Research Article

Spatial Distribution of Malaria Vector Breeding Sites in Purworejo District, Central Java Province

Distribusi Spasial Habitat Perkembangbiakan Vektor Malaria di Kabupaten Purworejo, Provinsi Jawa Tengah

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Abstrak. *Malaria merupakan masalah kesehatan utama di Purworejo terutama pada daerah perbukitan yang berbatasan dengan Kabupaten Magelang, Provinsi Jawa Tengah dan Kabupaten Kulonprogo, Provinsi Daerah Istimewa Yogyakarta. Daerah perbukitan tersebut merupakan daerah reseptif malaria. Keberadaan dari habitat perkembangbiakan vektor malaria yang berdekatan dengan pemukiman serta terjadi setiap musim, menyebabkan penularan malaria terjadi sepanjang tahun. Pemetaan spasial tempat perkembangbiakan vektor malaria dapat membantu penelusuran dan tindak lanjut intervensi terhadap pengendalian vektor malaria. Survei dan pemetaan tempat perkembangbiakan vektor malaria dilakukan menggunakan Global Positioning System (GPS) dan hasilnya diolah dengan ArcGIS. Penelitian dilakukan pada bulan April-November 2018 di Purworejo. Hasil penelitian menunjukkan bahwa tempat perkembangbiakan vektor malaria pada musim kemarau adalah genangan air di sepanjang aliran sungai dan mata air di sekitar pemukiman; dalam bentuk genangan-genangan kecil yang terisi sedikit air. Tempat perkembangbiakan dalam kondisi terlindung dengan adanya tanaman atau pepohonan. Tindakan intervensi yang tepat adalah dengan mengeringkan tempat perkembangbiakan vektor, membuat perlindungan mata air, larvasidasi pada musim kemarau serta penggunaan kelambu berinsektisida pada masyarakat di sekitar tempat perkembangbiakan vektor. Penelitian menyimpulkan bahwa identifikasi tempat perkembangbiakan vektor malaria pada musim kemarau di sepanjang aliran sungai dan mata air.*

Kata Kunci: *Tempat perkembangbiakan, vektor malaria, Purworejo, spasial*

Abstract. Malaria is the main health problem in Purworejo District, especially in the hilly areas which are bordered by Magelang District (Central Java Province) and Kulonprogo District (Yogyakarta Special Region), Those are identified as malaria receptive areas. Malaria vector breeding sites were found in nearby settlements and occur every season, resulting in the transmission of malaria throughout the year. Spatial mapping of malaria vector breeding sites could support tracing and follow-up of malaria vector control interventions in malaria-endemic areas. Survey and mapping of malaria vector breeding site were done using Global Positioning System (GPS) and the data obtained were processed with ArcGIS. The research was conducted in April – November 2018 in Purworejo. This research shows that vector breeding sites in the dry season are puddles along rivers and springs around settlements; small breeding sites with few water volumes. The breeding sites are in the shade of plants or trees. The appropriate intervention measures are action to dry the malaria vector breeding sites, protection of springs and puddles through larvacidation in the dry season, and mosquito nets using in communities around the malaria vector breeding sites. This research concludes the malaria vector breeding sites at dry season concentrates along the rivers and springs.

Keywords: Breeding sites, malaria vector, Purworejo, spatial

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INTRODUCTION

Malaria remains a public health concern worldwide, there were an estimated 219 million cases and 435,000 related deaths in 2017.[1] Malaria remains endemic in some regions particularly in the eastern part of Indonesia. While Indonesia has generally succeeded in reducing the number of malaria cases over the last 5 decades, proven by the unexpected achievement of malaria elimination, malaria remains endemic in some regions particularly in the eastern part of Indonesia.[2] Elimination of malaria in Indonesia is targeted in 2030 and for Java-Bali is targeted in 2023.[3]

The malaria incidences in the 2014-2018 period in Central Java, in general, showed a decline. Nevertheless, there are four District in Central Java that have not yet received malaria elimination certificates, by 2019, which are Purworejo, Banjarnegara, Banyumas, and Purbalingga District.[4-5]

Topographic variables such as elevation, slope, and aspect are influencing the development of Anopheles mosquitoes have demonstrated by Atieli et al.[6] There is a significant association of malaria transmission with local spatial variations like population density, lowland location, and proximity to aquatic environments in north-eastern Venezuela. Population growth of mosquitoes influenced by the number of breeding places.[7]

Malaria is one of the vector-borne diseases, which caused by a parasite that is plasmodium and spread by female *Anopheles*.[8] The breeding sites of *Anopheles* is depending on local environmental factors, the proximity between mosquito breeding places, humans' activity, and the *Anopheles* vector in the region. Malaria transmission can be local specific, meaning it is dependent on local conditions of the region, because of the bionomic variety of Anopheles as malaria vectors in each region.[9] *Anopheles* sp. found in Purworejo District *were An. maculatus, An. balabacensis, An. vagus, An. aconitus, An. kochi, An. barbirostris, An. annularis* and *An. minimus*.[10] Three of them were proven to be able to act as malaria vectors, namely *An. maculatus, An. balabacencis,* and *An. aconitus*.[11]

The hilly areas in Purworejo District are very enabling for the breeding sites of these three vectors. The breeding sites that have been found are in water springs, puddles on the river, and puddles in the salak plantations.[12] Geographic Information System can be used to map public health problems including diseases mapping, distribution of malaria vector breeding sites, accessibility of health facilities, and epidemiological data can be added.[13] This study aimed to identify and mapping vector malaria breeding sites in Purworejo District, with epidemiology spatial approaches and intervention solutions of the malaria control programs in Purworejo District.

MATERIAL AND METHOD

Study Area

The research location was in the domain area of two Public Health Center (PHC) in Menoreh Hill which have malaria problem that were Bagelen and Banyuasin.

Study Design

Research was conducted from July until October 2018 using cross-sectional study design, identified malaria vector breeding sites types, and adult Anopheles collection at the study area.

Data collection

Larva Inspection

Anopheles sp. larvae survey in breeding habit with the following criteria: permanent

water surface and temporary surface water inundation. The collected Anopheles larvae were reared until they became mosquitoes and identified the species using a stereo microscope with 20x and 40x magnification. [14,15]

Adult Mosquito Survey

The adult mosquito survey (*Anopheles* sp.) was carried out at night with the Night-Landing Collection (NLC) method and the Night Resting Collection (NRC) from 18.00–06.00.[16,17] Microclimate measurements include temperature and humidity around the study site.

Mapping Breeding Sites of *Anopheles* sp.

Mapping of Anopheles breeding sites locations using GPS. Global Positioning System tools is a system for determining the position on the surface of the earth with the help of satellite signal synchronization.

Data Analysis

The captured mosquitoes were identified based on identification key, using a dissecting microscope with 20x and 40x magnifications. Calculation of mosquitoes' density was carried out on various methods of capture for each species. Mosquitoes density is the number of mosquitoes that land per person per hour (MHD = Man Hour Density).[18]

The species grouping was based on the results of mosquitoes from larvae rearing. Spatial data were analyzed by using ArcGIS. The weakness in this spatial analysis is by using conventional GPS for point location picking, the accuracy is less than 7 m. There will be a bias between positive and negative Anopheles larvae breeding sites (overlapping) if plotting was done in an area with dense distribution of Anopheles breeding sites. It is different when using Geodetic GPS which have 1 – 2 m accuracy.

RESULT

Purworejo District, Central Java Province is located between 109.801535° to 110.113257° East Longitude and between 7.647361° and 7.676965° South Latitude. The area of Purworejo District is 1,034.82 km^2. Purworejo District has a wet tropical climate, with temperatures between 19°C – 28°C and humidity 70% – 90%.[19] Purworejo District is the most extensive part of Menoreh Hill compared to the part belonging to Magelang and Kulonprogo District (Figure 1). Malaria in Purworejo District shown in Figure 2 for the last 5 years from 2014 to 2018 has decreased significantly (75.42%).

Vector Malaria Survey

Intensive vector malaria surveys were conducted in two areas of Bagelen Public Health Center and Banyuasin Pubic Health Center, Purworejo District, which are malaria endemic Public Health Center with the highest number of cases in 2017.

Larvae Survey

The larvae survey was carried out around the malaria case index. Types of malaria vector breeding sites were found including inundation in rivers, pools of springs, pools of wood soaking, and seepage of waterways (Figure 3). The most common places where malaria vectors found were puddles along rivers in the dry season and pools of springs. The Malaria vector/Anopheles species larvae found were identified as *An. balabacensis* and *An. maculatus.* There were more Anopheles breeding sites identified during the dry season than during the rainy season. Buffer zone shows the distance between the malaria vector breeding sites and the group of houses ranges from 100 m (Figure 4). The larvae survey found 42 positive points of *Anopheles* larvae with varying densities.

Adult Vector Malaria Survey

Adult vector surveys were carried out twice, in July and October 2018. The result of malaria vector collection could be seen in Table 1.

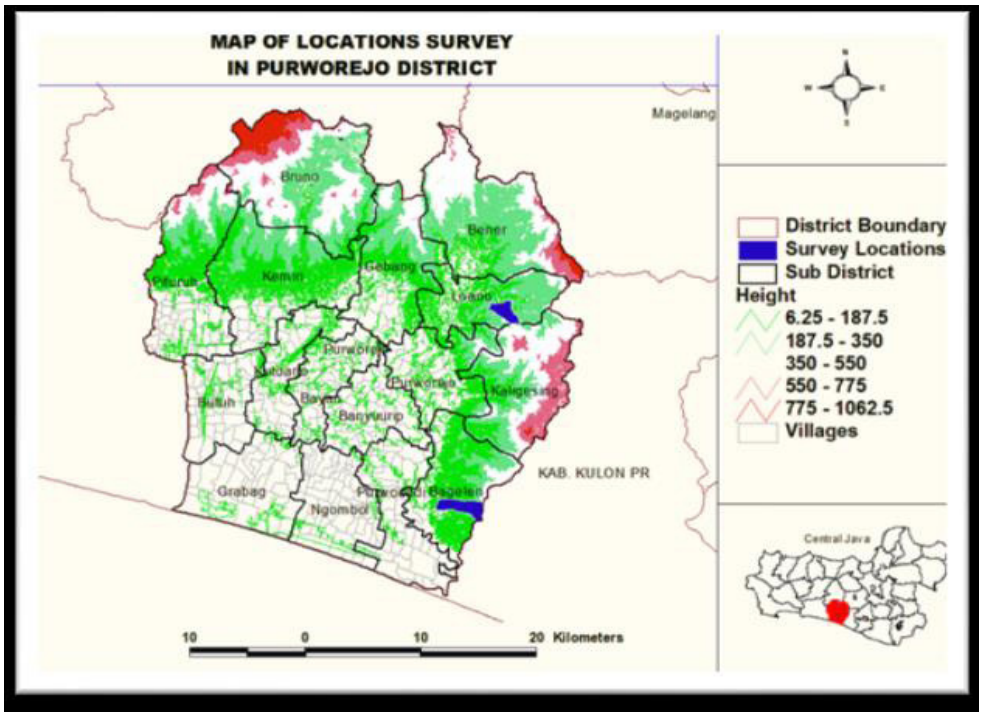

Figure 1. Location of Malaria survey in Purworejo

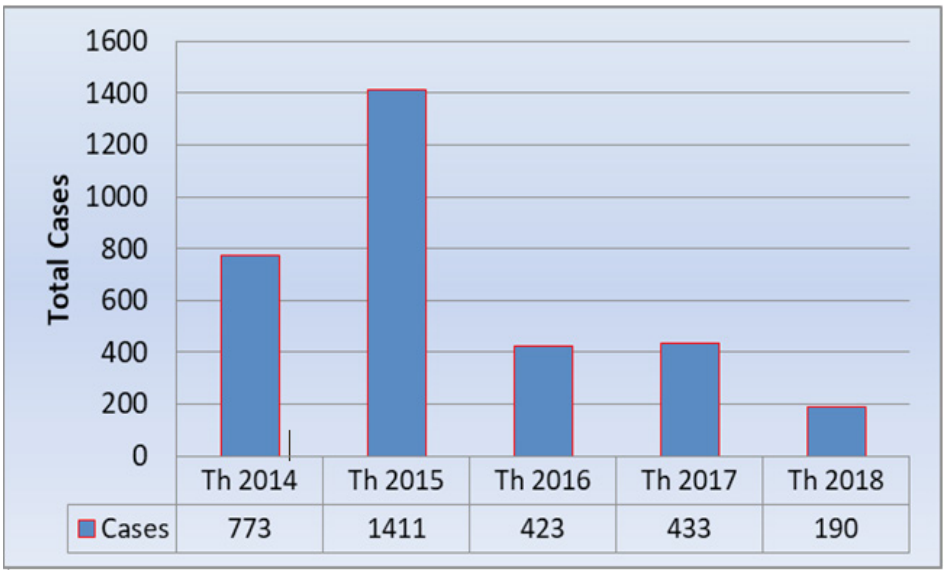

Figure 2. Malaria cases in Purworejo District

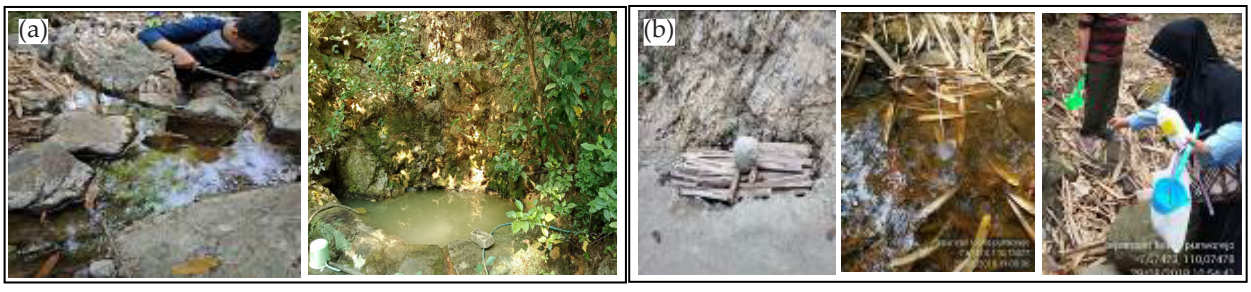

Figure 3. (a) Type of Breeding Sites in Purworejo and (b) intervention solution

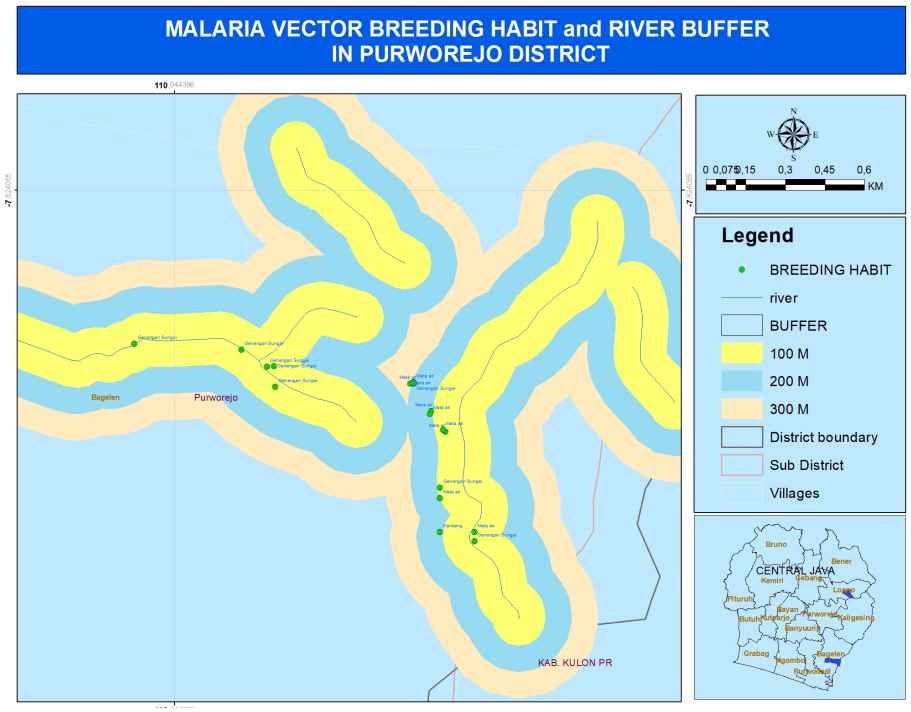

Figure 4. Malaria vector breeding habit and river buffer in Purworejo District

Table 1. Malaria Vector Species/Anopheles and Man Hour Density (MHD) with Night-Landing Collection (NLC) and the Night Resting Collection (NRC) Method

Species	Man Hour Density (MHD) (/person/hour)							
	Night-Landing Collection (NLC)				Night Resting Collection (NRC)			
	Indoor		Outdoor		Resting on the wall		Resting on The Cattle	
	July	Oct	July	Oct	July	Oct	July	Oct
An. balabacensis	0.03	0,00	0.12	0,00	0,00	0,00	0,00	0,00
An. maculatus	0,00	0,00	0,00	0,03	0,00	0.08	0.12	0.71
Anopheles spp. (Non vector)	0.03	0.01	0.07	0.01	0.08	0.04	1.33	0.75

The *Anopheles* species collected from the NLC and NRC method were identified as *An. balabacensis, An. maculatus, An. barbirostris* and *An. vagus.* The average temperature at the study site was 25.10°C and 25.44°C with Mean of Humidity at 75.10% and 79.85%.

DISCUSSION

Malaria is a major problem in Indonesia's public health. Purworejo is a district on the island of Java in which malaria was endemic. In 2015, most of the malaria cases in Purworejo were indigenous malaria (95%). The plasmodium found is predominantly *Plasmodium falciparum* (60%) and the rest is *Plasmodium vivax*.[20] Elimination of malaria requires non-existence indigenous malaria transmission but still allows the existence of imported malaria cases.

Purworejo district is a part of the Menoreh Hill region, where malaria has sometimes had a very high prevalence. This district has failed to achieve malaria elimination by 2015 so that 2023 has set up as the next target for entering malaria elimination.[21] Nevertheless, due to factors that were the geographical position of Purworejo which borders other endemic districts, environmental changes, and high mobility among residents, Purworejo needs regular assessments to maintain its malaria caseload below the requirement.[10]

Type of Anopheles larvae habitats found in survey locations are along the river with a 100 m buffer zone from the river and springs around settlements; small breeding sites with few water volumes. The breeding sites is in the shade of plants or trees. The close range of vector breeding sites with settlements has heightened the chance of malaria transmission. Mosquito nets are needed for communities around the malaria vector breeding sites to protect from malaria transmission. There were more Anopheles larvae in breeding sites that were identified during the dry season than during the rainy season. This condition contrast with the research finding of Atieli et al in Western Kenya, that in the wet season there are more positive larvae found in habitats than in the dry season.[6]

Spatial research on malaria in Purworejo shows that the distribution of malaria cases related to the presence or proximity of malaria vector breeding habitats (rivers, springs, stagnant water, puddles).[22] The appropriate intervention measures are action to drying malaria vector breeding sites, protection of springs, and puddle larvacidation in the dry season. The use of mosquito nets for communities around the malaria vector breeding habit is also a way to prevent transmission of malaria.

Anopheles species which is already categorized as vector transmitting malaria in Purworejo were *An. balabacensis* and *An. maculatus*, while *An. vagus* has also been confirmed as a vector using ELISA, but not yet confirmed by microscopic examination. Mursid (2015) reported that nine species found in Purworejo were *An. balabacensis, An. aconitus, An. barbirostris, An. vagus, An. anularis, An. kochi, An. maculatus, An. indifinitus,* and *An. subpictus*.[23,9] Research by Bina Ikawati *et al* reported that *An. balabacensis*, *An. maculatus* and *An. vagus* that was collected from Purworejo District in 2018 doesn't mature enough to transmit malaria. With a short lifespan, the gametocyte sexual cycle in the mosquito's body cannot be completed, so the transmission does not occur. However, this study also obtained data in the Kulonprogo area which borders Purworejo showed that *An. balabacensis* found was mature enough to transmit malaria.[24]

The average temperature and humidity at the study site were the normal thresholds for malaria vector life. Temperature and the extent of water availability for larval breeding are crucial factors in the vector life-cycle thus affecting transmission.[25] In Indonesia, the optimum temperature for malaria vector mosquitoes ranges between 25 and 27 °C.[20] The important factors for the vector-host relationship are the distance of people's houses from vector breeding sites such as a river, lakes, pond, and breeding sites in the forest. The houses of malaria patients in Winong Purworejo have a buffer zone of 1000 m from the mosquito breeding habitats. Research in South Sumatera showed that altituted, distance from forest and rainfall significantly associated with malaria cases.[26,27] The previous study showed that *Anopheles* sp. have a maximum average flight distance of 3,490 m.[28]

CONCLUSION

Malaria vector breeding sites found in Purworejo District were puddles of water along the rivers and springs. The distance between the malaria vector breeding sites and the group of houses ranges from 100 m. The larvae survey found 42 positive points of Anopheles larvae with varying densities. The appropriate intervention measures are action to drying malaria vector breeding sites, protection of springs, puddle larvacidation in the dry season, and the use of mosquito nets for communities around the malaria vector breeding sites.

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ETHICAL CLEARANCE

Studies conducted here were carried out with ethical approval from National Health Research and Development Number : LB.02.01/2/KE/056/2018, 15 February 2018.

AUTHOR CONTRIBUTIONS

In this article, all authors have the same role as the main contributors (equal contributors). The roles and contributions of each author are as follows:

Conceptualization; Formal Analysis: Methodology; Software	:	S
Data Curation; Project Administration; Supervision; Visualization	:	BI
Investigation; Validation; Writing – Original Draft Preparation; Writing – Review & Editing	:	S, BI, TW

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