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Research Report

PREDICTION OF DENGUE FEVER EPIDEMIC SPREADING USING DYNAMICS TRANSMISSION VECTOR MODEL

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ABSTRACT

Increasing number of dengue cases in Surabaya shows that its city has high potential of dengue fever epidemic. Although some policies were designed by Surabaya Health Department, such as fogging and mosquito's nest eradication, but these efforts still out of target because of inaccurate predictions. Ineffectiveness eradication of dengue fever epidemic is caused by lack of information and knowledge on environmental conditions in Surabaya. Developing spread and prediction system to minimize dengue fever epidemic is necessary to be conducted immediately. Spread and prediction system can improve eradication and prevention accuracy. The transmission dynamics vector simulation will be used as an approach to draw a complex system of mosquito life cycle in which involve a lot of factors. Dynamics transmission model used to build model in mosquito model (oviposition rate and pre adult mosquito), infected and death cases in dengue fever. The model of mosquito and infected population can represent system. The output of this research is website of spread and prediction system of dengue fever epidemics to predict growth rate of Aedes Aegypti mosquito, infected, and death population because of dengue fever epidemics. The deviation of infected population is 0,519. The model of death cases in dengue fever is less precision with the deviation 1,229. Death cases model need improvement by adding some variables that influence to dengue fever death cases. Spread of dengue fever prediction will help the government, health department to decide the best policies in minimizing the spread of dengue fever epidemics.

Key words: *Dengue Fever Epidemic, Knowledge Sharing, Transmission Dynamics Vector*

ABSTRAK

Peningkatan jumlah kasus DBD di Surabaya menunjukkan bahwa kota ini memiliki potensi tinggi epidemi demam berdarah. Meskipun beberapa kebijakan yang dirancang oleh Departemen Kesehatan Surabaya, seperti fogging dan pemberantasan sarang nyamuk, namun upaya ini masih tidak tepat sasaran karena prediksi yang tidak akurat. Ketidakefektifan pemberantasan wabah demam berdarah disebabkan oleh kurangnya informasi dan pengetahuan tentang kondisi lingkungan di Surabaya. Mengembangkan penyebaran dan sistem prediksi untuk meminimalkan wabah demam berdarah perlu segera dilakukan. Penyebaran dan sistem prediksi dapat meningkatkan akurasi pemberantasan dan pencegahan. Simulasi dinamika penularan vektor akan digunakan sebagai pendekatan untuk menarik suatu sistem yang kompleks dari siklus hidup nyamuk yang melibatkan banyak faktor. Dinamika model transmisi yang digunakan untuk membangun model Model nyamuk (tingkat oviposisi dan pra nyamuk dewasa), kasus yang terinfeksi dan kematian pada demam berdarah. Model nyamuk dan populasi yang terinfeksi dapat mewakili sistem. Output dari penelitian ini adalah situs penyebaran dan prediksi sistem epidemi demam berdarah untuk memprediksi tingkat pertumbuhan Aedes Aegypti, terinfeksi, dan populasi kematian karena demam berdarah epidemi demam. Penyimpangan populasi yang terinfeksi adalah 0519. Model kasus kematian demam berdarah kurang presisi dengan deviasi 1,229. Kematian kasus Model perlu perbaikan dengan menambahkan beberapa variabel yang berpengaruh terhadap kasus kematian demam berdarah. Penyebaran prediksi demam berdarah akan membantu, departemen kesehatan pemerintah untuk menentukan kebijakan terbaik dalam meminimalkan penyebaran epidemi demam berdarah.

Kata kunci: *Epidemik Demam Berdarah, Knowledge Sharing, Transmission Dynamics Vector*

INTRODUCTION

Dengue fever is the most frequent arthropod-borne viral disease in humans.[1] Over 50 million people living in tropical and subtropical urban and semi-urban areas are infected with dengue annually, and up to 500,000 people develop potentially lethal complications called dengue hemorrhagic fever/dengue shock syndrome. Dengue fever was founded in tropical and subtropical regions. The data from the Directorate of Animal Disease Control Source, Ministry of Health Department Republic of Indonesia, in 2010 Indonesia was the highest dengue cases in ASEAN with 150,000 cases and 1,317 deaths from the disease and in 2011 dengue cases were 126,908 cases with 1,125 deaths. Based on those data, the cases of dengue fever in Indonesia is first rank in the world.

Regarding to figure 1 about world spread of dengue fever shows that dengue activity in Indonesia is very high compared to other countries in the world. This condition becomes concentration for the government to decrease the number of dengue fever epidemics in Indonesia. A research was conducted by Fitriyani[3] to determine dengue critical epidemic areas in Indonesia. The research output is severity rate mapping of dengue fever in East Java and its classification in very critical, critical, and medium critical condition in East Java. Dengue fever cases classified into very critical when the cases in a city is more than 1,000 cases. Critical condition is happen when dengue fever cases reach 999–500 cases and dengue fever cases are less than 500 for medium critical category. Surabaya has high potential in spreading of dengue fever epidemics based on temperature and meteorology factors. (Figure 1)

The very critical level of dengue fever was 24% and Surabaya was included in this level with Blitar, Bondowoso, Gresik, Magetan, Mojokerto, Situbondo, Sumenep, and Tuban (fig. 2). Based on data, Surabaya was the city had the largest number of dengue cases in East Java with the amount up to 4,187 cases in 2006.[4] Figure 3 gives an overview of the high number of patients with dengue cases in Surabaya.

Surabaya Health Department has done some efforts in order to minimize the spread of dengue fever such as fogging (fumigation to kill dengue mosquitoes), "*abateseae"* (larvicides that aims to kill mosquito larvae), and mosquito's nest eradication (In Indonesian term called as Pemberantasan Sarang Nyamuk – PSN). Some efforts and policies that created by the government are still not working effectively. The current policies are less accordance in the real situation. If these problems happen every year then the spread of the Aedes Aegypti mosquito cannot be controlled optimally. Consequently in dengue fever cases, the health experts and government are required to decide the right policy to decrease the spread of dengue fever determine precisely, effectively, and efficiently in a short time, because dengue spread is relatively fast.[7]

Our previous research has been conducted in 2010[6] and 2011[7], it was integrated with knowledge sharing in preventing epidemic. It has developed a communication media (website) that aims to control the spread of tropical diseases. The website only displays information without give prediction of epidemics distribution in future time. When the prediction of disease distribution can be seen in future time or next period, the government or health department can easily make policies to minimize the

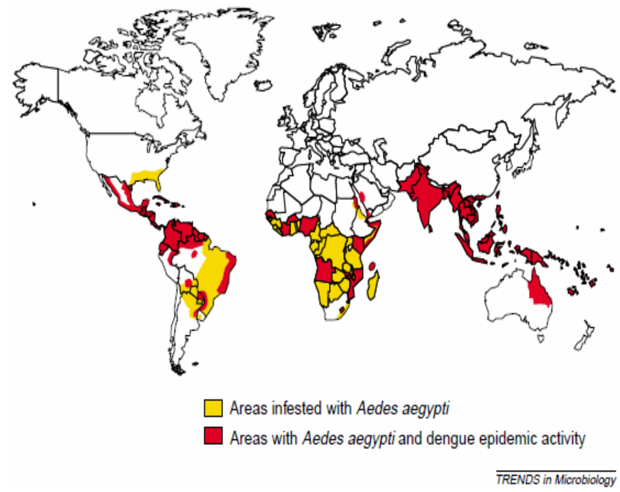

Figure 1. World Spread of Dengue Fever[2]

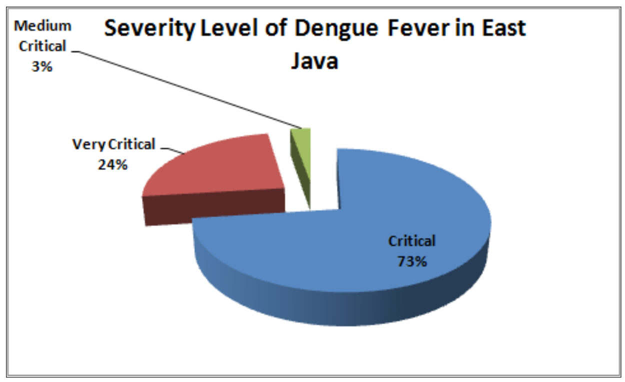

Figure 2. Dengue Fever Cases in East Java[4]

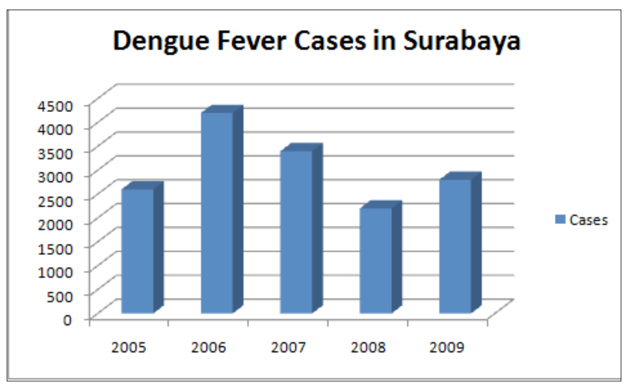

Figure 3. Dengue Fever Cases in Surabaya[5]

spread of the epidemic. In 2011, previous research showed the pattern of spread of dengue fever by using a dynamic system. In the dynamic system control method used the time factor; observe behavioral changes that occur in the system due to the change of time. Based on these aspects, it was tried to build models to predict the spread of dengue fever by using a dynamic system.

The results of dengue fever prediction using dynamics system were validated, but there was still inefficiency so this research still needs to be developed. Some lacks of condition in dynamics system are the modeling of dynamic system using Stella software integrated with the website. It was still unable to predict in the following years because of the different software logic in the computer. It caused the predictions only calculate in a next month, and for the next few months the programmer should be calculating again in Stella software to get the prediction of dengue fever spread. It is not efficiency when every month the programmer must run software to predict the spread of dengue fever. The lack of dynamics system model that conducted in previous research are there was no loop in model to balance steady state condition in system, the sub-models in continuous variable did not have a balance loop, so the model can be invalid and there are many variables used to build system dynamics model and some variables that used have less precise functions such as random function.

Based on some lacks of our previous research, it can become an opportunity for the development in spread and prediction system in dengue fever virus. It is necessary to do a research that able to predict the spread of dengue fever by using a method which is able to model the interaction between mosquito larvae, female mosquitoes, and people in complex system.[9]

In 2012, Chen, Szu Chieh and Hsieh, Meng Huan[8] showed the transmission dynamic modeling of dengue fever in subtropical Taiwan by the contributing temperature-dependent entomological parameters of Aedes Aegypti. This study adopted vector-host transmission model[9] and implemented for modeling transmission dynamics of dengue fever in Southern Taiwan. The study was conducted by Chen, Szu Chieh and Hsieh, Meng Huan[8] aims to incorporate temperature factor as entomological parameter and investigate the transmission potential using vector host dynamics model. It was focused on Aedes Aegypti mosquito parameters of pre-adult, mosquito maturation, oviposition rate, adult mosquito death rate, and virus incubation rate in the mosquito.

In this research tried to apply the dynamics transmission vector model to predict the spread of dengue fever cases in Surabaya. Dynamics transmission vector model is a mathematical model used to describe the development of an epidemic disease in detail by observing the life cycle of Aedes Aegypti mosquito and the transmission of dengue fever in human as host.[9]

The objectives of this study are determining variable in transmission dynamics vector in spreading of dengue fever epidemics and developing and simulating variable in models with transmission dynamics vector in spreading of dengue fever epidemics.

MATERIAL AND METHOD

Study Data

This study was conducted using some data, namely infected and death cases of dengue fever from Surabaya Health Department and Dr. Soetomo Hospital, population data from Bureau of Central Statistics in Surabaya and temperature data from Bureau of Meteorology and Geophysic Surabaya. Data collection is taken from 2011 until March 2013. Surabaya is second big city in Indonesia with high severity level of dengue fever cases in East Java. According data from Surabaya Health Department, Surabaya is largest dengue fever cases in 2006 up to 4,187 cases.

Vector Host Dynamics Models

Dynamic transmission model use some mathematical model implemented to predict Aedes Aegypti mosquito growth from oviposition rate, virus incubation rate, pre adult mosquito maturation rate, and adult mosquito maturation rate and human infected in dengue fever virus. Figure 6 about diagram in vector host transmission describe the interaction between vector (pre adult) mosquito, vector (adult), and host (human).

The interaction of vector in pre adult mosquito has two parts that is oviposition and oviposition vertical infection. Oviposition vector will continue in mature phase, if the condition or environment is good, so the Aedes Aegypti will continue in oral infection phase then become infection mosquito with Aedes Aegypti mosquito that can spread dengue fever virus to human. When the environment and weather is not good its growth then it will be death in every phase.[2,7,18,19]

The interaction between Aedes Aegypti and host vector (human) was described in host vector, figure 6. Host vector begin with birth then infection phase with Aedes Aegypti mosquito. When the immune system of human was good, then infected people will recover from dengue fever. When the human immune system was bad, it can cause death to infected people with dengue fever virus. Based on diagram vector host transmission model, there are two simulations, mosquito simulation and human simulation.

The mosquito simulation used to predict the oviposition rate, pre adult mosquito maturation rate, adult mosquito death rate, and virus incubation rate in mosquito. The models that used in mosquito simulation are:

a. **Ovipositon Rate**

$$y = -0.0163x2 + 1.897x - 15.837 \quad (1)$$

b. **Pre Adult Mosquito Maturation Rate**

$$y = -0.0000002x^5 + 0.00003x^4 - 0.0012x^3 + 0.0248x^2 - 0.2464x + 0.9089 \quad (2)$$

c. **Adult Mosquito Death Rate**
y = 205.03 -1.91x +0.15x1.5 – (725.9 / ln x) + (1247.68 / x) (3)

d. **Virus Incubation Rate in Mosquito**
y = 0.008x – 0.1393 (4)

where:
x = temperature dependent in observation area.

Temperature in observation area is variable that include in mosquito model, because temperature was importance things that affect in mosquito growth rate and virus incubation in mosquito. Mosquito eggs can hatch due to the temperature reaches above 28°C in the area, so that the temperature becomes a significant thing in mosquito growth.

Human infected of dengue fever (host) model used to simulate and predict the infected population because of dengue fever. This model combined with mosquito model because infected and death population depends on mosquito growth and virus incubation in mosquito. This is the model of human infected of dengue fever:

a. Susceptible Population (Se)

$$\frac{dSe}{dt} = bv\left(1 - v\left(\frac{Iv}{Sv+Ev+Iv}\right)\right) \quad (5)$$

b. Infected Population (Ie)

$$\frac{dIe}{dt} = bv * v\left(\frac{Iv}{Sv+Ev+Iv}\right) - \omega * Ie \quad (6)$$

c. Number at Time t Susceptible

$$\frac{dSv}{dt} = \omega * Se - \beta\frac{Ih}{Nh}Sv - \mu v * S \quad (7)$$

d. Infected but not Infectious

$$\frac{dSv}{dt} = \beta\frac{Ih}{Nh}Sv - \varepsilon Ev - \mu vEv \quad (8)$$

e. Infected Female Mosquito

$$\frac{dIv}{dt} = \varepsilon Ev + \omega Ie - \mu vIv \quad (9)$$

f. Sizes at Time t of Susceptible

$$\frac{dSh}{dt} = \mu hbNh - \beta\frac{Sh}{Nh}Iv - \mu hdSh \quad (10)$$

g. Recovered / Immune Human Population

$$\frac{dIh}{dt} = \beta\frac{Sh}{Nh}Iv - \gamma Ih - \mu hdIh \quad (11)$$

h. Infected / Infectious

$$\frac{dRh}{dt} = \gamma Ih - \mu hdRh \quad (12)$$

Table 1. Variable of Vector Host Dynamics Models

Variable	Meaning (Units)
Se	Susceptible population
Ie	Infected population
Sv	The number at time t of susceptible
Ev	Infected but not infectious
Iv	Infectious female mosquito
Ih	Infected/infectious
Rh = γ Ih/μhdRh	Recovered/immune human population
bv	Oviposition rate of the egg (per days)
v	Proportion vertical infection rate
ω	Pre adult mosquito maturation rate (per days)
Sv+Ev+Iv	Total size of vector population
Iv/Sv+Ev+Iv	Infected Probability
Nv	Total number of mosquitoes
Nh	Total size of human population
1/bv	Average oviposition periods
1/ω	Pre-adult mosquito average transition time hatched eggs into adults form
β	Transmission biting rate (per day) if β = 1 and 1.5 imply that 1–1.5 bites per day for one women mosquito
β(Ih/Nh)Sv	Infected by the dengue virus during a blood meal
β(Sh/Nh)Iv	Infected mosquitoes transmit the virus to susceptible people
γ	Human recovery rate (per day)
μhbNh	Human birth number
γ Ih	Human recovery number
MhdRh	Human death number
μv	Mosquito death rate
ε	Virus incubation in mosquito
μhd	Human death rate (per day)
μhb	Human birth rate (per day)

Source: [9]

Based on mathematical model in vector host dynamics models, the variable that used is:

Implementation Dynamics Transmission Vector Model

Dynamics transmission vector model was implemented in mosquito simulation, infected and death population of dengue fever for every sub district in Surabaya. Infected and death population in dengue fever simulate based on the model formulation with the input from mosquito formulation. In this model considered some factors such as environmental factors: temperature [8], social factors:

Table 2. Input parameter value in Dynamics Transmission Vector

Variable	Meaning	Value	Reference
v	Proportion vertical infection rate	0.028	[8]
ω	Pre adult mosquito maturation rate (per days)	0.099	[8]
β	Transmission bitting rate (per days) if β =1 and 1.5 imply that 1-1.5 bites per days for one women mosquito	0.33	[9]
bv	Oviposition rate of the egg (per days)	6.218	[8]
ε	Virus incubation in mosquito	0.0607	
μv	Mosquito death rate	0.0331	
γ	Human recovery rate (per days)	0.143	[9]

amount of population growth mortality rate [9] and [8], and medical factors: recovery factor of infected person with dengue fever and the immune system in their body [9] and [8].

RESULT AND DISCUSSION

Dynamics transmission model integrated with temperature data in Surabaya, number of population in Surabaya, number of infected and death population that is caused by dengue fever cases. Some parameters are used for applying this model to predict dengue fever cases in Surabaya. This is the input table of parameter in Dynamics Transmission Vector Model.

Based on the input parameter above, the quantitative calculation is used to know the oviposition mosquito rate,

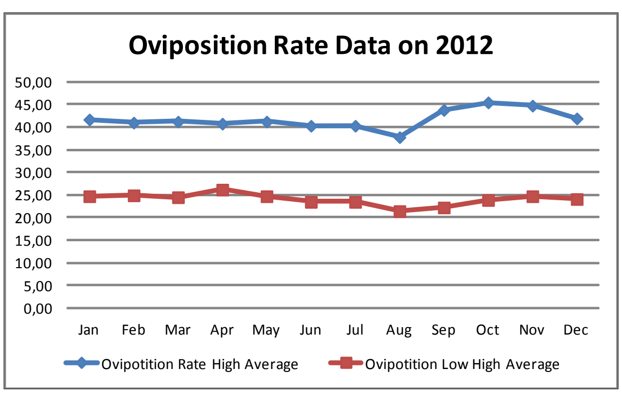

Figure 4. Oviposition Rate Data on 2012

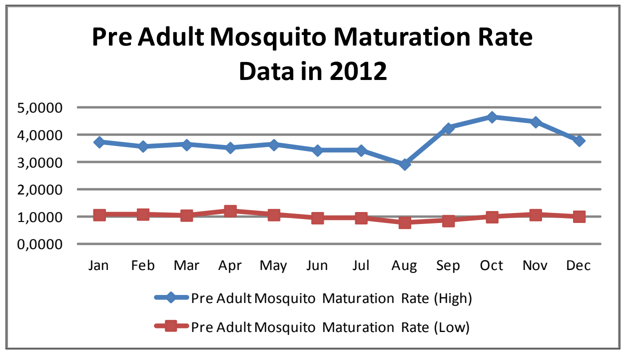

Figure 5. Maturation Rate of Pre Adult Mosquito Data on 2012

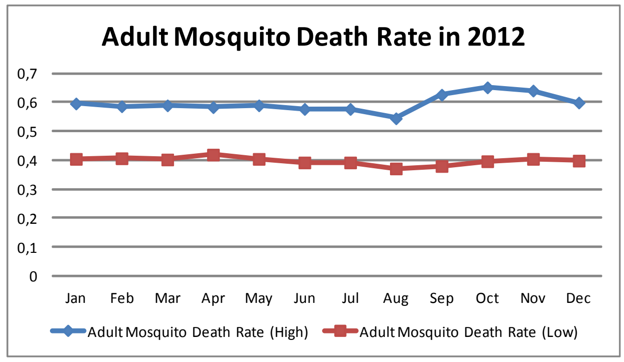

Figure 6. Adult Mosquito Death Rate Data on 2012

pre adult mosquito maturation rate, and virus incubation rate in mosquito.

Oviposition is the way ovipositor (Aedes Aegypti mosquito) to deposit or lay egg in the medium where it can mature likes in water and container. Based on that formulation, the simulation of mosquito vector was simulated in 2012 shown below:

Maturation rate is condition that mosquito in pre adult stage. This stage, mosquito's wings are fully expanded and hardened. So they can fly around and require blood meal to visit. This stage is dangerous for human because they bring dengue fever virus.

Adult mosquito death rate is depended on condition of the temperature, environment condition, and fogging policy. This is the graphic of adult mosquito death rate.

Virus incubation rate in mosquito is very important aspect because it will affect spreading virus dengue fever. The rate in every month is changing based on temperature in region. This is the rate of virus incubation in Aedes Aegypti mosquito.

Data for the oviposition rate of the mosquito egg, infected probability, proportion vertical infected rate, pre adult mosquito maturation rate, and infected population calculate with the formulation above. This is the data that used to calculate infected population in January 2012 in Tandes.

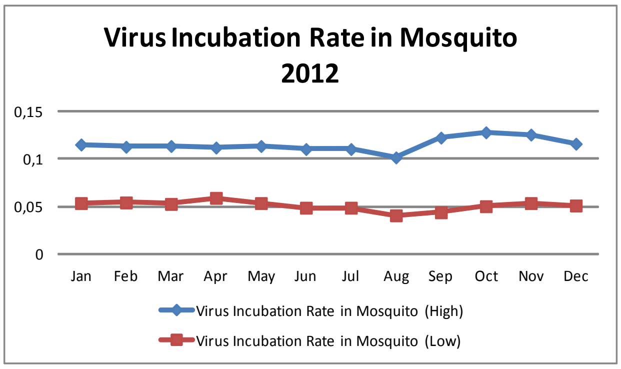

Figure 7. Virus Incubation Rate Data on 2012

$= (bv * v * Iv / Sv + Ev + Iv) – (\omega * Ie)$
$= (33.1853225 * 0.028 * 4.15776E\text{-}05) – (2.404788935 * 2)$
$= 4.809536$

Based on the calculation above, infected population in Tandes January 2012 is 4 people. The value of oviposition rate and pre adult mosquito maturation rate was based on mosquito simulation. Proportion vertical infected rate is constanta from mosquito bite human and infected human body by dengue fever virus and the value is 0.028. Infected probability value come from infected probability in December 2011 divided by population amount in Tandes in January 2012. Infected population data based on infected population in Tandes about dengue fever in December 2011.

The calculation of Death Population Tandes in January 2012 =

$= ((bv * v * Iv / Sv + Ev + Iv) – (\omega * Ie)) * Ie$
$= (33.1853225 * 0.028 * 4.15776E\text{-}05) – (2.404788935 * 2)) * 2$
$= 0.687077$ – 0 person

Based on the calculation above, death population in Tandes January 2012 is 0 people. The value of oviposition rate and pre adult mosquito maturation rate is based on mosquito simulation. Proportion vertical infected rate is constanta from mosquito bite human and infected human body by dengue fever virus and the value is 0.028. Infected probability value come from infected probability in December 2011 divided by population amount in Tandes in January 2012. Infected population data based on infected population in Tandes about dengue fever in December 2011. Human recovery rate is constanta from the process of human immune system for human to survive from dengue fever virus. The result of simulation was round down to get the exactly numbers of death population.

Validation

The graphics bellow is shown the comparation result from real and simulation of infected and death population in Tandes.

Validation model of transmission dynamics vector is using mean average deviation. Mean average deviation used to measure the error in simulation of infected population and death population in every sub districts that caused by dengue fever virus.

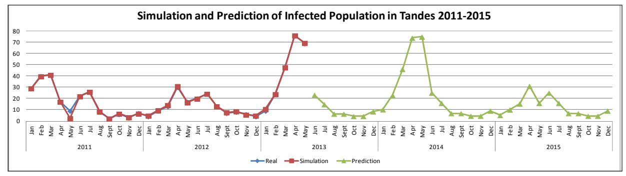

Figure 8. Simulation and Prediction of Infected Population in Tandes 2011–2015

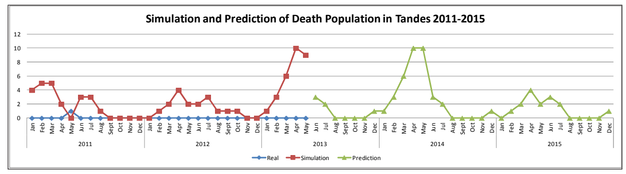

Figure 9. Simulation and Prediction of Death Population in Tandes 2011–2015

Table 3. Total and Average of MAD for Infected and Death Cases of Dengue Fever

MAD	Infected	Death
MAD 2011	0.209001	0.637097
MAD 2012	0.270383	0.610215
MAD 2013	1.076757	2.43871
TOTAL	1.556141	3.686022
AVERAGE	0.518714	1.228674

The average of MAD is 0.5187 that quite a bit for the error in forecasting and predicting infected population and with that result the model can represent the prediction of dengue fever infected people quite precision. The average of MAD is 1.228674 that quite big error in forecasting and predicting death cases and with that result the model cannot represent the prediction of dengue fever death cases because the validation result is less precision.

Severity Level Classification

Severity level classification is method that used to classify the condition of sub district in dengue fever epidemics. Severity level classification is divided into three condition by color red, yellow, and green.

Table 4. Color Classification on Severity Level

Colour	Mean
(red)	Dangerous
(yellow)	Warning
(green)	Safe

Table 5. Severity Level Classification of Dengue Fever Epidemic

VARIABLE	RED	YELLOW	GREEN
Death Population	≥ 1	< 0	< 0
Infected Population	≥ 7	6–3	2–0

Variable that consider in it is death population and infected population. The table bellow will show the category and value on severity level classification.

In the table above, death population is one factor which is used to determine the severity level of sub district from dengue fever virus. Quantitative calculation using normal distribution from total data of dengue fever in every districts calcululate using ± 3σ. When there is a death cases a minimum 7 person infected by dengue fever then the sub district declared as dangerous category. In warning category, there is 6-3 infected population in dengue fever. The last is safe category there are 2-0 infected population in dengue fever. Severity level classification as a reference to decided the best policy to minimize spread of dengue fever virus and apply it effectively and efficiently.

The model is applied to predict the growth of mosquito, dengue fever cases by Dynamics Transmission Vector approach using mathematical model approach using differential. The models use to simulate three aspects include oviposition rate and pre adult mosquito maturation rate, infected population, and death cases caused by dengue fever.

Oviposition and pre-adult mosquito maturation rate simulation shows that the highest number of oviposition rate and pre adult mosquito maturation rate is in October. It is because the temperature in October very high temperature with average of temperature is 28.55°C. Mosquitoes can incubate the eggs when temperatures are high. Mosquito growth rate is higher than the other months. In the other hand, the oviposition and pre adult mosquito maturation rate is very low in August. It is due to the temperature in August is quite low at 26.3°C and in August has entered the rainy season. The lower temperature can cause the growth rate of mosquitoes was low too. Then, simulation results on oviposition rate and pre adult mosquito maturation rate is used as an input in simulation of infected population and death cases caused by dengue fever.

Human simulation in this model is infected population and death population caused by dengue fever. The input variables in this model are population number in every sub district, infected population in previous month, vertical infected rate, oviposition rate and pre adult maturation rate in mosquito. Based on these inputs, it is used to simulate each sub-district every month to provide prediction in infected population and population death. Simulation and prediction of infected population models show that the results did not have many different or variance between the simulation and the real number of dengue fever infected population, an example in Tandes sub district on

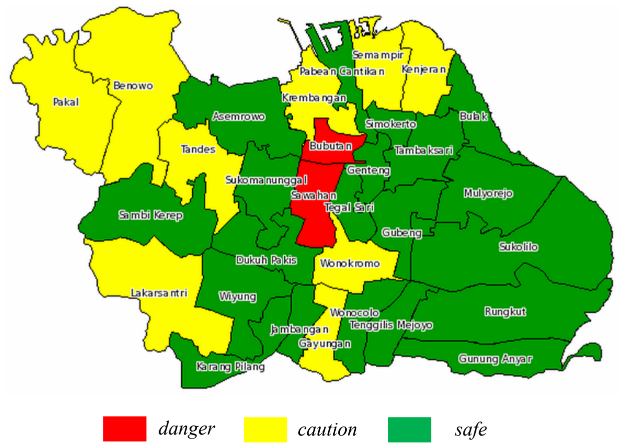

Figure 10. Spread and prediction System Dengue Fever (follow this link to view in detail : http://www.sebarandbd.ie.its.ac.id/)

January 2012 the results of the simulation was 4.8 while the real cases are 4 people. The deviation between actual and simulation are small. Sometimes, there are conditions when the simulation result is smaller or higher than the real infected number in sub district which is affected by several factors that are not considered in the model such as environmental factors and social factors. Both aspects are not included in the model and the simulation because the input of model is just temperature. If the simulation result is lower than the real infected population, then it can be influenced by poor of environmental condition and social factors likes lack of public knowledge in anticipation and treatment of dengue fever cases. The implementation of dynamics transmission model for infected population prediction is using MAD (Mean Average Deviation) to validate the models. The result of MAD is small enough, 0.5187. So the model appropriate in predicting the number of dengue cases. The low levels of accuracy between simulation and real outcomes in deaths cases caused this model needs modification with add some variables that can represent between the simulation results with the real value of the death cases in dengue fever.

As the continuity and maximise the benefit of this calculation to improve human health quality of life, it is necessary to develop the communication media by adding the map of spread dengue fever as predictions for the next period. The research also provided additional information to users about the condition of the region in Surabaya about the critical level of dengue fever epidemics based on historical data of dengue fever. The development can integrate health expert, health department, and people in spread and prediction system to minimize the number of dengue cases. This system also can help the health department in making policy about prevent dengue fever epidemics. This research will design and build an effective spread and prediction system to determine the spread, prevention, and treatment efforts of dengue fever epidemic. It will develop spread and prediction system, deployment patterns, and designing spread and prediction systems spread of dengue fever by using Dynamic Transmission Vector approach based on sharing knowledge using website. The benefit of developing early warning system in dengue fever are to increase public knowledge about the development of the spread of dengue in the region, increase public knowledge about the prevention and control of dengue fever epidemics, and improving the health quality of life in Surabaya. Another advantage in government sides are for assisting the government, health Department in Surabaya, to predict the spread of dengue fever based of development function time to increase response level in preventing dengue fever epidemics and to make policies and control the spread of dengue fever epidemics effectively and efficiently.

In dengue fever spread and prediction system allow users to identify the location that is needed to predict using Surabaya maps with 31 sub districts. The knowledge sharing for spread and prediction system that needed as anticipation in preventing dengue fever. The figure bellow will show the design of dengue fever spread and prediction system.

CONCLUSION

There are some lacks of variable in this study needed to be considered for future research. The model in this study is limited in temperature as input variable in spread of dengue fever. It is important to consider social factor, environmental factor, and people's behavior in model in order to capture the real condition of dengue fever epidemics. Requires advanced studies related to the effective website design and website content to appropriate it with cognitive principles. The difficulty of collecting data and information about dengue fever cases in Surabaya, therefore it is needed more accurate and integrated data in order to achive accurate calculation.

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