

# The Spatial Pattern of Dengue Fever Risk in Semarang City

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**Submission date:** 13-Dec-2019 03:51PM (UTC+0700)

**Submission ID:** 1233777586

**File name:** 49.\_The\_Spatial\_Pattern\_of\_Dengue...\_IR.pdf (985.49K)

**Word count:** 2934

**Character count:** 15448

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To cite this article: Widjonarko and I Rudiarto 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **313** 012008

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# The Spatial Pattern of Dengue Fever Risk in Semarang City

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**Abstract.** The city of Semarang has a high level of hazard and vulnerability to Dengue Fever disaster. Socio-economic conditions and low of hygienic and healthy living behavior lead to low adaptability to dengue fever disaster. Empirical facts show that the incidence of dengue fever disease occurs in areas which has low socioeconomic levels, poor of built environmental conditions and low of hygienic and healthy behavior which are mostly located in the northern part of Semarang City. The high level of hazard and vulnerability as well as the low adaptive capacity causes the dengue fever disasters in the northern part of Semarang City is always high, the periphery which has a better socioeconomic conditions and lower of population density has a lower risk of dengue fever.

## 1. Introduction

Semarang City is one of the metropolitan cities in Indonesia with a high population density. Based on BPS data, the population density in Semarang City reaches 4,300 people per km<sup>2</sup> (BPS, 2016). This population density impacts on the level of environmental health, specifically the incidence of infectious diseases. Based on research conducted in 2014 the pattern of the incidence of infectious diseases (especially dengue fever) is still high and with a clustering pattern in settlement centers in the City of Semarang [1,2].

The incidence of infectious diseases, especially dengue in the city of Semarang still occupies a high position when compared to other large cities on Java. The incidence of dengue fever experienced a significant surge in 2015. If in 2014 the incidence of dengue disease was 1,628 cases, in 2015 it became 1729 cases. This number has the potential to increase in 2016 because the report on the incidence of dengue in each puskesmas in Semarang City is still high [3]

The high incidence indicates that the ability to prevent dengue infectious diseases is still ineffective so that the risks that must be accepted by the community are also greater, both material risks and immaterial. In addition, the participation of the community in disease prevention does not seem to have become a single awareness. This condition can be proven by an increase in the incidence of dengue at the beginning of each rainy season in the city of Semarang. Public awareness is an important element that is expected to be able to become a medium to reduce the impact of extraordinary dengue events in the city of Semarang, or other infectious diseases. Forms of awareness that have actually been campaigned to prevent extraordinary events such as efforts to maintain the cleanliness of homes, reduce flood or inundation [4] as a medium for developing mosquitoes (known as 3M) if implemented and become a form of awareness will actually be able to increase the community's capacity to avoid disasters contagious [5–9].

The capacity of the community to reduce the risk of disaster in communicable diseases in general is largely determined by the socio-economic character of the community [10] (especially knowledge and economic resource capacity), people's access to basic infrastructure (related to the physical environment of the housing) and the local government's partiality to encourage public awareness of the meaning important health and cleanliness of the environment. Population adaptation capacity is strongly influenced by the level of the economy, competence (knowledge of disaster), ability to build social capital to solve environmental problems including natural disasters and non-natural disasters and the ability to communicate (invitation) and exchange ideas about the importance of minimization the impact of the disaster [11].



4 The aim of this study is to analyze the spatial patterns of the potential risks of disease disasters in the city of Semarang. Based on the mapping of the potential risks, it is expected that it will become an instrument to deal with the incidence of infectious diseases so that the losses that will be received by the community become increasingly minimal. The assessment of the risk of spatial disasters is very important considering the incidence of dengue infectious diseases in Semarang City has not shown significant results and the incidence of diseases from 2014-2016 tends to increase, especially at the beginning of the rainy season.

Disease risk assessment for infectious diseases will use the arithmetic method overlaying the level of disasters, disease vulnerability and adaptive capacity for disasters. Through this assessment, it is expected that the characteristics and spatial patterns of the risk of disease disasters (DHF) can be identified in the city of Semarang. This research is expected to provide a valuable contribution in order to minimize the potential loss due to disease in Semarang.

## 2. Research Method

This study uses a spatial scoring method using GIS and assessing the variables that influence the risk of Dengue Fever [12,13]. The spatial risk scoring process will be influenced by vulnerability to disease, vulnerability to disease and community adaptive capacity. The unit of analysis in this study uses the urban village unit.

The vulnerability in this study uses the age variable of the population, where the age of toddlers and the elderly is a age with a high level of vulnerability. In urban areas, with a proportion of the population at high risk, it automatically has a high level of vulnerability. The second parameter in risk assessment is the level of vulnerability to dengue disease. Vulnerability to dengue disease is inseparable from external factors, namely the quality of the built environment and internal factors in the form of clean and healthy lifestyle habits. The third parameter is adaptation capacity to disease. Capacity for adaptation to disease is based on the ability of the community at the kelurahan level to avoid disease.

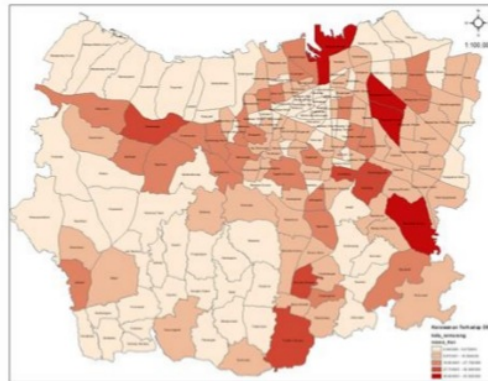
Each parameter is included in the kelurahan map and then a scoring analysis process is carried out to see areas with high risk levels to low risk levels. A high level of risk will occur in kelurahan with a high number of vulnerable populations, the ability to improve environmental quality is low and the incidence of dengue fever is not significantly reduced.

## 3. Results and Discussion

### 3.1 The Vulnerability of Dengue Fever

Vulnerability can be defined as a condition that can cause a decrease / decrease in the ability of the community to avoid danger or threat. Vulnerability to dengue disease can be defined as reduced / reduced ability of the community to be avoided from the incidence of dengue disease. Based on previous research [2] the vulnerability of the community to dengue disease is caused by internal factors, namely the physical condition of individuals related to age, welfare and knowledge of healthy living and also external factors, namely in the form of the quality of health in the neighborhood.

Spatial patterns of vulnerability levels based on population aspects have a spread pattern where the highest level of vulnerability is found in Tanjungmas Village, Sendangmulyo and Tambakaji. Other kelurahan have a relatively low level of vulnerability when compared to the three kelurahan (Figure 1).

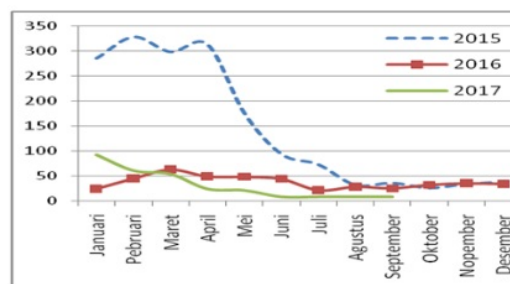


**Figure 1.** The Spatial Patter of Dengue Fever Vulnerability  
 Source: Analyse, 2018

Factors in the number of people aged under five and elderly are the main factors determining the level of vulnerability to dengue disease. This condition is inseparable from the pattern of transmission that usually occurs during the day and these age groups tend not to have activities outside the environment. If kelurahan with a high level of vulnerability possess unhealthy physical environment quality and become a place to breed the *Aedes Aegypti* mosquito, then that age population will have a high chance of getting the disease.

### 3.2 The Hazard of Dengue Fever

Dengue Fever is a disease that is strongly influenced by the presence of a virus-carrying vector, namely the *Aedes Aegypti* mosquito which usually lives in an unhealthy residential environment and the community is less concerned about environmental health. The incidence of DHF is also strongly influenced by seasonal factors, where during the peak rainy season the incidence increases significantly. The efforts of the Semarang City Government in order to reduce the incidence through various efforts have been quite successful in reducing the number of dengue cases significantly, if in January-April 2015 the incidence of the disease reached hundreds, then the same month in 2016 the incidence decreased significantly to below 50 events. But in 2017 there was an increase again to above 50 events per month in the same period. The condition of the fluctuating pattern of events adequately illustrates the readiness of the community in anticipating the incidence of dengue in their settlement environment. A clearer picture of the pattern of the incidence of dengue in Semarang City can be followed in Figure 2.

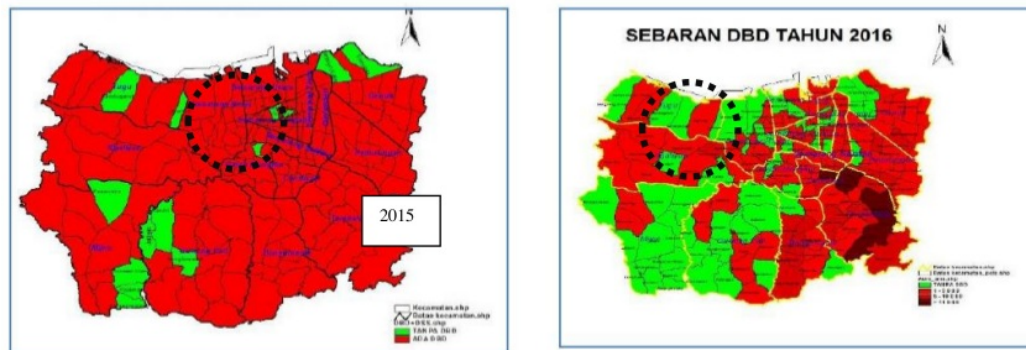


Source: Heath Office of Semarang, 2017

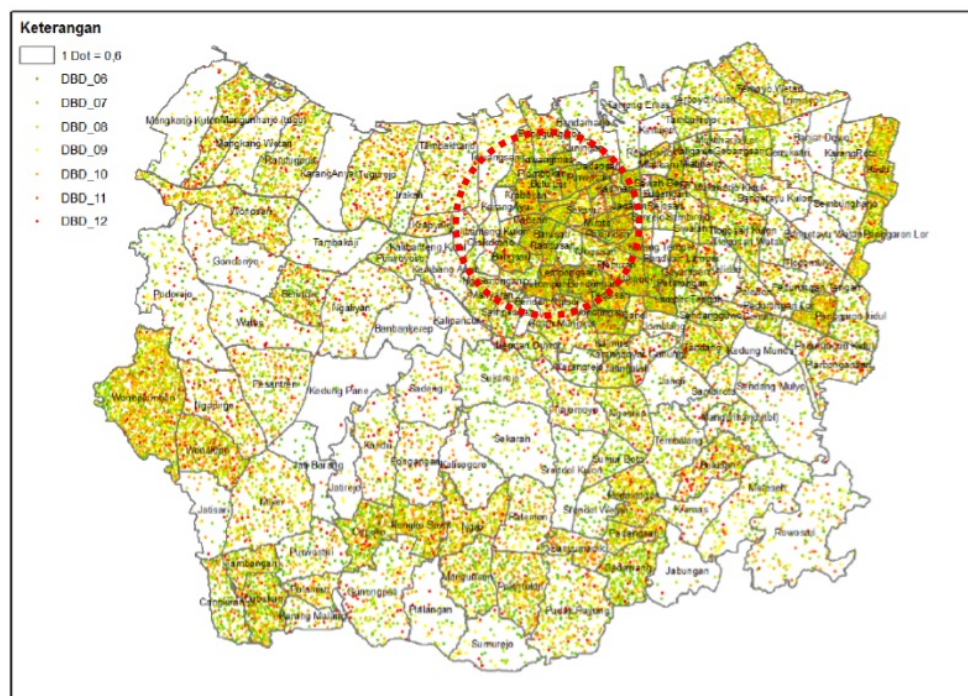
**Figure 2.** Dengue Fever Prevalence in Semarang 2015-2017



The pattern of the incidence of DHF in Semarang City also changed. In 2015 the incidence of disease was spread evenly across almost all villages. In 2016 the incidence of dengue disease in DHF was more prevalent in the central and eastern part of Semarang City (Figure 3 and Figure 4).



**Figure 3.** Spatial Pattern Of Dengue Fever Prevalence in 2015 and 2016  
Source: Health Office of Semarang, 2017



**Figure 4.** The Dengue Fever Prevalence In Semarang 2006 Until 2012  
Source: Widjonarko, et al, 2014

When compared with the spatial pattern of disease occurrences in 2006-2012 there was one regional slice that always experienced high intensity disease events, namely the central part of Semarang City which was a settlement with high density and relatively poor quality of built environment [2]

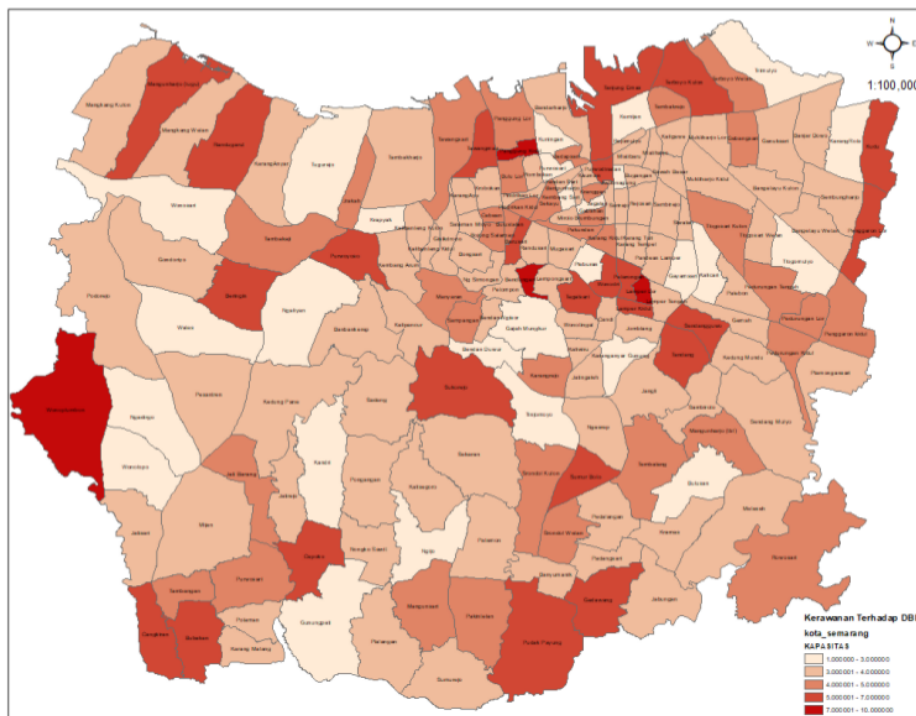
The same spatial pattern indicates that the people in high density areas tend to be less anticipative of the incidence of DHF. This condition is inseparable from the socio-economic character

of the community in the region which incidentally is dominated by people with economic characters who are less fortunate, so that they lack one awareness to increase awareness of the incidence of disease.

### 3.3 Community Adaptation Capacity

Adaptation capacity can be defined as the ability to deal with vulnerability. The capacity of community adaptation to dengue disease can be defined by the ability of the people of Semarang City to deal with the vulnerability of dengue disease caused by external factors such as the quality of the physical environment of the area.

The adaptation ability of the Semarang City community to dengue disease can be characterized by the incidence of DHF per year in each kelurahan. The village with the success of reducing the incidence of disease can be claimed as a village with a good level of adaptive capacity. Based on the data from the Semarang Health Office in the last five years, there were villages that managed to significantly reduce the number of disasters and there were also villages that were still unable to reduce the incidence of disasters. Urban villages with low adaptive capacity are mostly located in the coastal areas of Semarang City and in the downtown area. A clearer picture of the spatial pattern of adaptive capacity can be followed in Figure 5. below.



**Figure 5.** Spatial Patter Of Adaptive Capacity To Overcome Dengue Fever in 2017

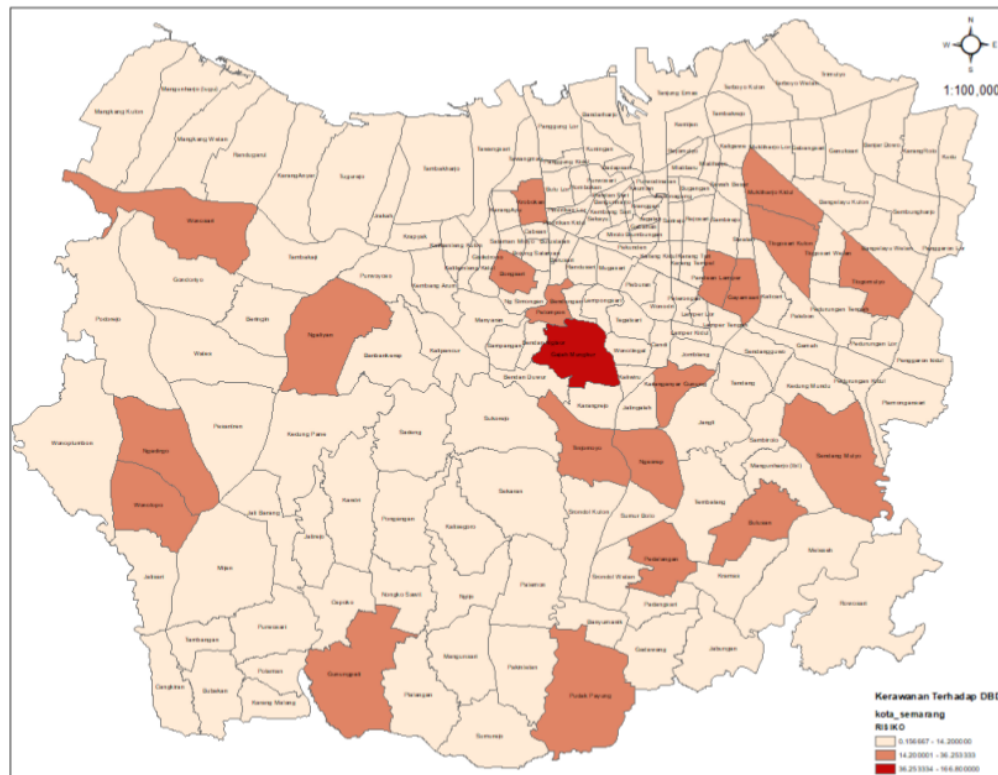
Source: Analyse, 2018

The Tanjungmas region which in fact has a high vulnerability to dengue disease in the last five years is still not able to show performance to reduce the incidence of disease significantly.

### 3.4 Dengue Fever Risk

Based on the data on the level of vulnerability of the community, vulnerability and adaptive capacity of the community to dengue disease, it can be assessed the level of risk of dengue disease in each village in the city of Semarang. The basic assumptions used in this assessment are based on the higher vulnerability and vulnerability and the lower the adaptive capacity, the higher the risk of disasters.

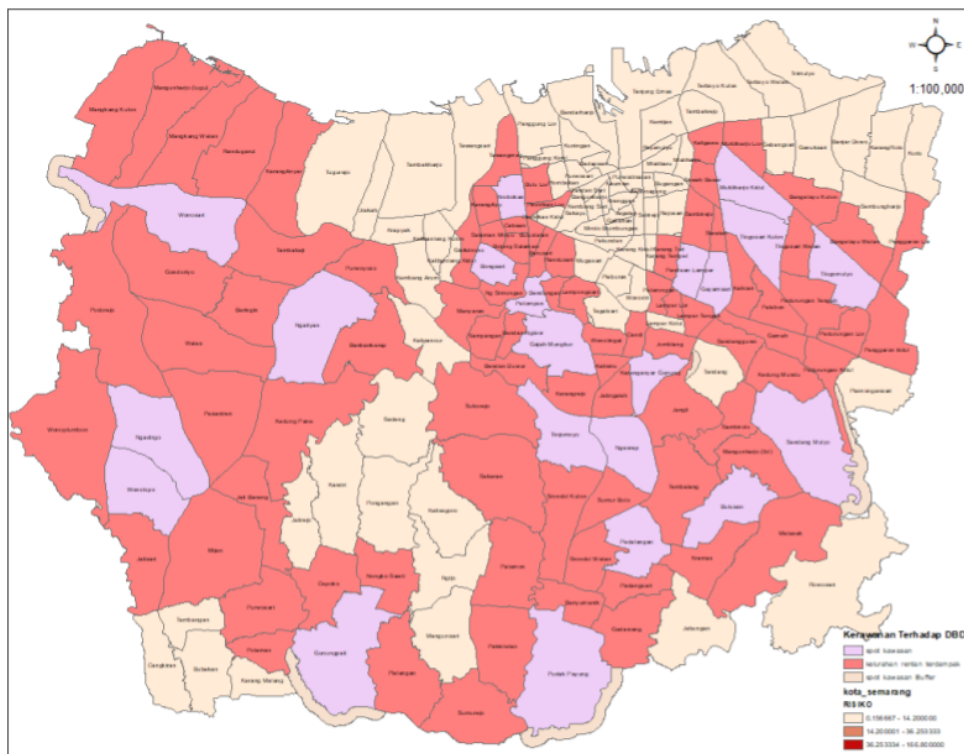
The spatial pattern of the risk of dengue in Semarang City tends to have a diffuse pattern (figure 5.12). Areas with high risk are spread evenly in each sub-district. This condition will create potential for opportunities for transmission to areas around a radius of 300 meters (flying vector capabilities) from each village (Figure 6).



**Figure 6.** Spatial Patter of dengue Fever Risk In Semarang City Year 2017  
 Source: Analyse, 2018

This condition is very risky considering the opportunity for transmission through mosquito vectors will be able to reach areas around high risk villages. A clearer picture of the area of the kelurahan that has the potential to be affected is because the existence of urban villages with a high risk of dengue disease is quite significant. If simulated with the ability to fly vector as far as 300 meters, then at least there will be 107 urban villages that will potentially be affected by the incidence of dengue if in high-risk urban villages there is an incident of dengue which is categorized as extraordinary events. A clearer picture of the ward that will be affected can be seen in Figure 7.





**Figure 7** Spatial Probability of Vektor Dispersion from High Risk Dengue Fever Region  
 Source: Analyse, 2018

#### 4. Conclusion

The spatial pattern of dengue fever risk in Semarang City is disperses. This pattern has an opportunity to expand the scope of risk of dengue fever. This opportunity is based on the ability of vectors carrying diseases, namely mosquitoes and the mobility of people who are suspected of being affected by the disease. The vector carrying disease has the ability to roam up to a radius of 300 meters, while the mobility of the suspected population of disease is further the potential of its movement. So if there is an incident of dengue disease that falls into the extraordinary category, then the population in the area around a radius of 300 meters will have the opportunity to contract dengue fever.

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