International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Global and Micro Climate Change Related to the Dynamics of Anopheles sp. In Malaria-Endemic Area Purworejo City, Central Java

Mursid R.[a*], Sudibyakto H. A.[b], Gunawan T.[c], Sutomo A. H.[d], Windraswara R.[e]

[a] *Environmental Health Department, Public Health Faculty, Diponegoro University*
[b,c] *Faculty of Geography, University of Gadjah Mada*
[d] *Faculty of Medicine, University of Gadjah Mada*
[e] *Public Health, University of Semarang*

Abstract

The effect of global climate change continues to this day and generates impacts on various aspects of life including on changing of disease pattern. Purworejo city, one of the Malaria endemic regions in Indonesian, has also suspected to be affected by that situation. Malaria is a vector-borne disease diseases, shows a tendency to increase in morbidity. Cases of malaria in Indonesia, recorded at 417.819 cases, API 1.69 per 1000 population. This condition resulted in Purworejo city still struggle to eliminate malaria. Furthermore, Mopi numbers in the last 4 years is 0.72% o (2011), 0.82% o (2012), 1.02% o (2013), 1.1% o (2014). In this case, global climate change then allegedly to affect micro-climate and the dynamics of *Anopheles sp*. Data of global climate change used Southern Oscillation Index (SOI) for the last twenty years has been used to classify Purworejo microclimate by Schimth & Ferguson and Oldeman formula. The correlation coefficient is then used to analyze the effect of global climate change on micro-climates. Further step, the influence of weather variability to the variability of the type and density of *Anopheles sp*. was investigated by longitudinal survey application, and conducted during the 4 seasons of the year in 34 observation points. SOI during the period 1996 - 2014 fluctuated in the range of (+ 22.3) tends to be wet climate to (-29.1) to a dry climate. In extreme conditions (SOI> +8) or (SOI <-8) global climate change affect the microclimate in Purworejo.

----

* Corresponding author.

The correlation coefficient (R) between the SOI and rainfall in Purworejo in extreme year of 0.48 to 0.86; against air temperature R value of 0.41 to 0.76. The tendency of air temperature decrease y = (-0,0051x + 29.932), over a period of 16 years the air temperature decreases by (0,98º C). Based on field investigation, there were nine *Anopheles*species found: *An.balabaensis; An.aconitus; An.barbirostris; An.vagus; An.anullaris; An.kochi; An.maculatus; An.indifinitus; An.subpictus;* spread over 82.35% of the total area of observation, 2 of them *An.maculatus* and *An.balabasencis* was identified as vectors. However, the result of this study is lower than those in 2010; which 14 *Anopheles* species have been found, 3 of which were identified as vectors. Global climate changes affect the microclimate in malaria-endemic areas, especially in extreme conditions. However, the mild of climate change conditions has no effect on the microclimate state. In related to vector growth, micro climate change influence malaria-endemic areas in term of type and density of malaria vectors.

***Keywords**:* Global climate; microclimate; malaria species; Purworejo; Indonesia.

1. Introduction

Global climate change continues to this day. Extreme weather with high air temperature, and low air temperatures up to blizzard felt in many parts of the world [1,2]. Climate change impact on various aspects of life [3,4]. Direct influence on climate change in each region. Indonesia is among countries affected climate change. Extreme weather increases the risk of the spread of infectious diseases including diarrhea, vector-based disease (vector-borne diseases), including non-communicable diseases malaria, floods [5,6]. Changes in weather due to El-Nino (ENSO) affects the spread of vector-based diseases such as malaria, dengue fever, cholera, hantavirus [7,8]. Global climate change in Indonesia has an impact on the health and lives of others [9].

Purworejo potentially affected by global climate change [10, 11]. In 2010 the average flawed rainfall occurs throughout the year, with the average temperature is lower than the annual average temperature. Substitution season has shifted from October to April to the next month [12]. Purworejo also fluctuated month wet and dry months, which is one of climatic factors [13]. Malaria is an infectious disease that shows the trend of increased morbidity [14, 15]. WHO report on the prevention of malaria, in 2009, showed the prevalence of malaria is a top ten diseases in Indonesia [16]. The report shows Annual Parasite Incidence (API), an increase of 0.21 per 1000 population in 2000 to 0.75 per 1000 population in 2007. Figures API return increased to 0.95 per 1000 population in 2008. Data ministry Health of the Republic of Indonesia, recorded in 2012 amounted to 417,819 malaria cases, the API of 1.69 per 1000 population [17].

Purworejo experienced extraordinary events during the period 2009-2012 [18]. Purworejo not yet succeeded in realizing a malaria area until 2015. Eliminate Mopi figures in the last 4 years is 0.72 (2011), 0.82 (2012), 1.02 (2013), 1.1 (2014) [19]. Macro mapping results indicate spread of malaria in coastal areas, the area surrounding farmland and belt of Menoreh Hill [10, 20]. Are you the last six years the variability of malaria endemic areas. In 2008 (10 regions), 2009 (5 region), in 2010 (8 regions), in 2011 (7 region), in 2012 (13 regions), in 2013 (15 regions). In temporal fluctuations in Purworejo malaria cases occur in addition to the year was also occur from month to month. Peak malaria cases usually occur two periods shifting, i.e. [10, 20]. Anopheles species distribution of research results in Purworejo, found 14 (fourteen) species of Anopheles, 3 (three) of them identified as vectors of malaria. [21]. Every living creature will live according to its suitable environment. Any changes in the environment (habitat) will be followed by migration, adaptation, mutation, extinction [22]. The type and density of Anopheles species suspected to be influenced by changes in the weather. Global climate change suspected to affect the micro-climate and the dynamics of the species Anopheles. Indonesian government policy shifting from eradicate malaria (control) to eliminate (deletion), would takes an integrated approach to implementing malaria programs to be more effective and efficient.

2. Material and Methods

This study was conducted to examine the effects of global climate change on the weather and the elements deviation malaria vector abundance. The survey was carried out with indicators of global climate change according to Southern Oscillation Index (SOI), over the last 20 years, from the Australian Government Bureau of Meteorology, 2014. Changes in microclimate obtained from mutilations weather elements for 20 years Purworejo. Fluctuations in the density of Anopheles species were observed during the period of one year in 4 seasons, calculated using the method of Man biting Rate (MBR). Malaria endemicity grouped in the region there is no case (NCI), regions with low case (LCI), the region with the intermediate case (MCI) and regions with high case (HCI), grouped in a class of 100. The study sample intervals determined by multistage sampling method . The samples were selected is proportional random sampling Classified. The height interval is based on changes in natural weather elements (lapserate) which shows that any increase in the 100m surface of the earth will experience a drop in temperature of 0.6 ° C [23].

The population is a village that had experienced malaria cases as much as 224 villages. Overall sample calculation result class number 4, bound of error at 95% confidence level, and is taken as 1, (Nasir, 1983; Lapao, 2012). The formula used to determine the number of samples is: n = (L Σ Ni2. Σi2) / (N2D + Σ Ni. Σi2), D = B2 / 4, with 95% confidence. Based on calculation, it was obtained that the number of samples was 34 locations. Climate variables used were rainfall, air temperature and humidity, obtained from Purworejo Irrigation Department (1997-2014). Micro weather variability, temperature and humidity during the year, the result of primary data measurement during 4 periods of the season. Research density (density) of mosquitoes is done by using the guidelines of the "Manual on Practical Entomology In Malaria, WHO Division of Malaria and Other Parasitic Diseases, Part I, II) [24,25]. Identification of species carried in Parasitology Laboratory UGM, confirmative test for species that act as vectors performed by Elisa test.

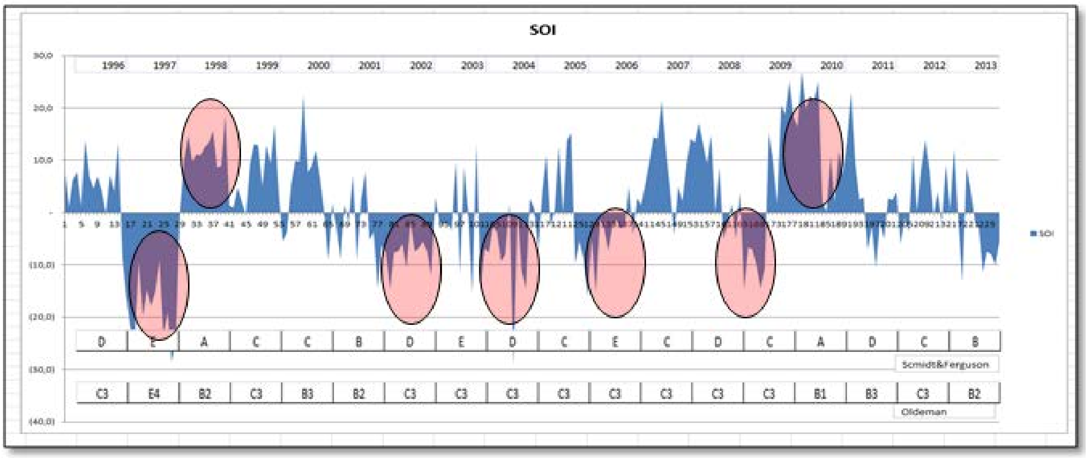
3. Results

3.1 Indicators of Global Climate Change

Global climate change is analyzed with one of the indicators of the southern oscillation index (South Oscillation Index, SOI). SOI data obtained from the Australian Government Bureau of Meteorology. Recording the results showed that there was a negative index gives the likelihood of El-Nino phenomenon that has the potential occurrence of drought and give the likelihood of positive index La-Nina phenomenon in favor of increasing rainfall. 1997 showed a negative index to (-28.5). Year occurred el-nino, which affects the occurrence of drought. El-nino else happened in 2002 and 2004, although not as big as in 1997. la-nina phenomenon occurred in 1998, 2007, 2008, 2010. In 2010, the magnitude of the positive index of (25.0) is in the influence of la-nina greatest. Effect occurs is increased rainfall, the change of classification "climate indicators", more SOI and climate class is presented in Figure 1.

3.2 Micro Climate

Climate in Purworejo was assessed by Schmidt and Ferguson's approach and Olderman. Mohr calculation [26] also used for classify month condition and humidity. In accordance with the Schmidt and Ferguson method, the value of the ratio between the dry and wet season months (Q), the average years of 1996 to 2012, was 38%. It has been obtained from calculation; Purworejo is included in the Climate category C.



Source: Australian Government Bureau of Meteorology, 2015.
Weather processed Purworejo Regency, 2014

Figure 1: Deviation Climate and Climate Classification

There are 5 categories when the climate is observed annually. Fifth climate is A, B, C, D, E, experienced variations every year. In accordance with the classification are the most arid climate (E) occurred in 1997, 2003 and 2006, while the wettest climate (A) occurred in 1998 and 2010. The results of the calculation of the annual climate Purworejo presented in Table 1 and Figure 1.

Another classification approach also uses the comparison month Oldeman wet and dry months. Known that climate zone 5 A, B, C, D, and E. Classification more specifically classified based on number of wet months and dry months. Analysis result showed that on average over the period of 1996-2012, including the Climate category C3. The climate experienced variations each year, namely zone C, B and E. The most arid climate occurred in 1997 in the category E4, while wet weather occurred in 1998 (B2), 2000 (B3), 2001 (B2), 2010 (B1) and 2011 (B3).

CLASIFICATION BASE ON SCHMITH&FERGUSON

year	number of month			Q	climate clasification
	wet	wet-dry	dry		
1996	7	0	5	71%	D
1997	4	2	6	150%	E
1998	10	1	1	10%	A
1999	8	0	4	50%	C
2000	8	1	3	38%	C
2001	9	1	2	22%	B
2002	6	1	5	83%	D
2003	6	0	6	100%	E
2004	6	1	5	83%	D
2005	8	1	3	38%	C
2006	6	0	6	100%	E
2007	6	3	3	50%	C
2008	7	0	5	71%	D
2009	7	1	4	57%	C
2010	11	1	0	0%	A
2011	7	0	5	71%	D
2012	7	1	4	57%	C
2013	10	0	2	20%	B
average	8	1	3	38%	C

Note :
A = 0% < Q < 14.3%
B = 14,3% < Q < 33,3%
C = 33,3% < Q < 60%
D = 60% < Q < 100%
E = 100% < Q <167%
F = 167% < Q < 300%
G = 300% < Q < 700%
H = Q > 700%

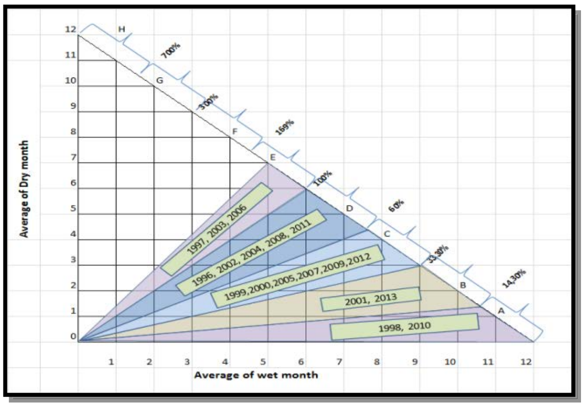


Figure 2: Classification and Climate Dynamics Purworejo Year 1996-2012

3.3 Climate Deviations Purworejo

The results of analysis by combining graph SOI with climate category resulted in several trends. In 1996 the index was positive, there are chances of La-Nina wet, climate occurs in Purworejo is C3 is wet. In 1997, negative SOI index, occur El-Nino is dry, the year in temperate Purworejo E, is dry. The condition also occurred in the next year similar to climate properties with the southern oscillation index changes. It was understood that global climate change has the effect of climate change in Purworejo. Short-term climate changes were described in the weather elements which consist of air temperature, humidity, rainfall. The weather is happening in Purworejo very likely to be affected by global climate change. Measurement is used to determine the weather elements also changes the lives mainly on the density of malaria vectors. Learn trend of global climate change and climate variability in Purworejo presented in Figure 3.

The results of the analysis of the maximum temperature in Purworejo recorded since the year 1996 - 2012, there is a downward trend. The results of the analysis are mathematical equation y = (-0,0051x + 29.932). The equation showed during the period of 16 years the air temperature decreases by (0,98º C). The tendency of a decrease in air temperature is experiencing variability, which in a few years, there is a maximum temperature warmer than average temperatures.

3.4 Effects of Global Climate Change against the Elements Weather

The influence of global climate change on rainfall in Purworejo, was calculated with correlation between the Southern Oscillation Index (SOI) with monthly rainfall during the period 1996-2012. From analysis, it is showed a correlation coefficient variety. In conditions of extreme global climate change where the SOI index greater than 10 or less than (-10), there were strong influence on rainfall. In 1997 the correlation coefficient reached 0.86. Similarly, another year correlation coefficient showed a significant value, namely: 0.44 (1996); 0.43 (1998); 0.77 (1997, 2000); 0.48 (2001); 0.52 (2002); 0.76 (2006); 0.61 (2008); 0.73 (2011).

On global climate conditions are relatively normal; SOI between 10 to -10, and the influence on rainfall is not significant. The correlation coefficient is smaller than 0.3, such as occurred in 2003 (0.33); 2004 (0.06); 2005 (0.19); 2010 (0.09). Analysis results that in the event of extreme global climate change to affect the rainfall in the district Purworejo. Global climate showed relatively normal condition when it has no effect on precipitation.

3.5 Type and Density Malaria Vectors

The results of field research conducted by the mosquito trapping of Anopheles species at 34 sites in a longitudinal study that is in May, July, October and December. Anopheles species for each season are presented in the following discussion. Mosquito trap in May represent a state of transition rainy season to dry season. Catches in the transition period discovered 9 (nine) species distributed in 28 (82%) the location of the observation. Nine species found are as follows: *An.balabacensis; An.aconitus; An.barbirostres; An.vagus; An.anularis; An.kochi; An.maculatus; An.indifinitus; An.subpictus*. The number of species caught dominant Anopheles vagus (209 in number) followed by Anopheles barbirostres (84 animals) and Anopheles a conitus were 49 tails. Vector density from 0.38 to 3.85 sp/man/hr.

An.vagus found in a wide range of territory, covering 17 villages with a height range of <100 to> 700 m msl. Other species that have a wide distribution is *An.aconitus* and *An.balanecenci*s. *An.barbirostres*, scattered in 11 (eleven) observations village. Anopheles aconitus found at an altitude of 200-300 m and 400-600 m above sea level. Species of *An.barbirostres* species found in the area with an altitude range <100-600 m above sea level. Other species were found with low populations are Anopheles indifinitus, found only region of the height of 300-500 m above sea level. *An.subpictus* are found at low densities in areas with an altitude of 100-400 m above sea level.

3.6 Dry season (July)

Mosquito trap analysis in the dry season (July) found eight (8) species spread in 30 (88%) the location of the observation. Eight species found are as follows: *An.balabaensis; An.aconitus; An.barbirostres; An.vagus; An.anularis; An.kochi; An.maculatus; An.subpictus*. *An.indifinitus* not found in the mosquito trapping of the dry season. The number of the most dominant species are caught *An.barbirostres* (382 in number) followed by *An.aconitus* (225 head) and Anopheles vagus (73 in number), vector density 0.02 to 0.3 sp/man/hr.

The distribution is based on the discovery of the species, *An.aconitus* found at an altitude range <100 m to> 700 m msl. Other species that have a wide distribution is *An.barbirostres*, *An.vagus* and *An.maculatus*. *An.barbirostres* found at an altitude of 100-600 m above sea level. *An.vagus* species found in the area with an altitude range of <100 to more than 700 m above sea level, the same as the species of *An.maculatus* have the same height distribution.

3.7 Drought Pre-Rainy Season (October)

Mosquito trap analysis in the dry-wet transition season (October) found eight (8) species spread in 26 (76%) the location of the observation. Eight species found are as follows: *An.balabaensis; An.aconitus; An.barbirostres;*

An.vagus; An.anularis; An.kochi; An.maculatus; An.indifinitus. An.subpictus not found in the mosquito trapping on the dry-wet transition season (October). The number of the most dominant species are caught *An.vaus* (349 in number) followed by *An.aconitus* (65 animals) and *An.barbirostres* (52 head). Vector density from 0.15 to 1.4 sp/man/hr.

The distribution is based on a finding of a species, *An.vagus* found in a wide range of territory, covering 16 villages which became the location of the observation, the height range <100 m to> 700 m msl. Other species that have a wide distribution is Anopheles aconitus, barbirostres. Anopheles species indifinitus only found at an altitude of 300-400 m dpl. On previous observations of this species is not found. Other species found in low population is *An.anularis*, only found in the area with an altitude of 100-200 m above sea level. *An.kochi* species is found at an altitude of 500-600 m above sea level.

3.8 Rainy Season (December)

Mosquito trap analysis in the rainy season (December) found the 7 (seven) species distributed in 30 (88%) the location of the observation. To seven species found are as follows: *An.balabaensis; An.econitus; An.barbirostres; An.vagus; An.anularis; An.kochi. An.subpictus and An.indifinitus* not found on the mosquito trapping of the rainy season (December). The number of the most dominant species are caught *An.vagus* (346 in number) followed by *An.aconitus* (113 head) and *An.balabaensis* (40 fish). Vector density from 0.21 to 0.67 sp/man/hr.

The distribution is based on a finding of a species, *An.vagus* found in a wide range of territory, included 15 villages are home to the observations, with a height range <100 m to> 700 m msl. Other species that have a wide distribution is *An.aconitus* (14 villages observation), *An.balabaensis* (13 villages observation). *Anopheles maculates* and *Anopheles indifinitus*have not been found based on the observation of the rainy season. Other species found in low population is *An.anularis*, only found in the landscape 200-300 m msl and landscape with 300-400 m msl. Results of other studies found the area with the highest number of species, namely the location of the observation 200-300 m msl, found as many as 5 species. The type and density of vector catching results for 4 seasons in one year are presented in Table 1 and Figure 3.

Eliza Test for Vectors Confirmation

Elisa test is used to determine the content of sporozoites in the mosquito's body. This test refers to the sporozoites ELIZA direction. Mosquito test results for each species were found. The test results were able to show Anopheles species that act as transmitters of plasmodium (malaria vectors). Species found during mosquito trapping dry rainy transition period (May), summer (July), the transition rainy dry (October) and the rainy season (December) is as follows: 1. An. balaensis; 2. An. barbirostris; 3. An. vagus; 4. An.maculatus; 5. An. aconitus; 6. An.kochi; 7. An.indifinitus; 8.An.anularis; 9. An. supictus. Elisa test result indicate *An. balabasensis and An.maculatus*as vector.

Table1. Malaria species distribution base on elevation of four survey periods

Part - 1

No	sampling location	densities (sp/m/hr)	balabasensis				aconitus				barbirostres				vagus			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	0-100 mdpal	number	1	2	2	9	1	69	8	14	42	198	2	4	14	14	17	26
		densities	0,02	0,04	0,04	0,19	0,02	1,44	0,17	0,29	0,88	4,13	0,04	0,08	0,29	0,29	0,35	0,54
2	100-200 mdpal	number	1	3	4	5	5	58	14	25	1	2	5	9	28	9	100	58
		densities	0,02	0,06	0,08	0,10	0,10	1,21	0,29	0,52	0,02	0,04	0,10	0,19	0,58	0,19	2,08	1,21
3	200 - 300 mdpal	number	2	3	1	15	2	58	1	9	1	16	1	0	32	9	143	79
		densities	0,04	0,06	0,02	0,31	0,04	1,21	0,02	0,19	0,02	0,33	0,02	0,00	0,67	0,19	2,98	1,65
4	300 - 400 mdpal	number	0	6	1	1	0	5	10	4	14	19	0	0	4	11	11	3
		densities	0,00	0,13	0,02	0,02	0,00	0,10	0,21	0,08	0,29	0,40	0,00	0,00	0,08	0,23	0,23	0,06
5	400 - 500 mdpal	number	3	0	0	10	29	11	3	3	15	35	1	1	118	12	57	18
		densities	0,06	0,00	0,00	0,21	0,60	0,23	0,06	0,06	0,31	0,73	0,02	0,02	2,46	0,25	1,19	0,38
6	500 - 600 mdpal	number	2	1	1	6	11	3	15	22	11	92	44	18	11	0	21	11
		densities	0,04	0,02	0,02	0,13	0,23	0,06	0,31	0,46	0,23	1,92	0,92	0,38	0,23	0,00	0,44	0,23
7	600 - > 700 mdpal	number	3	4	3	14	1	12	12	0	0	0	0	0	2	1	4	1
		densities	0,06	0,08	0,06	0,29	0,02	0,25	0,25	0,00	0,00	0,00	0,00	0,00	0,04	0,02	0,08	0,02
	number of species (sp)		11	14	9	55	49	166	52	55	84	355	52	25	209	48	255	129
	densities		0,23	0,29	0,19	1,15	1,02	3,46	1,08	1,15	1,75	7,40	1,08	0,52	4,35	1,00	5,31	2,69

Number of Species Anopheles

part-2

No	sampling location	densities (sp/m/hr)	anularis				kochi				maculatus				indifinitus				subpictus			
			A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1	0-100 mdpal	number	0	0	0	0	3	9	0	1	0	10	1	7	0	0	0	0	0	1	0	0
		densities	-	-	-	-	0,06	0,19	-	0,02	-	0,21	0,02	0,15	-	-	-	-	-	0,02	-	-
2	100-200 mdpal	number	0	0	2	0	2	0	0	0	5	13	8	30	1	0	0	0	5	0	0	0
		densities	0,00	0,00	0,04	0,00	0,04	0,00	0,00	0,00	0,10	0,27	0,17	0,63	0,02	0,00	0,00	0,00	0,10	0,00	0,00	0,00
3	200 - 300 mdpal	number	0	0	0	1	1	0	0	0	0	7	3	3	0	0	0	0	0	0	0	0
		densities	0,00	0,00	0,00	0,02	0,02	0,00	0,00	0,00	0,00	0,15	0,06	0,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	300 - 400 mdpal	number	0	0	0	1	0	1	0	0	0	0	0	2	1	0	1	0	0	0	0	0
		densities	0,00	0,00	0,00	0,02	0,00	0,02	0,00	0,00	0,00	0,00	0,00	0,04	0,02	0,00	0,02	0,00	0,00	0,00	0,00	0,00
5	400 - 500 mdpal	number	18	14	0	0	15	10	1	2	6	1	9	5	0	0	0	0	0	0	0	0
		densities	0,38	0,29	0,00	0,00	0,31	0,21	0,02	0,04	0,13	0,02	0,19	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
6	500 - 600 mdpal	number	0	0	0	0	2	1	3	4	1	1	10	0	0	0	0	0	0	0	0	0
		densities	0,00	0,00	0,00	0,00	0,04	0,02	0,06	0,08	0,02	0,02	0,21	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	600 - > 700 mdpal	number	0	0	0	0	0	0	0	0	1	2	2	1	0	0	0	0	0	0	0	0
		densities	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02	0,04	0,04	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	number of species (sp)		18	14	0	2	23	21	4	7	13	30	29	45	2	0	0	0	5	0		
	densities		0,38	0,29	0,00	0,04	0,48	0,44	0,08	0,15	0,27	0,63	0,60	0,94	0,04	0,00	0,00	0,00	0,10	0,00	0,00	0,00

Note :
A. PRE-DRY SEASON
B. DRY SEASON
C. PRE-WET SEASON
D. WET SEASON

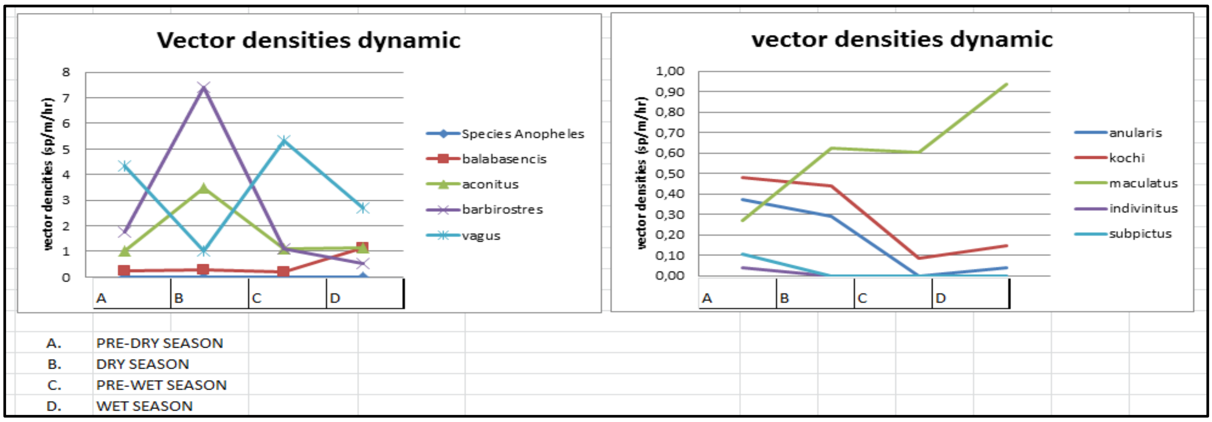


Figure 3: type and density of vector catching results for 4 seasons in one year

4. Discussion

Global climate change may appear in the form of extreme heat (warming) or extreme cold (cooling). Some areas of increased temperature but in other regions may experience a drop in temperature. The results of the analysis between the Southern Oscillation Index (SOI) with air temperature, rainfall, and humidity, there is a strong correlation (R> 0.5) during the extreme conditions with SOI> 8 or less than (-8). In between the SOI (-8) to 8, the climate is the average condition, there is no influence of global climate change on micro-climates. On the negative SOI index (<-8) give any indication of the El-Nino which causes a decrease in rainfall. On the positive SOI (> +8) will occur indication La-Nina, an increase in precipitation [27].

Climate is influenced by weather factors micro-region. Weather in every region in Indonesia is influenced by three factors: monsoon, the Inter Tropical Convergen Zone (ITCZ), and the topography of the region [28]. Air movement is influenced by differences in temperature and pressure. Temperature changes in the Ocean Pacific effect in accordance with the level of the index difference. In index> +8 global climate change is extreme wet, then the effect is felt up in some parts of Indonesia. Purworejo into the affected area index changes. In the wet climate change is happening trend of increased rainfall. On the opposite, the climate change is dry, a decline in rainfall. The correlation between SOI and rainfall, temperature and humidity obtained R> 0.5 amplify the effect. Therefore, climate change phenomenon impacts on micro climate change [29, 30, 31].

Movement moving monsoonal winds from the ocean Pacific is dry so that in parts of Indonesia experienced a drought. Wind movement of the Australian continent is wet which caused the rainy season in parts of Indonesia. Rainy season, dry and transition, occurs throughout the year, will generally take place in a cyclic manner. The change generally occurs in April and October. Several cases of irregularities in the cyclic [32,33].

The results of the analysis of the wet and dry season months showed the average climate in Purworejo included in climate classification C (Schmith Ferguson) and classification C3 (Oldeman). In some cases the classification of such cases shifted to B (very wet) or even to E (very dry). The results of the analysis show the SOI index <-8, the classification will lead to E (dry), whereas when the SOI> 8, then the classification leads to B (wet). In the SOI values in the range -8 to 8, the climate ranges in classification C. The results showed that there was the influence of extreme global climate change on the microclimate in Purworejo. Several other studies also showed the same thing in Vietnam [34], other Asian regions [35]. The results of the analysis of the maximum temperature in Purworejo recorded since the year 1996 - 2012, there is a downward trend. The results of the analysis are mathematical equation $y = (-0{,}0051x + 29.932)$. The equation show during the period of 16 years the air temperature decreases by (0,98º C). The tendency of a decrease in air temperature is experiencing variability, which in a few years, there is a maximum temperature warmer than average temperatures. The tendency of the temperature changes also occurred in several other regions [36,37].

Global climate change is real influence on the variability of the weather every year. In 1997, the weather in Purworejo greatly affected by global climate change. In the El-Nino phenomenon (SOI> 8), so that in Purworejo also very dry to achieve climate classification E. In the lower reaches 1,041 cases of malaria cases. In 2000, 2001, 2010, 2011, 2013 weather in Purworejo included in the wet classification. Globally La-Nina phenomenon

(SOI <-8), is wet. Weather in Purworejo in the year included in the classification of B. In these conditions of high malaria cases occurring up to 34 778 cases (2000). In 2013 cases of malaria were recorded at 615 cases. The data indicate that in wet tends to increase the case. Availability breeding place in all areas supporting the development of malaria vectors [38, 39].

The results of the study type and density of Anopheles species indicates that the species is found 9: *An.balabacensis; An.aconitus; An.barbirostres; An.vagus; An.anularis; An.kochi; An.maculatus; An.indifinitus; An.subpictus*. Elisa analysis results showed that two species *of An. Balabacencis and An.maculatus* identified as vectors of malaria. This study differs from previous studies that found 15 species of Anopheles 3 of them were identified as vectors [21]. Species originally found but not recovered are: *An. Minimus; An. tesselatusAn. flavirostri*; *An.arbumrosus; An.sundaikus*. *An.aconitus* previously acted as a vector, is not identified as a vector. These results indicate that in 2010 the rainfall almost throughout the year, it provides opportunities for breeding species more than in 2012 with relatively low rainfall. The results are consistent with other research in the area of Tanzania [40], Dakar, Senegal [41]. Wide spread of malaria species discovery area also fluctuated throughout the year. Distribution of *Anopheles* species was 28 (82%) in the observation location transition dry rainy (May) with 9 species. In the next period recorded eight (8) species, in 30 (88%) the location of the observation (July); 8 (eight) species in 26 (76%) the location of the observation (October); 7 (seven) species in 30 (88%) the location of the observation (December). The fluctuations caused by changes in the existence of a culture and suitability resting place *Anopheles* species [10]. Fluctuations in temperature, humidity and rainfall had strong influences on the fluctuation of malaria [43, 44].

Malaria transmission is affected by environmental, behavioral, genetic and health services (Bloom, 1972). The concept of "the epidemiological triad" Snieszko, 1974, said that the spread of disease involved host (human), pathogens (diseases, vector, plasmodium) and the environment (environment). Deviations weather changing patterns of distribution and transmission of infectious diseases (including malaria) indirectly by their impact on local ecosystems and behavior (Githeko et al., 2000). Complex ecology of disease-based vectors (vector-borne diseases) provides an understanding of the influence of temperature sensitivity variations, which can alter the pattern of incidence of malaria transmission patterns of seasonal and geographical range of other conditions [41, 45]. Institute of Medicine, delivering convergent models, that the local climate is one of the physical factors that have influence with biological factors, socio-economic, the (host) and the presence of microbes [46].

Various expert opinions indicate that physical factors (weather, and other physical factors), biological factors (heredity, vectors, microbes) and socioeconomic factors influence on the dynamics of the disease. Accordingly, the pattern of malaria spreading in Purworejo city has been influenced by these factors. The study is consistent with studies conducted in Ghana, that the distribution of malaria vectors *An.gambiae* as distributed by regions type with different characteristics [47]. There are environmental factors as a differentiator that air temperatures affect the distribution pattern of malaria vectors. Another study by Rakotomanana, (2010), found that environmental conditions and geographical location is not directly correlated with the incidence of malaria but the malaria vector abundance contributing factor [27]. Research conducted on An.arabiensis, shows the distribution uneven and concentrated in hilly location. The study also stated that the distribution of the main factors of malaria in Cameroon, showed the strongest factor is the impact of those activities on the environment, namely the stability of habitats [11]. Ecological factors more tolerance for some species, among others An.gambiae, An.mauceti, An.nili. That information is used to perform vector control. Other researchers on the spatial and temporal distribution of *Anopheles arabiensis* in Sudan, shows that of the approximately 3,349 breeding place, about 9.6% containing larvae of An. Arabiensis [7]. Habitats of *Anopheles* larvae have a large variety. Some of mosquitos were found along the river, around rocks, pipelines, as well as an open channel along the river.

5. Conclusions

5.1 Global climate change on extreme conditions, with SOI over +8 or less than (-8), giving effect to the micro-climate in Purworejo, R correlation coefficient from 0.44 to 0.86. However, on the condition of mild climate change would not give effect to the micro-climate.

5.2 The effect of global climate change in the characteristics of the season in Purworejo, wet characteristic causes seasons goes the classification of B, while the characteristics of the dry season would change seasons goes to classification of E.

5.3 The micro climate change affect the presence of 14 species of *Anopheles species* to 9 species in environment. Mosquito vector has decreased from 3 species (*An. Balabacencis*; *An.maculatus*; *An.aconits),* into only two vectors found, where *An.aconitus* not identified as a vector.

5.4 Size distribution and species of *Anopheles*, fluctuated throughout the year, in the dry monsoon transition (May) is the culmination of extensive type and distribution.

References

[1] Easterbrook D.J, Global Research, Department of Geology, Western Washington University and Global Research By, June 28, 2014, http://www.globalresearch.ca/global-cooling-is-here/10783

[2] Dixon G.P, Climate Change and Human Health, special issue of International Journal of Environmental Research and Public Health, 2010,Vol 5 : 78-91

[3] Gratz NG : Emerging and resurging vector-borne diseases, Annu Rev Entomol 1999, 44:51-75

[4] Partz JA, Graczyk TK, Geller N : Effects of environmental change on emerging parasitic diseases, Int J Parasitol 2000, 30:1395-1405

[5] IPPC J. McCarthy; O Canciani; Impact, Adaptation and Vulnerability,2001,CambrideUnivercity Press, Cambridge

[6] IPPC a,b,c, Ecosystem, Human Health, Intergovernmental Panel on Climate Change, 2007, Cambridge University Press, Cambridge

[7] Ageep TB, Cox J, Hassan MM, Spatial And Temporal Distribution Of The Malaria Mosquito Anopheles Arabiensis In Northern Sudan: Influence Of Environmental Factors And Implications For Vector Control, 2009,

Malaria Journal, Vol 8:123

[8] Unaited Nation Development Programde Indonesia (UNDP), Climate Risk Management an Integration Approach For Climate Change Adapatation dan Disease Risk Reduction in Indeonesia, Jakarta, Human Development Report, 2009, p: 78-98

[9] Witular R, Climate ChangeImplikaisnyaFor Indonesia, Annual Report, Jakarta, National Councilon Climate Change, 2011, p : 25-35

[10] Raharjo M, Environmental Variability And Habitat Suitability Of Malaria Vector In Purworejo District, Central Java Indonesia, proceeding of International Conference, 2012, Diponegoro Univercity, Indonesia

[11] Ayala D, Costantini C, Habitat Suitability And Ecological Niche Profile Of Major Malaria Vectors In Cameroon, 2009, Malaria Journal, Vol : 8:307

[12] Office of Meteorology and Geophysics of Central Java Province, 2011

[13] Annual Report of the Department of Irrigation Purworejo, 2013

[14] Adlaoui E, Faraj C, Bouhmi EM, Mapping Malaria Transmission Risk in Northern Morocco Using Entomological and Environmental Data, 2011,Malaria Research and Treatment Volume 2011

[15] Craig and David, A Climate-based Distribution Model of Malaria Transmission in Sub-Saharan Africa, South African Medical Research Council, South Africa, 1999, Parasitology Today, vol. 15, no. 3

[16] WHO, World Malaria Report 2010, 2010, WHO Press, Geneva

[17] http://www .depkes.go.id , Ministry of Health, 2013, the Malaria Free Future Investment Nation, accessible, 24 April 2013

[18] Annual Report Purworejo district health officein 2012

[19] Dwityo, 2015, HealthAnnual ReportPurworejo, SectionP2PLPurworejoHealth Servicein 2015.

[20] Raharjo M, MalariaVulnerability IndexForRiskManagementGlobal Climate Change ImpactsAgainstMalariaexplosioninIndonesia, Vektora Jurnal Vektordan Reservoar Penyakit, BBPPVRV, Salatiga, 2011, Vol III No 1, 54-80

[21] Sukowati S, The behavior ofmalariavectorsinPurworejo, researchreports, Jakarta, Research and Development,Litbangkes, 2011

[22] Odum T, Basic of Ecology, New York, John Wiley&Sons LTD, 1988

[23] Strahler A, Strahler A, Physical Geography Science and System Of The Human Environment, 1997, John Wiley&SonsInc, New York

[24] WHO Study Group, 1995, Vector Control for Malaria and Other Mosquito-Borne Disease, WHO, Geneva

[25] WHO, Mannual of Practical Entomology in Malaria, 1975, Geneva, WHO.

[26] Schmidt and Ferguson, Detail Climate of Indonesia, 1951, Jakarta, Directorat of Meteorological & Geophysical.

[27] Rakotomanana F, Ratovonjato J, Geographical and environmental approaches tourban malaria in Antananarivo (Madagascar), 2010, BMC Infectious Diseases, Vol : 10:173

[28] Oke TR, Boundary Layer Climate, 1987,Second Edition, Routledge, London

[29] David AR, Margaret AH, Eileen R, 2008, Global Climate Change and Extreme Weather Event, The National Academic Press, New York

[30] http://www.climatechangebusiness.com/first_annual_overview_climate_change, LONDON--(BUSINESS WIRE)--, United Nations Climate-Change Conference In Cancun Establishes A Green Fund To Cut Global Warming By Cutting Emissions, December 14, 2010

[31] Lioubimtseva E, Henebry GM, Climate and Environmental Change in Arid Central Asia:Impact, Vulnerability, Adaptation, Journal Of Arid Environments, 2009, Vol 4 : 44-62

[32] Verstappen, H.Th, Applied Geomorphology, Elsevier Science Publisher, 1983, New York

[33] Gillian H. S, Beyond Temperature And Precipitation: Ecological Risk Factors That Modify Malaria Transmission, 2009,ActaTropica, Vol 116 : 167-172

[34] Garos C, Cam V NG, Ho D T, Distribution Of Anopheles in Vietnam, With Particular Attention to Malaria Vectors Of The Anopheles Minimus Complex, , 2008, Malaria Journal, Vol : 7:11

[35] Lioubimtseva E, Henebry GM, Climate and Environmental Change in Arid Central Asia:Impact, Vulnerability, Adaptation, 2009, Journal Of Arid Environments

[36] http://www.cdc.gov/ncidod/eid/vol6no4/reiter_letter.htm : Fischhoff B, Carnegie, , 2010, The Perception Factor Climate Change Get Personel, Environmental Health Perspectives

[37] http://montreal.ctv.ca/servlet/an/local/CTVNews/20101211/cancun-un-climate-deal-101211/20101211/, Climate is warming - despite ups and downs: CSIRO, 28 Dec, 2010

[38] Diego A, Carlo C, Kenji O, Habitat Suitability and Ecological Niche Profile Of Major Malaria Vectors in

Cameron, , 2009, Malaria Journal, Vol : 8:307

[39] Ferguson HF, Ng'habi KREstablishment Of A Large Semi-Field System For Experimental Study Of African Malaria Vector Ecology And Control In Tanzania, , 2008, Malaria Journal Vol.7:158

[40] Kulkarni MA, Rachlee E, High Resolution Niche Models Of Malaria Vectors in Nothern Tanzania : A New Capacity to Predict Malaria Risk, 2010, Plos One, Volume 5 Issue 2 , e9396

[41] Machault V, Vignolles C, Pagès P, Spatial heterogeneity and temporal evolution of malaria transmission risk in Dakar, Senegal, according to remotely sensed Environmental data,2010, Malaria Journal Vol 9: 252

[42] Michelozzi P, Francesca K. ,Bargagli M.A, Surveillance of Summer Mortality and Preparedness to Reduce the Health Impact of Heat Waves in Italy 2010, Int. J. Environ. Res. Public Health , doi:10.3390/ijerph7052256

[43] Li Li, Biang L, Yan G, A Study Of The Distribution And Abundance Of The Adult Malaria Vector In Western Kenya Highlands, 2008, International Journal of Health Geographics.

[44] Obsomer V, Defourny P, The Anopheles dirus complex: spatial distribution and environmental drivers, 2007, Malaria Journal , Vol 6:26

[45] Muthers S, Matzarakis A, Climate Change and Mortality in Vienna, A Human Biometeorological Analysis Base On Regional Climate Modeling, 2010,Environmental Research and Public Health

[46] IOM, Vector-Borne Diseases: Understanding The Environmental, Human Health And Ecological Connections. 2008, Washington, DC: The National Academies Press

[47] Sousa D, Louise KH, Environmenal Factor Associated With The Distribution of Anopheles gambiae in Ghana : an importan vector of Malaria, 2010,Plos One, Volume 5, Issue 3, e9927