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Review of Environmental Aspects and Community Behavior in the Determination of Filariasis Risk Vulnerability Zone

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Abstract

Pekalongan City is a filariasis endemic area with the highest number of filariasis cases in Central Java. One of the factors influencing the risk of transmission of filariasis is environmental factors and community behavior. The purpose of this research was to know the potential areas of filariasis transmission risk in terms of environmental condition and behavior of society. This research was conducted on 6 urban villages in Pekalongan City on May-June 2017.
It was quantitative descriptive research based on Geographic Information System (GIS) with the object of research in the form of environmental factors and community behavior in the mapping unit. The sample technique used proportional random sampling with 387 respondents in a sample area. Data analysis used univariat and spatial analysis with buffer, overlapping and overlay techniques.
The result of this study were still there region that categorized very vulnerable to transmission of filariasis with amount each variable as many as 55.3% (21 RWs) based on sewerage condition, 57.8% (22 RWs) based on the presence of stagnant water, 23.7% (9 RWs) based on the night outdoor habit, 86.9% (33 RWs) based on the habit of using mosquito nets, and 39.5% (15 RWs) based on the overlay of vulnerability to environmental conditions and community behavior.

Abstrak

Kota Pekalongan merupakan daerah endemik filariasis dengan jumlah kejadian filariasis tertinggi di Jawa Tengah. Salah satu faktor yang mempengaruhi tingkat risiko penularan filariasis di Kota Pekalongan adalah faktor lingkungan dan perilaku masyarakat. Tujuan penelitian ini adalah untuk mengetahui daerah potensial penularan filariasis ditinjau dari kondisi lingkungan dan perilaku masyarakat. Penelitian ini dilakukan pada 6 kelurahan di Kota Pekalongan pada bulan Mei-Juni 2017.
Jenis penelitian ini adalah penelitian deskriptif kuantitatif berbasis Sistem Informasi Geografis (SIG) dengan objek penelitian berupa faktor lingkungan dan perilaku masyarakat dalam unit pemetaan. Pengambilan sampel perilaku dilakukan dengan teknik proporsional random sampling menggunakan sampel wilayah terdahap 387 responden. Analisis data menggunakan analisis univariat dan analisis spasial dengan teknik buffer, pengharkatan dan overlay.
Hasil penelitian menunjukkan bahwa masih terdapat wilayah yang masuk kategori sangat rentan penularan filariasis proporsi sebanyak 55,3% (21 RW) berdasarkan kondisi SPAL, 57,8% (22 RW) berdasarkan keberadaan genangan air, 23,7% (9 RW) berdasarkan kebiasaan keluar rumah pada malam hari, 86,9% (33 RW) berdasarkan kebiasaan memakai kelambu, dan 39,5% (15 RW) berdasarkan overlay kerentanan kondisi lingkungan dan perilaku masyarakat.

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INTRODUCTION

Filariasis is an infectious disease caused by filarial worms through various types of mosquitoes. This disease can cause permanent disability and economic losses due to decreased productivity of patients in endemic areas (Siwiendrayanti et al, 2016). WHO data show that in 2004, there were 1.3 billion (65%) of the world's population at risk of filariasis transmission in more than 83 countries, and 60% of cases were in Southeast Asia, including Indonesia. In 2014 in Indonesia there was an increase of filariasis cases from 12,714 cases to 14,932 cases (Ministry of Health Republic of Indonesia, 2014).

Filariasis incidence in Indonesia is spread throughout the province. In Central Java Province, in 2012 there were 565 cases and in 2015 there were 508, which 108 cases were found in Pekalongan City, the rest of which were spread in 33 other cities/regencies. From 2004 to 2012, there were 2 subdistricts (*kecamatan)* in Pekalongan City with the highest number of cases namely Pekalongan Utara Sub-district (Bandengan and Padukuhan Kraton urban villages (*kelurahan*)) of 176 cases and Pekalongan Selatan Sub-District (Kertoharjo, Kuripan Yosorejo, Jenggot, and Banyurip Ageng urban villages) of 83 cases. In addition to the high number of cases, Pekalongan City is filariasis endemic area with MF Rate> 1%. Results of Finger-Prick Survey (SDJ) in 2012 showed that urban villages which have MF rate> 1% that are Jenggot (5%), Kuripan Kertoharjo (2.4%), Padratuhan Kraton (3,7%), and Bandengan (2%).

Based on data of regional endemicity level and international commitment in "The Global Goal of Elimination of Lymphatic Filariasis as a Public Health by the Year 2020", Pekalongan City implemented a filariasis elimination program through Mass Drug Administration (MDA) for filariasis and treatment to prevent patient's disability starting from year 2011 and was expected to end in 2015. However, based on the evaluation of post-five-year implementation of MDA for filariasis, the results of the program were less optimal in breaking the chain of filariasis transmission so that Pekalongan City needs to continue the MDA. Program evaluation is performed by examining antigen-antibody on 300 children aged 2 to 4 years old. If positive result is found in 1 person, then the mass treatment needs to be continued (Ministry of Health Republic of Indonesia, 2014).

During this time, filariasis elimination program in Pekalongan City still focused on MDA for filariasis and clinical case implementation without reinforced by termination in the chain of transmission. According to Kyelem et al (2008), the success determinants of the filariasis elimination program in the area are influenced by several aspects, namely the level of early endemicity in the filariasis region, the effectiveness of mosquito vector, the procedure of mass treatment and population adherence. In addition, based on research of Windiastuti et al (2013), Pekalongan City is still very potential as transmission area of filariasis and endemic with Mf Rate of 6.67% (Windiastuti, 2013).

The potential for transmission of filariasis disease is influenced by three things, namely the source of disease, vectors and vulnerable humans. The source of the disease is closely related to the presence of patients and reservoir hosts, the vector is highly dependent on the carrying capacity of the environment as a mosquito habitat, and the vulnerable human being associated with the behavior of the community in an effort to avoid themselves from the bites of infectious mosquitoes (Ministry of Health Republic of Indonesia, 2014).This is in line with the research of Syuhada et al (2012)thatthe most dominant environmental risk factors that influence the transmission of filariasis in Pekalongan City are the existence of stagnant sewerage, and water puddles such as rice fields and swamps that can become a breeding ground for filariasis vector mosquitoes. While the behavior aspects of people who are more at risk of getting bites by the transmitter vector are the habit of going out at night and the habit of using mosquito nets while sleeping (Amelia, 2014). The results of this study were also reinforced by the results of mapping conducted by Arum Siwiendrayanti et al (2015) which shows that the location of filariasis patients in Pekalongan City is located in the risky areas namely stagnant sewerage, swamps, and water puddles with community behavior that still tends to be prone to contact directly with the transmitter vector.

Based on a preliminary study conducted in January 2017, it was known that six filariasis endemic villages in Pekalongan City have characteristics of various environmental and behavioral conditions and have the potential to facilitate the transmission of filariasis. Bandengan and Padukuhan Kraton urban villages are coastal area and tidal flood prone area which during rainy and dry seasons there are many stangnant sewerage that mixed with puddle of tidal flood which has potency as breeding place of filariasis vector. While the other four urban villages are not tidal flood-prone area but there are still many rice fields and stagnant sewerage that can increase the number of resting place and breeding placce of filariasis vector. The diversity of behavior can be seen from the diversity of occupations that will determine the intensity of outdoor activities at night. The majority of coastal communities have jobs

as fishermen, while the majority of urban communities work as factory workers and entrepreneurs. In addition, the people of Pekalongan City are also still full of religious routine activities (*pengajian*) which activities are more often performed at night.

In relation to the less optimal of MDA program for Filariasis in 2011-2015 and the condition of Pekalongan City both in terms of environment and community behavior that still potential in filariasis transmission, it is necessary to have an alternative problem solving which is integrated between health services (MDA for filariasis) and the environment or region planning to optimize the further filariasis elimination program in Pekalongan City to be implemented in 2017 and 2018. The alternative is integrated management of area-based disease control through spatial analysis.

The previous research had seen the relationship between filariasis incidence with risk factors. Whereas the analysis of filariasis incidence is also important to be seen in macro through the map of vulnerability area that had never been done in Pekalongan City. The spatial approach to vulnerability area is very effective in providing regional information support for environmental management and regional planning related to the solving of environmental problems more comprehensively. A vulnerability map also provides data that can help in epidemiology such as the most appropriate location suggestion for the delivery of health interventions (Masimalai, 2014).

Based on the urgency of the problem and unknown pattern of post-mass endemic vulnerability area about the distribution of filariasis cases in terms of environmental factors and behavior of the people of Pekalongan City in the image actualization, the purpose of the research was to determine the pattern of vulnerability areas of filariasis transmission based on environmental aspects and community behavior in Pekalongan City in the form of sewerage, the existence of water puddles, the habit of going out at night and habit of using mosquito net. This study is a part of the research scheme entitled "*AKTIF-MANDIRI* Program as Acceleration Enhancment of Filariasis Elimination in Lowering MF-Rate of Endemic Filariasis Area in Pekalongan City" (*Program AKTIF-MANDIRI sebagai Penyempurna Akselerasi Eliminasi Filariasis dalam Menurunkan Mf-Rate Wilayah Endemis Filariasis di Kota Pekalongan*).

METHODS

This research was conducted in the filariasis-endemic area in Pekalongan City, Pekalongan Utara and Pekalongan Selatan Subdistricts. Research in Pekalongan Utara subdistrict was performed in two urban villages namely Bandengan and Padukuhan Kraton (Pabean). While in the Pekalongan Selatan subdistrict conducted on four villages of Banyurip (Banyurip Ageng), Jenggot, Kuripan Yosorejo (Kuripan Lor), and Kuripan Kertoharjo (Kertoharjo). The number of filariasis case in the study area was 54 cases.

The type of research used in this research is quantitative descriptive research based on Geographic Information System (GIS). This descriptive research was performed by analyzing the data in aggregate using GIS approach to the environmental condition and behavior of the people, namely the existence and condition of sewerage, the existence of water puddles, the habit of going out at night, and the habit of using mosquito net.

The research objects were environmental factors and community behavior in the mapping unit. The community behavior objects in this research were 387 respondents in the research location that met the criteria of inclusion-exclusion. Sampling technique used was the technique of proportional random sampling with details of the number of each urban village by 69 families in Bandengan urban village, 44 families in Pabean urban village, 59 families in Banyurip Ageng urban village, 113 families in Jenggot urban village, 28 families in Kertoharjo urban village and 74 families in Kuripan Lor urban village.

The research data sources were primary data and secondary data. In this study, primary data were obtained through direct observation of environmental conditions and in-depth interviews with respondents to know the behavior of respondents. While secondary data in this research were obtained from Pekalongan City Health Office, Pekalongan Selatan Health Center (*Puskesmas*), Buaran Health Center, Jenggot Health Center, and Dukuh Health Center in the form of filariasis patient data based on the last FBS (Finger Blood Survey) result in the research location. In addition, other secondary data sources in the form of image maps and spatial plans data of Pekalongan City were obtained from the Department of Public Works (*DPU*) of Pekalongan City.

The research instruments used in this study were patient medical records, questionnaires, Global Positioning System (GPS), baseline map of *RW* (hamlet), satellite imagery, and Geographic Information Systems (GIS) software. This medical record was used to find out data of filariasis patient which include patient name, age, gender and patient's address. Questionnaire sheets were used when interviewing respondents to find out the habits or behavior of the respondents. The Global Positioning System (GPS) device was used to digitize the locati-

on of filariasis patients and environmental variables including sewerage conditions, the presence of water puddles which is then inputted into the geographic information system software (GIS).

Data collection techniques in this research were observation, interview, and documentation. The observation was performed by direct observation of the environment variable condition and at the same time digitize the existence of the variable for reference correction materials of spatial plans that have been obtained. In addition, the observation was made to determine the location of filariasis patients who were then digitized with the help of Global Positioning System (GPS) tool. The interview was conducted by using questionnaires sheet to know the habit or behavior of the respondent. While the documentation was performed by taking pictures on the condition of environmental variables and research stages that had been done.

Spatial data analysis was performed by using SPSS application in univariate analysis of respondent behavior and geographic information system software (GIS). Data processing that uses SPSS was performed to analyze the percentage of habits or behavior of respondents which was inputted into GIS devices. Spatial analysis was performed by using buffer, overlay, and overlapping techniques.

The buffer technique was used to obtain the percentage of area within the flight distance of filariasis transmitter mosquitoes in the research area. Variables of research which analyzed by using buffer technique that are condition variables of open and stagnant sewerage and water puddle. After buffer was performed and percentage of buffer area was obtained, then the categorization of vulnerability analysis of filariasis with the rules as shown in Table 1.

As for the categorization of community behavior in the form of the habit of going out at night and habit of using mosquito net was performed by doing the percentage of respondent who have good behavior in accordance with the rule of the Ministry of Health Republic of Indonesia that is not going out at night and use mosquito net while sleeping. The boundaries of each category based on community behavior can be seen in Table 2.

The overlay technique was used by overlapping several parameters that affect the vulnerability of filariasis transmission in the same area. While overlapping was performed to facilitate the overlay activity by scoring each parameter so that will be obtained vulnerability area of filariasis transmission. Overlapping was performed by using a sturgess formula with a score boundary of each vulnerability zone classification as shown in Table 3.

RESULTS AND DISCUSSION

The vulnerability of filariasis transmission risk in Pekalongan City in this study was observed from environmental conditions and community behavior which include vulnerability of sewerage condition, the vulnerability of water puddle, vulnerability of night outdoor habit and vulnerability of using mosquito net habit. Vulnerability distribution of filariasis transmission risk in Pekalongan City 2017 can be seen in Table 4.

Vulnerability of The AreaIn Terms of SEWERAGE Existence and Condition

Based on Table 4, it is known that 7 *RW*s in Pekalongan Utara subdistrict that included in very vulnerable area namely the *RW*s of 1, 3, 4, and 5 in Bandengan urban village and the *RW*s of 12, 13 and 15 in Pabean urban village. While the area of Pekalongan Selatan subdistrict that was categorized very vulnerable area namely Banyurip Ageng urban village (the *RW*s of 1, 2, and 3), Jenggot urban village (the *RW*s of 1, 2, 3, 4, 5, 6, 7, 8, and 9), and Kertoharjo urban village (the *RW*s of 7 and 9). It shows that the condition of sewerage in Pabean, Bandengan, Banyurip Ageng, Jenggot, and Kertoharjo urban villages

Table 1. Boundaries of Vulnerability Category of Sewerage and Water Puddles

Variable	Vulnerability Category	Statistical Rules	Boundary	Score
Sewerage Condition	Very vulnerable	X > SD+Mean	Very vulnerable= X > 98%	1
	Vulnerable	Mean-SD ≤X≤ SD+Mean	Vulnerable = 73.2% ≤ X ≤ 100%	2
	Not vulnerable	X < Mean-SD	Not vulnerable= X < 73.2%	3
Water Puddle	Very vulnerable	X > Mean+SD	Very vulnerable= X > 66.49%	1
	Vulnerable	Mean-SD ≤X≤ Mean+SD	Vulnerable = 58.63% ≤X≤ 66.49%	2
	Not vulnerable	X < Mean-SD	Not vulnerable= X < 58.63%	3

Table 2. Boundaries of Vulnerability Category of The Night Outdoor Habit and The Habit of Using Mosquito Net

Variable	Vulnerability Category	Batasan	Score
The Night Outdoor Habit	Very vulnerable	>66.7% of respondents have a night outdoor habit	1
	Vulnerable	33.3-66.7% of respondents have a night outdoor habit	2
	Not vulnerable	< 33.3% of respondents have a night outdoor habit	3
The Habit of Using Mosquito Net	Very vulnerable	>66.7% of respondents have a habit of not using mosquito nets	1
	Vulnerable	33.3-66.7% of respondents have a habit of not using mosquito nets	2
	Not vulnerable	< 33.3% of respondents have a habit of not using mosquito nets	3

there were still open and stagnant areas that enter the buffer> 98% from the area which stated that the average sewerage condition in the filariasis endemic area in Northeast of Brazil amounted to 65.4% in the form of open and stagnant sewerage. The open and stagnant sewerage strongly supports the proliferation of the transmitter vector as it is known that the potential vector in Pekalongan City comes from the *Culex quinquefasciatus* mosquito species (Nurjazuli, 2015).

Sewerage condition in *RW* areas which were included in the very vulnerable area of Pekalongan Utara Subdistrict that were open and stagnant as well as mixed with tidal flood water and garbage along sewerage track, either right or left of the road. While in Pekalongan Selatan subdistrict, water in sewerage was dominated by domestic waste and home industry in the form of soap water, detergent water, and leaf litter. The presence of sewerage contaminated with open and stagnant waste was very beneficial in the formation of vector mosquito breeding habitat (Ladan, 2014). Breeding habitat of filariasis transmitter mosquitoes according to Nguyen et al (2012) is a polluted sewer that has adequate nutrients for seasonal oviposition processes. Higher nutritional concentrations according to research by Dowling et al (2013) also make more microbes as food sources of vector larvae and reduce predator competition. In addition, contaminated sewerage can also make the number of *Culex quinquefasciatus* mosquito become more numerous. The presence of a larger number of mosquito eggs will increase the number of infectious vectors, which in turn will increase the vulnerability of the area to get infected by filariasis due to mosquito habitat. As Mutheneni et all (2015) study stated that poor drainage conditions increase the risk of infected by filariasis with OR of 3.5.

In addition to the polluted sewerage conditions, there were some sewerage puddles in areas that is very vulnerable namely Kertoharjo Urban Village where there were mosquito larvae. The presence of puddles with larva indicated that the location is suitable for breeding place by mosquito vectors. The presence of puddles with mosquito larvae may increase the risk of occurrence of filariasis transmission with OR of 6.00 (Sarungu et al, 2012).

Meanwhile, based on filariasis patients it is known that the highest proportion of filariasis patients were found in very vulnerable area based on sewerage condition of 69.1% (38 patients) that spread in the *RW*s of 1, 3, 4, and 5 in Bandengan Urban Village, the *RW*s of 12, 13 and 15 in Pabean Urban Village, the 4 *RW* in Banyurip Ageng Urban Village, the 5 *RW*s of Jenggot Urban Village, and the 9 *RW* of Kertoharjo Urban Village. The results are in accordance with the study of Upadhyayula et al (2012) which suggested that areas with high risk due to open drainage and more water puddle have a greater number of filariasis positive cases compared to areas with closed drainage conditions.

The existence of a very vulnerable area due

Table 3. Scoring of Vulnerability Zone Classification

No	Vulnerability Zone Classification	Overlapping Score
1	Very vulnerable	4-6
2	Vulnerable	7-9
3	Not vulnerable	10-12

Table 4. Overlapping and Categorization Results of Risk Vulnerability of Filariasis Transmission in Pekalongan City 2017

Urban Village	***RW***	**A**	B	C	D	Total Score	Level of Area Vulnerability
Pabean	12	1	1	2	2	6	Very vulnerable
	13	1	1	1	2	5	Very vulnerable
	14	2	1	2	1	6	Very vulnerable
	15	1	3	2	2	8	Vulnerable
Bandengan	1	1	3	2	1	7	Vulnerable
	2	2	1	1	1	5	Very vulnerable
	3	1	1	2	1	5	Very vulnerable
	4	1	1	3	2	7	Vulnerable
	5	1	1	2	1	5	Very vulnerable
	6	2	1	2	1	6	Very vulnerable
Banyurip Ageng	1	1	1	1	1	4	Very vulnerable
	2	1	3	2	1	7	Vulnerable
	3	1	1	1	1	4	Very vulnerable
	4	2	1	2	1	6	Very vulnerable
	5	2	1	1	1	5	Very vulnerable
	6	2	1	2	1	6	Very vulnerable
Jenggot	1	1	3	2	1	7	Vulnerable
	2	1	3	2	1	7	Vulnerable
	3	1	3	2	1	7	Vulnerable
	4	1	1	2	1	5	Very vulnerable
	5	1	3	2	1	7	Vulnerable
	6	1	3	2	1	7	Vulnerable
	7	1	3	3	2	9	Vulnerable
	8	1	3	2	1	7	Vulnerable
	9	1	3	2	1	7	Vulnerable
	10	2	3	1	1	7	Vulnerable
	11	2	3	2	1	8	Vulnerable
Kertoharjo	5	3	1	2	1	7	Vulnerable
	6	2	1	2	1	6	Very vulnerable
	7	1	1	1	1	4	Very vulnerable
	8	2	1	1	1	5	Very vulnerable
	9	1	1	1	1	4	Very vulnerable
	10	3	1	2	1	7	Vulnerable
Kuripan Lor	1	3	3	2	1	9	Vulnerable
	2	3	2	2	1	8	Vulnerable
	3	3	2	2	1	8	Vulnerable
	4	3	1	2	1	7	Vulnerable
	5	3	1	2	1	7	Vulnerable

Information:
A : Score of Risk Vulnerability of Filariasis Transmission Based On Sewerage Condition
B : Score of Risk Vulnerability of Filariasis Transmission Based On Water Puddle Existence
C : Score of Filariasis Transmission Risk Vulnerability Based OnThe Night Outdoor Habit
D : Score of Filariasis Transmission Risk Vulnerability Based On The Habit of Using Mosquito Net

to the open and stagnant sewerage conditions requires community care and participation to clean it up in an attempt to decrease the potential level in the transmission of filariasis to the surrounding environment. The research of Amelia (2014)also mentioned that by cleaning the mosquito habitat of sewerage can decrease 8.556 times of filariasis incidence risk. In addition to the need for an active role of the community to clean the habitat of mosquitoes, this case also needs a cross-sectoral cooperation by local governments in an effort to improve the condition of open and stagnant sewerage in order to become the sewerage that in accordance with existing regulations.

Vulnerability of The Area In Terms of Water Puddle Existence

Based on Table 4, it is known that the *RW* areas in the Pekalongan Utara subdistrict and Pekalongan Selatan subdistrict were still in the category of very vulnerable (buffer area> 66.49%) and vulnerable (buffer area between 58.63- 66.49%). The proportion of area in Pekalongan Utara subdistrict that included in the very vulnerable zone was 83,33% (5 *RW*s that are 2, 3, 4, 5, and 6) in Bandengan and 75% (3 *RW*s that are 12, 13, and 14) in Pabean. While the areas in Pekalongan Selatan subdistrict that included in very vulnerable zone namely Banyurip Ageng Urban Village (the *RW*s of 1, 3, 4, 5, and 6), Jenggot Urban Village (the 4 *RW*), Kertoharjo Urban Village (the *RW*s of 5, 6, 7, 8, 9, and 10), and Kuripan Lor (the *RW*s of 4 and 5).

Results of survey in the field indicated that the very vulnerable areas in Pekalongan Utara Subdistrict (Pabean and Bandengan urban villages) have characteristics of water puddles in the form of swamps with aquatic plants with a distance from the settlement that is not too far (<200 m). The research of Ikhwan et al (2016)mentioned that settlements that close to water puddle in the form of swamps are more significant for the occurrence of filariasis transmission or filariasis incidence with OR of 1.358. This is in line with the research of Jontari et al (2014) which showed the presence of swamp puddles at a distance <100 m which increases the incidence of filariasis occurrence with OR 6.2. This association occurs because the characteristics of swamps with aquatic plants can be used as breeding grounds and increase the number of mosquitoes. Culex quinquefasciatus mosquito larvae are found to be highest in permanent water habitats such as swamps with aquatic vegetation especially in summer (Grech et al, 2013).

Meanwhile, the areas in Pekalongan Selatan District that included in very vulnerable zone have characteristic of water puddle in the form of wet rice field area which is united with residential area.This is in line with the research of Mulyonoet al (2008) in Pekalongan Regency,that the existence of water puddle in the form of rice fields around the house

Table 5. Filariasis Patients Location Based On Environmental Condition and Behavior of Communityin Pekalongan City 2017

Vulnerability Category	Vulnerability Level	Number of Patients (people)	Pecentage (%)
Vulnerability Based On Sewerage Condition	Very vulnerable	38	69.1
	Vulnerable	15	27.3
	Not vulnerable	2	3.6
Vulnerability Based On Water Puddle Existence	Very vulnerable	33	60
	Vulnerable	0	0
	Not vulnerable	22	40
Vulnerability Based On The Night Outdoor Habit	Very vulnerable	25	45.4
	Vulnearble	29	52.7
	Not vulnerable	1	1.9
Vulnerability Based On The Habit of Using Mosquito	Very vulnerable	48	87.3
	Vulnerable	7	12.7
	Not vulnerable	0	0
Vulnerability Based On environmental condition and behavior of community	Very vulnerable	30	54.5
	Vulnerable	25	45.5
	Not vulnerable	0	0

increases the risk of 10.31 times greater to get filariasis disease. The association occurs because the rice field becomes a risky habitat for filariasis vector because the fields have water puddle that can be used by mosquitoes to lay eggs and breed until the pupa stage.

Culex quinquefasciatus vectors are generally in a dirty habitat, but they also have high adaptive and invasive behaviors to survive in puddles such as rice fields when ecological changes occur. Thus, these mosquitoes have the potential to initiate and facilitate the transmission of disease by establishing a vector-host transmission cycle in different Indonesian environments (Bhattacharya & Basu, 2016).

Based on filariasis patients in the study sites, it can be seen that the highest proportion is in vulnerable areas (*RW*s of 9 and 10 in Kertoharjo Urban Village), but filariasis patients in Jenggot (*RW*s of 5 and 11) and Banyurip Ageng urban village (the 2 *RW*) are in not vulnerable areas. It shows that there are other factors besides the existence of water puddle that more support the filariasis incidence both from the environment and community behavior aspects.

Vulnerability of The Area In Terms of The Habit of Going Out at Night

Based on Table 6, it is known that all urban villages that included in the category of very vulnerable tofilariasis transmission (except Kuripan Lor) namely Bandengan (the 2 *RW*), Pabean (the 13 *RW*), Banyurip Ageng of 50% (3 *RW*s that are 1, 3, and 5),

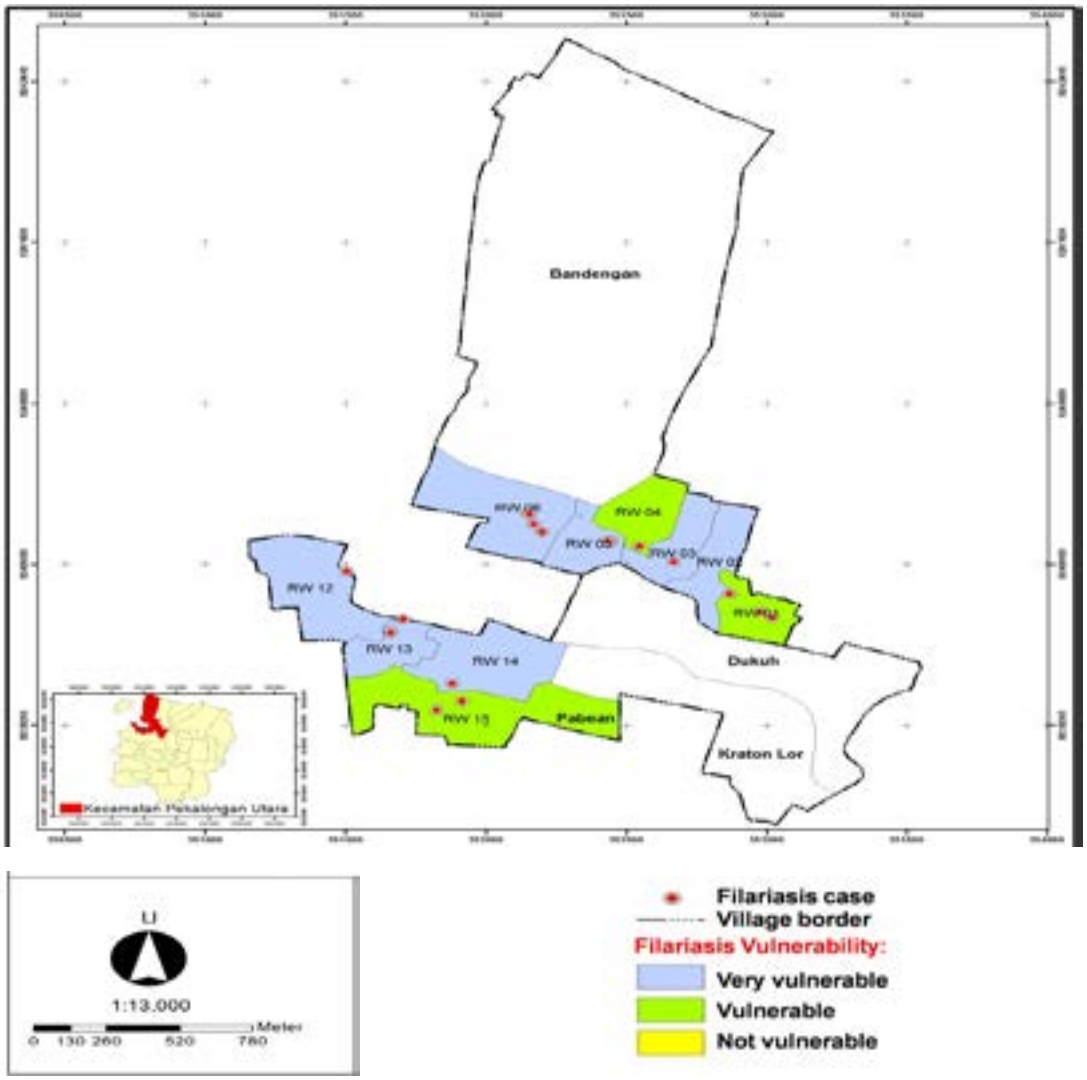

Figure 1. Distribution Map of Filariasis Transmission Risk Vulnerability In Terms of Environmental Condition and Community Behavior with Patients Distribution in North Pekalongan Subdistrict

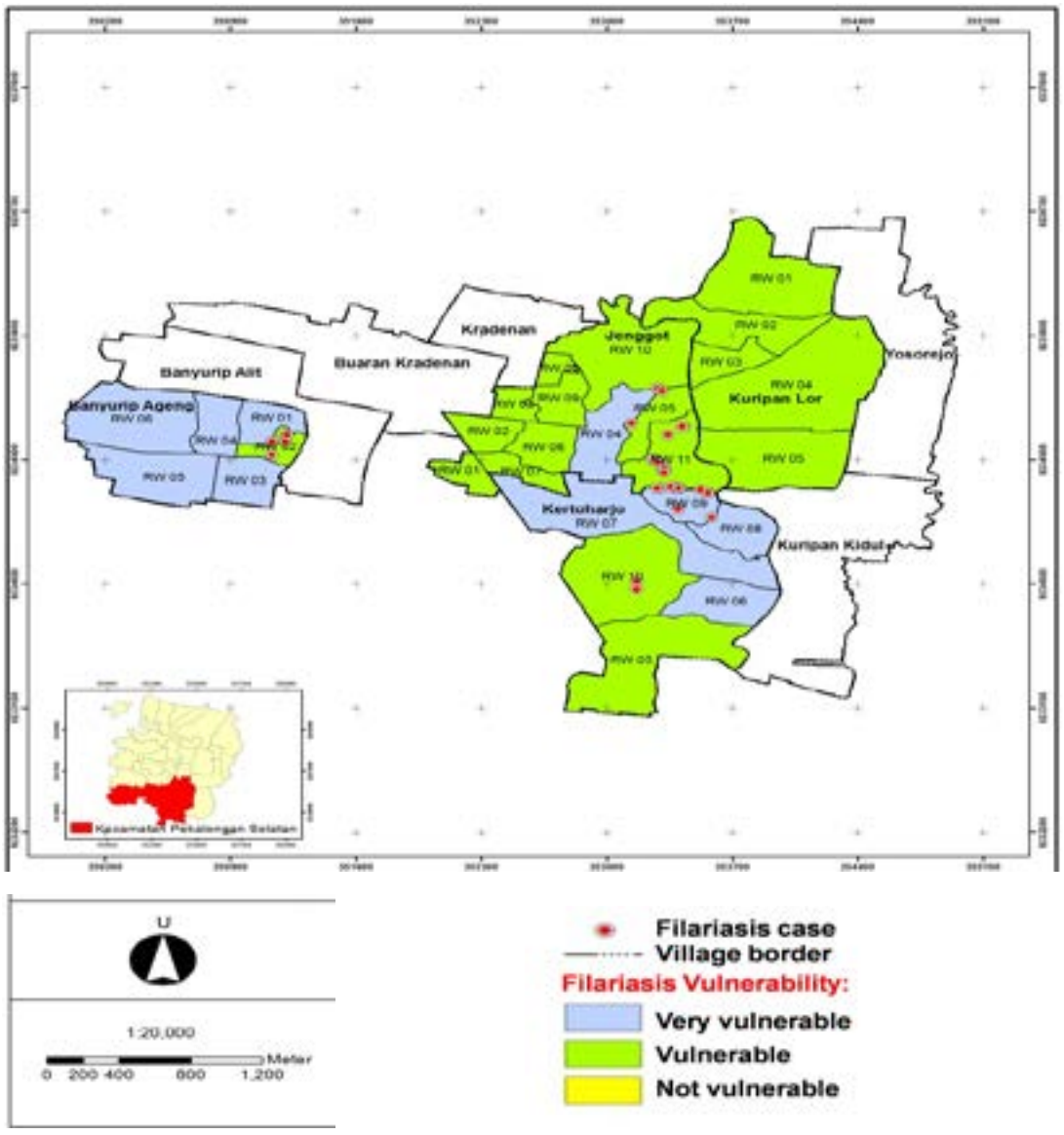

Figure 2. Distribution Map of Filariasis Transmission Risk Vulnerability In Terms of Environmental Condition and Community Behavior with Patients Distribution in South Pekalongan Subdistrict

Jenggot (the 10 *RW*) and Kertoharjo of 50% (3 *RW*s that are 7, 8, and 9). While the area that included into the not vulnerable area only found in the 4 *RW* in Bandengan and the 7 *RW* in Jenggot Village. The results also showed the average percentage of respondents from all urban villages who have the night outdoor habit as much as 57.4%. This indicated that the average of the six urban villages which was the research area included into the category of vulnerable areas of filariasis transmission.

The habit of going out at night affects the transmission and occurrence of filariasis in a filariasis endemic area (Ardias, 2012; Sapada et al, 2014), including Pekalongan City (Amelia, 2014). The research of Ardias (2012) showed that people in filariasis-endemic areas who have a night outdoor habit are more vulnerable to filariasis with OR 39.054.

The habit of going out at night increases the potential for filariasis transmission. It is based on bionomic of Culex quinfasciatus mosquito which acts as a filariasis transmitter in Pekalongan City that more active biting at night after sunset until sunrise with peak density on 20.00-21.00 WIB and 22.00-23.00 WIB (Ramadhani & Wahyudi, 2015). In addition, Culex quinfasciatus mosquitoes prefer to suck human blood in than the others (Janssen et al,

2015).

When doing the night out activities, it is recommended by the Ministry of Health of the Republic of Indonesia in an effort to prevent filariasis to use anti-mosquito lotion and wear long-sleeved clothes. So the greater the percentage of people in an area that has a habit of going out at night without using anti-mosquito lotion and wearing long-sleeved shirts when mosquitoes are active foraging, the area is more vulnerable to filariasis, especially in endemic areas such as Pekalongan City. Endemic areas with high microfilaria densities allow vector mosquitoes to transmit microfilariae in their bodies at the time of sucking blood (Wahyudiet al, 2016). The interview results of people who have a habit of going out at night in the study area are known that people still often perform activities at night such as recitation activities, working overtime, night patrol, and chat outside the home without using anti-mosquito lotion. As it is known that *Culex* mosquitoes have exophilic and exophagic properties that more often bite when outside the room, so people who do activities outside the home have more mosquito bites frequency compared with people who do activities in the house (Anindita, 2016).

Based on the location of the patient, the proportion of filariasis case location was the very vulnerable zone of 45.4% (25 patients), the vulnerable zone of 52.7% (29 patients) and the not vulnerable zone of 1.9% (1 patient). The results are also in line with research Windiastuti (2014) that filariasis cases in endemic areas more commonly found in respondents who have a habit of going out at night with a percentage of 51.3%. Therefore, people in areas that are very vulnerable are advised to conduct self-protection when going outdoors at night such as wearing long-sleeved shirts and apply mosquito repellent.

Vulnerability of The Area In Terms of The Habit of Using Mosquito Net

Based on Table 4, it is known that from all areas of the research area, there are still very vulnerable areas with a total proportion of of 60% (6 *RW*s that are 1, 2, 3, 5, and 6 in Bandengan Urban Village, and the 14 *RW* in Pabean Urban Village) in Kecamatan Pekalongan Utara and 96.4% (27 *RW* ie all areas of *RW* except *RW* 7 Kelurahan Jenggot) in Pekalongan Selatan Subdistrict. The other 5 *RW*s included into the category of vulnerable areas. The proportion of Urban Village with the most vulnerable zone was found in Banyurip Ageng Urban Village(100%), Kertoharjo Urban Village (100%) and Kuripan Lor Urban Village (100%) with the percentage of respondents who did not use bed nets <16.67%. While reviewing the location of filariasis patients in Pekalongan City, 87.3% of patients (48 patients) were located in the very vulnerable areas. Other cases were the vulnerability area of filariasis transmission but adjacent to very vulnerable areas.

Theoretically, the habit of using mosquito net is one method of community self-protection against the transmission of vector-borne disease such as filariasis disease (Sarungu, 2012). The high percentage of people who do not do self-protection shows the greater the probability of the community to occur filariasis transmission, so that filariasis incidence may occur in the area. In the filariasis occurrence in areas with very low percentage of self-protection or very vulnerable areas of filariasis transmission, it will facilitate the mobility of filariasis transmission in the area. So the habit of using mosquito nets during sleep affects the spread and transmission of filariasis disease.

The results of in-depth interviews on the community that use the mosquito net in Pekalongan City, obtained that 97.8% of the mosquito net condition is perfectly closed and without the hole, while the rest of the condition is net with holes. The use of mosquito nets recommended by the Ministry of Health of the Republic of Indonesia that the mosquito net should be in a perfectly closed condition and without hole either ordinary mosquito nets and insecticide-treated nets (dyed in insecticide namely Insecticide Bed Net type). So if the mosquito net with hollow bigger than the mosquito body, the mosquito will easily enter the mosquito net and bite the human. However, on the principle of use, mosquito nets will not be meaningless if not followed by regular use.

Filariasis Transmission Risk Vulnerability In Terms of Environmental Condition and Community Behavior

The environmental and behavioral components of the community that are the focus of research namely the existence and condition of sewerage, the existence of water puddle, the habit of going out at night and the habit of not using mosquito net while sleeping. Based on figures 1 and 2. it is known that in Pekalongan City there were 17 *RW*s (44.7%) which included into very vulnerable category and 21 *RW*s (55,3%) which were categorized as vulnerable based on environmental aspect and community behavior, with the *RW*s of 1, and 3 in Banyurip Ageng, and the 9 *RW* in Kertoharjo were the very vulnerable area of the highest risk of filariasis transmission that is based on high vulnerability in all aspects of environmental conditions and community behavior.

In terms of each variable of filariasis transmission risk vulnerability, between *RW* areas have various risk factors that affect a region into a very

vulnerable zone category. The *RW* areas in Pabean and Bandengan that included into the very vulnerable category were dominated by sewerage conditions and the existence of very vulnerable water puddles. The *RW* in Banyurip Ageng which is categorized as very vulnerable was more dominated by the presence of water puddle, the habit of going out at night and the habit of using mosquito net. The *RW* in Jenggot which included into the very vulnerable category was dominated by sewerage condition factor and habit of using mosquito net. While the *RW* in Kertoharjo which is categorized as very vulnerable which was dominated by the existence of water puddle, the habit of going out at night and the habit of using mosquito net, but at the *RW*s 7 and 9 there was additional factor that is condition of sewerage.

Based on the location of the patient, the location of filariasis patients were all located in the vulnerable and very vulnerable areas based on environmental conditions and community behavior in Pekalongan City 2017. The proportion of patients at each level of vulnerability is 54.5% (30 patients) were in very vulnerable and 45.5% (25 patients) were in vulnerable areas. This is in accordance with the theory of HL Blum that the incidence of a disease can be influenced by environmental factors, behavior, genetic, and the availability of health services. Environmental conditions and unhealthy community behavior can make the incidence of disease increases.

The existence of risk factors diversity both environmental components and community behavior components that have potential diseases will produce disease incidence, in other words, the transmission of vector-borne disease (eg filariasis). Therefore, by knowing the level of vulnerability of the region in terms of environmental conditions and behavior of the community, it is necessary to adjust and improve the behavior and environmental management in accordance with the level of vulnerability in an effort to prevent transmission and incidence of filariasis.

CONCLUSION

Based on the results of research, it can be concluded that the results of data analysis and spatial analysis using regional zonation techniques, there were still *RW*s that categorized as very vulnerable to filariasis transmission based on environmental conditions and community behavior variables with 21 *RW*s based on the vulnerability of SEWERAGE condition, 23 *RW*s based on the vulnerability of the existence of water puddles, 9 *RW*s based on the vulnerability of going out at night habits, 33 *RW*s based on the vulnerability of using mosquito net habit, and 17 *RW*s based on overlay of vulnerability of environment condition and community behavior in Pekalongan City, with the areas ofthe *RW*s of 1and 3 in Banyurip Ageng, and the 9 *RW* in Kertoharjo were the very vulnerable area of the highest risk of filariasis transmission that is based on high vulnerability in all aspects of environmental conditions and community behavior.

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