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Malaria Vulnerability Index (MVI) as Models of Malaria Risk Analyze in Purworejo, Indonesia

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Purworejo's landscape was composed the coastal and hilly regions, endemic malaria diseases, influences of global climate change. The Annual Parasite Incidence (API) fluctuated of 5 years later, at range 0,45-0,57, increased to 1,12 on 2011th. Suitability of habitat conditions determines a species distribution in space and time. Understanding and modeling the influences of breeding and resting quality and mosquito vector can, therefore, be a powerful predictor of the risk of exposure to the pathogens they transmit.

Breeding and resting mosquito were sampled 34 villages covering settings available. Classified Random Sampling was designed base on topographic with 100m intervals. The influences of 11 parameters of breeding and resting place, 7 of social economic variable and topographic variables on mosquito densities was assessed by multivariate correlation. The Observation going on 4 period, wet season, intermediate, dry season and intermediate. Using Mathematic models to evaluated the breeding place and resting variable as potential risk to mosquito abundant, declared as MVI.

Nine species were fond : *An.balabaensis; An.aconitus; An.barbirostris; An.vagus; An.anullaris; An.kochi; An.maculatus; An.indifinitus; An.subpictus*, distributed at 82.35% of the total village, more species number collected than the research before. The highest vector density was 3.40 sp/man/hour (intermediate season), and the highest vector density 3.96 sp/man/hour (dry season). The environmental factors have significant related to vector densities were pH, total suspended solid, salinity, dissolved oxygen, chloride, temperature, humidity. The mathematics modeling, **MVI = I_{PH} + I_{PE} + I_{AC} + Is** The impact of the global climate change on dynamics malaria vector, increased from 5 to 9 species. Malaria Vulnerability Index (MVI) shows that there are a total of 14 regions (41%) with a no-risk category (NR) and 4 (12%) with a very low risk (VLR). Areas with very high risk (HR) cover 8 areas (23%), intermediate risk (MR) as much as 3 areas (9%) and low risk (LR) by 5 regions (15%). MVI change throughout the seasons.

Keywords: Malaria Vulnerability Index, Vector Density, Indonesia

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A. BACKGROUND

Climate change influence on various aspects of life. Weather elements perceived irregularities in the last decade in the majority of regions in Indonesia. Report of the United National Development Project (UNDP) 2007. Indonesia is a country affected by climate change. The changes are an extreme form of either a hotter or colder. The IPCC report (2007) shows the influence of global climate change on biological systems and social systems. Increased rainfall, increased frequency of storms, and the impact of some areas due to low rainfall. Extreme weather increases the risk of spread of infectious diseases including diarrhea, vector-based diseases (vector-borne diseases). Several studies have tested the relationship between variations in weather and infectious events. Changes in weather due to El-Nino (ENSO) influence on the spread of vector-based or non-vectors such as malaria, dengue fever, cholera, hantavirus (Anyamba et al., 2006; Mc.Michael et al., 2006).

Climate change has a major impact on disease transmitted by vectors (vector borne disease). Frequency of disease such as malaria and dengue fever increased. Residents with low capacity to adapt will be increasingly vulnerable to diarrhea, malnutrition, and the changing patterns of distribution of diseases that are transmitted through a variety of insects and animals. "Global warming" is also triggered increased cases of tropical diseases such as malaria and dengue fever. Residents with low capacity to adapt will be increasingly vulnerable to diarrhea, malnutrition, and the changing patterns of distribution of diseases that are transmitted through a variety of insects and animals. Climatic factors influence the risk of transmission of vector-borne diseases such as dengue hemorrhagic fever (DHF) and malaria. The higher the rainfall, dengue cases will increase. temperature is negatively related to DHF cases, therefore temperature increase per week will reduce dengue cases. Weather changes influence the formation of a stable ecosystem for the growth of malaria vectors (Dixon, 2010).

Environmental factors (geophysical, climatology and biogeography) indirectly affect malaria transmission dynamics, so that by monitoring factors geophysical, climatology, bio-geographic and land elements, will be obtained a description of population dynamics, distribution and location of mosquito breeding places as vector (Mardihusodo, 1998). Environmental factors can be projected on the scale of space and time in a row,

periodic and continuous, and then the transmission of malaria can be predicted and done anticipation.

Weather in Purworejo, influenced by the northeast and southeast trade. Both were wet and dry that influences the occurrence of wet and dry seasons. Locally dominant wind directed changes and direction due to the hills landscape Menoreh Winds blowing from the west are wet and bring water vapor, while winds from the east are dry.

Menoreh hilly landscape formed various zone provides support to the life and development of the Anopheles mosquito as a vector of malaria, which is different. These differences occur in both water bodies as a breeding (breeding site), the neighborhood as a place to rest (resting) and weather as supporting proliferation.

The results of the District Health Office records Purworejo, shows fluctuations cases during the year 2005-2011. Fluctuations of malaria cases occur due to an accumulation of various factors. Interaction between the mosquito (vector), parasites, and human environments, to change from time to time. Increased incidence of malaria in

addition to climate change as well as changes in the environment, such as changes in land use, changes in behavior and socio-economic changes (Fahmi, 2007).
Fluctuations in Purworejo malaria cases occur in addition to the year was also going from month to month. Usually, the peak incidence of malaria occurs two periods shift, which is between March and July and in August to October (DHO Purworejo, 2010). The highlight of the case coincided with the malaria vector densities. Incidence of malaria cases and the fact that Purworejo follow particular patterns, be interesting to study, especially to determine the relationship between the characteristics of the region as a spatial distribution of malaria cases, and the relationship of climate change to the case of malaria. Alleged while there is a limiting factor inhibiting the spread of malaria in an area that is a determinant factor of the characteristics of the region, where it becomes an interesting problem to be examined.
Spatial and temporal fluctuations provide an indication of areas that have vulnerability to the spread of malaria. Malaria Vulnerability Index (MVI) is a new approach to identifying and mapping areas and vulnerabilities. Vulnerability of each area of the basis for the conduct of the management of malaria.

B. **METHOD**

The study area

The study was conducted in Purworejo with many characteristics between coastal (zero m sea level), up to the mountains (>700 m sea level). Purworejo as a malaria's endemic area and experience the extraordinary events in the last 2 years.

Sample Research

The population in this study are all endemics area include 233 villages. Each region has characteristics that control the breeding of malaria vectors. Mapping unit in this study was generated from land units perform overlapping stacking (overlay) of several land classifications. Classification used is the endemic of malaria each region, altitude, and land use. Land units as the smallest unit analyze with specific characteristic. The research sample set based method multistage sampling or sampling stages. Method of selected samples are Classified Random Sampling. Number of sample 34 base on representative of characteristic area study

Determination of area Studies

Study area was selected as the village chief representatives used to take measurements of environmental quality data and entomology. Determination of the study area is done by the following steps.

First step, the establishment of land classification. Classification is determined by using the parameters of malaria endemic area, elevation, land use,. Environment variables as constituting the class are as follows:

a. Malaria endemicity Classification based on the amount of index cases as follows: 1. High Case Incidence (HCI) to the village with MoPI> 5; 2. Middle Case Incidence (MCI) to the village with MoPI 1-5; 3. Low Case Incidence (LCI) village MoPI <1; 4. Free village malaria (BM)

b. Topographic, Topography as environmental components grouped into height classes of land, with an interval of 100 m. Altitude intervals are based on changes in weather elements naturally (*lapserate*) which suggests that any increase in 100m surface of the earth will experience a drop in temperature of 0.6 ° C (Strahler, 1997)

c. Land Use

Land use has a dominant factor on land cover and resting area for malaria vectors. Malaria

vectors which tend to be classified by anthropogenic land use as residential.

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The results of this classification will then produce a number of land units. Unit of land - land units are the populations in this study.

The second step, determining the proportion of the sample. The results of the identification of land units each administrative region produce a number of members of each group with a population of a certain magnitude. Overlay results obtained 34 groups of regions with specific characteristics.

The third step, the determination of the sample study area. Samples of each class is determined by 1 region. Selection of the study area is determined based on random sampling of members of each class region. Be produce 34 study area as an object of observation and study the characteristics of the environment.

The fourth step, define research variables. The variables in this study are water quality, weather, socio-economic, density and type of malaria vectors. Research conducted longitudinal surveys that rainy transition drought, drought, drought transition rainy and rainy season. Up until this point has been done in 4 periods of the transition and dry, two other periods are still running.

a) Water quality

Water samples to be taken is a breeding (breeding place), of any land units as a sample selected. Water quality variables that will be examined is the salinity, pH, turbidity (cloudiness), electrical conductivity, TDS, TSS, DO, chloride, and hardness.

b) Elements of Weather

Samples weather elements do recording and measurement directly at the sample unit of land. Weather elements are used as variables are air temperature, humidity, rainfall, wind speed and direction.

c) The density and type Vector

The type and vector density performed in 34 areas of study. Dilakuan vector density arrest at 18:00 - 06:00 hours. Each study area on the second house arrest. Every house arrest for the house, outside the house and resting (cage). Supervision of each study area by 1 person supervisor. Results of arrest vector species identification in the laboratory of Parasitology.

d) Socio-Economic Data

Socio-economic data conducted structured interviews of 170 respondents, who are scattered in 34 areas of study. Socio-economic data collection undertaken include:

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household income, livelihoods, daily society, people's behavior, nutritional status of the community, utilization of vector control.

Malaria Vulnerability Index (MVI) Method

Malaria Vulnerability Index (MVI) is an index to describe the level of vulnerability of each region for the transmission of malaria. There are four dimensions of the index are the dimensions of the potential danger (hazard), the potential exposure (exposure), adaptability (adaptive capacity) and sensitivity (sensitivity).

The potential hazard is the area that provides habitat characteristics are suitable for the growth of malaria vectors. Potential include: air temperature suitable, moisture, air, rainfall, the quality of the culture, elevation, and the quality of the resting place (place of rest).

The Potential Exposure is a characteristic of the environment that supports the spread of malaria vectors. Potential exposure consists of the proportion of patients with malaria, population density, the density of malaria vectors, people's behavior and endemicity areas.

Adaptability consists of socio-economic conditions, knowledge, attitudes, practices and technologies or infrastructure. As for the sensitivity consists of immune and nutritional status of the community.

MVI is the sum of the Hazard Potential Index (I_{PH}), Exposure Potential Index (I_{PE}), Adaptive Index Capacity (I_{AC}) and Sensitivity Index (I_S). Each index has a sub-index, as well as each sub-index has sub-indices. Hazard potential index (I_{PH}) has a sub-index temperature (SI_T), sub-humidity index (SI_H), Sub Precipitation Index (SI_{RF}), Sub Breeding Quality Index (SI_{qb}), Sub elevation index (SI_{EL}), and Rest of Sub Index (SI_{rp}). Index has the same grade, so Hazard Potential Index is the sum of the sub-sub-index.

The breeding quality sub index is composed of several sub-sub-index pH (SSI_{ph}), the subindex of turbidity (SSI_T), sub-sub-index TDS (SSI_{tds}), sub-sub-index TSS (SSI_{tss}), the subindices of salinity (SSI_{sl}), the sub-indices DO (SSI_{do}), the sub-indices chloride (SSI_{cl}), subsub-index Conductivity (SSI_{cd}), sub-sub-index hardness (SSI_{hr}). Complete presented in the following formula.

$$\mathbf{MVI = I_{PH} + I_{PE} + I_{AC} + I_S} \quad \text{..... (1)}$$

$$\mathbf{I_{PH} = SI_t + SI_h + SI_{rf} + SI_{qb} + SI_{el} + SI_{rp}} \quad \text{..... (2)}$$

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$$\mathbf{SI_{qb} = 1/9\ (SSI_{ph}+SSI_{tb}+SSI_{tds}+SSI_{tss}+SSI_{sl}+SSI_{do}+SSI_{cl}+SSI_{cd}+SSI_{hr})} \quad \text{.....(3)}$$

I_{PH} = Hazard Potential Index

I_{PE} = Potential Exposure Index

I_{AC} = Adaptive Capacity Index

I_S = Sensitivity Index

$$\mathbf{SI_{qb} = 1/9\ (SSI_{ph}+SSI_{tb}+SSI_{tds}+SSI_{tss}+SSI_{sl}+SSI_{do}+SSI_{cl}+SSI_{cd}+SSI_{hr})} \quad \text{.....(4)}$$

SIqb = Sub Index Breeding Quality

C. RESULTS

Malaria in Purworejo

Purworejo geographically located at 3 ° 23'20 "- 4 ° 9'35" (E) and 5 ° 43'30 "- 6 ° 47'44" (S). Purworejo has coastal and mountainous landscape, affected global climate change. Locally dominant wind direction, changes direction due Menoreh hills landscape. Menoreh is one area endemic of malaria. Purworejo as endemic area, have fluctuation of malaria cases. The peak of cases occurred in 1973, 1979, 1987, 2001 and 2011. Three sub districts Loano, Bagelen and Bener areas as extraordinary events, Figure -1.

Figure 1

Fluctuation of Malaria Insidence 1969 – 2012

Spatial spread of malaria in coastal areas, some farmland, Menoreh belt. Temporal fluctuations in malaria cases occur in year to year and also each month. The peak incidence of malaria usually occurs two periods shift, which is between March and July and in August to October (DHO Purworejo, 2010). Formation zone is naturally controlled by the quality of the environment which is a habitat for Anopheles mosquitoes as vectors of

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malaria. In 2010 go down the intensity of rainfall occurs throughout the year, with the average temperature is lower than the annual average temperature (BMG Central Java, 2010). In 2011 shows that the air temperature is higher than the annual average. Environmental characteristics allegedly also changing due to climate change.

The research results in 2010 there are 5 species of Anopheles are: *An.aconitus, Anopheles barbirostris, Anopheles vagus, Anopheles kochi, Anopheles annularis*. The results Litbangkes (2010) suggests there is a development change in the vector, which is expressed

as a vector *Anopheles aconitus* single, there are currently three other species that have been turned into vectors. The presence of additional species are *Anopheles barbirostris, Anopheles vagus, Anopheles annularis.*Based on these cases segregated into 5 groups: 1. Case High Incidence Areas (HCI), the region with the Annual Parasite Incidence (API)> 5; 2. Regional Medium Case Incidence (MCI), which is the region with the Annual Parasite Incidence (API) 1-5 3. Regional Low Incidence Case (LCI), which is the region with the Annual Parasite Incidence (API) <1, 4. the area has a history of malaria and 5.

Environmental Quality

The results are grouped environmental quality for water quality (breeding place), air quality (resting plcae). Water quality parameters include 9 measurements, whereas for air quality includes 4 parameters. The measurement results in May (pre- dry season) water quality, showed a pH range of 5.9 - 8.2. While other parameters measurement ranges are as follows: 1-48 NTU turbidity; Total Dissolved Solid 43-293 mg / lt; Total Suspended Solid TSS 1-87 mg / l; salinity 0002 - 0.0173% 0; Dissolved Oxygen (DO) 1 -6.2 mg / lt; chloride 4 - 30.8 mg / l; Conductivity 91-604 µmhos / cm and hardness 31.84 - 184.08 mg / lt. As for the quality of the resting area (air quality) are as follows: air temperature 25-30 ° C, 71-92% humidity, and wind speed 1.8-2,16 km / h.

The measurement results in July (dry season) water quality, showed a pH range of 6 - 8.5. While other parameters measurement ranges are as follows: 1-183 NTU turbidity; Total Dissolved Solid 37-357 mg / lt; Total Suspended Solid TSS 1-31 mg / l; salinity 0001 - 0.03% 0; Dissolved Oxygen (DO) 2 -6.8 mg / lt; chloride 1.7 - 36.6 mg / l; Conductivity 57-567 µmhos/cm and hardness 34.65 - 225.72 mg / lt. As for the quality of the resting area (air quality) are as follows: air temperature 23 - 31.5 ° C, 71-87% humidity, and wind speed 1.08-2,88 km / h.

Malaria Vectors

Results arrest of Anopheles species in the study area was found nine species. Anopheles species are as follows: *1. An.balabaensis 2. An.aconitus 3. An.barbirostris; 4.An.vagus; 5.An.anullaris; 6.An.kochi; 7.An.maculatus; 8.An.indifinitus; 9. An.subpictu*. Anopheles species spread in most areas is 82.35% of the total observation location. 3:40 vector density

is highest sp / or / h (in the transition season), and the highest density of 3.96 sp / or / h (dry season).

The Bionomic of Malaria Vector The distribution of malaria vectors to a variety of pecies that exist in Purworejo there are certain patterns. ***1. An.balabaensis***

Anopheles species are scattered in the area with an altitude of 200-700 msl. Perform activities on the night of the afternoon at about 20.00 hours ampai around 02.00 midnight. The temperature was 23.5 ° C-30 ° C, with a humidity of 75-96%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 5.9-7.4; turbidity 1-48 NTU; total dissolved solid (TDS) 64-293 mg / lt; total suspended solid (TSS) 1-87 mg / lt; 0.0021-0.0084 ‰ salinity; dissolved oxygen (DO) 1.3 - 6.1 mg / l; Clorida (Cl) 4-14 mg / l; electric conductivity (EC) 135-604 µmhos / cm; hardness 44.78-184.08 mg / lt.

2. An.aconitus

Anopheles species are scattered in the area with an altitude of 100-700 mdpal. Doing activities throughout the night (18.00-24.00). The temperature was 23.5 ° C-30 ° C, with a humidity of 71-96%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 6 - 7.7; turbidity 1-21 NTU; total dissolved solid (TDS) 69-163 mg / lt; total suspended solid (TSS) 1-84 mg / lt; 0.0009-0.0173 ‰ salinity; dissolved oxygen (DO) 1.9 - 6.2 mg / l; Clorida (Cl) 3-29.9 mg / lt; electric conductivity (EC) 124-310 µmhos / cm; hardness 38.8-141.29 mg / lt.

3. An.barbirostris

Anopheles species are scattered in the area with an altitude of 100-600 mdpal. Doing activities ahead of the afternoon until midnight (19:00 to 23:00) and the menejelang morning (03:00 to 05:00). The temperature was 25.5 ° C-31 ° C, with a humidity of 71-89%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 5.9 - 7.6; turbidity 1-41 NTU; total dissolved solid (TDS) 59-189 mg / lt; total suspended solid (TSS) 3-84 mg / lt; 0.0009-0.0163 ‰ salinity; dissolved oxygen (DO) 1.9 - 6.2 mg / l; Clorida (Cl) 3-30.8 mg / lt; electric conductivity (EC) 108-328 µmhos / cm; hardness 31.84-142.28 mg / lt.

4.An.vagus

Anopheles species are scattered in the area with an altitude of 0-700 msl. Doing activities throughout the night between the hours of 6:00 p.m. to 5:00. The temperature was 25.5 ° C-31 ° C, with a humidity of 71-92%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 5.6-8.2; turbidity 1-48 NTU; total dissolved solid (TDS) 43-196 mg / lt; total suspended solid (TSS) 1-84 mg / lt; 0.0009-0.0084 ‰ salinity; dissolved oxygen (DO) 1 - 4.6 mg / l; Clorida (Cl) 3-14 mg / l; electric conductivity (EC) 91-395 µmhos / cm; hardness 26.86-175.12 mg / lt.

5.An.anularis

Anopheles species are scattered in the area with an altitude of 500-600 mdpal. Doing the activity around midnight at 23.00 till morning around 5:00. The air temperature is about 26 ° C, with humidity around 71%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) of about 6; turbidity about 3 NTU; total dissolved solid (TDS) of about 67 mg / l; total suspended solid (TSS) of approximately 3 mg / lt; salinity around 0.0009 ‰; dissolved oxygen (DO) approximately 3.1 mg / lt; Clorida (Cl) 3 mg / lt; electric conductivity (EC) 141 µmhos / cm; hardness of 63.68 mg / lt.

6.An.kochi

Anopheles species are scattered in the area with an altitude of 0-600 msl. Its activity at about 24.00 midnight till early morning at around 06.00. The temperature was 25.5 º C-30 º C, with a humidity of 71-88%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 6-7.6; turbidity 1-41 NTU; total dissolved solid (TDS) 59-196 mg / lt; total suspended solid (TSS) 3-84 mg / lt; 0.0009-0.0076 ‰ salinity; dissolved oxygen (DO) 2.4 - 4.5 mg / l; Clorida (Cl) 3-13 mg / l; electric conductivity (EC) 108-395 µmhos / cm; hardness 31.8-175 mg / lt.

7.An.maculatus

Anopheles species are scattered in the area with an altitude of 100-700 msl. Its activity started at around 20:00 pm to midnight at about 01.00. The air temperature is 26 º C-29 º C, with a humidity of 71-92%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 5.6-6.8; turbidity 1-21 NTU; total dissolved solid (TDS) 43-163 mg / lt; total suspended solid (TSS) 1-87 mg / lt; 0.0009-0.0035 ‰ salinity; dissolved oxygen (DO) 2.4 - 4.3 mg / l; Clorida (Cl) 3-10 mg / l; electric conductivity (EC) 91-310 µmhos / cm; hardness 26.86-141.29 mg / lt.

8.An.indifinitus

Anopheles species are scattered in the area with an altitude of 300-500 msl. Its activity in the afternoon at around 19:00 to 21:00. The temperature was 25.5 º C-29 º C, with a humidity of 72-88%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 6.9-7; turbidity 3-26 NTU; total dissolved solid (TDS) 101-172 mg / lt; total suspended solid (TSS) 14-17 mg / lt; 0.0035-0.0163 ‰ salinity; dissolved oxygen (DO) 1.9 - 2.9mg/lt; Clorida (Cl) 10-30.8 mg / l; electric conductivity (EC) 212-381 µmhos / cm; hardness 71-88 mg / lt.

9. An.subpictus

Anopheles species are scattered in the area with an altitude of 0-400 msl. Having sektar activities in the afternoon and early morning hours of 19:00 to 22:00 hours of 4:00 to 6:00. The temperature was 25.5 º C-30 º C, with a humidity of 73-88%. Water quality is a suitable place for the growth of culture has the following qualities. The degree of acidity (pH) between 6.8-7.6; turbidity 21-41 NTU; total dissolved solid (TDS) 59-105 mg / lt; total suspended solid (TSS) 14-28 mg / lt; 0.0009-0.0076 ‰ salinity; dissolved oxygen (DO) 2.9 - 4.5 mg / l; Clorida (Cl) 3-13 mg / l; electric conductivity (EC) 108-212 µmhos /

cm; hardness 31.84-97.51 mg / lt.

Malaria Vulnerability Index (MVI)

Using 18 variables to composed MVI, each variable is graded by 1-5. MVI identified for four periods of activity, intermediate dry season (in May), and during the dry season (July), intermediate wet season (October), and wet season (December). The results of the identification of the rainy to dry season transition as follows: 1. there are 8 areas of research (23%) with the category of High Risk (HR), with an index of 53 - 57.8 2. category of Medium Risk (MR), there are 3

areas of research (9%) with a value of 50.3-51.8; 3. category of Low Risk (LR), as many as 5 study area (15%), with a value of 48.3-49.7; 4. Very Low Risk category (VLR) by 4 study sites (12%), with a value of 45.2 - 47; 5. Non Risk category (NR) by 14 study area (41%), with a value of 36.8 - 44.90.

In the dry season (July) identification results show the following: 1. number of the regions of the study with the category High Risk (HR) as 6 areas (17%) with a value of 51.0-58.0; 2. category of Medium Risk (MR), a total of 6 regions (18%) with a value of 48.4 - 50.3 3. Low Risk category (VLR) by 5 study area (15%) with a value of 45.9-47.4; Veri Low Risk category as 6 areas (18%) with a value of 43.3-45.1; categories of Non-Risk (NR) covers 11 regions (32%) with a value of 32.0-42.4.

D. DISCUSSION

Distribution and Density Vector

Malaria vectors in Purworejo experienced dynamics from year to year and from month to month. The results Litbangkes (2010) found five species of Anopheles, while the identification results of the study found nine species of Anopheles (May 2012). Further research in July (2012) at the same sampling sites found 8 species. *Anopheles indifinitus* which was originally discovered in previous was not found in further observations. *Anopheles balabaensis* distributed in 8 locations of observation (May 2012), the observation and experience a shift to another observation area with the same number of sites (8 locations). There is only one location in Kaliglagah observation is found in the two observation times. *Anopheles aconitus* the observation of the transition season (May 2012) spread over 11 regions of observation. In subsequent observations in the dry season (July 2012) found the species in 20 sampling sites, with 3 villages shift. *Anopheles barbirostres* species distribution ditemukanya locations as many as 11 locations. In observation in July (dry) species are spread 13 study area. Species is not shifted from the study area increased only spreading.

Anopheles vagus, was found in 17 sampling sites in May 2012. Further observations on the dry seasons, distribution of the at 12 locations observations. *Anopheles anularis*, was found

in the study area is in the village Wonosido, the continued observation of the species found in the same study area and no shifting. *Anopheles kochi* species found in the study area on the season . In advanced observation found in 6 locations but the 5 locations shift and 1 fixed location that is in the village of Wonosido. *Anopheles maculatus*, found in six locations of observation (May 2012), while further observations are found at 11 sampling sites (July 2012). Anopheles indifinitus, was found in two locations observation (May 2012) and the follow-up observations (dry) species is not found. *Anopheles subpictus*, found in three locations of study and living found in one study a different location from the previous location. Dispersal of region species between the time of observation can be explained as follows: 1. the potential changes in water sources for breeding place; 2. changes in water quality that is suitable for breeding; 3. the appropriate resting as a resting place for mosquitoes.

Dynamics of MVI

Malaria Vulnerability Index (MVI) provide an overview of the potential hazards of each region by the influence of the dynamics of malaria vectors. Malaria vectors always have dynamics due to changes in environmental characteristics. The main factor is the presence

of malaria vector breeding places. Not all of the standing water can act as breeding places of malaria vectors. Each species of Anopheles has its own habitat. Each species also had the pleasure of rest (resting) separately. The potential danger of any resource area is contained within each region that can provide energy for growth and berrmbangnya each Anopheles species. Temperature and Humidity each region providing isrihat place for every species of mosquito. Temperature and humidity is in general determined by the altitude.

Rainfall give effect to the potential formation of a pool of water as a culture. High rainfall is not suitable for the establishment of places of culture, because the water flow has speed, which does not allow mosquitoes to lay eggs. Low rainfall, especially during the dry season led to the formation of puddles in the middle of the river as a potential breeding places. Another factor that affects the development of the malaria vector species is the water quality of the breed. Hazard rate (hazard) of the characteristics of the environment is used as one of the sub-index for the calculation of the overall index.

Another sub-index is to look at the potential for exposure (exposure) in each region. Exposure in question is the condition of the environment and community which give effect

to the potential transmission of malaria. The number of malaria patients in the study area exhibited significantly impacting. Transmission can occur when there is malaria, mosquito bites and mosquito bites another person. Endemic overcrowding and provide an overview of the level of hazard areas malaria.

Another index component used is the adaptability of the community in responding to the presence of malaria vectors. The ability to adapt is influenced by socio-economic circumstances. The behavior community consisting of component of knowledge attitude and practice of a major effect on malaria transmission. Behavior that is capable of protecting against mosquito attack can reduce transmission patterns. The existence of the technology to protect mosquito bites to be one of the factors that influence the transmission of malaria. Another component that is used to calculate the index is the durability and sensitivity (sensitivity). Included in this endurance is the nutritional status of the community and durability owned.

MVI calculation results showed a shift in areas with different levels of risk. In the transition area with no risk category (NR) a total of 14 regions (41%) and with a very low risk (VLR) 4 (12%) in the dry season the area is not at risk (NR) has decreased to 11 regions (32%) and with a very low risk (VLR) up into 6 regions (18%). Areas with very high risk (HR) covers 8 areas (23%), intermediate risk (MR) as much as 3 areas (9%) and low risk (LR) by 5 regions (15%).

In the dry season, especially shifting risk areas increased by 50%. Areas with no risk of the VLR and NR changed from 53% to 50%. As for the risk areas (HR, MR, LR) increased from the original 47% to 50%.

There are 2 areas that decreased the risk assessment of high risk (HR) to low risk (LR) and Kaliurip Kaliharjo the region. Other regions are at increased risk Kaliglagah and Kedung Pom Kulon of low risk (LR) to high risk (MR). Another area that was originally a no-risk region (NR) increased to medium risk (MR) and a very low risk (VLR) is Durensari, Watuduwur and Wonosido.

Index Changes

Seasonal changes influence the level of risk each region of malaria. A total of 7 of the 34 study area (20:58%) experienced a change in the index. MVI changes primarily of Hazard Potential Index (IPH) and Exposure Potential Index (IPE). Although other regions also

change the index but the change does not change the index class changes.

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Kaliharjo region and Kaliurip is a region which has decreased the risk of high risk (HR) to low risk (LR). Of Hazard Potential Index (IPH) were changed due to the change of seasons. Humidity and Rainfall has decreased due to the lack of rainfall in the region, which led to the decrease in the presence of moisture and resting area. Decrease in rainfall decrease puddles that serves as a place of culture. This is in contrast to other regions, where low rainfall raises new puddle on main rivers that cross the region. Decrease in other indexes is Exposure Potential Index (IPE) mainly from malaria vector density. In July the decline in standing water as a lower density of malaria vector breeding. With the fall of the vector density will impact on the index of the level of risk of transmission of malaria.

Region experienced an increase in the risk assessment that there are 5 regions Kaliglagah, Kedung pom Kulon, Durensari, Watuduwur and Wonosido. Kaliglagah and Kedung Pom Kulon particularly changes in temperature and humidity increased risk level (from 4 to 5). Similarly, rainfall has decreased the level of risk due to low rainfall (from 2 to 1). Although rainfall has decreased but the areas where it has increased the emergence of a new culture in the form of puddles with the quality that increases the level of risk. Sub-index of water quality have increased risk factors so as to provide an index changes (from 3.1 and 3.8 to 4). Malaria vector densities Kaliglagah primarily to increase the level of risk, sub index vector density increased from 3 to 5.

MVI Durensari study area changed from class category medium risk (MR) into the category of high risk (HR). Index changes occurs at a potential hazard index (IPH), especially of temperature and humidity increased. As for the rainfall index decreased. Increased higher in vector density. The increase in vector density was caused by an increase in standing water such as rivers due to decreased river discharge. Vector density has increased from 1 to 3.

Watuduwur region and Wonosido increased risk level of medium category (MR) to high risk (HR). The increase occurred in sub culture where water quality index and sub-index of the density of malaria vectors. Density sub-index temperature, humidity and rainfall has decreased. Vector density caused by the emergence of a new culture where the quality of water that is comfortable for the development of malaria vector breeding.

MIV Utilization

MIV Utilization for Prediction of Malaria Risk Level

Malaria vulnerability index (MVI) can be used as an early warning for routine monitoring.

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Thirty-four (34) of sites can be used as a generalization across the region in Purworejo. Use of this MVI to do with the phasing as follows.

Step 1

Malaria Vulnerability Index (MVI) for 4 periods within one year have been prepared (2 period has been completed). MVI describe the level of risk each region with different indices. Index is composed of all the variables that are directly related to proliferation and potential transmission of malaria vectors in each region. MVI will be much better when made every month (mountly) as a data base (the base) Purworejo region. By using the MVI will be able to watch high-risk areas each time period.

Step 2

Establish monitoring point of change of variables. The point of this monitor primarily for Hazard Potential Index (IPH) and Exposue Potential Index (IPE) which always changes

from time to time. As for the Sensitivity Index (IS) and Adaptive Capacity Index (IAC) changes slowly, can dilkukan annual evaluation. Monitoring points primarily to measure water quality variables (breeding place), air quality (resting place) and vector density.

Step 3

Preparing Software MVI, which include all variables used in the index are available in the software. Software that can be used is by Arc-Gis or use spreed sheet. By utilizing Arc Gis quickly be able to show that there are changes in MVI.

Step 4

Conducting simulations MVI, done by inserting a variable field observations into a preprepared software MVI. The result of the simulation is the information that describes the level of risk of each area of any changes in the variables. Information can be grouped into the working area of health centers in order to provide instant information to the agency responsible for the health (PHC).

Step 5

Socializing and delivery of early warning information to the public, especially areas with a high risk index. Information can be submitted through either through structural urban residents as well as informal groups.

D. CONCLUSION

1. Global climate change impact on the dynamic of species of Anopheles in Purworejo. There are 9 species: *An.balabaensis; An.aconitus; An.barbirostris; An.vagus; An.anullaris; An.kochi; An.maculatus; An.indifinitus; An.subpictus*. The species Anopheles were spread of 82.35% the most area's observation. The highest vector density is 3.4 sp/or/h (in intermediate season), and the highest density of 3.96 sp/or/h (dry season).
2. Malaria Vulnerability Index (MVI) shows that there are a total of 14 regions (41%) with a no-risk category (NR) and 4 (12%) with a very low risk (VLR). In the dry season the area is not at risk (NR) has decreased to 11 regions (32%) and with a very low risk (VLR) up into 6 regions (18%). Areas with very high risk (HR) covers 8 areas (23%), intermediate risk (MR) as much as 3 areas (9%) and low risk (LR) by 5 regions (15%). In the dry season, especially shifting risk areas increased by 50%. Areas with no risk of the VLR and NR changed from 53% to 50%. As for the risk areas (HR, MR, LR) increased from the original 47% to 50%.

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GENERAL COMMENTS

Instructor

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