

The Spatiotemporal Analysis of Dengue Fever in Purwosari District, Gunungkidul Regency, Indonesia

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Abstract From 2014 to 2016, the number of prevalence of Dengue Hemorrhagic Fever (DHF) and deaths associated with DHF in Indonesia increased. DHF fatal cases were also reported from three administrative units in the Special Region of Yogyakarta, namely Bantul Regency, Gunungkidul Regency, and Yogyakarta City. Two related deaths in Purwosari, a district in Gunungkidul, raised the status of DHF to an outbreak. This study was designed to characterize the spread pattern of DHF in its endemic areas in Purwosari District using the retrospective method, anamnesis, in-depth interviews, Geographic Information System (GIS), and environmental analysis. The kernel density estimation revealed that in 2011-2017, DHF was concentrated in four villages, namely Giriasih, Giricahyo, Giritirto, and Giripurwo. There was a correlation between DHF incidents and physical geographical features of these villages, including proximity to water sources, high vegetation density, elevation, humidity, and rainfall, which created habitats for mosquito growth. A high incidence of DHF has been observed in children (50.8%) and students (57.4%), with most cases (78.7%) showing typical symptoms of the disease. A few of the 61 cases in the district developed into dengue shock syndrome (DSS) and led to death (4.9%), mainly because the public was unable to recognize the warning signs of DHF early and had limited knowledge of required management therapy. Moreover, the preventive or precautionary measures known as the 3M-Plus were not fully implemented yet.

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1. Introduction

In the last 50 years, there has been a 30-fold increase in cases of dengue fever, reaching up to 50 million patients each year. Around 70% of the population in the Asia Pacific, especially in developing countries such as the Philippines, Indonesia, Vietnam, and Thailand, are at risk of dengue fever (Duncombe *et al.*, 2012). In Indonesia, 100,347 cases of dengue hemorrhagic fever (DHF) and 907 related fatalities were reported in 2014. This figure increased to 129,650 cases that resulted in 1,071 deaths in 2015 and to 202,314 cases with 1,593 deaths in 2016 (Departemen Kesehatan RI, 2018).

In the Special Region of Yogyakarta, paying closer attention to the occurrence of DHF throughout the year is essential as it is endemic in the region (Dinas Kesehatan Pemerintah Kota Yogyakarta, 2015). In 2016, 6,247 cases

were reported with 26 deaths or a fatality rate of 0.42%. Meanwhile, back in 2011, there were records of DHF-related deaths in three administrative units in the region, including Bantul Regency, Gunungkidul Regency, and Yogyakarta City (Dinas Kesehatan Provinsi D.I. Yogyakarta, 2012).

As publicized in the Gunungkidul Health Service report, there was no record of DHF cases in Purwosari, a district in Gunungkidul Regency, in 2011. However, it changed as two cases of DHF led to one fatality in 2012, marking the start of an outbreak in the district. Afterward, the incidents of DHF continued to occur in Purwosari District at least until the latest official report in 2017.

DHF outbreaks are associated with various risk factors, namely (1) suitable environment for the breeding site of Ae-

des mosquito, (2) low public awareness of eradication of mosquito nests through the preventive measures known as 3M-Plus, (3) expansion of endemic areas because environmental changes and modifications intensify with urbanization and the construction of new residential areas, and (4) increased population mobility (Kementerian Kesehatan Republik Indonesia, 2016). In 2016, up to 20,713 people lived in Purwosari District where a high intensity of in- and out-migration takes place. At the same time, densely vegetated land received high rainfall during the rainy season. These factors preconditioned the DHF outbreaks in Purwosari District.

Geographic Information System (GIS) will help identify the spread pattern of DHF in the study area. Endemicity and spread pattern are attributable to surface water conditions and climatic factors, which are temperature, rainfall, humidity, and wind (Soegijanto, 2004). A physical environmental analysis can determine the environmental risk factors of DHF outbreak. Based on the DHF case report acquired from the Office of Health Service and community health center, the extent and direction to which DHF spreads need to be mapped. This paper characterizes the distribution patterns based on physical environments, risk factors, and community habits against dengue fever in 2011-2017, as observed from the applied precautionary and promotive efforts and early detections to break the chain of DHF endemicity and mortality in Purwosari.

2. The Methods

This observational and descriptive research employed several methods: (1) retrospective approach to search for any DHF incidence in Purwosari District in 2011-2017 through the case reports issued by the Office of Gunungkidul Health Service and the district's healthcare center, (2) anamnesis and in-depth interview to obtain demographic data of patients, clinical details, and community behavior toward DHF, (3) spatiotemporal analysis using GIS to identify DHF distribution from 2011 through 2017, and (4) physical analysis to process data of rainfall, temperature, humidity, elevation, vegetation density, and proximity to water sources that were obtained from field observations and secondary data analysis.

For the interview, the respondents were determined from a census of DHF patients. The main observed parameters during the in-depth interview were (1) demographic data (i.e., age, sex, education level, occupation, and marital status), (2) clinical data (i.e., clinical symptoms, place of care, time-lapse between the fever onset and the start of treatment, length of hospital stay, diagnosis, patient outcomes, and laboratory examination results), (3) DHF-preventive behavior, (4) transmigration patterns of DHF patients and the people in their surroundings, and (5) the number of water reservoirs with or without apparent mosquito larvae. These data were

recorded in a questionnaire and then analyzed by descriptive methods.

The GIS analysis was spatiotemporal and used a time-series map of yearly cases of dengue fever to determine the distribution patterns of the disease. In addition to annual distribution, the analysis also utilized the spatial analysis tools, namely kernel density. This feature estimated the trend of DHF cases based on their density (Davies *et al.*, 2011; Shi *et al.*, 2013; Aziz *et al.*, 2014). GIS-based analysis and processing were executed in ArcGIS 10.3. The locations of the DHF patients were recorded during the field survey using a Global Positioning System (GPS).

The environmental analysis emphasized on the relationship between the living requirements of mosquitoes and the physical conditions in the district, including climate (temperature and humidity), geomorphology (elevation), vegetation density, and distance from house to water sources (ponds, river, and springs). The secondary climatic data were temperature, humidity, and rainfall in the last five years; all of which were interpolated with different geostatistical analysis tools, and the selected interpolation technique was the one producing the smallest RMS error (Ohmer *et al.*, 2017). The geomorphological analysis processed elevation data extracted from the Digital Elevation Model (DEM). As for the vegetation density, the investigation was based on field observations (qualitative) and satellite imagery (quantitative). The environmental and GIS analyses were carried out descriptively and correlated with the living requirements of the carrier mosquitos and the location of DHF incidents. In this study, the relationship between dengue fever prevalence and environmental factor is analyzed using SaTScan v9.6. The result will show the dengue distribution is clusterly or randomly distributed (Coleman *et al.*, 2009).

Purwosari District is located in Gunungkidul Regency, part of the Special Region of Yogyakarta, Indonesia (Figure 1). It lies between 110°20'00"-110°25'00"E and 7°58'30"-8°4'30"S and covers an area of 67.97 km² with five villages, namely Girijati, Giricahyo, Giriasih, Giritirto, and Giripurwo. This district has a population of 20,713 people, with a density of 2.73 people per ha (BPS Kabupaten Gunungkidul, 2017). Generally, it receives 2300-2400 mm of rainfall per year (Brunsch *et al.*, 2011) and has an average temperature of 27°C (Haryono and Day, 2004).

Purwosari District lies in a karst region designated as the Gunungsewu Geopark (Haryono and Suratman, 2010) with morphological slopes varying between 15 and 20°. The land area is mostly used for dry agricultural practices (5,403.35 ha), whereas only small parts of it are utilized as rice field (180.30 ha), forest (319.76 ha), and settlement (466.81 ha) (BPS Kabupaten Gunungkidul, 2017).

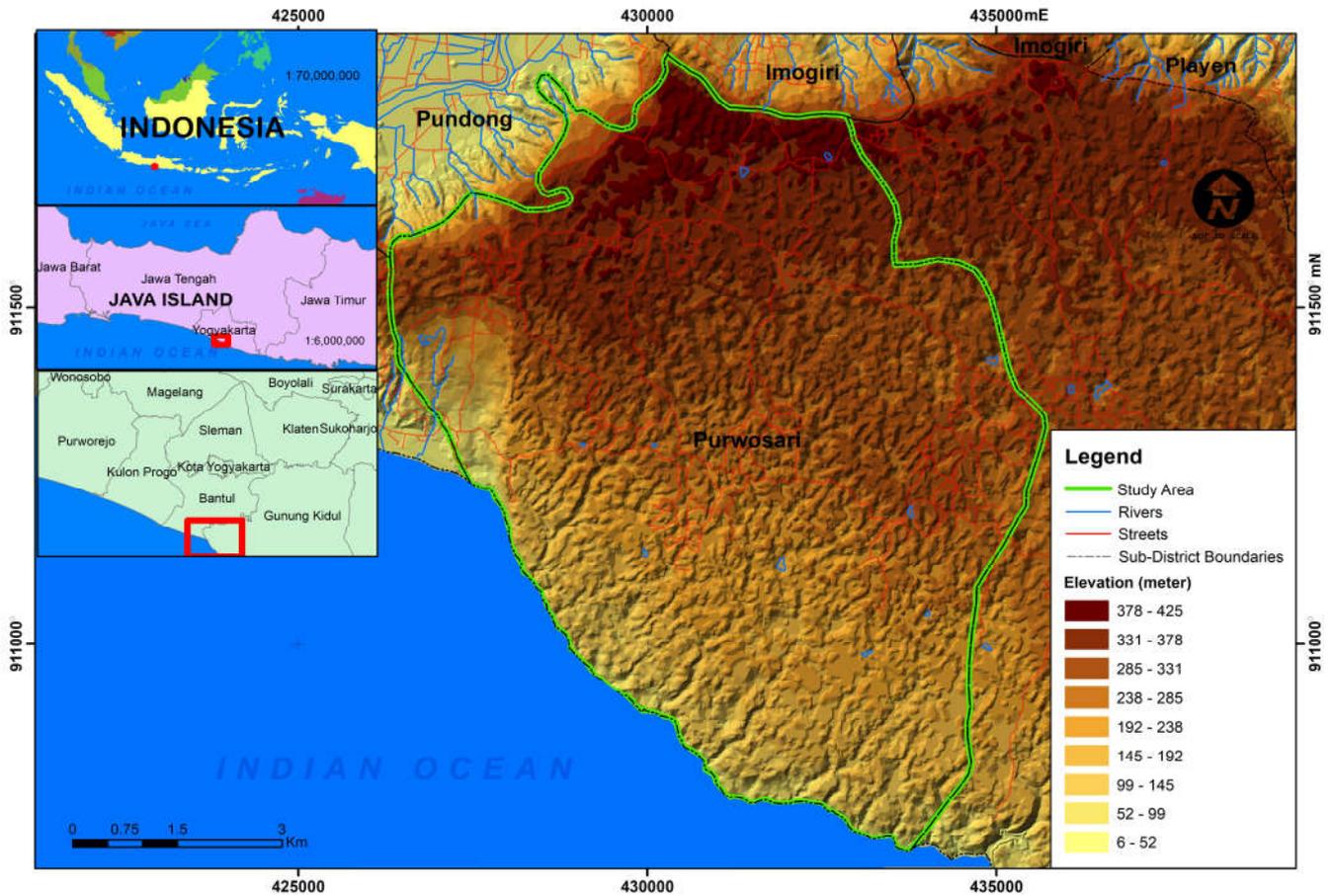


Figure 1. The map of the study area

3. Results and Discussion

The surveillance of DHF from 2011 to 2018 revealed that there were 61 cases in five villages, namely Girijati, Giricahyo, Giriasih, Giritirto, and Giripurwo. The highest incidence, i.e., 21 cases, occurred in 2013, with Giritirto Village having the most considerable number of DHF cases in 2011-2017 (Figure 2). The kernel density estimation generated the spatiotemporal distribution and repetition patterns of DHF incidence in the study area, as presented in Figure 3. DHF was found to primarily cluster in four villages, namely Giriasih, Giricahyo, Giritirto, and Giripurwo.

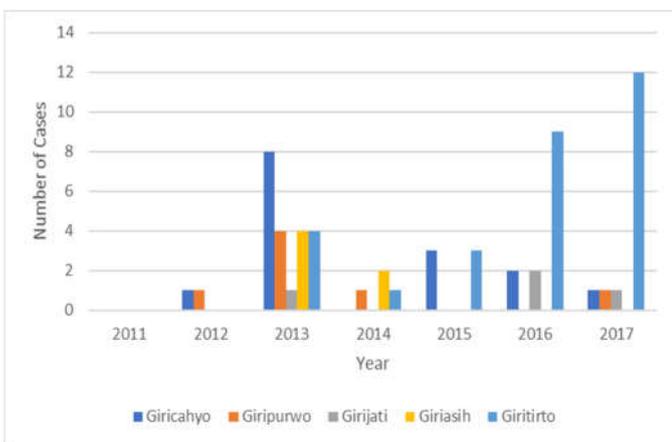


Figure 2. The number of dengue hemorrhagic fever (DHF) cases in Purwosari District, Gunungkidul Regency, the Special Region of Yogyakarta in 2011-2017

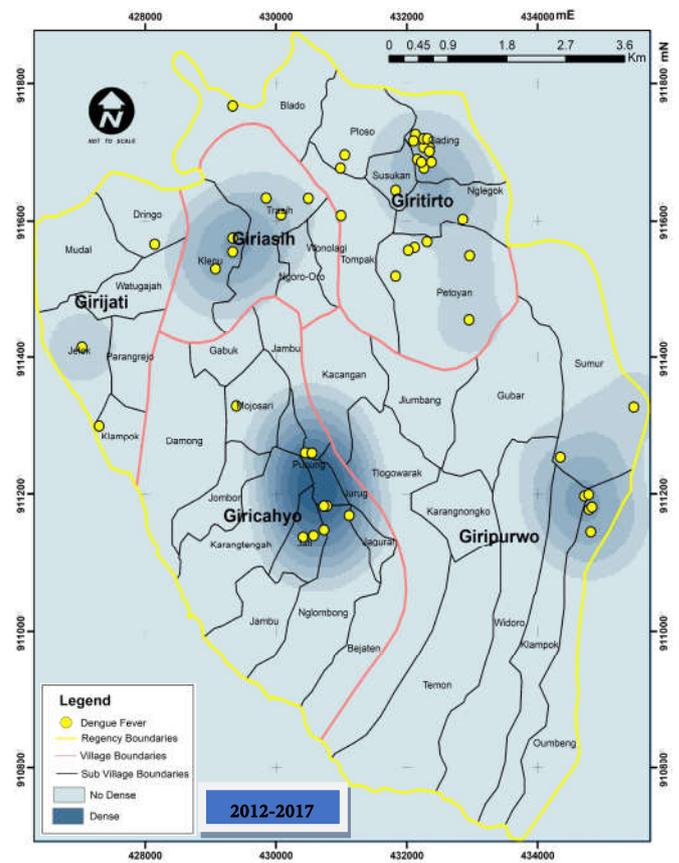


Figure 3. The maps of dengue hemorrhagic fever (DHF) incidents produced by kernel density estimation in Purwosari District in 2011-2017

A more detailed analysis at the sub-village level showed that the incidence was centered at Trasih and Klepu Hamlets (parts of Giriasih Village), Jambu, Jati, and Nglombong Hamlets (Giricahyo Village), and Gading, Ploso, and Pe-toyan Hamlets (Giritirto Village). The GIS-based analysis provides information on the DHF distribution patterns and deduces the endemic regions (Chu *et al.*, 2013; Castillo *et al.*, 2011; Panthwer *et al.*, 2017).

The second step in the physical environmental analysis attempted to identify whether the geographical features were suitable for the life cycle of DHF-carrier mosquitos. The parameters included elevation, rainfall, humidity, temperature, distance to water sources, and vegetation density. The elevation data was analyzed from the Digital Elevation Model (DEM) of Purwosari District, which is located at 150-400 m a.s.l. (Figure 4-left). Giritirto, Giriasih, and Girijati have varying elevations from 280 to 400 m, while Giricahyo and Giripurwo are situated on lower terrains between 61-280 m. These elevations are suitable for the living and breeding conditions of DHF-carrier mosquitos, i.e., 0-1700 m (Lozano-Fuentes *et al.*, 2012; Gama *et al.*, 2013; Moreno-Madrinan *et al.*, 2014). Accordingly, more occurrences dengue fever were reported from higher altitudes in the district. Giritirto has the highest elevation and, at the same time, the most significant number of DHF (29 cases), indicating a correlation between elevation and DHF incidents.

The temperature analysis from the records of the meteorological stations showed that the temperature of the district ranged from 26 to 28°C (Figure 4-right). Girijati, Giriasih, Giritirto, Giricahyo, and part of Giripurwo had an average temperature of 27-28°C, while the other part of Giripurwo had an average temperature of 26-27°C. This range of temperature meets the living and breeding conditions of DHF-carrier mosquitos, that is, 20-30°C (Gomes *et al.*, 2012; Ehelepolo *et al.*, 2015; Jemal and Al-Thukair, 2016). An environment with lower or higher temperatures than this classification can inhibit the growth and multiplication of the carrier mosquitos.

The rainfall analysis used a five-year data and found that the regional rainfall of Purwosari District was approximately 2000-2200 mm/year (Figure 5-left). The rainfall distribution was divided into two zones, namely (1) 2,100-2,200 mm/year of rainfall that covered Girijati, Giriasih, Giricahyo, part of Giritirto, and part of Giripurwo and (2) 2,000-2,100 mm/year of rainfall in the other parts of Giritirto and Giripurwo. With this amount of rain, the physical condition of the district allows DHF-carrier mosquitos to multiply and grow. The larvae, pupae, and mosquitos that carry and transmit DHF thrive in tropical regions with an average rainfall of 2000-3000 mm/year (Paul and Tham, 2015; Edirisinghe, 2017; Chanprasopchai *et al.*, 2017). Rainfall positively correlates with humidity. The analysis results showed that more cases of DHF were reported from areas receiving higher annual rainfall.

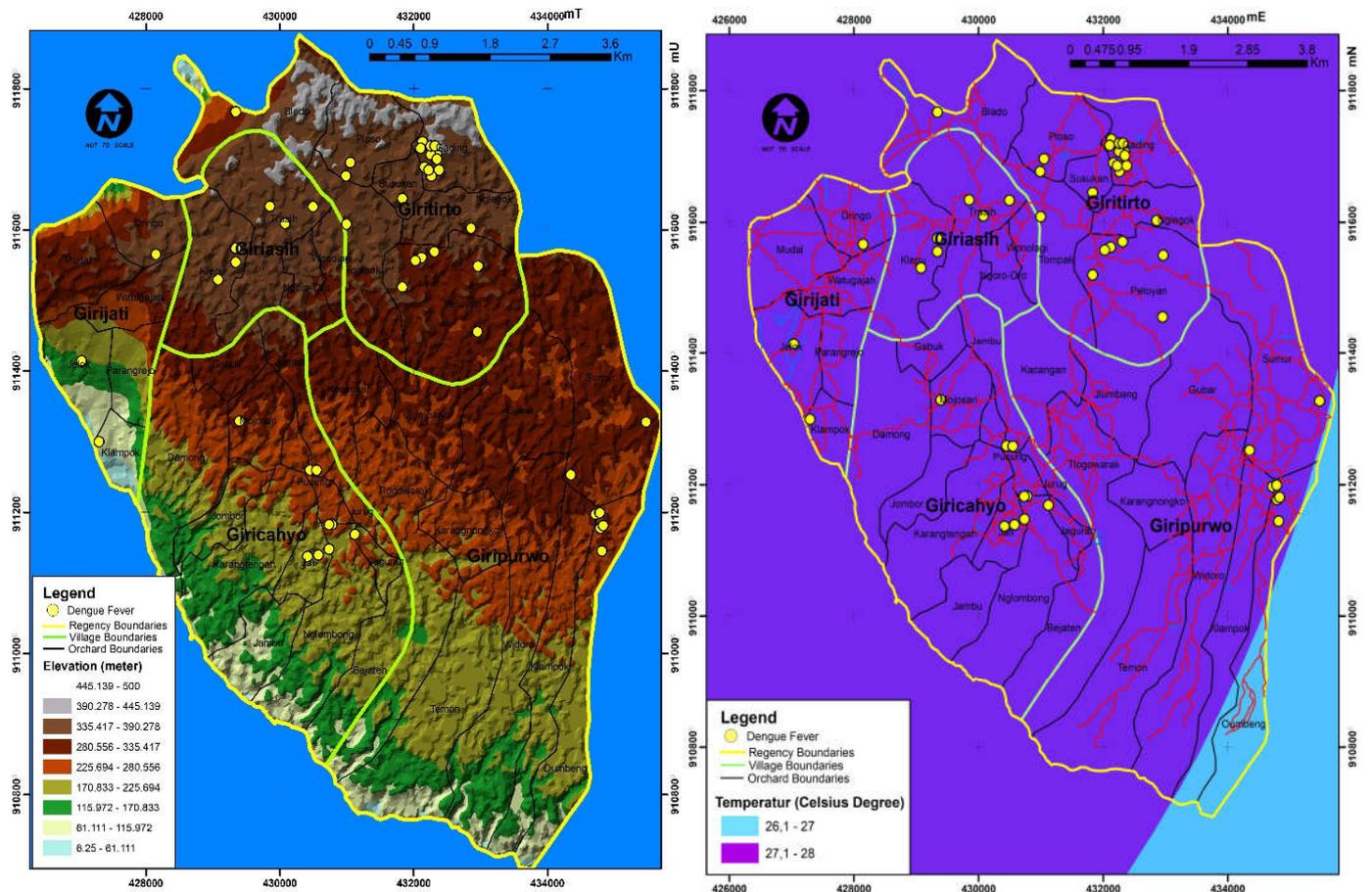


Figure 4. The elevation (left) and temperature (right) distribution in Purwosari District

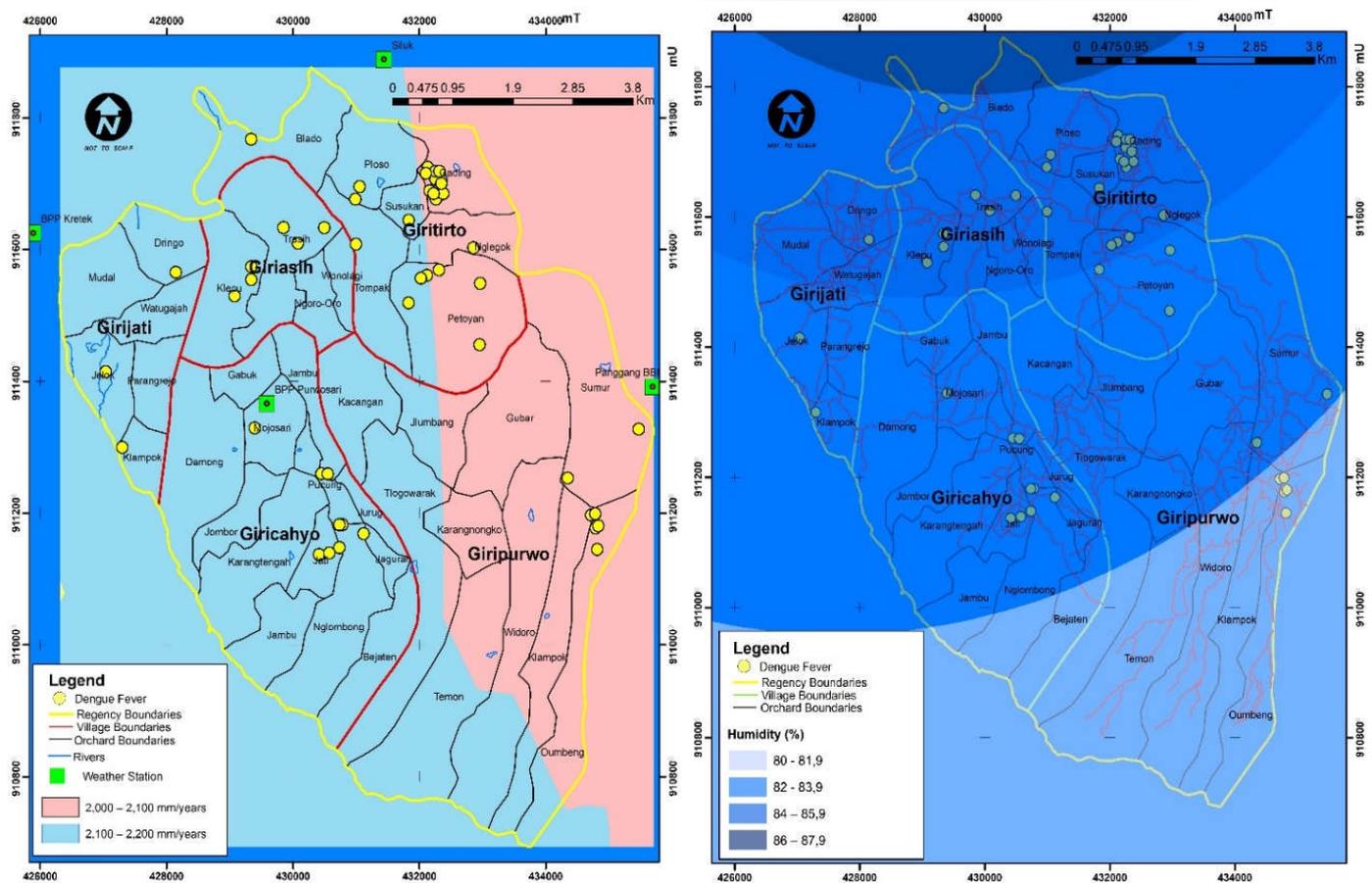


Figure 5. The rainfall (left) and humidity (right) distribution in Purwosari District

The meteorological station also gauges humidity, and the analysis results showed that the humidity of the district ranged from 80 to 87% (Figure 5-right). The humidity of Girijati, Giriasih, and Giritirto was 85-87%, while that of Giricahyo and Giripurwo was 80-85%. At this range, the entire district is the right place for DHF-carrier mosquitoes to grow, that is, 60-90% (Al-Ghamdi *et al.*, 2009; Gu *et al.*, 2016; Ruzman and Rahman, 2017). The higher the humidity, the better the growth and the longer the life span of these mosquitoes are. As a conclusion, the cases of DHF in Purwosari District increase with humidity.

Based on the buffer analysis results, the distance from home to water sources correlated with the incidents of DHF. The 400m and 1000m buffers from rivers, ponds, and springs indicated that nearly all cases of DHF in Girijati, Giricahyo, Giritirto, and Giripurwo were within the buffer areas (Figure 6-left). The abundance of surface water provides potential areas for DHF-carrier mosquitoes to breed and spread (Cheong *et al.*, 2014; Tiong *et al.*, 2015; Dom *et al.*, 2016). Moreover, the buffer analysis is useful to determine the movement of these mosquitoes. These mosquitoes can move at least 200 m and up to 1000 m (Tsuda *et al.*, 2001; HonÓrio *et al.*, 2013; Alshehri, 2013) depending on the direction of the wind. Several DHF incidents in the district took place outside the generated buffers, namely in Giriasih and Giritirto Village. It is potentially the result of the in-migration of infected patients from outside the region (Table 3).

Based on the satellite imagery, all villages in the district have high vegetation density (Figure 7-left), and the land is dominantly used for plantations and dry agricultural fields (Figure 7-right). Field survey on several samples of vegetation density (Girijati and Giricahyo Village) proved that the residential areas infected by DHF were adjacent to thickly vegetated plantations (Figure 7-right). Because the entire Purwosari District has dense vegetation, it creates suitable living and breeding areas for the carrier mosquitoes. Dry agricultural fields and multiple-species plantations are habitats where mosquitoes can lay their eggs and forage from plant nectars (Sarfranz *et al.*, 2012; Cheong *et al.*, 2014; Tiong *et al.*, 2015). There is a correlation between vegetation density, land use, and DHF incidents in Purwosari District.

The analysis results indicate that environmental factors create an endemic area of DHF. The most influencing factors are temperature, rainfall, temperature, elevation, and proximity to water sources (springs, rivers, and ponds), which cannot be treated nor changed. Any environmental shifts can only occur over a geological timescale, except for climate change that alters temperature, humidity, and rainfall patterns (Hugget, 2011; Boyce & Lee, 2017; Sur *et al.*, 2010).

The analysis showed that clustered patterns are distributed in north, centre, and south area (Figure 8). In north area, the occurrence is centered in Giritirto, center of Giriasih, south of Giripurwo and Giricahyo (Table 1). The patterns are concentrated in those regions because the

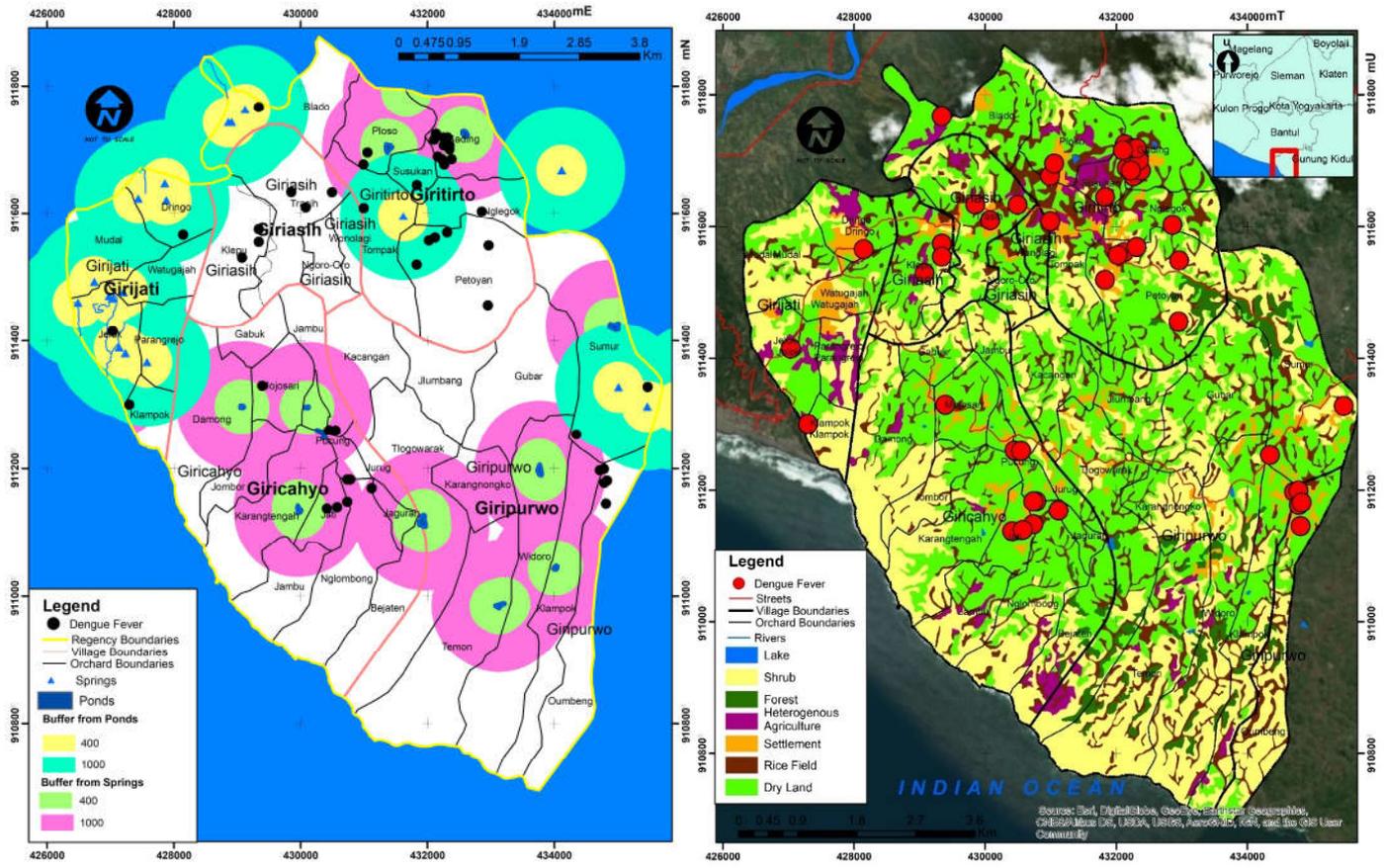


Figure 6. Buffer areas from springs and ponds (left) and the land use (right) in Purwosari District

Table 1. Autocorrelation of Dengue Fever in Purwosari

Years	Clustered	Random
2012	1	1
2013	19	2
2014	3	1
2015	4	2
2016	5	8
2017	9	6

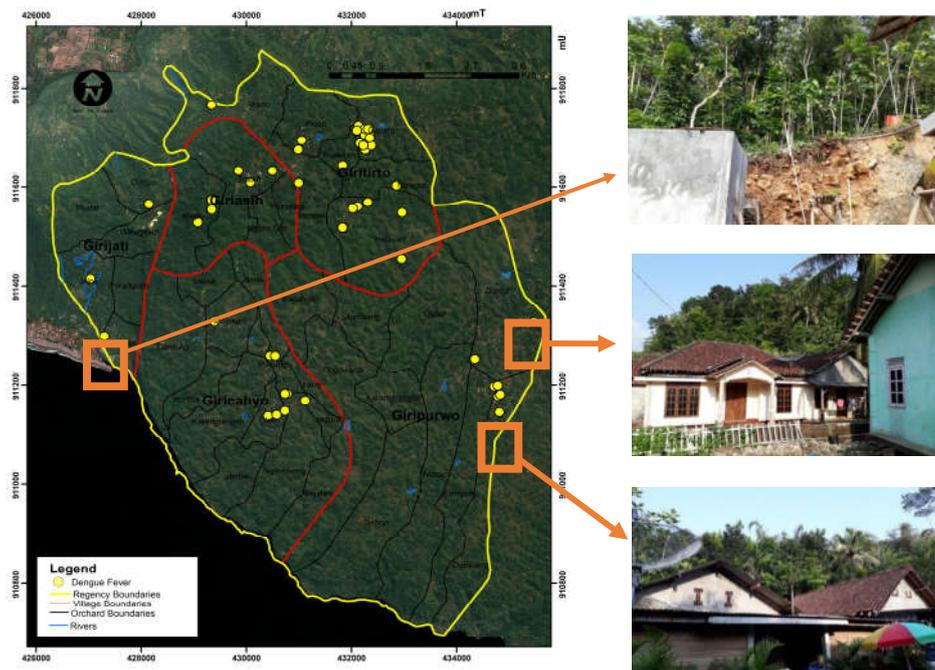


Figure 7. The SPOT image of Purwosari District (left) and pictures taken during the field survey of vegetation density (right)

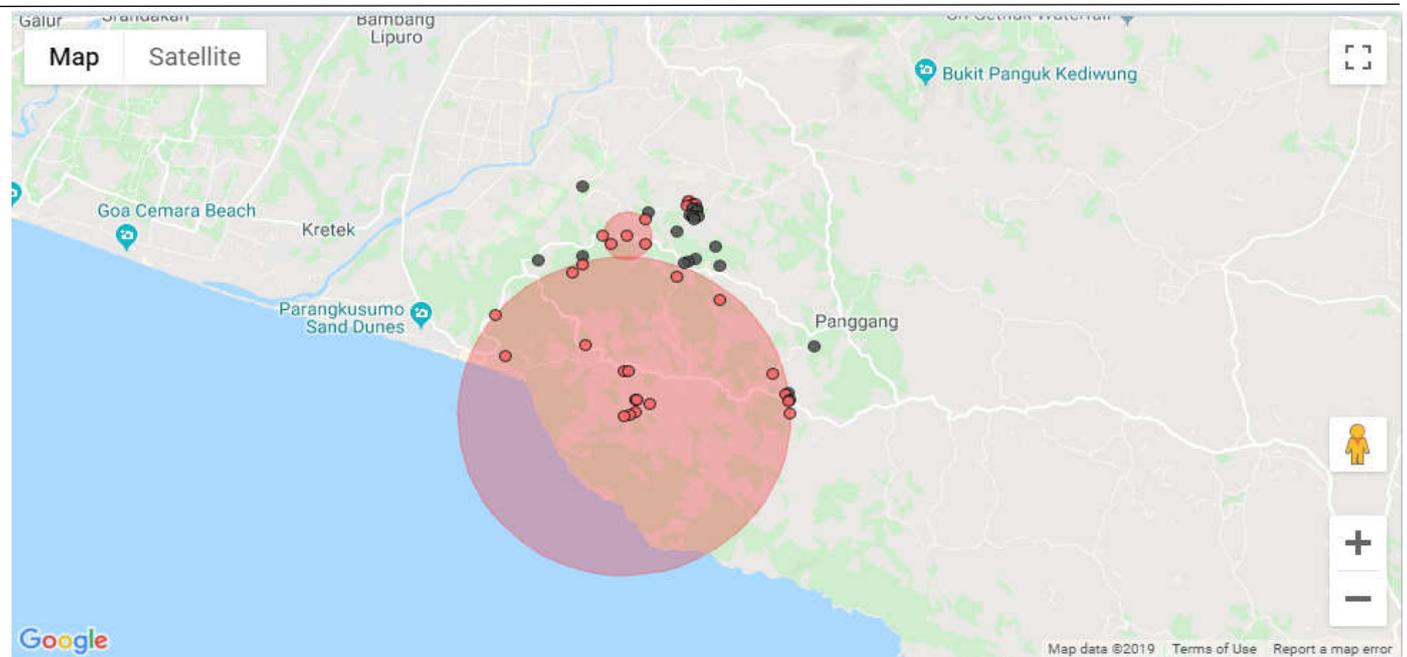


Figure 8. The clustered and random dengue distribution in Purwosari

Table 2. The demographic characteristics of DHF patients in Purwosari District, Gunungkidul Regency, the Special Region of Yogyakarta in 2011-2017

Demographic Characteristics	2011	2012	2013	2014	2015	2016	2017	Total
Sex								
Female	0	1	14	1	3	5	6	30 (49.0%)
Male	0	1	7	3	3	8	9	31 (51.0%)
Age								
Children	0	0	13	2	3	6	7	31 (50.8%)
Adolescents	0	1	6	2	3	6	5	23 (37.7%)
Adults	0	0	2	0	0	0	2	4 (6.6%)
Elderly	0	1	0	0	0	1	1	3 (4.9%)
Occupation								
Unemployed	0	1	4	1	1	4	3	14 (23.0%)
Students	0	0	13	3	4	7	8	35 (57.4%)
Farmers	0	1	0	0	0	1	3	5 (8.2%)
Employees	0	0	4	0	0	0	0	4 (6.5%)
No Data	0	0	0	0	1	1	1	3 (4.9%)
Marital Status								
Married	0	1	1	0	0	4	5	11 (18.0%)
Not Married	0	1	20	4	6	9	10	50 (82%)
Educational Level								
Elementary School	0	1	9	2	3	10	9	34 (55.7%)
Junior High School	0	0	3	0	1	0	2	6 (9.8%)
Senior High School	0	1	2	1	1	2	2	9 (14.8%)
Higher Education	0	0	1	0	1	1	0	3 (24.2)
Do not attend school	0	0	6	1	0	0	1	8 (13.1%)
No Data	0	0	0	0	0	0	1	1(1.6%)

settlements also concentrate in karst area and near the water sources (lake and springs). In other hand, the random patterned is created because the settlements in those area are randomly distributed but still near the water sources. The settlements have dense vegetation, temperature, rain fall, humidity which are suitable and support the breeding process of *Aedes aegypti*. The result show that

environmental factors are contributed to dengue fever endemicity, this condition is strengthened by the wide range of the clustered dengue occurrence (Rejeki *et al.*, 2019).

The characteristics of DHF patients support the results of GIS-based and environmental factor analyses. DHF cases seemed to affect all levels of society, and both men and women with similar percentage, namely 49% and 51%. However,

Table 3. The clinical characteristics of DHF cases in Purwosari District, Gunungkidul Regency, the Special Region of Yogyakarta in 2011-2017

Clinical Characteristics	2011	2012	2013	2014	2015	2016	2017	Total
Showing typical symptoms of DHF*								
Yes								
No	0	2	13	4	6	11	12	48 (78.7%)
No data	0	0	3	0	0	1	0	4 (6.6%)
	0	0	5	0	0	1	3	9 (14.8%)
Status of treatment								
Inpatient	0	2	20	4	5	12	12	55 (90.2%)
Outpatient	0	0	0	0	0	0	1	1 (1.6%)
No data	0	0	1	0	1	1	2	5 (8.2%)
Length of stay at the hospital								
≤ 7 days								
> 7 days	0	0	12	3	4	9	12	40 (65.6%)
No data	0	2	3	1	1	3	1	11 (18.0%)
	0	0	6	0	1	1	2	10 (16.4%)
Time-lapse between the onset of fever and hospitalization								
≤ 3 days	0	1	7	3	1	0	7	19 (31.1%)
4-7 days	0	1	7	0	2	9	5	24 (39.3%)
> 7 days	0	0	1	1	2	3	0	7 (11.5)
Not hospitalized	0	0	0	0	0	0	1	1 (1.6%)
No data	0	0	6	0	1	1	2	10 (16.4%)
Diagnosis								
DHF	0	1	20	4	5	13	15	58 (95.1%)
DSS	0	1	1	0	1	0	0	3 (4.9%)
Cases								
Alive	0	1	20	4	5	13	15	58 (95.1%)
Death	0	1	1	0	1	0	0	3 (4.9%)
Same-household transmission								
Yes	0	0	5	0	0	4	5	14 (23.0%)
No	0	2	11	4	6	8	2	33 (54.0%)
No data	0	0	5	0	0	1	8	14 (23.0%)
Source of cases								
Local	0	2	15	3	4	8	6	38 (62.3%)
Outside	0	0	1	1	2	4	7	15 (24.6%)
No data	0	0	5	0	0	1	2	8 (13.1%)

Table 4. The follow-up examinations to establish the diagnosis of dengue hemorrhagic fever in 2011-2017

Laboratory Examinations	Positive	Negative	No data
Decreased platelet counts	48	0	13
Anti-dengue IgG	16	1	44
Anti-dengue IgM	15	2	44
NS1	1	1	59

there were trends in age and occupation; both of which are intercorrelated. DHF mostly infected children (50.8%) and students (57.4%) (Table 2). Based on the in-depth interviews, patients' family (pediatric patients and students) reported that DHF had infected many students in one school before it spread to the other children.

Based on the in-depth interviews with patients and their families and case reports, DHF cases in Purwosari District exhibit specific clinical characteristics. More than two-thirds (78.7%) of the patients showed typical symptoms of DHF, namely sudden high fever that lowers only with medication and is accompanied by nausea or vomiting, dizziness, headache, pain behind the eyes, muscle aches, and signs of spontaneous bleeding like nosebleeds, bleeding gums, black or bloody vomits, and black-colored feces. Almost all patients were hospitalized (90.2%) with the most prolonged stay of ≤ 7 days (65.6%), and many of them consulted physicians after four to seven days from the onset of fever (39.3%). Among the 61 cases of DHF, two infected children and one elderly patient developed Dengue Shock Syndrome (DSS), leading to one fatality (4.9%). Not all cases in the district were locally originated because 24.6% of them were infected in other areas before returning to Purwosari. Also, 54.0% of these cases were the results of disease transmission from other DHF-infected members of the same household (Table 3).

The reports from the Gunungkidul Health Office, the district healthcare center, and patients or their families signified that only three follow-up examinations were performed to determine the diagnosis of DHF, including (1) routine blood tests to identify a decrease in platelet counts, (2) antibody tests against dengue, namely IgG and IgM, and (3) NS1 antigen assays. Unfortunately, due to inadequate reports and records of DHF cases and reliance on patients' ability to remember, only a few patients were diagnosed. The results of

the follow-up examinations and corresponding diagnosis are presented in Table 4.

The combination of anamnesis, physical examinations, and follow-up examinations is essential to decide the diagnosis of DHF, and early detection is expected to prevent the development of DSS and eradicate DHF-related mortality. To achieve a good anamnesis, physicians need to ask every patient suspected of DHF about the experienced clinical characteristics of DHF because all of the official case reports and information submitted by patients and their families suggested that in 78.7% cases, the patients exhibited typical symptoms of DHF. The best but most frequently forgotten physical examination to diagnose DHF is the Rumpel-Leede test, whose positive value further confirms the diagnosis of DHF. In Indonesia, DHF examination mostly includes IgG and IgM antibody tests against DHF and NS1 antigen assays. Although these tests have high sensitivity and specificity to the diagnosis of DHF, they have several weaknesses. Both IgG and IgM antibodies are detectable by Day 5 after the onset of fever; hence, early examination tends to give a false negative result. Meanwhile, the NS1 antigen is detectable within 1 to 3 days after the onset of fever, but afterward, the assays are likely to give a false negative result. Clinics often forget one easy and straightforward examination that can be performed even in primary health services, namely the peripheral blood test. This test measures platelet and blue plasma lymphocyte counts and characterizes the morphology of erythrocytes. Blue plasma lymphocyte is a form of lymphocyte reactions to dengue infection. If it is more than or equal to 4%, then its sensitivity and specificity on Day 4 are 68% and 86%, while on Day 5, they are 81% and 83%, respectively (Sutaryo, 1991).

Nevertheless, not every case of DHF in Purwosari District was locally originated. As many as 15 cases came from outside of the district (Table 3). Based on the statements

Table 5. Transmigration data of DHF patients in Purwosari District in 2011-2017

Transmigration Data	2011	2012	2013	2014	2015	2016	2017	Total
Patients leaving in the last 2 weeks or when ill								
Yes								
No	0	0	4	1	2	5	5	17 (27.9%)
No data	0	2	12	3	4	7	8	36 (59.0%)
	0	0	5	0	0	1	2	8 (13.1%)
Patients' family leaving in the last 2 weeks								
Yes								
No	0	0	2	1	0	3	3	9 (14.8%)
No data	0	2	14	3	6	9	10	44 (72.1%)
	0	0	5	0	0	1	2	8 (13.1)
Relatives or guests staying in the last 2 weeks or when patients are ill								
Yes								
No	0	0	1	0	1	3	1	6 (9.8%)
No data	0	2	15	4	5	9	12	47 (77.1%)
	0	0	5	0	0	1	2	8 (13.1)

Table 6. The 3M-Plus behavior of the DHF patients in Purwosari District in 2011-2017

3M-Plus Behaviors	2011	2012	2013	2014	2015	2016	2017	Total
Draining water reservoirs								
Yes	0	0	9	3	5	12	9	38
No	0	2	7	1	1	0	4	15
No data	0	0	5	0	0	1	2	8
Closing water reservoirs								
Yes	0	0	6	2	6	10	5	29
No	0	2	10	2	0	2	8	24
No data	0	0	5	0	0	1	2	8
Recycling used items								
Yes	0	0	3	4	6	4	1	18
No	0	2	13	0	0	8	12	35
No data	0	0	0	0	0	1	2	8
Sowing abate powder to water reservoirs								
Yes	0	1	4	4	2	4	4	19
No	0	1	12	0	4	8	9	34
No data	0	0	0	0	0	1	2	8
Applying mosquito repellent lotion, incense, spray, or electric diffuser								
Yes	0	2	7	2	4	4	7	26
No	0	0	9	2	2	8	6	27
No data	0	0	0	0	0	1	2	8
Setting up mosquito nets								
Yes	0	1	10	1	3	6	5	26
No	0	1	6	0	3	6	8	24
No data	0	0	0	0	0	1	2	8
Releasing mosquito larva eaters to water reservoirs								
Yes	0	1	14	3	3	3	2	26
No	0	1	2	1	3	9	11	27
No data	0	0	0	0	0	1	2	8
Planting mosquito repellent plants in the yard								
Yes	0	0	0	4	1	0	1	6
No	0	2	16	0	5	12	12	47
No data	0	0	0	0	0	1	2	8
Improving room lighting and ventilation								
Yes	0	2	0	0	2	9	7	26
No	0	0	16	4	4	3	6	27
No data	0	0	0	0	0	1	2	8

given by patients and their families, patients contracted DHF during their stay outside the district, and when they felt very sick, they returned home. The transmigration patterns of DHF patients (27.9) support this assertion. Furthermore, some members of the patients' family (14.8%) left Purwosari in the last two weeks, contracted DHF, and spread the disease when they returned (14.8%). Also, guests were staying at patients' homes in the last two weeks (9.8%) (Table 5). This population mobility facilitates the transmission of DHF from one place to another, that is, from the center to the destination area of patients' transmigration. Higher population mobility in a region likely increases the transmission of DHF (Soegijanto, 2004).

The preventive measures against DHF are called the 3M Program, which consists of closing, draining, and burying potential water reservoirs. This program has been modified and upgraded to 3M-Plus, including (1) draining water reservoirs, (2) closing any water reservoirs tightly, (3) recycling used items, (4) sowing abate powder to water reservoirs, (5) applying mosquito repellent lotion, (6) setting up mosquito nets over the bed, (7) releasing mosquito larvae eaters into water reservoirs, (8) planting mosquito repellent plants in the yard, and (9) improving room lighting and ventilation. In this study, the community behavior was assessed by first sampling the DHF-infected family members as a key factor that can be modified in preventive measures against DHF.

The patterns of community behavior are summarized in Table 5.

The analysis revealed that infected patients and their families had not incorporated each item in the 3M-Plus Program into their behavior (Table 6). The 3M-Plus is designed to prevent the occurrence of DHF early, that is, during the larval phase or breeding period of mosquitoes (Point 1, 2, 4, and 7), the presence of *Aedes aegypti* (Point 3, 8, and 9), and bites from dengue fever-carrier mosquitoes (Point 5 and 6). If the public implements each of these points, then the 3M-Plus can be very useful and efficient to prevent the incidence of DHF (Centers for Disease Control and Prevention, 1998). The Office of Health Service and primary healthcare centers that are in charge of the affected areas must disseminate information about this program not only once during the occurrence of DHF but also repeatedly to transform these points into habits and ensure their continuous existence. The analysis proved that public dissemination was carried out during the case of DHF and was not followed by the actualization of the 3M-Plus behavior. For example, the communities did not sow the previously distributed abate powder because of misplaced fear and perception, which emerged from their unfamiliarity of the effects of this larvicide.

4. Conclusion

In Purwosari District, dengue fever tends to occur in four villages, namely Giricahyo, Girijati, Giritirto, and Giripurwo. There are two major factors of DHF outbreak in this district, namely modifiable and non-modifiable factors. The modifiable factors are the environmental parameters (temperature, humidity, rainfall, elevation, surface water density) that support the life cycle of the disease vector. Based on the environmental analysis and SatScan analysis, Purwosari District provides a potential living habitat for the mosquitoes and is thereby prone to DHF endemicity.

Meanwhile, the non-modifiable factor stems from land use and the community's preventive behavior. Land use with dense vegetation is a physical factor that, in the case of Purwosari, meets the living and breeding conditions of DHF-carrier mosquitoes. The preventive behavior among the community has not been appropriately implemented, underlying the need for health workers to promote DHF-preventive habits and ensure their implementation. Relevant public dissemination has been carried out during the occurrence of DHF, but the actualization is still far from expected. Also, improving medical perception, recognizing the symptoms and warning signs of DHF, and managing DHF among the community can prevent cases of fatality due to this contagious disease.

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