SPATIAL ASSESSMENT OF CLIMATE CHANGE IMPACT FOR DENGUE FEVER DISEASE DISTRIBUTION IN EAST JAVA PROVINCE: CASE STUDY UTILIZATION OF GEOSPATIAL INFORMATION FOR PUBLIC HEALTH

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ABSTRACT: Some of climate change effects have been appeared, such as increasing average temperature of the earth, anomalies of rainy and dry season and so on. Therefore, it is important to do more observation, in-depth research and analysis related to climate change influences on human life. This research is as an example to assess climate change impact for dengue fever disease occurrences (especially precipitation, temperature and humidity). Dengue fever disease has occurred in all parts of Indonesia and having many victims died. It is understood that climate change caused the changes the weather. The weather changes will affect to certain ecosystems or species such as mosquitoes. Changes in specific ecosystems or species were cause changes in the host-agent-pathogens relationship and the spread of infectious diseases such as dengue fever, malaria and so on. Method of this study was used statistical data analysis as well as spatial analysis. The spatially information can be more easily understood by public and policy makers than numbers or tables. So that public could be able to anticipate the spread of the dengue fever disease.

1. INTRODUTION

1.1. Background

Some of climate change effects have been appeared, such as increasing average temperature of the earth, anomalies of rainy and dry season and so on. According to data that reported by the National Development Planning Agency, Indonesia during the 20th century that the temperature has been a rise in average at 0.5 ^{o}Celsius, when compared to the temperature in the 1961 – 1990. Even will be increased to 0.8 to 1.0 ^{o}Celsius projected for 2020 – 2050. Climate change also trigger extreme weather caused many disasters, such as high intensity rainfall and long periods of time cause a lot of flooding in some parts of Indonesia. Therefore, it is important to do more observation, in-depth research and analysis related to climate change influences on human life.

One of the researches that needs to be done is to analyze the effects of climate change (especially rainfall, temperature and humidity) to the rising occurrences Dengue Fever Disease (DFD). DFD occurs throughout many parts of Indonesia and the many victims had died. It is understood that climate change leads to changes in the weather. Changes in weather will affect the ecosystem or certain species such as mosquitoes. Changes in specific ecosystems or species were cause changes in the host-agent-pathogens relationship and the spread of infectious diseases such as dengue fever, malaria and so on. Method of this study will use statistical data analysis as well as spatial analysis. The spatially information can be more easily understood by public and policy makers than numbers or tables. So that public could be able to anticipate the spread of the dengue fever disease.

1.2. The Climate Change and Dengue Fever Disease (DFD)

Definition of climate based on Wikipedia is average weather condition in long period measurement in one location on the earth or other planet. Long period it means more than 30 years, even hundreds of years. The climate in one location is depending on the geographic and topographic position. Indonesia is located on equator, where that location will affect to sun position relatively. So that Indonesia has different season compared with other countries. Climate change means significant changes in climate in long period more than 30 years. The changes occurred in temperature, precipitation, number of day of sun shining, etc. In generally, climate change that easily detect is season uncertainty or unpredictable and season anomaly. Unpredictable season would influence agricultural productivity, because agriculture is highly dependent on climatic condition. Extreme weather also will trigger the occurrence of natural disasters in disaster-prone areas. Another impact of climate change is the emergence of certain diseases that are always recurring and its tendency increasing year by year, such as Dengue Fever Disease.

The presence of mosquito habitats is dependent on climate patterns. Cahyati (2006) explains that the climate is one of the main components in the physical environment which consists of temperature, humidity and rainfall. The optimum temperature for mosquito growth is range between 25 – 27^{o} Celcius. Temperature affects the virus growth in the mosquito's body. When humidity is low causes evaporation of water from the mosquito's body, causing dryness of body fluids. This condition is one of the enemies of mosquitoes is evaporation. Humidity affects the life of the mosquito, fly distance, speed breeding, biting habits, and rest. Rain can affect the lives of mosquitoes in two ways, namely: causes increasing humidity and add places for breeding. Each 1 mm of rainfall adds to the density of 1 mosquito, but if the rainfall is 140 mm per week, the larvae will be swept away and die. In addition to socio-economic circumstances of climatic factors also influence the susceptibility of a community against vector-borne diseases. Knowledge, education and economic status influence the spread of dengue. In addition, Patz et al. (2003) mentions the spread of dengue disease is influenced by the health facilities, unplanned population growth and uncontrolled urbanization. Mondzozo et al. (2011) in a study involving temperature and precipitation as a climatic factor, while the socio-economic factors are population, population density, gross domestic product (GDP) per capita, and expenditures for health. Kemenkes RI (2010) mentions that the DFD mostly attacks children aged less than 15 years. However DFD can attack all ages, although until recently DFD is more common attack in children, but in the last decade tend to increase the proportion of dengue fever in adulthood. Because in this group have high mobility and in line with the development of transportation, this condition is making it possible for greater infected dengue virus.

1.3. Objective

The research objectives is to analysis climate change affect, especially for temperature, precipitation and humidity for increasing occurrences of Dengue Fever Disease (DFD), in East Java Province, and analyze the spatial distribution.

1.4. Data and Method

This research used statistics data years 2003 to 2010 such as population, climatology, meteorology and geophysics data, information about the geographical conditions, number of dengue fever patients, and field surveys conducted in August 2013. Method that used in this research was the collection and analysis of climatology, meteorology and geophysics data. Analysis of trend temperature based on a time series data namely average temperature, maximum and minimum as well as maximum and minimum annual absolute. Analysis of Rainfall trends was done early season and length of season based on time series data and amounts of rainfall during 6 (six) months period from October to March and April to September. And the last was analysis of spatial distribution of dengue disease.

2. RESULT AND DISCUSSION

2.1. Result

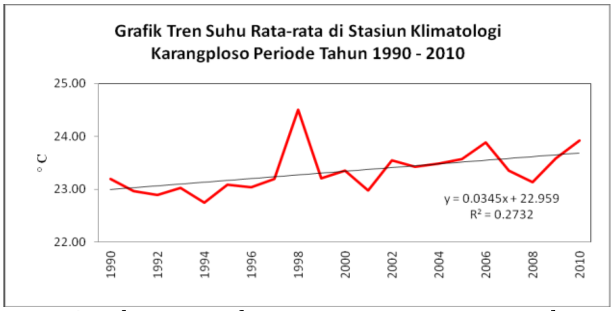
Based on climatologically data processing from the Climatological Station in Karangploso, Malang, there was an increase the length of the season from 1990 through 2010 with increasing rate 0.1571 annually. If there is no trend, the long rainy season in Karangploso station average is 14.5-day periods or 145 days. Beginning of the rainy season occurs at about 31th and 32nd-day periods or the first week and the second week of November. The dry season has declined in the long dry season of the same year, the trend rate of decline is 0.0883 or if there is no trend, the long dry season in Karangploso Climatology Station average 20.9-day periods or 209 days. Early dry season is around 11th -day periods or third week of April.

Result of Temperature Changes Analysis

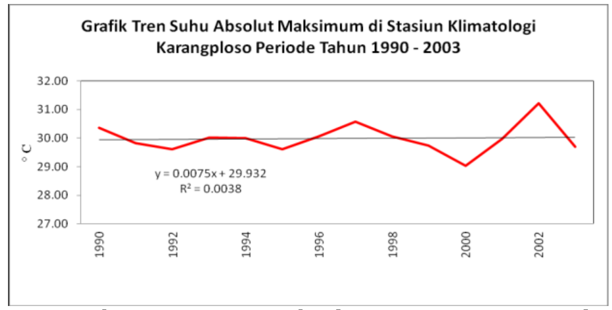
The identification and analysis of temperature changes, the data used from 1990 through 2010 from Karangploso station, the data is processed from daily into monthly data. The results of data processing can be described in the following chart 1. While the trend of the absolute maximum and minimum temperatures is illustrated in chart 2 and chart 3. Changes of average annual temperatures occurred at Karangploso station with trend value 0.03 ^{o}Celsius, if there is no trend, the value of the average annual temperature is about 22.96 ^{o}Celsius. The chart of absolute maximum temperature trend in Karangploso station didn’t show an increasing or decreasing in each year. The value of maximum absolute temperatures is about 29.93 oCelsius. And, there is no trend based on graph of absolute minimum temperature trends in Karangploso Climatological Station, the absolute value of the minimum temperature averaged around 16.11 ^{o}Celsius.

Result of Rainfall Changes Analysis

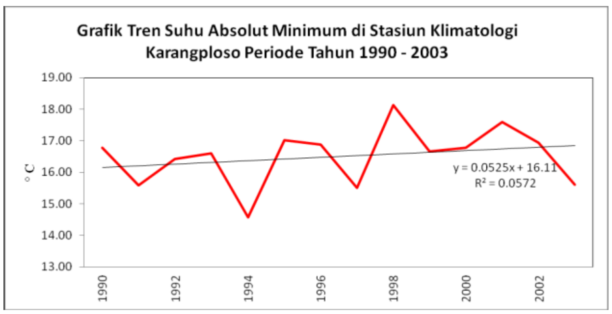
Graph the amount of rainfall during dry season (April to September), there was an increasing trend 9.1408 mm in every year, if there is no trend the average number of rainfall in that months around 185.2 mm.



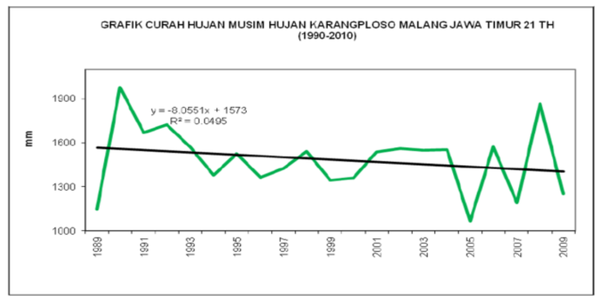
Graph 1. Annual Average Temperature Trend



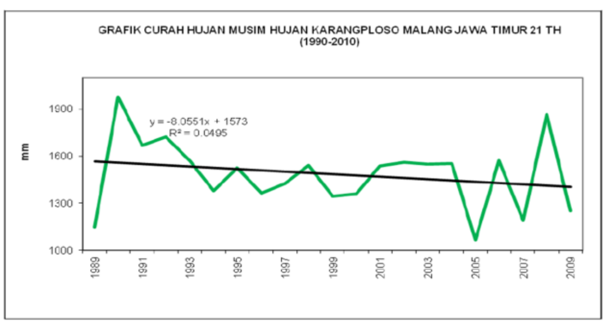
Graph 2. Maximum Absolute Temperature Trend



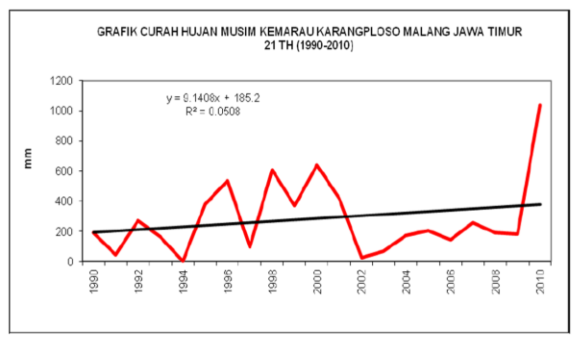
Graph 3. Minimum Absolute Temperature Trend



Graph 4. Six Month Period of Rainfall (October – March) Trend



Graph 5. Rainfall in Rainy Season



Graph 6. Rainfall in Dry Season

Result of Humidity Analysis

Humidity is a percentage of water vapor content in the air in someplace. The percentage of water vapor in the air is showing the potential of occurrences of rainfall, and also affects to air temperature. The amount of water vapor in the air also affects the thermodynamic properties of the atmosphere. Based on the results of the classification of data for 10 years from thirteen climatological station in East Java province, most of the moisture has an average from 76 to 80%. Tabel 1 is show the humidity and location.

Table 1. The Humidity of Research Area

No.	Humidity	Location
1.	86 sd 90 %	Most of Tulungagung, Kediri, West Blitar and small part of Pasuruan Regency
2.	81 sd 85 %	Part of Trenggalek, Tulungagung, Kediri, Jombang , Mojokerto, Blitar, Malang, Sumenep Regency.
3.	76 sd 80 %	Almost in East Java Province
4.	71 sd 75 %	Part of Madiun, East Ngawi, Bojonegoro, North Gresik, Pasuruan, Probolinggo, Bangkalan dan Sampan.

2.2. Discussion

Statistical analysis only focused on 13 districts/cities that have complete data for all variables. Nonparametric component which consists of three variables, namely rainfall, temperature and humidity were estimated using kernel functions for each variable, and generate a plot the regression line, as shown in Figure 7, 8 and 9. Non-parametric modeling can explain variability of the number of dengue cases per 100,000 populations is about 80.54%, this value was obtained from the value of R2. Figure 7, 8 and 9 is a plot generated by the kernel nonparametric regression using a 95% of confidence interval.

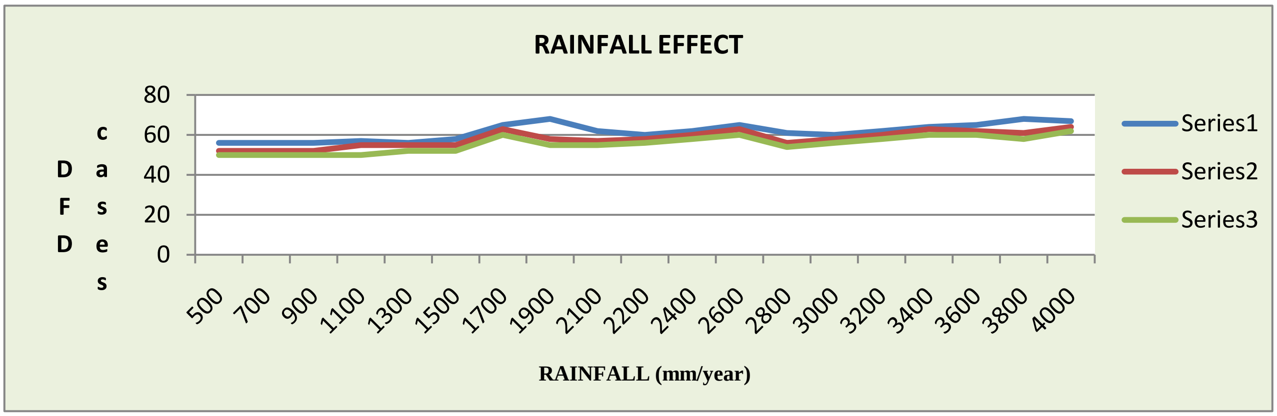


Figure 7. Rainfall Effect for DFD

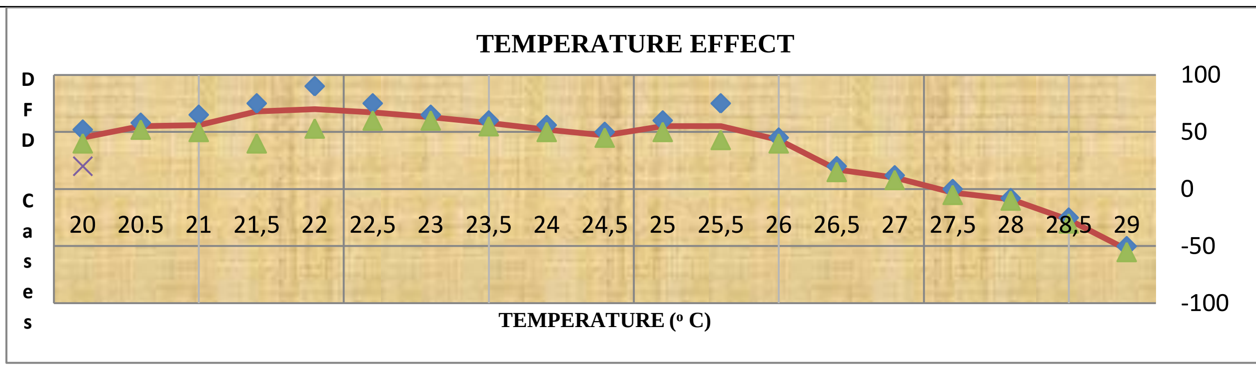


Figure 8. Temperature Effect for DFD

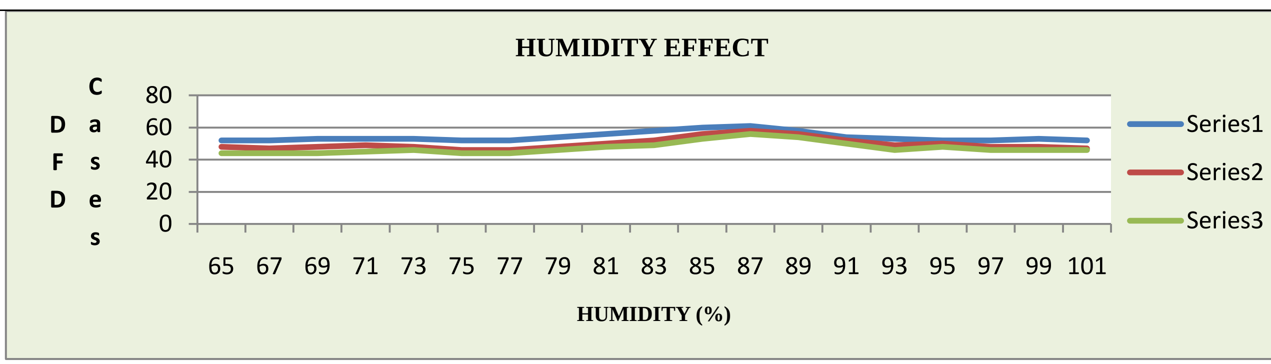


Figure 9. Humidity Effect DFD

Figure 7 shows that the incidence of dengue fever tend to not changed in the intensity of rainfall between 500 mm to 1,500 mm per year, but if the rainfall is in the interval 1,500 up to 3500 mm / year it will tend to increase the incidence of dengue fever. Rainfall factor that is closely linked to the increasing rate of the mosquito population. Figure 8 shows the relationship between the temperature and the incidence of DFD is not linear, as shown by the plot fluctuates. In general, at temperatures ranging from 22 °C to 27 °C will increase the number of dengue cases. At temperatures above 27 °C will decrease the incidence of dengue. So based on the graph can be interpreted that the temperature is below 22 and above 27 mosquitos growth is not maximal. Figure 9 show that the humidity affects the development of DFD with a nonlinear pattern. In terms of the regression line on the humidity between 70% to 75% incidence of dengue fever will tend to decline. The incidence of dengue fever tends to increase the humidity between 82% to 87%. But the humidity is less than 70% can also increase the number of dengue cases. Humidity affects the Aedes aegypti mosquito breeding cycles, especially the eggs.

Elasticity of Incident of DFD based on Climate Variable

Elasticity values obtained from Smooth Coefisien of non-parametric regression that indicates elasticity incident of DFD to climatic condition. Table 2 shows the elasticity values of every region in Java Province. The values indicate fluctuations of changes in dengue incidence when rainfall, temperature and humidity are changes. From that table show that regency/district responsive to temperature and humidity changes, not so in rainfall. Surabaya is the most responsive in temperature and humidity changes. It is means that region has a sensitivity to the incidence of dengue fever if there is changes in climate variables, especially temperature and humidity.

Table 2. Elasticity Values Based on Climate Variable

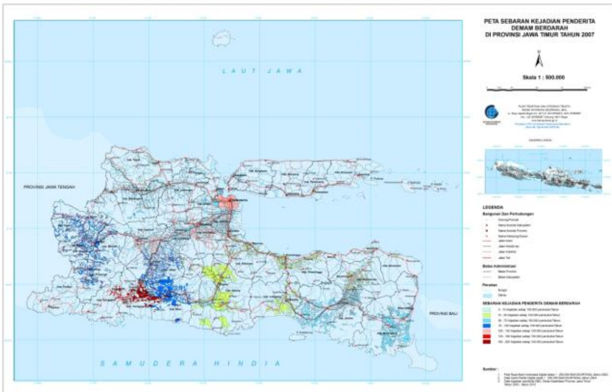
Regency/district	**Rainfall**	**Temperature**	**Humidity**
Kab.Blitar	0.090	30.087	12.084
Kab.Kediri	-0.027	-98.953	8.023
Kab.Malang	0.035	3.911	-11.008
Kab.Jember	-0.065	2.558	-1.727
Kab.Banyuwangi	-0.113	-34.117	1.146
Kab.Pasuruan	0.003	0.122	0.540
Kab.Sidoarjo	-0.058	5.071	3.698
Kab.Nganjuk	0.157	-20.650	-1.032
Kab.Magetan	0.002	-0.869	-3.649
Kab.Gresik	0.002	-0.869	-3.649
Kab.Sumenep	-0.017	0.058	0.174
Kota Surabaya	-0.319	136.825	50.185
Kota Batu	0.035	18.418	1.386

Spatial Analysis of Dengue Fever Incidence

The spatial analysis used statistical data mapped based on geographical location. Distribution of spatially is presented in figure 10. Differences or color gradation indicated the incidence rate of dengue fever; the darker color indicates a higher incidence. The green color indicates the incidence below 50, blue color 50 – 100, and red color is more than 100 per 100,000 populations. In 2010 the incidence of 130-200 per 100,000 populations (colored red to dark red) spread more widely than before. This map shows that in East Java Province along period 2003 - 2010 is getting increase in the incidence of dengue disease per 100,000 populations.

Distribution of DFD in 2003

Distribution of DFD in 2005



Distribution of DFD in 2007

Distribution of DFD in 2010

Figure 10. Map of Distribution of DFD in East Java Province Year 2003, 2005, 2007 and 2010

3. CONCLUSION

Based on the results of statistical analysis can be concluded that there are climate change effect in the incidence of dengue fever in East Java Province, especially for temperature and humidity changes. The results of spatial analysis show that in East Java Province along period 2003 - 2010 is getting increase in the incidence of dengue disease per 100,000 populations, this indicates that there is a correlation between climate changes and increasing incidence of dengue fever. While, socio-economic analysis is required in this research to gain more comprehensive analysis of the results.

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