DENGUE RISK PREDICTION IN ILLEGAL DUMPSITE OF HOUSING AREA BY USING GEOSPATIAL ANALYSIS

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ABSTRACT

Malaysia suffered from several dengue epidemics with a highly contagious health threat in the last few decades. Analyses of the incidence number of dengue cases and the illegal dumpsite by using the Geographical Information System, GIS, standard deviational ellipse, SDE, produces a scientific-based evidence of dengue map for the urbanized area of Iskandar Puteri, Johor State, Malaysia. A high incidence of dengue cases in the illegal dumpsite area was recognized in radius 200 to 1000 meter with the trend towards the east and west of the city with standard distance (STD) value 0.03. It was identified as a high spot area. It was noteworthy that illegal dumpsite has potential to be a predictive tool for dengue risk to prevent the outbreak. Furthermore, the study recognized the sites i.e. pedestrian walkway, roadside, abundant land and riverside as a spotted illegal dumpsite. Nevertheless, an increment about 40 percent out of the total cost to manage illegal dumpsite from 2011 to 2016 is showing the urgency in tackling this problem comprehensively. Close monitoring system on the sub- contractor of waste disposal collection works and having concentrated effort by involving the relevant government agencies are among crucial issues need to be tackled to solve dengue problem related with illegal dumpsite.

Keywords: dengue, illegal dumpsite, waste, urban.

INTRODUCTION

As a newly industrialized country, Malaysia is experiencing fast economic development followed by the urbanization and industrialization. An increase in urban population and high level of living standard, cause an escalating of waste quantities which added by industrialization that cause changes in consumption pattern (Haron et al. 2005). The latest, resulted a complex waste composition and the complication in managing it (Badgie et al. 2012). Recorded as the most urbanized countries in South East Asia, it was predicted that about 70 percent of the population in Malaysia locate in urban area by 2030. Hence, needs an efficient of urban services, facilities and infrastructures such as waste management system covers the collection and disposal that has to be the main concern of local authorities (McDougall et al. 2001, Hara & Yabar 2012) despite the high cost of waste management that dominates the local authorities budget (Zen 2001). Nevertheless, it needs a support from the concern citizen whose practices waste recycling and not perform wrong disposal behavior such as 'Not- In-My-Backyard-Syndrome' that implicate to the existence of illegal dumpsite in mostly housing area.

Increase of populations and standards of living contribute to the quantity and characteristics of waste, especially in urban area (Wang, 2014). This situation case high demands for advanced waste management systems driven for resource recovery, public health, and environmental well-being (Wilson, 2007). Regulation of waste collection, transportation, processing and disposal lessens the environmental impact of waste generation on the environment (Wang, 2014). The presence of illegal dumpsite without permitted and controlled facilities increases the transmission of human pathogens by the presence of illegal dumpsite. For example, a source of nutrition and shelter for rodents that lead to the spread of endoparasites (Duh et al. 2017). The presence of two distinct zoonotic viruses, lymphocytic choriomeningitis virus (LCMV) and tick-borne encephalitis virus (TBEV) had identified at illegal waste sites.

The Aedes mosquito thrives in urban environments. Several type of Aedes dengue species breed in artificial man-made environment such as in illegal dumpsite and in construction sites (Chua et al. 2006). The type of waste such as containers, truck tires, pots, non-biodegradable plastic containers potential become the breeding ground (Dutta & Mahanta 2006) and highly risk for dengue due to a stagnant water in high rainy season (Gubler & Dengue 2001, Wilder-Smith & Gubler 2008). Moreover, the status of dengue -as a result of mosquito-borne viral infection- in urban area, especially in tropical country like Malaysia, becomes more prevalent due to the environmental high-risk factor such as global warming which have increase the temperature and the potential risk of outbreaks. This man-made situation favors the Aedes which becomes environmentally suitable for mosquito's lifecycle and for dengue transmission. On the other side, the dengue transmission in Malaysia at the alarming state where the trend estimate of 390 million infections per annum (Ee Leen Pang & Hwei- SanLoh 2016) and Aedes metabolism oviposition activity increase due to meteorological factors (Focks et al. 1993, Azil et al. 2010). The incidence of dengue in Malaysia has increased 30-fold over the past 50 years (Ebi & Neslon 2016).

The reported case of dengue fever, DF and dengue hemorrhagic fever, DHF are commonly found in construction sites, factories and schools where High Aedes Index are recorded in Malaysia (Ministry of Health, Annual Report 2005). On the other side, there was trend where dengue outbreaks become more frequent at residential areas especially around flats which consider low income housing area with improper of disposal waste. An increase of a total of 1,774 dengue cases reported as per July, 2013 compared to 1,640 cases for the whole of 2012 in the area where there is improper disposal of solid waste, at illegal dumping sites including adjacent to drainage system area (Ann Kili, K. 2013). Hence, it is crucial to provide quality waste management and collection service to prevent the dengue risk. While, controlling the environmental conditions to prevent the host of mosquitoes from spread of are remain the biggest challenges in a major public health, especially in tropical and sub-tropical country like Malaysia and in urban and industrialized environment.

Dengue disease has no vaccine or cure. The only available option to manage the disease relies on vector control programs is still high cost and limited its effectiveness (Ee Leen Pang & Hwei-SanLoh 2016). Hence, managing the vector inhabitant such as illegal dumpsite in housing area is very crucial to control the risk. Based on several factor above and concerning the urban planning, there is an urgency to analyze to what extend the existence of illegal dumpsite can be a predictor of dengue risk especially in urban environment. Therefore, the study aims to analyze to what extend the high incidence number of dengue cases is correlated with the illegal dumpsite area which

described as prone area for breeding ground of Aedes mosquitos.

In detail, the objective identified are as follows:

1. To recognize the physical characteristics of illegal dumpsite with its waste composition, land use pattern and assess it through the visual and field observations for further geospatial analysis;
2. To develop the map for dengue (hotspot area) based on the recorded data of the incident of dengue case and perform geospatial analysis for further identification of its relationship with illegal dumpsite;
3. To evaluate the scientific and potential relationship of the area with the illegal dumpsite and dengue hotspot to produce dengue risk area;

LITERATURE REVIEW

It is widely known about the illegal waste disposal impacts on public health, aesthetic of the surrounding, cleanliness and environmental pollution. It is closely related with waste collection services and facilities that play crucial role in provide the best services consider the mixture of dwelling types as well as to suit household disposal behavior. This also need to consider the type of waste container used and the source of waste generated (Mukhtar et al. 2016). Nevertheless, operational costs for waste management subsequently increased and became the most challenging issue for the local authority. Designing localized waste management strategies that are economically viable, environmentally effective and socially acceptable is remain as the big challenges by local authorities. Several strategies for the improvement of waste management in Malaysia are privatization (Zen 2001, Zen & Siwar 2015) through subcontracting out and decentralized the responsibility of the local authorities (Mulligan et al. 2012) as well as the nationwide recycling campaign that encourage separation at source (Zen et al. 2014)

Dengue disease is usually called an ‘‘urban’’ disease, with the Aedes mosquitoes, such as Aedes aegypti and Ae. albopictus, are mainly found in breeding places such as artificial containers in areas with high population density (Chen et al., 2005; Gubler & Clark, 1995), in natural environments and in vegetated areas and area with uncollected waste. The accumulation of rainwater in various type of waste containers provide conducive for Aedes breeding especially for the larval habitats of dengue vector (Banerjee et al. 2015). There has been a growing concern for re-emerging of infectious disease, such as dengue particularly in poor and urbanizing areas (Sabel et al. 2009, Manderson et al. 2009).

Meanwhile, low income group in urban area closely related with low environmental awareness (Jha et al. 2011) that cause illegal dumpsite despite issues in low frequency of waste collection (Kapepula et al. 2007).

There are various studies of dengue and the relationship with the urban planning has been conducted in Malaysia. Geospatial analyses indicated the DF infection was normally distributed in urban area (Nazri et al. 2013a), the control the emergence of adult mosquitoes (Yasuoka & Levin 2007). Geospatial analysis was utilized for three temporal risk indices enables the identification of risk area of DF occurrence (Wen et al, 2006), the distribution pattern of a dengue outbreak (Nazri et al. 2009), socio-economic characteristic of urban environment and the incidence case of dengue for spatial monitoring (Nazri et al. 2013a). Hence, controlling the risk factors for Ae. mosquito breeding sites should be considered the most in carrying an effective vector control.

Community studies trying to establish the causal relationship between the health effect of solid waste disposal is needed to estimate the risk and its associated urban health planning and management. Several studies prove the negative relationship between waste disposal and health effect to the community (Porta et al. 2009),

In Malaysia, illegal dumpsite related issues fall under jurisdiction of the Urban Wellbeing, Housing and Local Government Ministry at federal level and Solid Waste and Public Cleansing Management Corporation (SWCorp) at State level. Under section 71 of the Solid Waste and Public Cleansing Management Act 2007 (Act 672) for illegally collecting and processing solid waste at an un authorized site, fine with a maximum RM10,000 or jailed up to five years or both for parties proven to be involve in recurrent incidence of illegal dumpsite (Commissioner of Law Revision, Malaysia. 2017).

Furthermore, to assess the ecological characteristics of Aedes larvae to improve the environmental management and others control measures by targeting the most productive categories of breeding sites was performed by developing the management model for effective and accurate preventive and control measures by integrating climatic variables and spatial data (Nazri et al. 2011), as a control management strategy (Nazri et al. 2013b), as analytical tools of dengue fever (Nazri et al. 2012), apply ovitrap method to quantify the infestation level of Ae. mosquitoes (Anis et al. 2016). Ovitrap surveillance is very beneficial for planning and managing dengue vector. This approach also is a useful tool in providing spatial and temporal data for monitoring the impact of control measures (Ligia et al., 2013). The entomological surveillance study conducted to determine infestation profile (IP) dengue mosquitoes, Ae.albopictus in apartments and flats within Subang Jaya, Selangor (Farah Amirah et al. 2016). However, none of the geospatial analysis studies conducted has established the link between dengue and illegal dumpsite. While, illegal dumpsite is still among the major issues of urban environment in Malaysia (Haron et al. 2005). Since there is no cure for dengue disease, controlling the vector of mosquito larva on site by identifying the dengue risk area as to prevent the dengue outbreak is crucial especially in the hotspot area where its prone to illegal dumpsite. Hence, the study will be the first to establish the link between illegal dumpsite and dengue cases by using geospatial analysis.

METHODOLOGY

Overall, the study is a mixed mode research method, where a combination of primary and secondary data were gathered and analyses. Basically, the study focuses on the identification of the root causes of the dengue by performed site observation on illegal dumpsite and the hotspot area of dengue cases, conducted and analyze the standardize household survey on waste disposal practices, and computed the number of dengue cases data with the illegal dumpsites location.

The research methodology of the study was divided into four parts. First, secondary data on number of dengue cases reported based on the area was collected and match with the illegal dumpsite area data collected from SW Corp. Second, the site observation was performed to check the reliability of secondary data gathered on illegal dumpsite and several photographs were taken. In further, analyze according to land use characteristics such as residential area, walkway/ pedestrian, industrial zone, commercial, road was performed. Third, household survey on waste disposal behavior are conducted in the area adjacent to illegal dumpsite. Fourth, two type of analysis performed are the, geographical information system, GIS and statistical analysis by using the Statistical Package for Social Science, SPSS. The Iskandar Puteri area has been selected as a study area to represent the dengue and illegal dumpsite the Johor Bahru district based on the information received from the SW Corp, solid waste department.

Study Area

The study was conducted in the area under the jurisdiction of Johor Bahru Tengah Municipality or rename as Iskandar Puteri City Council, where it houses for Kota Iskandar, the administrative centre for the government of Johor State, Malaysia. Iskandar Puteri covers an area of 367.4 km^2 and is located at 1o25’20N and 103 o39’00E. Iskandar Puteri area was selected as the studies to represent city in the Johor Bahru district, which has the highest number of cases and repeated dengue outbreaks.

Data Collection

The study collected the primary and secondary data. Primary data gather from interview by using guided question to local authority staff at Iskandar Puteri City Council, SW Corp, household survey in the residential area close to the illegal dumpsite, the observation and site visit to several illegal dumpsite surrounds Iskandar Puteri City Council. The 16 illegal dumpsites list gather from the SW Corp was visited. The illegal dumpsite recognized as the ‘hot-spot’ area located either in residential house, abundant land was served which include waste composition disposed. Survey to 100 respondent represents household in study area conducted to identify the issues related with illegal dumpsite, the impact to the community adjacent, their level of knowledge towards recycling practices. Size sample chosen is based on convenient sample where 100 respondents represent 0.3% of the community involves in this activity.

Data Analysis

The data collected from the household survey were then analyzed by using the latest Statistical Package for the Social Science (SPSS). The illegal dumpsite data then analyze by using the Geographical Information System, GIS by using standard deviational ellipse, SDE. SDE use to calculate the standard distance, STD of the illegal dumpsite location and the influenced of attribute value associated by the sites with number of dengue cases recorded. Illegal dumpsite data on "hot- spot" area gather from the local authority were analyze to map the area with high frequency of illegal dumpsite by using geographical information system, GIS. By using the standard deviational ellipse (SDE), the direction on illegal dumpsite under the Iskandar Puteri City Council was concentrated. By using SDE the distribution trend towards one note in certain area by account the continue standards separated for x and y was formulate and description of standard deviational ellipse. Directional Distribution (Standard Deviational Ellipse, SDE) measures a trend for a set of points or areas by calculating the standard distance separately in the x- and y-directions. Standard deviational ellipse is derived from the standard distance calculation (Yuill, 1971) and the standard distance measures the degree to which features are concentrated or dispersed around the geometric mean center (Fischer and Getis, 2010). It provides a single summary measure of features' distribution around their centers. SDE calculates and provides three attribute values. It has a capability to measure the orientation of distribution in two dimensions. In describing and defining SDE, three components are needed; an angle of rotation, the deviation along the major axis and the deviation along the minor axis. The coordinates of the mean centers, two standard distance measures (deviation along the major and minor axis) and the orientation of the ellipse, that is, the angle of rotation (Wong and Lee, 2005). Hence, the relationship between illegal dumpsite and dengue cases, the SDE duplication will analyze and the buffer technique deployed to look at the distance between waste disposal site and dengue cases. The distance buffer adopted are 200 meter, 400 meter, 600 meter, 800 meter and 1000 meter. The distance considers the ability of the dengue mosquito flying ability.

$$SDE_x = \sqrt{\frac{\sum_{i=1}^{n}(X_i - X_c)^2 + \sum_{i=1}^{n}(Y_i - Y_c)^2}{N}}$$

Where

- X_i and Y_i are coordinates of feature I.
- X_i Y are coordinates of the mean centre for the set of features
- n is the number of features in the set.

FINDINGS

Physical Characteristic of Illegal Dumpsite

There are two types of analysis being use to analyze the illegal waste dumpsite in this study area. First is the physical characteristic of the illegal dumpsite by using site observation analysis and photograph for further identification of its land use pattern and finally to perform the geo-spatial analysis.

1. Occurrence of the Illegal Dumpsite & Its Land Use Pattern

The occurrence of illegal dumpsite was analyzed based on the data gathered from the Solid Waste, SW Corp. There are 34 illegal dumping sites identified in year 2015 from the Iskandar Putri City Council. Sites observation performed during the period of January until April 2016 to identify the existent of illegal dumpsite recorded by SW Corp. From the sites visit, there are 36 illegal dumpsites identified and listed bellows in Table 1. The observation site visit for the 34 of illegal dumpsite coupled with the photograph and land use type in that area was performed. It was found that most of the illegal dumpsites are recognized on the roadside such as pedestrian and walkway, commercial area, housing area, water body and agriculture sites. However, illegal dumpsite in residential area are recognized as the highest number where there are 24 case of illegal dumpsite located in housing area or 67.7 % out of the total of 36 case of illegal dumpsite. Repetitive cases found in the 14 illegal dumpsites (38.9%) exist in 2015 which are still exist in 2016 even though the cleaning has been performed by waste contractor. These two areas become high prevalent as a dengue risk area. The residential areas identified having illegal dumpsite are presents in Fig. 3 and 4 below which contains construction waste, domestic, commercial and bulky waste in various size. Study by Brandt (2017) to understand the systemic causes of illegal dumping within San José, California showed that commonly dumped debris types were furniture, and garbage. While, the most common illegal dumping occurred in low median family incomes area with high percentages of non-English speaking individuals, and high percentages of renters. Other factors contribute to the existence of illegal dumpsite are social disorganization, inequitable levels of garbage service, and lack of awareness of free city programs dumping within San José.

2. Solid Waste Composition for Illegal Dumpsite

Based on observation site and information gather from SW Corp, there are several types of waste recorded in each location. The type of waste disposal was construction waste, domestic, bulky item of waste and commercial waste which listed in Table 2. From 16 illegal dumpsite listed, there are 9 sites record domestic waste, 3 sites for construction waste, 2 sites for bulky item waste and 2 sites for commercial waste. The result shows that domestic waste dominated the illegal dumpsites. From the 36 illegal dumpsites observe in 2015, about 14 sites are repetitive or found in 2016. Showing that almost 39% illegal dumpsite are persistent. This site can be a high priority for dengue hotspot area for further surveillance and monitoring.

Household Survey on Waste Disposal Practices

Based on survey conducted to the household in the study area, majority respondent

acknowledges the existence of illegal dumpsite surrounds their area, only 8% of respondent do not know about the existence illegal dumpsite in their area. In details, respondent stated that 92% of illegal dumpsite found in pedestrian walkway, about 68.5% in roadside, about 29.3% in abundant land or government reserves land and about 2.2% near the river.
About 46 respondent or 46% were stated that illegal dumpsite cause by the less capacity of waste bin compared to quantity of waste dumped as well as the number of waste bin provided at the residential area is beyond the capacity of waste generated. It is also related with less frequency of waste collection by the waste truck. In the survey, respondent is stated that about 39% of delayed waste collection cause illegal dumpsite. The situation gets worse as waste composition in developing countries where organic food waste. This delayed waste collection cause terrible smell. It was stated that in the survey that illegal dumpsite causes bad smell and air pollution (38% of respondent), sources of various illness (35%) and invite the wild dog, animals and pest (27%).

On waste collection frequency, about 7 percent of respondent are 'Very Not Satisfied', 35% 'Not Satisfied', 26% 'Satisfied' and 32% 'Very Satisfied'. About 16% do not know about waste collection schedule and 84% knows waste collection 1 or 2 times a week. For better waste collection and disposal and to avoid the illegal dumpsite, most of respondent (59%) agree that waste contractor need to improve the waste frequency in a week, about 24% respondent want bigger waste bin and about 4% suggest decreasing amount of waste charge collection.

Solid Waste Management Cost Implication for Illegal Dumpsite
The existence of illegal dumpsite caused external cost to the solid waste management especially in urban area. The cost covers the work such as clean up the sites and transport the solid waste to sanitary landfill. Based on the data gathered from the SW Corp, the budget allocated for managing illegal dumpsite shows an increasing amount. Start with MYR 60,510.00 since 2011 and shut up to MYR 1,087 million in 2015 or 40 percent out of the total cost of illegal dumpsite management cost MYR 2,604.14 (Table 3).

Besides, fees paid by SW Corp for managing illegal dumpsite for Johor State since 2011 until 2015 was showing an increasing trend in Figure 5. The graph showing an increasing cost for illegal dumpsite for five years from 2 % on 2011, 12 % on year 2013 and reach the peak at MYR 1,037.62 in 2015. It is a 39.85 % from the five years cost of waste management and an increment of MYR 977.110.00 from 2011.

Geospatial Analysis Result

1. Illegal Dumpsite Map in Iskandar Puteri City Council

The geospatial analysis result from the illegal dumpsite data found that majority of illegal dumpsite were located in the housing area, which is about 9 cases located in Skudai housing area (Fig 6). The distance adjacent to each other especially in Taman Sri Skudai which is located within one kilometer between the recorded site.

Based on the estimation of the total of x and y of SDE, the standard distance (STD) value 0.03 or less than 1 (<1), it was found a trend of the majority sites grouping into another especially in the area within range of SDE in Fig. 7.

2. Map for the Incident of Dengue Cases in Johor Bahru Iskandar Puteri

Based on the secondary data gathered from Health Department, Iskandar Puteri City Council, there are 2893 dengue cases recorded for Johor State. From that amount, about 759 are dengue cases or 26.2% recorded in Iskandar Puteri. From that statistic, about 98.6% cases recorded adjacent to housing area, 0.8% cases recorded in commercial area, 0.4% cases recorded at University area and 0.1% cases recorded at industrial area and agriculture sites.

Analysis of Illegal Dump Site with the Recorded Data of Incident of Dengue Cases

The analysis identified there is similar pattern between the existence of incident of dengue cases with the illegal dumpsite. The similarity on location for illegal dumpsite and dengue cases shown in SDE result which is shows the trend towards the east and west of Iskandar Puteri with the eclipse 5.17% (Fig 8, 9). The location analysis and dengue cases recorded high incident of dengue cases adjacent to the illegal dumpsite in the radius of 200 meter to 1000 meter. The result support with other study in Malaysia who shows positive relationship between the number of dengue cases with the existence of illegal dumpsite in construction site (Zainun et al. 2016). The relationship between the two is also within the 200meter radius is due to the probability of the mosquito fly into the area recorded as high incident of dengue cases.

DISCUSSION

It was found that the illegal dumpsites in Iskandar Puteri, Johor State are recognized on the roadside such as pedestrian and walkway, commercial area, housing are, water body and agriculture sites. The highest number of illegal dumpsites found in residential area where there are 24 case or 67.7 % out of the total of 36 case of illegal dumpsite. About 14 illegal dumpsites (38.9%) found in 2015 are still exist in 2016 even though the cleaning work has been performed by the waste contractor hired by SW Corp. From the total cost of illegal dumpsite management MYR 2,604.14 (2011 – 2015), an increasing trend was recorded from 2 % in 2011, 12 % in year 2013 and reach the peak at MYR 1,037.62 in 2015. It is a 39.85 % from the five years cost of waste management and an increment of MYR 977.110.00 from 2011. This huge amount of budget allocated to combat the illegal dumpsite and its consequences effect shown a serious effort given by the waste management division of Johor State as a whole. This self-initiative by the division may contribute to the success of combating the illegal dumpsite issues link with dengue case. However, other issues on the waste collection and disposal reveal from the survey to the residential house adjacent to the illegal dumpsite area.

From the survey, it was found that 92% of illegal dumpsite found in pedestrian walkway, about 68.5% in pedestrian walkway, about 29.3% in abundant land or government reserves land and about 2.2% near the river. It was stated that the less

capacity of waste bin (46% respondent), less frequency of waste collection by the waste truck (39% respondent) are among the issues that cause of illegal dumpsite. Due to that, respondent recognized several effects surrounds the illegal dumpsite such as 'bad smell and air pollution' (38% of respondent), 'serious illness' (35%) and source of wild dog, animals and pest (27%). In total, about 42% of respondent not satisfied and 58% are satisfied with the waste collection frequency. This problem may relate with other issues on subcontracting out of the municipality responsibility to other parties.

One of the concerns on the existence of illegal dumpsite is relating with issues in providing solid waste management services. Subcontracting of many public services to smaller private companies is common for solid waste disposal in Malaysia and other developing countries. This is where the decentralization of responsibility happened from local authorities to smaller private companies, mostly for essential services such as landscaping, building maintenance and sanitation.

Many problems were raised from the subcontracting out due to profit concerned, save cost and lack of monitoring (Mulligan et al. 2012). The non-performances companies who did not pick up rubbish resulted the uncollected rubbish that stays on the ground and unscheduled rubbish collection at the household level pertaining illegal dumpsite. Households will experience bad smell from uncollected waste and the over quantity of rubbish in waste bin cause illegal dumping which often occurred surrounds the residential area. Then, it's provided prone area for the breeding ground of Aedes mosquito.

The dengue map produced has found similar pattern between the incident number of dengue cases and the existence of illegal dumpsites which has been shown in SDE with the trend towards the east and west of Iskandar Puteri with 5.17% difference of rotation. It was shown in the SDE with Standard Distance (STD) value 0.03 which is less than 1 (<1) where the location analysis and dengue cases recorded high incident of dengue cases adjacent to the illegal dumpsite in radius 200 to 1000 meter. Majority of the illegal dumpsite located in the housing area compared to other type of land-use; commercial and industrial area which has shown in one group mainly in surrounding of the ellipse. One study conducted in selected residential area of Iskandar Putri City Council found out that illegal dumpsite was observed in the area adjacent to pedestrian corridor or walkway where the type of waste is domestic waste (51%), construction waste (42%) and industrial waste (7%) (Nazerry et al. 2007).

CONCLUSION & RECOMMENDATIONS

Less consideration to include the environmental health aspect associated with infection's disease and its management in mainstreaming the urban planning and governance cause a lacking in managing and solve the dengue disease in urban environment. This is might be caused by less interactions between public health officials, the planners and policy makers who should make a concerted effort for urban development and its governance. This case found in Putrajaya, Malaysia (Mulligan et al. 2012). Hence, the development of dengue map can be a potential for integrative tool across government agencies such as Health Department, SW

Corp for solid waste disposal and management and Land use Planning Department for co-management of the dengue risk to prevent the outbreak especially in facing climate risk.

Finally, dengue map function to improve state's surveillance and early warning detection system by identifying the high-risk of dengue areas i.e. illegal dumpsite for potential dengue outbreak especially during the rainy season. Better strategic land use planning especially in the abundant land and an monitor the schedule waste collection frequency, facilities and infrastructure along the pedestrian and sidewalk is crucial to prevent the mosquito larva breeding ground for protecting public health. Further study needs to include the climate data on numbers of rainy days to provide more comprehensive of dengue map.

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Table 1. Illegal Waste Dumpsite Status in year 2015 & 2016

No.	Location 2015	Status 2016
1	Jalan Lebuhraya Kota Iskandar – Adjacent to Educity	Finish
2	Jalan Menghala Ke Tuas - Flyover Adjacent to Leisure Farm	Finish
3	Taman Sri Skudai – Jalan Sejahtera 6	Repetitive
4	Taman Sri Skudai - Jalan Sejahtera 7	Repetitive
5	Taman Sri Skudai - Jalan Sejahtera 1	Repetitive
6	Taman Jaya - Jalan Jaya	Finish
7	Bandar Baru Kangkar Pulai – Towards Pulai Indah	Repetitive
8	Taman Pulai Indah -Jalan Persiaran Pulai Indah	Repetitive
9	Taman Impian Emas - Jalan Impian Emas (KTM)	Finish
10	Kg. Sinaran Baru - Jalan Utama	Repetitive
11	Taman Impian Emas - Jalan Bukit Impian	Finish
12	Taman Nusa Bestari Jaya - Jalan Jati 2	New
13	Taman Sutera Utama - Jalan Sutera Danga	Finish
14	Taman Skudai Baru - Jalan Hang Jebat 52	Repetitive
15	Taman Skudai Baru - Jalan Hang Lekir 22	Repetitive
16	Taman Damai Jaya - Jalan Aman 1	Repetitive
17	Taman Lima Kedai - Jalan 5	Repetitive
18	Taman Melawati - Jalan Melawati 3	Finish
19	Taman Lima Kedai - Jalan 8	Finish
20	Taman Damai Jaya - Jalan Makmur 12	Finish
21	Taman Bukit Tiram - Jalan Banang 2	Finish
22	Taman Bestari Indah - Jalan Utama Bestari Indah	Repetitive
23	Taman Sri Tiram - Jalan Hang Kasturi	Finish
24	Ulu Tiram -Jalan Sungai Tiram	Finish
25	Taman Perindustrian Tiram -Jalan Tiram 6	Finish
26	Taman Perindustrian Plentong -Jalan Mutiara 5	Repetitive
27	Sungai Plentong -Jalan Bunga Matahari	Repetitive
28	Taman Ehsan Jaya -Jalan Ej 5/1	Finish
29	Bandar Seri Alam -Jalan Bukit 27	Repetitive
30	Kg Baru Masai -Jalan Pekeliling	Finish
31	Taman Perling -Jalan Rawa 1	New
32	Taman Bukit Indah -Jalan Indah 10/4	Finish
33	Taman Nusa Bestari -Jalan Nusa Bestari 12/2	Finish
34	Taman Bukit Indah -Jalan Persisiran Sungai Dangga	Finish
35	Nusa Sentral -Jalan Gelang Patah	Finish
36	Lebuhraya Sultan Iskandar -Jalan Lebuhraya Sultan Iskandar (Plot Interchange Horizon Hills)	Finish

(Source: SW Corp 2015)

Table 2. Type and Weight of Estimated Solid Waste at Illegal Dumpsite

No.	Location	Type of Waste	Estimated Waste Weight 2015 (Tonnage)	Estimated Weight of Waste 2016 (Tonnage)
1	Taman Sri Skudai	Construction	5	5
2	Taman Sri Skudai	Domestic	5	5
3	Taman Sri Skudai	Domestic	5	25
4	Bandar Baru Kangkar	Bulky	2	5
5	Taman Pulai Indah	Domestic	5	5
6	Kg. Sinaran Baru	Domestic	5	3
7	Taman Nusa Bestari Jaya	Commercial	0	0.02
8	Taman Skudai Baru	Domestic	3	4
9	Taman Skudai Baru	Bulky	8	4
10	Taman Lima Kedai	Domestic	5	0.05
11	Taman Bestari Indah	Domestic	5	10
12	Taman Perindustrian Plentong	Construction	16	35
13	Sungai Plentong	Construction	25	1

14	Bandar Seri Alam	Commercial	4	0.01
15	Taman Perling	Domestic	0	0.01
16	Taman Damai jaya	Domestic	5	0.05

Source: SW Corp 2015

Table 3. Management Cost for Illegal Dump Site under the Iskandar Puteri City Council

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
Illegal Dumpsite Management Cost (MYR)	60.51	304.47	413.76	565.46	1,037.62	222.32	2,604.14
Illegal Dumpsite Management Cost (%)	0.02	0.12	0.15	0.22	0.40	0.09	100

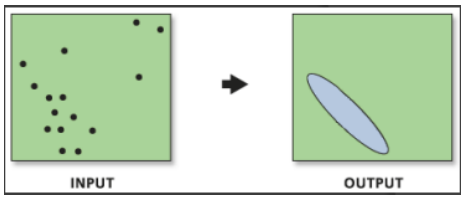


Fig. 1: Input dan output standard deviational ellipse

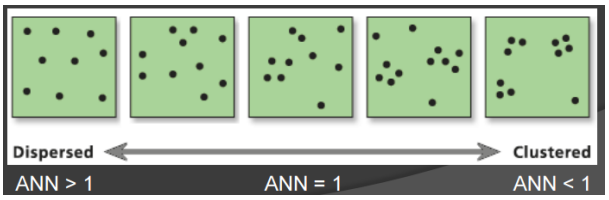


Fig. 2: Indicator Apply in Interpreting SDE

Fig. 3: Illegal Dumpsite at Residential Area, Taman Skudai, Jalan Sejahtera 1

Fig. 4 : Illegal Dumpsite at Bandar Baru Kangkar Pulai Residential Area

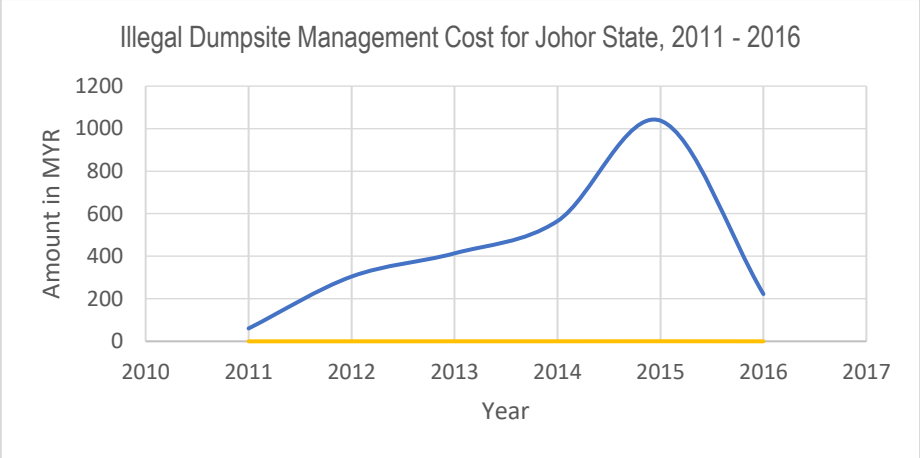


Figure 5. The Illegal Dumpsite Management Cost for the area under Iskandar Puteri City Council

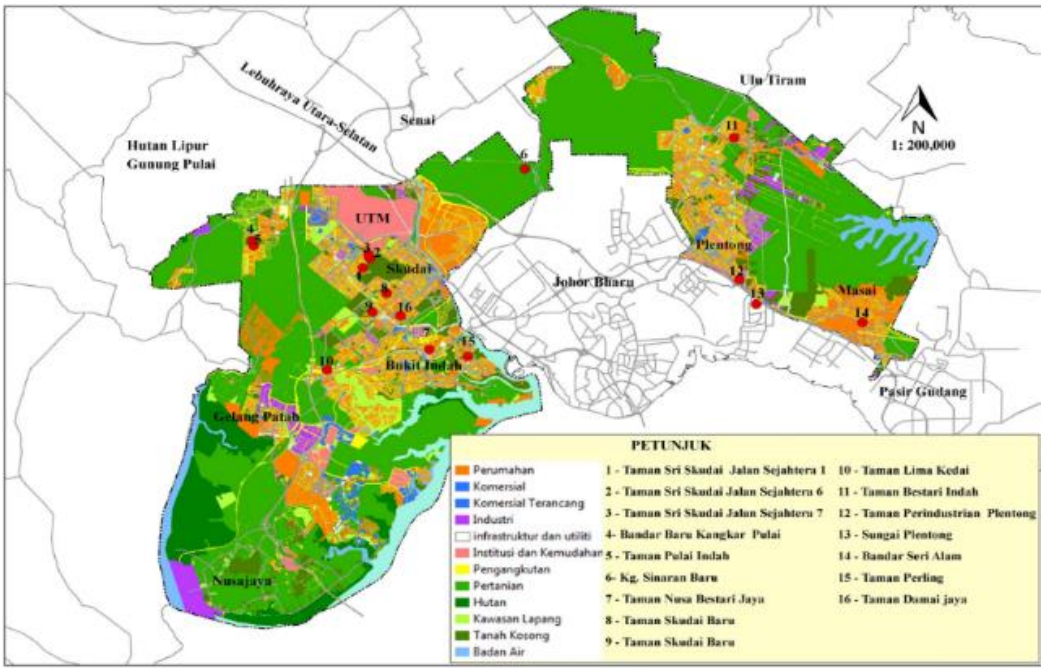


Fig. 6. Map of 16 Illegal Dumpsite Based on Dengue Cases Recorded
(Source : Iskandar Puteri City Council)

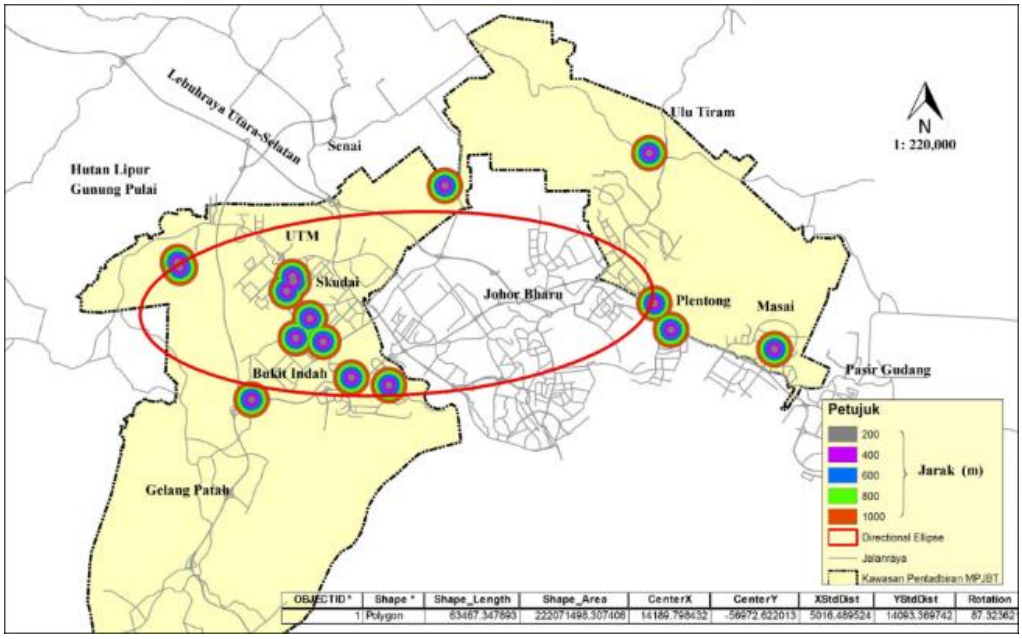


Fig. 7. Map of 16 Illegal Dumpsite Map Dengue Cases Recorded
(Source: Iskandar Puteri City Council)

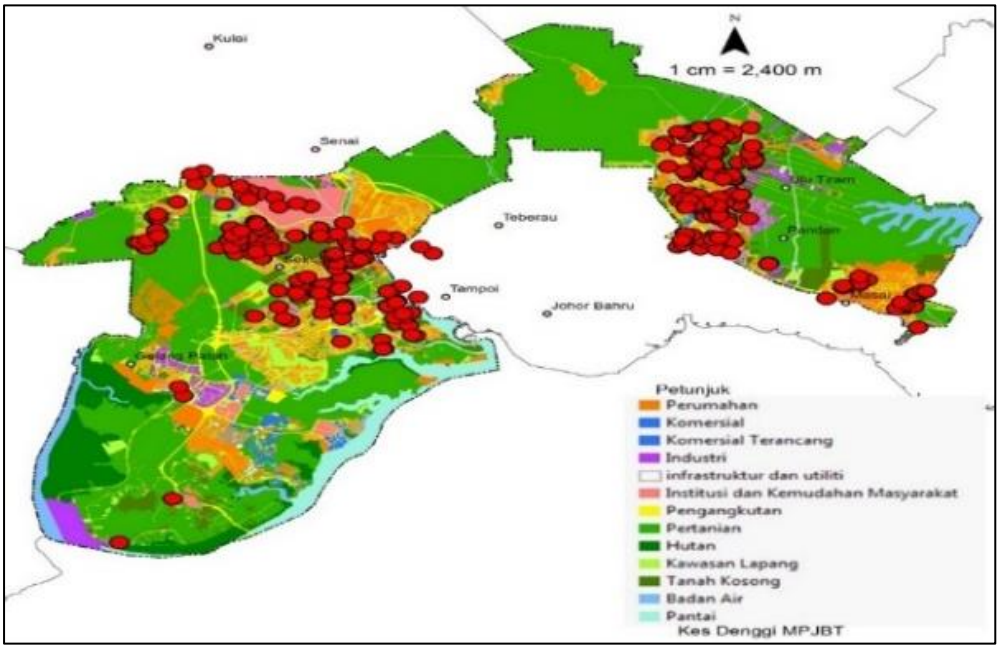
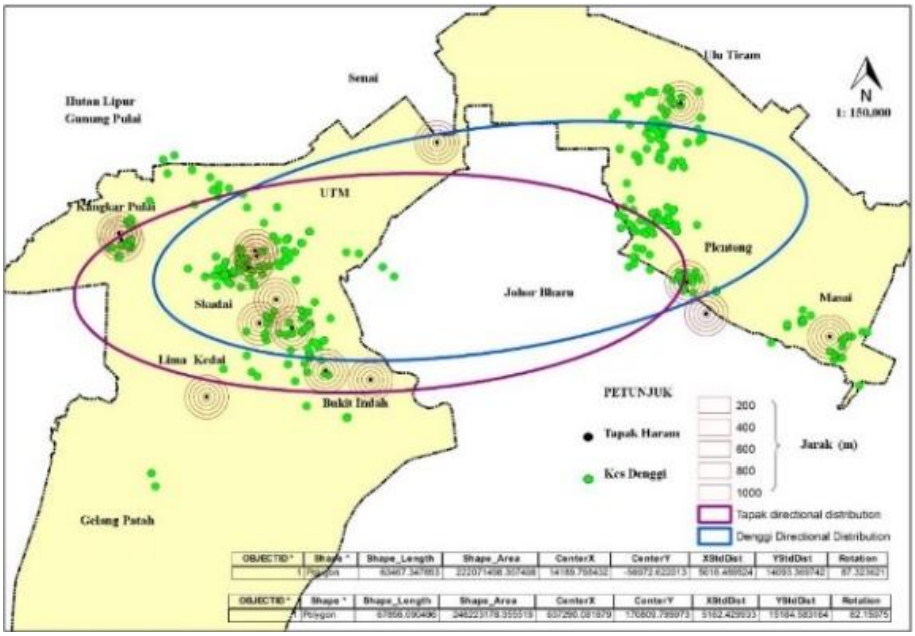


Fig. 8: Dengue Cases Map Produced Based on the Recorded Data
of the Incidence of Dengue Cases (Source: Iskandar Puteri City Council).



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OBJECTID *	Shape *	Shape_Length	Shape_Area	CenterX	CenterY	XStdDist	YStdDist	Rotation
1	Polygon	67856.090496	2462231?8.355319	837290.081879	170809.799973	5162.429933	15184.583164	82.15975

Fig. 9: The trend of Standard Deviation Ellipse and the relationship with Illegal Dumpsite and Dengue Cases recorded