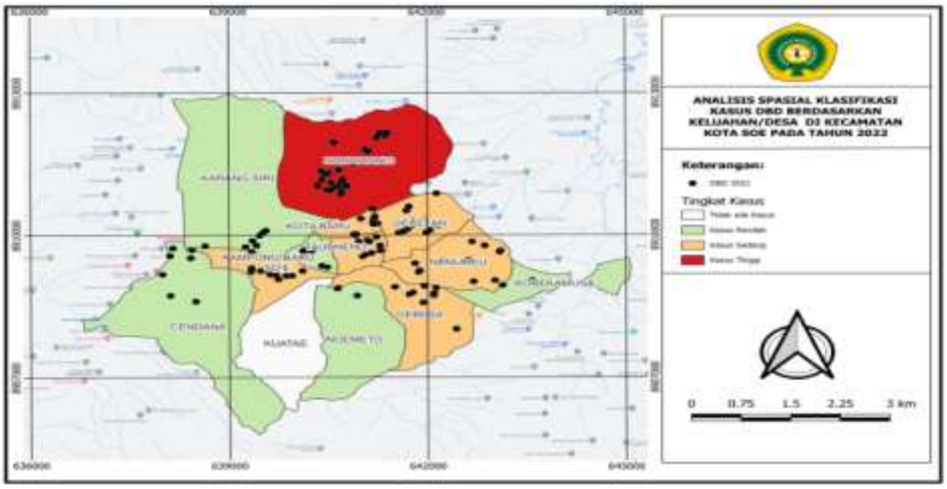

Figure 1 Spatial Analysis of DHF Case Classification based on sub-districts/villages in Soe District in 2022

Based on figure 1, it can be seen that the area with the highest level of dengue fever cases is in Nonohonis sub-district in red, followed by Taubneno, Oekefan, Nunumeu, Oebesa, Kota Baru, and Soe sub-districts with moderate cases in yellow. The dengue fever case with the lowest case rate was in Kuatae Village with 0 cases.

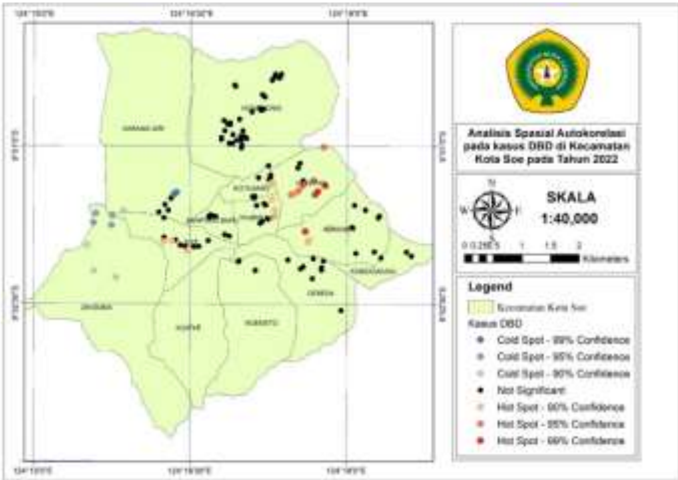

Figure 2 Spatial autocorrelation analysis of dengue fever cases in Soe District in 2023

Based on the results of spatial autocorrelation analysis in Figure 2, it can be seen that dengue fever cases are highly concentrated in Oekefan Village. This condition is followed by several sub-districts in the surrounding area, Nunumeu Village, Kota Baru Village, Taubneno Village, and Soe Village. Furthermore, the areas with dengue cases that have a low cluster level are Cendana, Karang Siri, and Cendana Villages. Even though the Nonohonis Village area has a high number of cases, based on the results of the Hotspot autocorrelation analysis, it does not show any correlation indicating that there are clusters or cases in Nonohonis Village that are spread randomly. Clusters based on spatial autocorrelation are carried out in more reference to the Oekefan sub-district.

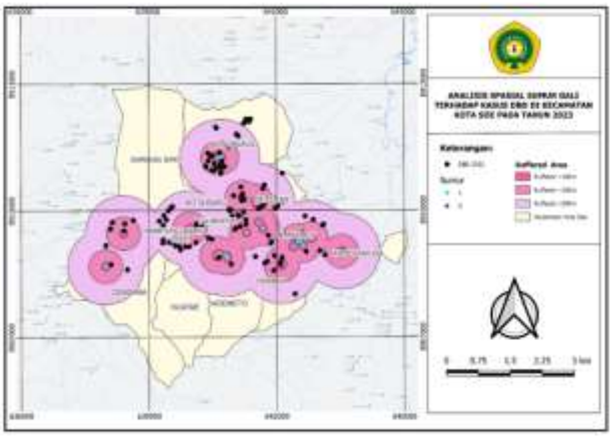

Figure 3 Spatial analysis of dug well buffering for dengue fever cases in Soe District in 2023

Based on Figure 3, it can be seen that in the analysis using a buffer radius of <100m, there were 14 cases of dengue fever or 11.02% of the total case locations. The subdistrict with the most cases for this radius was the dug well in Kota Baru subdistrict with the number of cases being 7. and the sub-districts with the fewest cases are Taubneno, Kampung Baru, Naemeto, Oekefan and Nunumeu sub-districts, namely with 0 cases. Furthermore, in a radius of <300m there were 54 cases of dengue fever or 42.52% of the total cases. The sub-district with the most cases for this radius was the dug well in Nonohonis sub-district with a total of 20 cases and the sub-district with the fewest cases was Kobekamusa with the number of cases being 2 cases in the sub-district. In a radius of <500m there were 94 cases of .

dengue fever or 74.02% of the total cases. The sub-district with the most cases for this radius was the dug well in Nonohonis sub-district with a total of 26 cases and the sub-district with the fewest cases was Kobekamusa with the number cases namely 3 cases

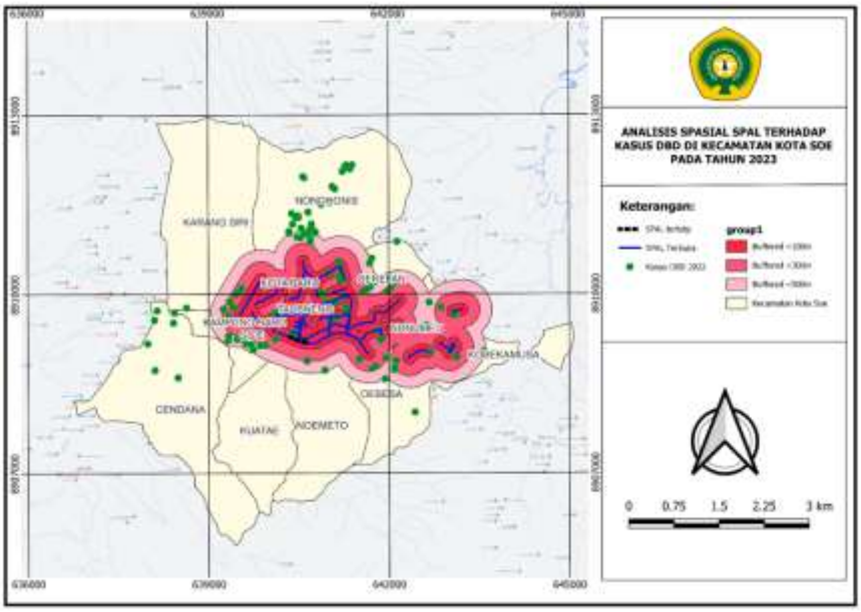

Figure 4 Spatial analysis of SPAL buffering of dengue cases in Kota Soe District in 2022

Based on the research results in Figure 4, it can be seen that the areas identified as having wastewater drainage channels in the research are around the sub-district, Kampung Baru, Taubneno sub-district, Kota Baru sub-district, Nunumeu sub-district, Oebesa sub-district, Oekefan sub-district, and Soe sub-district. The identified wastewater drainage conditions are open wastewater drainage channels and open wastewater drainage channels are found in all sub-districts identified as having wastewater drainage channels, while open wastewater drainage channels are in the Kampung Baru area. in a radius of <100m there were 35 cases of dengue fever or 27.56% of the total case locations, in a radius of <300m there were 58 cases of dengue fever or 45.67% of the total cases, and in a radius of <500m there were 87 cases of dengue fever or 68.50 % of total cases.

Discussion

Water reservoirs

Based on the results of research in the field, the presence of water reservoirs is one of the risk factors for mosquito breeding. The existence of water reservoirs is supported by the type of water source that is generally used by the community, namely regional drinking water companies which really need water reservoirs because the frequency of water flowing is once every 4 days. The potential for growth in water reservoirs is shown in research by Pertiwi & Bustomi (2021) which states that the existence of risky water reservoirs is significantly related to the presence of Aedes Aegypti mosquito larvae. In the community environment in Soe City sub-district, there are several factors that increase the risk of mosquito survival, namely: the type of water reservoir and the number of water reservoirs . (10)

Based on the research results, respondents in Soe City sub-district, the types of water reservoirs used by the community are generally open and closed as many as 75 (72.8%) of the residences and the type of water reservoirs is open as many as 27 (26.2%) of the residences are very potential for breeding mosquitoes. This is supported by research by Dewi & Sukendra, (2018) which shows that open water reservoirs have a 3.08 times greater risk of suffering from dengue fever than samples that have closed water reservoirs. This research is also in line with that conducted by Pertiwi & Bustomi (2021), the presence of water reservoir covers has an effect on mosquito breeding (p value = 0.004).(11)

Based on the research results, respondents in Soe City sub-district had a number of water reservoirs >3 was 103 (100%) people. This is supported by research by Lagu et al, (2017) which shows that houses with >3 water reservoirs have a risk of experiencing dengue fever because the large number of water reservoirs makes it possible for Aedes sp larvae to reproduce. This is in line with research conducted by Wisfer et al., (2020) that the more water reservoirs there are, the greater the chance of the presence of larvae compared to houses that have few water reservoirs.(12,13)

Based on the risk factors for mosquito breeding in water reservoirs, it can be concluded that the presence of water reservoirs is one of the risk factors for dengue fever in Soe City District. This condition is also a concern of the Soe City Community Health Center which can be shown by the fact that all the houses observed by researchers received larvicide to anticipate dengue fever cases that occurred in the Soe City sub-district.

Dig Wells

Based on the research results, the risk factors for dengue fever from dug wells are found in 9 sub-districts/villages, namely Nunumeu, Kampung Sabu, Nonohonis, Kobekamusa, Oekefan, Soe, Cendana, Kota Baru, Taubneno, and Oebesa. When observations were made, it turned out that there were no visible mosquito larvae in the dug well. However, the determination of dug wells as one of the breeding factors for dengue fever mosquitoes is based on research by Rosita et al., (2021) which states that wells have a risk of breeding Aedes Sp mosquitoes, especially those that have conditions that make life easier for mosquitoes such as conditions (open or closed) and depth (<15m or >15m) (3).

Based on the results of research on well types, there were 30 (96.8%) open wells, while 1 (3.2%) were closed wells. The open well type is usually at risk as a breeding place for the Aedes Sp mosquito. This is in line with research by Fauziah (2012) which shows that there is a relationship between the presence of surface covers on dug wells and the presence of Aedes aegypti mosquito larvae (p value 0.0001). Similar research was also shown by Irawan & Suryati, (2021) that the existence of a dug well without a cover has a risk of up to five times the incidence of dengue fever compared to one with a cover. (14,15)

Furthermore, based on research on well depths, it was found that well depths <15m were 27 (87.1%) of them, while well depths of >15m were 4 (12.9%) of them. At a depth of <15m there is a greater risk of being a breeding place for mosquitoes. This was shown in research by Yulianto, (2020) that the depth of the well is between ten and fifteen meters, the condition of the well is not exposed to direct sunlight, has calm water and has moss growing on the walls of the well which has the potential to become a breeding ground for dengue fever mosquitoes. The presence of moss will affect low light reflection which results in low water temperatures, making it a preferred place for mosquitoes to breed.

Meanwhile, at a well depth of >15 meters, the temperature and humidity are not suitable for mosquitoes to live optimally or mosquito eggs cannot hatch. A similar thing was also shown in research by Said (2019) in Irawan & Suryati, (2021), namely, the depth of a dug well can influence the temperature and humidity of the well so that it becomes a comfortable place for mosquitoes to lay their eggs.(16,17)

Apart from the two risk factors above, in the sub-districts of Nunumeu, Kampung Sabu, Nonohonis, Kobekamusa, Oekefan, Soe, Cendana, Kota Baru, Taubneno, and Oebesa the category of dug wells is located close to the location where dengue sufferers live. Based on spatial analysis of the buffering area in wells dug with a radius of <100m, there were 14 cases of dengue fever (11.02%), in a radius of <300m there were 54 cases of dengue fever (42.52%) and in a radius of <500m there were 94 cases of dengue fever (74.02%) of the total cases. This shows that the majority of dengue fever cases that occur in Soe City District are still within the flight radius of the Aedes Aegypty mosquito if dug wells become its breeding place(17). This was also shown in Lestanto's research (2018), namely that after the mosquitoes hatch, they usually stop in tallow, ornamental plants in the yard, yard plants, garden plants, which are close to human settlements (maximum distance of 500 m).(17,18)

Based on the risk factors for mosquito breeding in dug wells, it can be concluded that the presence of dug wells is one of the risk factors for dengue fever in Soe City District.

Waste Water Drain Channels

The results of the research show that the risk factor in the form of wastewater drainage canals is found in the area around Kampung Baru Village, Taubneno Village, Kota Baru Village, Nunumeu Village, Oebesa Village, Oekefan Village and Soe Village with fewer closed wastewater drainage channels than canals. open wastewater discharge. This is in line with research by Rismawari & Nurmala (2017) in Agustin, (2019), namely that the availability of open waste water drainage channels further supports the increase in the chances of dengue fever incidents increasing.(19)

During the rainy season, open wastewater drains can become a place for Aedes sp to lay their eggs. The results of the spatial analysis of buffering areas in waste water drainage channels showed that at a radius of <100m there were 35 cases of dengue fever or 27.56% of the total case locations, at a radius of <300m there were 58 cases of dengue fever or 45.67% of the total cases and at a radius of <500m there were 87 cases of dengue fever or 68.50% of the total cases. Apart from that, in Nonohonis Village most of the area is still bushes, empty land and trees, so there are few wastewater drainage channels, especially closed wastewater drainage channels. There is an open waste water drainage channel around the Oenasi River which flows in the middle of the Nonohonis sub-district. Closed wastewater drainage channels in Taubneno Village, Soe and Oebesa Villages are generally located around shop housing. Of the three sub-districts, the location where sufferers live is generally close to the location of an open waste water drainage channel.(20,21)

In open wastewater drainage channels at several research locations there is stagnant water. Waste water drainage channels include puddles made by human hands. Waste water drainage channels at the research location are generally exposed to sunlight. This situation does not support the reproduction of Aedes aegypti mosquito larvae. This situation is reinforced by the Guidelines for Ecology and Vector Behavior Aspects which state that the Aedes aegypti mosquito prefers standing water that is protected from direct exposure to sunlight.(22,23)

The water in the wastewater drainage channel at the research location is domestic waste, especially soapy water, detergent water and solid waste, especially plastic. This water cannot support the breeding ground for the Aedes aegypti mosquito. This is in accordance with Indonesian Ministry of Health regulation which states that the breeding place for the Aedes aegypti mosquito is clear water. The research results of Yulianti et al., (2020) stated that household wastewater, especially those containing soap and detergent, is not a suitable medium for the Aedes aegypti mosquito to lay its eggs. The results of research by Jacob et al (2022) state that Aedes aegypti can live in sewer water if the feces have settled (clear water).

Even though the location of the dengue sufferer's house is in the vicinity of a waste water drainage channel, it cannot be said that they are interconnected because the waste water drainage channel at the research location is still exposed to direct sunlight and the water is not clear. It is possible that there are other factors that support the transmission of dengue fever.(24)

Based on the description on the map of the location of waste water drainage channels and the residence of dengue fever sufferers, it can be seen that wastewater drainage channels do not have the potential to become breeding grounds for the Aedes aegypti mosquito, whether the wastewater drainage channels are open or closed.(22,23).

Conclusion

Based on the results of research conducted on environmental factors and the incidence of dengue hemorrhagic fever in Soe City District, it can be concluded that the existence and condition of air reservoirs with dengue fever incidents can be seen in data related to the number of water reservoirs used by the community which are left open and the number is >3, making it easier for mosquitoes to breed.

Even though the Spatial Classification Analysis states that the Nonohonis sub-district has the highest level of risk due to the large number of cases, the Autocorrelation Analysis states that the Oekefan area has larger cluster points than the Nonohonis sub-district. So the area that has the greatest risk of dengue fever due to the presence of water reservoirs is Noohonis Village. This condition is the basis for water storage as a risk factor for dengue fever in the Soe City sub-district

Another environmental factor such as the existence and condition of dug wells with dengue cases can be seen in the data which states that the majority of dug wells in the Soe City sub-district have a depth of ≤15m with closed conditions, making it easier for mosquitoes to breed. Apart from that, based on the buffer data above, it can be seen that at a radius of <100m there were 14 cases, while at a radius of 100 to a radius of <300m there were 42 cases, which indicates that at this radius the risk of dengue fever is 3 times greater than at a radius of <100m. Furthermore, in a radius of 300m to a radius of <500m there were 38 cases, which indicates that in this radius the risk of dengue fever is 2.7 times greater than in a radius of <100m. This condition shows that people who are close to dug wells have good dengue management methods and immune systems or that people who are in a buffer of >100m have other risk factors. In Nonohonis Village itself, although there are only two wells, those with a radius of <300m cover most of the cases. This condition is the basic risk factor for the existence of dug wells as a breeding ground for mosquitoes.

Furthermore, the existence and condition of waste water drainage channels (SPAL) with dengue fever incidents generally located around Kampung Baru Village, Taubneno Village, Kota Baru Village, Nunumeu Village, Oebesa Village, Oekefan Village, and Soe Village. Even though there are many SPALs in the Soe City District, the existing SPALs are in an open condition. Based on the buffer data above, it can be seen that at a radius of <100m there were 35 cases, while at a radius of 100 to a radius of <300m there were 23 cases, which indicates that at this radius the risk of dengue fever is 0.6 times greater than at a radius of <100m. This condition states that at greater distances the risk of dengue fever cases decreases. Furthermore, in a radius of 300m to a radius of <500m there were 29 cases which indicates that in this radius the risk of dengue fever is 0.8 times greater than in a radius of <100m. This condition is different from the comparison situation at a radius of 100 to a radius <300m which increases more. This condition has an impact because in that radius there are many individuals who are susceptible to dengue fever or there are additional risk factors for dengue cases in that radius. Furthermore, the area with the largest number of dengue fever cases, namely Nonohonis, has the lowest number of SPALs. However, around the Nonohonis area, there are many dead rivers that have the potential to become breeding grounds for mosquitoes because the larvae have no natural predators.

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