Using Geographical Information System to Identify High Risk Areas of Substance Abuse in Malaysia

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Abstract

Substance abuse problems have been a growing concern from all over the world. Not surprising, the abuse of illicit drugs remains a serious problem in Malaysia. Over the decade there has been a drastic increase in illegal drugs used. Current methods for estimating the incidence, prevalence, and spread of drug misuse tend to be retrospective and are not capable of forecasting spatio-temporal trends. Mapping of drug misuse is therefore restricted to displays of incidence and prevalence rates. Hence, the objective of this study is to develop a "Geographical Information System" to identify the high-risk areas of substance abuse in Malaysia. The research methodology consists of three parts which are the creation of the spatial distribution and interpolation analysis, hot spot map and spatial drug abuse risk map. The study area consisted of six different states in Malaysia, namely, Pulau Pinang, Kedah, Kelantan, Johor, Selangor and Wilayah Persekutuan Kuala Lumpur. The data used in this study were collected from two different agencies which are AADK's data and PDRM's data. Both data were processed by using ArcGIS software to produce hot spot map, spatial distribution map and geostatistical analysis. The findings of the study showed that Pulau Pinang has the highest number of drug abuse. This analysis also revealed that mostly 'very high' hot spot areas are located in the capital city or in vicinity for each state such as Pulau Pinang (Georgetown), Johor (Johor Bharu), WP Kuala Lumpur (Ampang, Cheras), Kelantan (Kota Bahru, Pengkalan Chepa), Selangor (Klang, Damansara, Ampang Jaya) and Kedah (Kota Setar, Jitra). This specific data analysis related to drug abuse can be used by local authority to objectively focus on these areas to intensify drug prevention program such as Perangi Dadah Habis-habisan (PDH) initiatives to reduce the number of drug abuse cases in these six high prevalence areas.

Keywords: Geographical information system, high risk areas, substance abuse

Abstrak

Penyalahgunaan bahan telah menjadi satu isu yang semakin meruncing di merata pelusuk benua. Oleh kerana itu, tidak hairan sekiranya penyalahgunaan dadah merbahaya masih lagi menjadi permasalahan yang serius di Malaysia. Penyalahgunaan dadah yang direkodan telah menjadi semakin meruncing sepanjang dekad ini. Pelbagai cara terkini yang digunakan untuk menjangka kejadian, kelaziman, dan tebaran penyalahgunaan dadah lebih cenderung menjadi retrospektif dan tidak berupaya untuk meramal corak dari segi masa dan tempat. Oleh sebab itu, pemetaan untuk penyalahgunaan dadah lebih terfokus kepada kadar kejadian dan kelaziman semata-mata. Disebabkan itu, objektif kajian ini dilakukan adalah untuk mewujudkan "Geographical Information System" bagi mengenal pasti kawasan yang berpotensi tinggi atau cenderung terhadap penyalahgunaan dadah di Malaysia. Metodologi untuk kajian ini terdiri daripada tiga bahagian iaitu mewujudkan analisis interpolasi dan tebaran masa dan tempat, peta 'hot-spot', dan peta masa dan tempat bagi penyalahgunaan dadah. Kawasan kajian merangkumi enam negeri di Malaysia iaitu Pulau Pinang, Kedah, Kelantan, Johor, Selangor dan Wilayah Persekutuan Kuala Lumpur. Data yang digunakan dalam kajian ini telah diperolehi daripada dua agensi yang berbeza iaitu AADK dan PDRM. Kedua-dua data telah diproses menggunakan aplikasi ArcGIS bagi menghasilkan peta 'hot-spot', tebaran ruang dan masa, dan analisis geostatistik. Dapatan kajian ini telah menunjukkan Pulau Pinang sebagai negeri dengan frekuensi penyalahgunaan dadah terbanyak. Analisis kajian juga menunjukkan kawasan 'hot-spot' tertinggi dicatatkan di ibu negeri atau kawasan berhampiran bagi setiap negeri dalam kajian iaitu Pulau Pinang (Georgetown), Johor (Johor Bharu), WP Kuala Lumpur (Ampang, Cheras), Kelantan (Kota Bahru, Pengkalan Chepa), Selangor (Klang, Damansara, Ampang Jaya) dan Kedah (Kota Setar, Jitra). Analisis data yang terperinci berkenaan penyalahgunaan dadah ini boleh digunapakai oleh pihak berkuasa tempatan untuk lebih memfokus kepada kawasan-kawasan ini demi memperhebatkan lagi program pencegahan salah guna dadah Perangi Dadah Habis-habisan (PDH) bagi mengurangkan kadar penyalahgunaan dadah di enam kawasan terlazim.

Kata kunci: Sistem maklumat geografi, kawasan berisiko tinggi, penyalahgunaan dadah

Introduction

Drug use continues to exact a significant toll, with valuable human lives and productive years of many persons being lost. An estimated 183,000 (range: 95,000-226,000) drug-related deaths were reported in 2012. That figure corresponds to a mortality rate of 40.0 (range: 20.8-49.3) deaths per million among the population aged 15-64. While that estimate is lower than 2011, the reduction can be ascribed to the lower number of deaths reported in a few countries in Asia. Globally, it is estimated that in 2012, between 162 million and 324 million people, corresponding to between 3.5 per cent and 7.0 per cent of the world population aged 15-64, had used an illicit drug — mainly a substance belonging to the cannabis, opioid, cocaine or amphetamine-type stimulants group — at least once in the previous year (UNODC, 2014).

The extent of problematic drug use - by regular drug users and those with drug use disorders or dependence remains stable at between 16 million and 39 million people. However, there continues to be a gap in service provision, as in recent years, only one in six problem drug users globally have had access to or received drug dependence treatment services each year. Although the general public may perceive cannabis to be the least harmful illicit drug, there has been a noticeable increase in the number of persons seeking treatment for cannabis use disorders over the past decade, particularly in the Americas, Oceania and Europe. Nonetheless, opiates remained the most prevalent primary drug of abuse among those seeking treatment in Asia and in Europe, as did cocaine in the Americas.

With regard to injecting drug use, the United Nations Office on Drugs and Crime (UNODC), the Joint United Nations Programme on HIV/AIDS (UNAIDS), the World Bank and the World Health Organization (WHO), drawing on the most recent data available, jointly estimate that the number of people who inject drugs is 12.7 million (range: 8.9 million-22.4 million). That corresponds to a prevalence of 0.27 per cent (range: 0.19-0.48 per cent) of the population aged 15-64.2 The problem is particularly stark in Eastern and South-Eastern Europe, where the rate of injecting drug use is 4.6 times higher than the global average (UNODC, 2014).

According to Malaysian Psychiatric Association (2006), the abuse of illicit drugs remains a serious problem in Malaysia. Over the decade there has been a drastic increase in illegal drugs used. The National Drug Agency (ADK) has, through its efforts, registered more than 300,000 addicts in its drug fight over the years. However, just like the iceberg, the numbers are only what is seen above the surface. Some local studies have suggested there are an estimated three to four addicts who are not registered with the ADK for every one that is (Chan et al., 2012). Hence the potential numbers of addicts in Malaysia is quite staggering, a possible one million addicts in our country of 25 million, or 4% of the populace! In comparison, some statistics from the United States estimate that the number of addicts there is one in 3,000, or only 0.03% of their population. Another source of alcoholrehab.com (2015) indicated that half of all illegal drug use in Malaysia involves heroin. Records from 2006 show there were 22,811 drug users who had been officially detected, and this is a drop from 2005 when there were 34,813 cases detected. The majority of drug users seem to live in Pulau Pinang and Kedah. It is believed that at least 1.1% of the Malaysian population is involved in illegal drug use (alcoholrehab.com, 2015).

Literature Review

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. Geographic information science is also the science underlying geographic concepts, applications, and systems (Patel & Waters, 2012). In a general sense, the term GIS describes any information system that integrates, stores, edits, analyzes, shares, and displays geographic information. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations. GIS provides, for every kind of location based organization, a platform to update geographical data without wasting time to visit the field and update a database manually. GIS when integrated with other powerful enterprise solutions like SAP, helps creating powerful decision support system at enterprise level.

The acronym GIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems and is a large domain within the broader academic discipline of Geoinformatics. Normally, users are primarily government related, town planning, local authority, and public utility management, environmental, resource management, engineering, business, marketing, and health research. What goes beyond a GIS is a spatial data infrastructure, a concept that has no such restrictive boundaries. These might be represented as several different layers where each layer holds data about a particular kind of feature (e.g. roads). Each feature is linked to a position on the graphical image of a map, and layers of data are organised to be studied and to perform statistical analysis (i.e. a layer of customer locations could include fields for Name, Address, Contact, Number, Area).

While the use of GIS is gaining favour with health researchers, barriers remain in the uptake of more advanced geospatial methods by health care decision-makers. Whilst there is much value in attempts to monitor and improve knowledge about patterns of drug misuse many current initiatives still rely on estimates and deliver information about past events. Current methods for estimating incidence and prevalence of drug misuse therefore tend to be retrospective and can only adequately provide data on past events. Crucially, they are not capable of forecasting spatio-temporal trends or, in many instances, consider important geographical characteristics that link location, environment and behaviour. In fact, it takes a Geographical Information System (GIS) approach to formulating an effective model which is a departure from previous work in this area. In this sense, it draws on the use of GIS to

combine geographical factors known to define the spread of drug misuse to create a predictive model and allow map output.

Undeniably, the wide-ranging capability means that GIS can provide powerful tools for health and environment-based research (Gatrell & Löytönen, 1998). In the area of health care, for example, GIS is being increasingly used for the purposes of needs assessment, resource allocation and service planning (e.g. Jones & Bentham, 1995; Love & Lindquist, 1995; Lovett, Haynes, Bentham, Gale, Brainard & Sucnnenberg, 1998) and for disease mapping and epidemiological research (e.g. Hightower & Klein, 1995; WHO, 1997; Becker Becker, Glass, Brathwaite & Zenilman, 1998). Similarly, GIS are well established in the area of environmental health and epidemiology (Dunn, Woodhouse, Bhopal & Acquilla, 1995; Elliott & Briggs, 1998; Briggs & Field, 2000a; 2000b). The power of GIS lies in its ability to analyze, store and display large amounts of spatially referenced data. In a field where, manual data analysis can become overwhelming, GIS is a valuable tool. There have been several reviews and textbooks published in the past decade that focus on the application of GIS to different areas of health research (Kurland & Gorr, 2009; McLafferty, 2003; Rushton, 2003).

A recent qualitative study conducted in the UK found that although health care decision-makers see the value of using GIS in the decision-making process, however, many (especially those in the community setting) still view GIS primarily as a visualization tool (Joyce, 2009). For that reason, GIS and location intelligence applications can be the foundation for many location-enabled services that rely on analysis and visualization. GIS can link unrelated information by using location as the key index variable. Locations or extents in the Earth space–time may be recorded as dates/times of occurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively. All Earth-based spatial–temporal location and extent references should, ideally, be relatable to one another and ultimately to a "real" physical location or extent. Hence, this key characteristic of GIS has begun to open new avenues of scientific inquiry.

By the end of the 20th century, the rapid growth in various systems had been consolidated and standardized on relatively few platforms and users were beginning to explore viewing GIS data over the Internet, requiring data format and transfer standards. More recently, a growing number of free, open-source GIS packages run on a range of operating systems and can be customized to perform specific tasks. Increasingly geospatial data and mapping applications are being made available via the World Wide Web. However, the implementation of a GIS is often driven by jurisdictional (such as a city), purpose, or application requirements. Generally, a GIS implementation may be custom-designed for an

organization. Hence, a GIS deployment developed for an application, jurisdiction, enterprise, or purpose may not be necessarily interoperable or compatible with a GIS that has been developed for some other application, jurisdiction, enterprise, or purpose.

Research Method

For the purpose of the research, an application software called ArcGIS 10.4 is used to produce the hot spot and spatial distribution maps of the drug abuse cases. It is used because it has suitable and necessary tools to perform the GIS analysis. The ArcGIS tools that were used in this study consists of spatial statistics tool, spatial analyst tool and statistical analysis tool.

Geospatial technique was used to analyse the data collected from *Agensi Anti-Dadah Kebangsaan* (AADK) and *Polis Diraja Malaysia* (PDRM) in the study. For the purpose of the research, the data only covers the cases that were reported for 2017, with specific period of time from January 2017 until July 2017. According to Caitlin (2012), geospatial technique is a technique to acquire, manipulate and store geographic information, and its associated technology has a geographic or location component. The common example of the hot spot techniques are hot spot and interpolation. This technique is very useful and a valuable technique for visualizing the drug abuse and crime pattern in the areas of study. Geospatial data refers to the data that entails a geographic component to it, as well as the location information such as geographic data in the form of coordinate, address or city. Spatial interpolation is known as spatial prediction which is an analytical procedure commonly employed for predicting an unknown spatial value using known values observed at a set of sample locations (Shiode & Shiode, 2011). The production of the interpolation maps take place in ArcGIS software. The tool that contributes to this analysis is spatial analyst tool. The three methods of interpolation used were IDW, Kriging and Spline. The drug addicts and crime cases data were then processed through the three interpolation methods mentioned above in order to produce interpolation maps. These three interpolation maps were then compared where the best interpolation map will be selected . This map will then be compared with the hot spot map to analyse the relationship between drug addicts' rates and criminal cases.

The hot spot map outcomes will show the areas of high occurrence versus areas of low occurrence of drug abuse cases. The hot spot mapping technique is chosen as it is able to identify the areas of high concentrations of drug abuse cases. The hot spot analysis basically

uses vectors to identify the locations of statistically significant hot spot and cold spot in the data. Existing hot spot mapping methods can be essentially divided into three main categories which are point mapping, choropleth mapping, and kernel density estimation (KDE) (Wang et al., 2013). Point mapping uses *'standard deviational ellipses'* to display crime hot spots on a map and does not pre-define any spatial boundary. For the popular hot spot representation which is choropleth, the boundary areas (geographic boundaries like census blocks or uniform grids) are used as the basic mapping elements (Hirschfield, 2001). Unlike point mapping, choropleth mapping uses aggregate data, which removes spatial details within the thematic areas and also the identified hot spots are restricted to the shape of these areas. Meanwhile, the method of Kernel Density Estimation (KDE) aggregates point data inside a user specified search radius and generates a continuous surface representing the density of points (Wand & Jones, 1995).

Findings

The hot spot analysis was done using Getis-ord-Gi statistic technique which is available in the ArcGIS software. The results from the analysis were classified into five hot spot categories, each marked with specific colours; Very Low (Blue), Low (Cyan), Moderate (Yellow), High (Orange) and Very High (Red). In Pulau Pinang, Georgetown area was identified to be the area with the highest hot spot of drug addiction by using geospatial technique. Meanwhile, in Kedah, the hot spot areas detected by using geospatial analysis were mostly focused in Kota Setar and Kubang Pasu (Figure 1).

Meanwhile, Kelantan's districts of Kota Bharu and Pengkalan Chepa were included in the "very high" categories for drug abuse hot spot areas. In Johor, the districts of Johor Bahru, Kluang and Batu Pahat have also shown a very high hot spot activity for drug abuse (Figure 2). Besides that, the districts of Hulu Langat, Petaling and Klang district in Selangor were also shown to have very high hot spot area for drug abuse as well. In WP Kuala Lumpur, the sub-districts of Lembah Pantai (Sri Angkasa and Pantai Dalam), Ampang Jaya and Damansara were also detected as high hot spot area (Figure 3) through the hot spot analysis.

This hot spot analysis also revealed that mostly 'very high' hot spot areas are located in the capital city or in vicinity for each state such as Pulau Pinang (Georgetown), Johor

(Johor Bharu), WP Kuala Lumpur (Ampang, Cheras), Kelantan (Kota Bahru, Pengkalan Chepa), Selangor (Klang, Damansara, Ampang Jaya) and Kedah (Kota Setar, Jitra) (Figures 4 to 5). This specific data analysis related to drug abuse can be used by local authority to objectively focus on these identified areas to intensify drug prevention program such as *Perangi Dadah Habis-habisan* (PDH) initiatives to reduce the number of drug abuse cases throughout the six states.

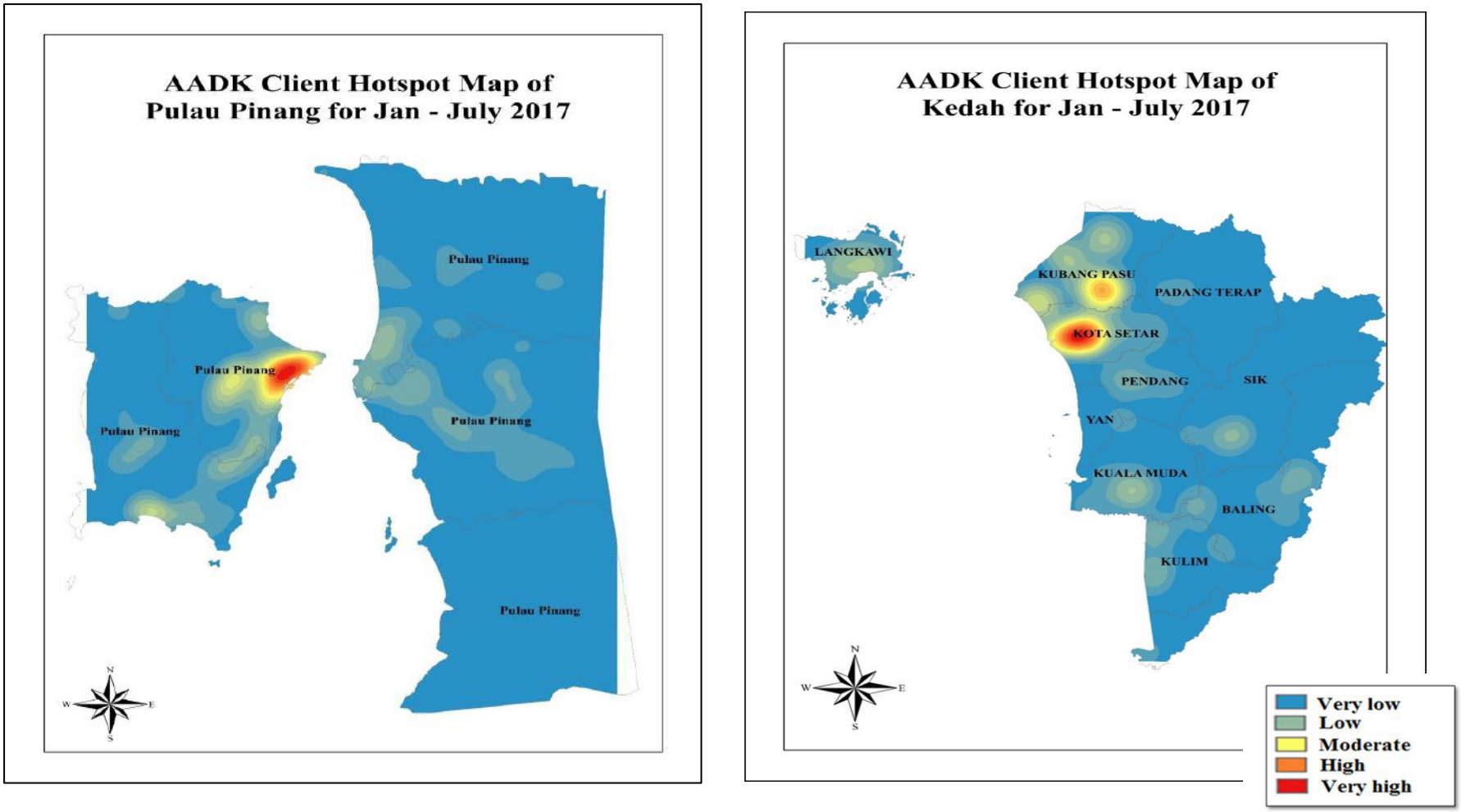
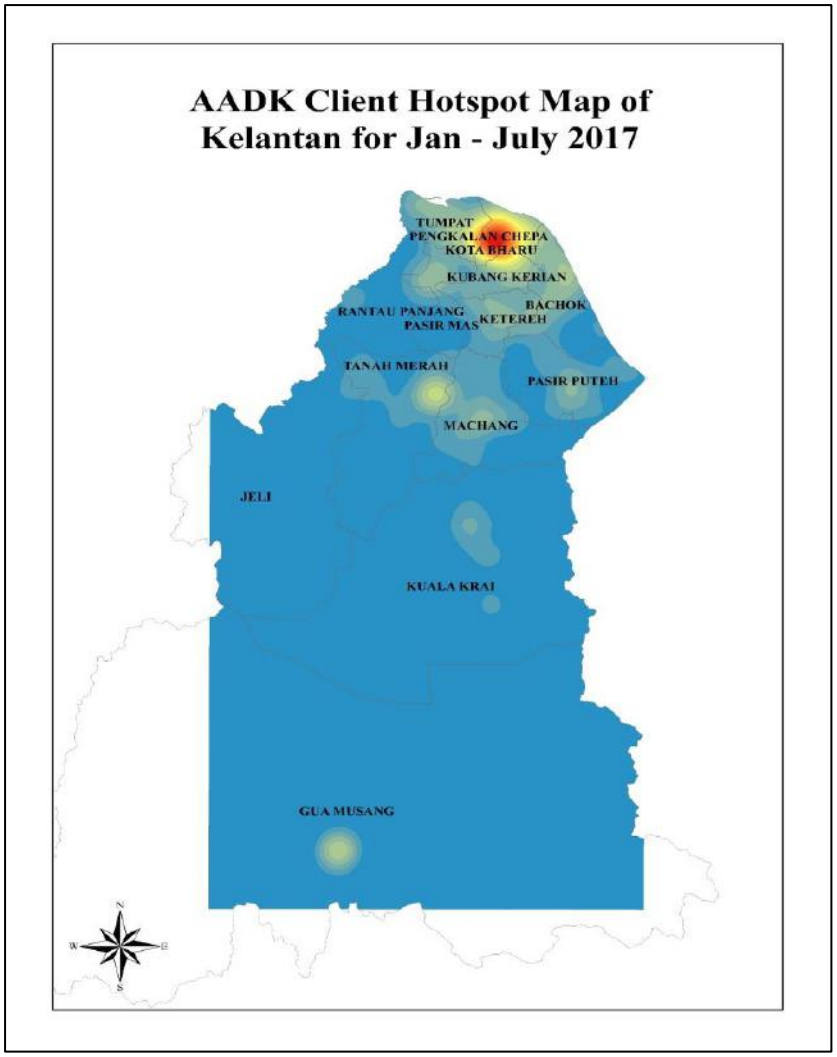


Figure 1 Hot spot category of reported drug abuse distribution in Pulau Pinang and Kedah.



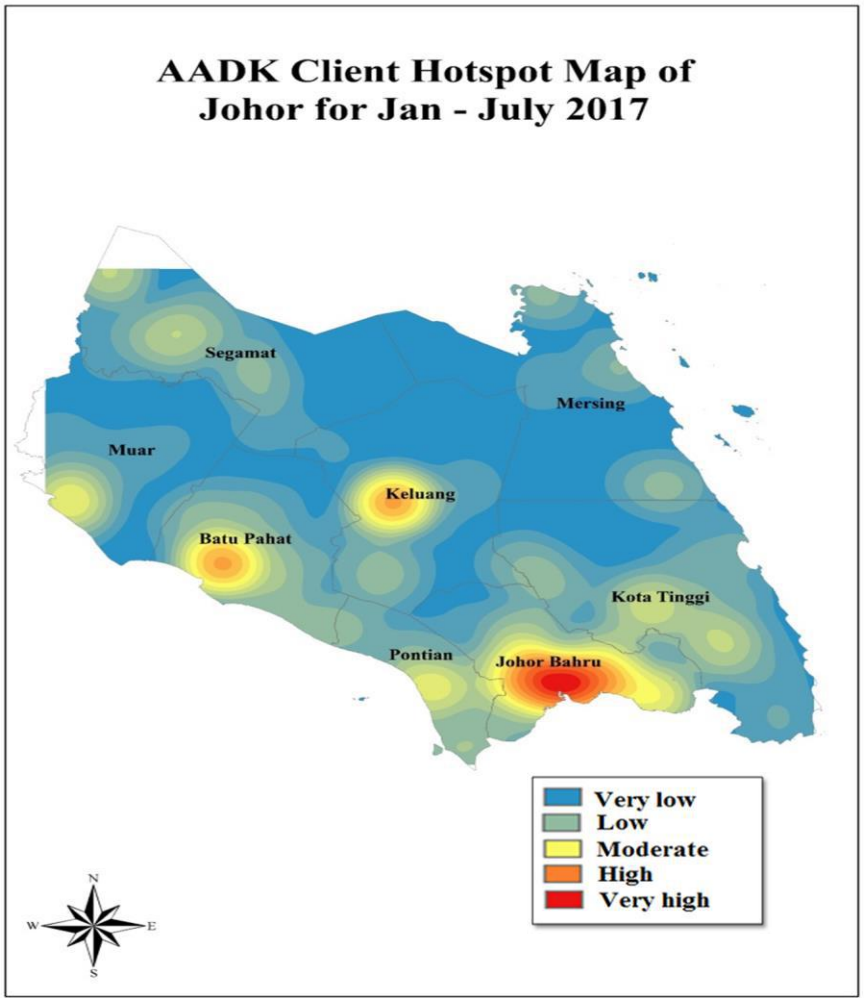
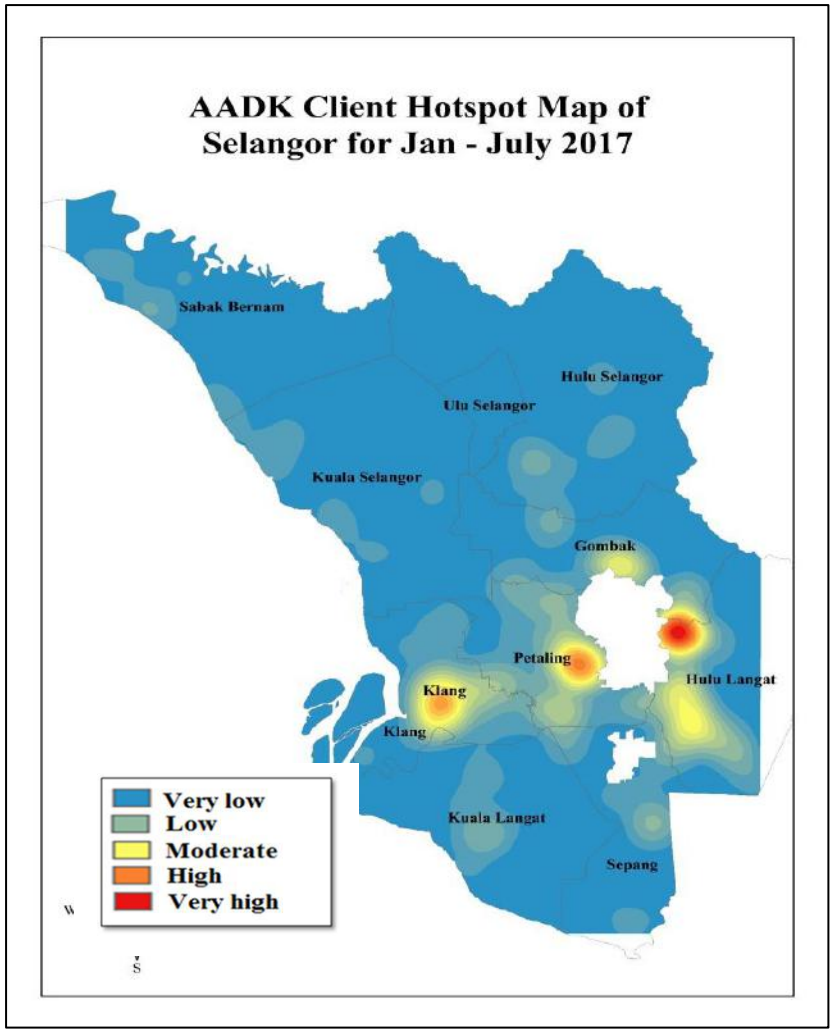


Figure 2 Hot spot category of reported drug abuse distribution in Kelantan and Johor.



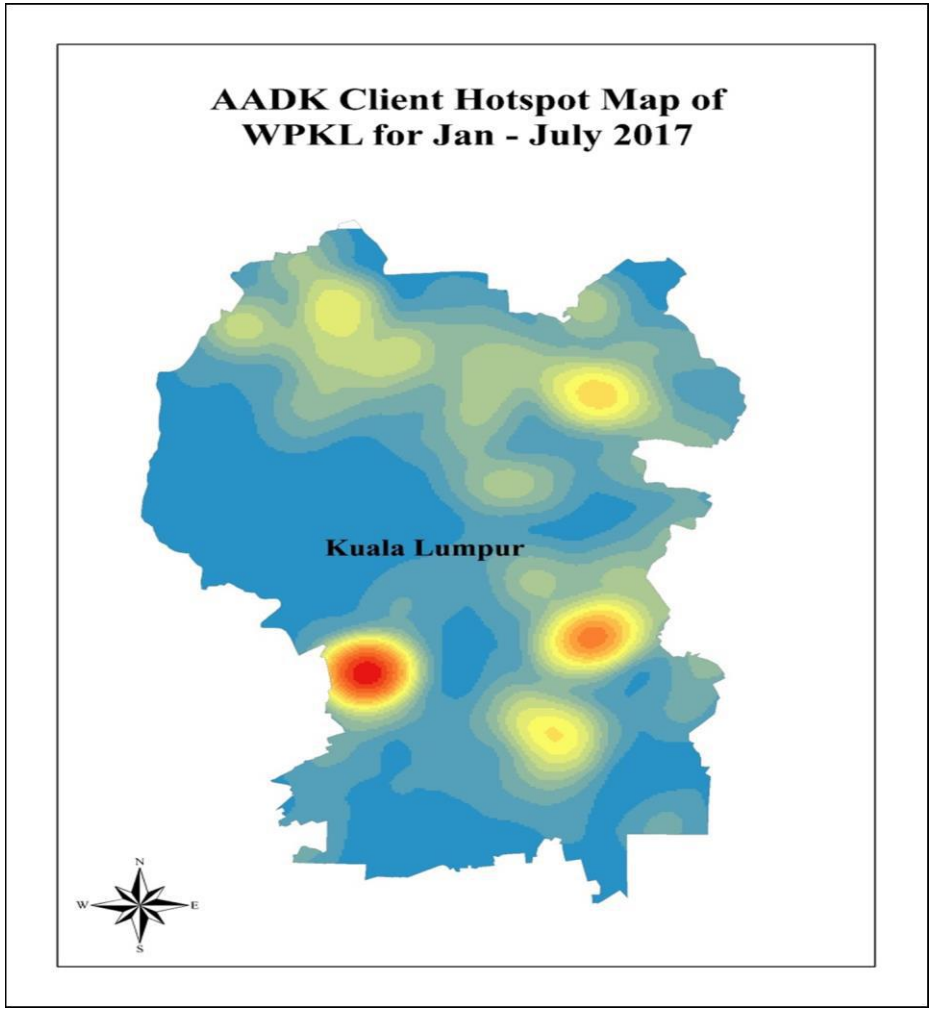


Figure 3 Hot spot category of reported drug abuse distribution in Selangor and WP Kuala Lumpur.

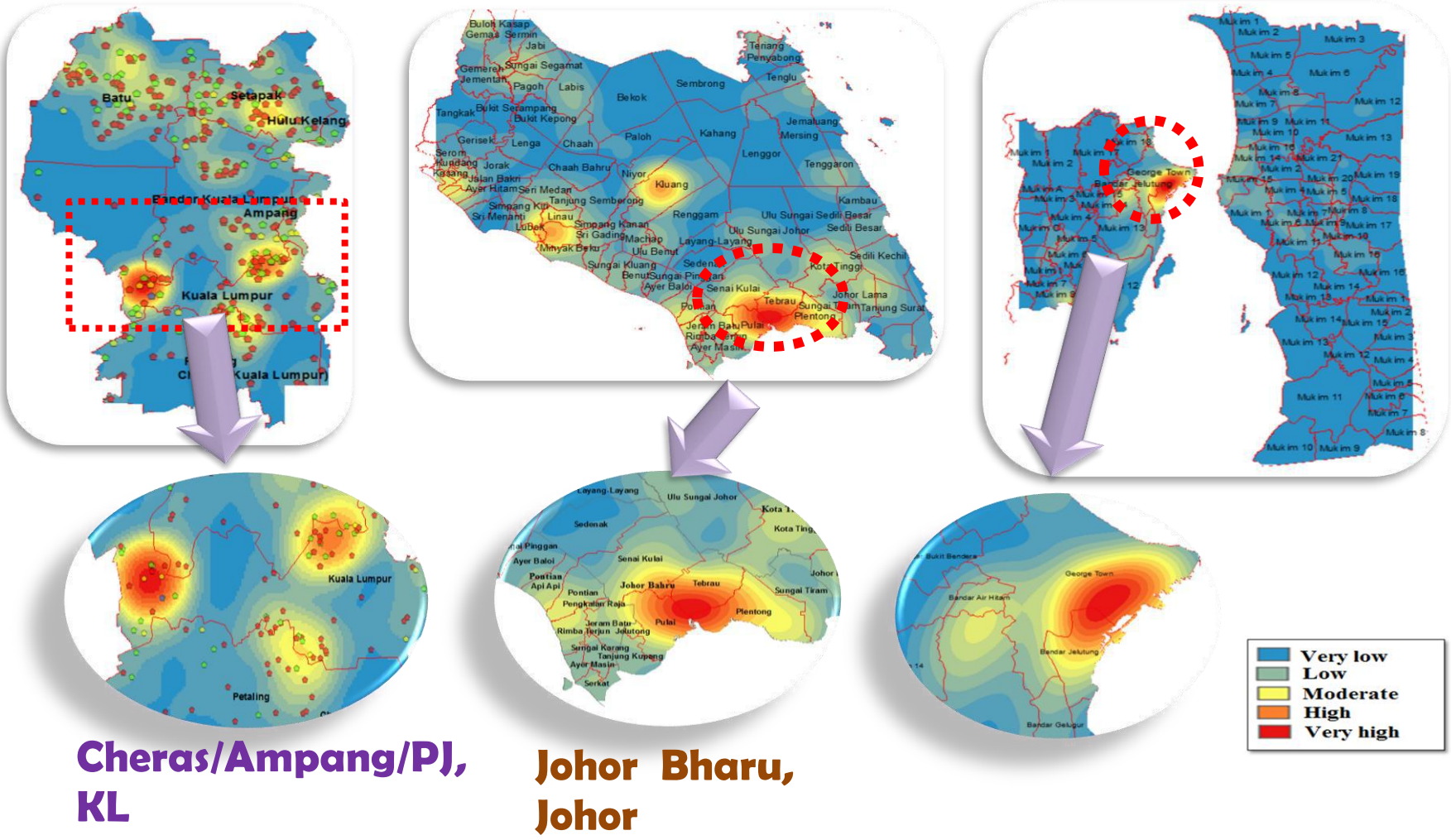


Figure 4 Hot spot area in several capital city for WP Kuala Lumpur, Johor and Pulau Pinang.

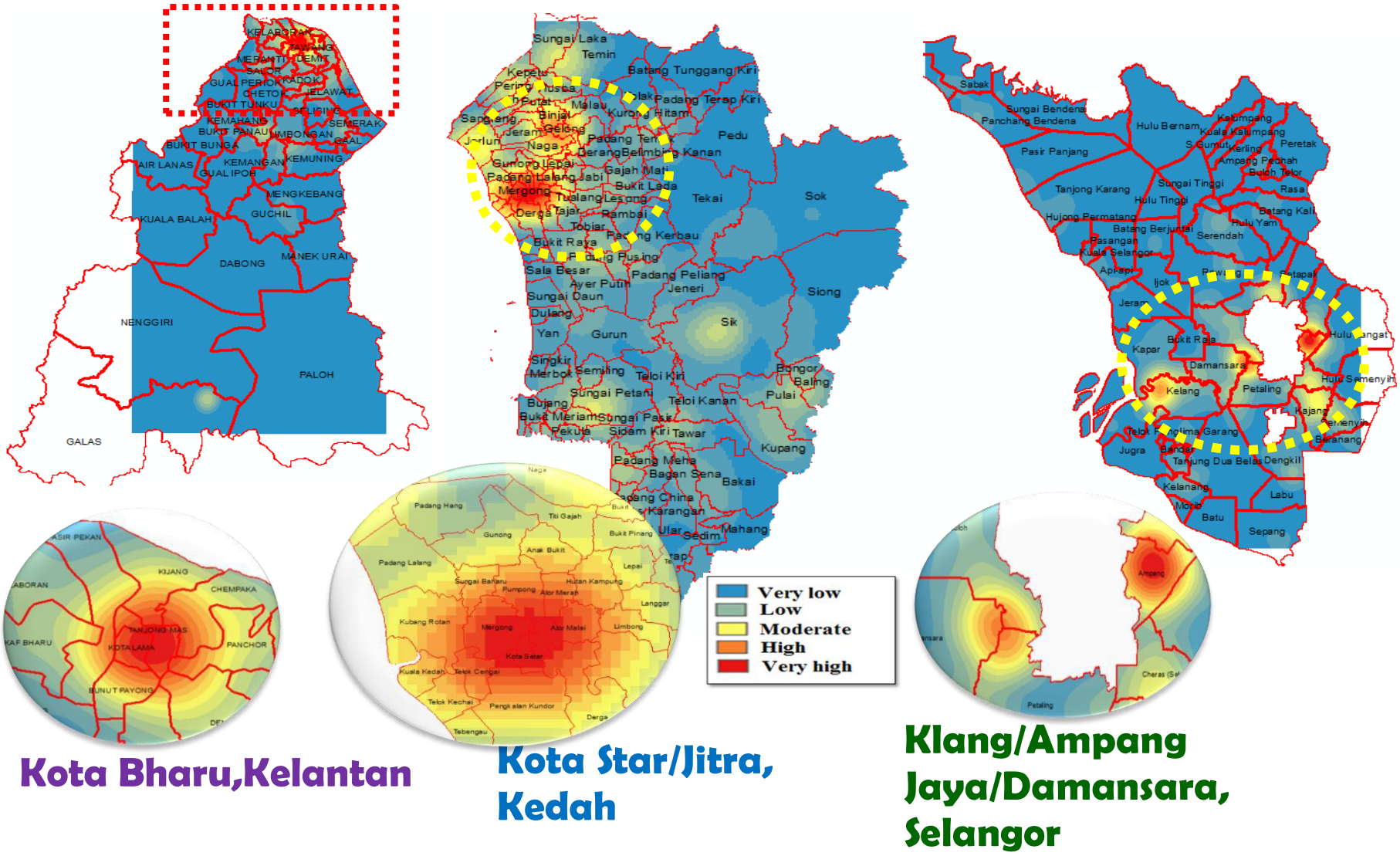


Figure 5 Hot spot area in several capital city for Kelantan, Kedah and Selangor

DISCUSSION

As can be seen from the distribution maps, the high-risk area for district in Pulau Pinang was the Timur Laut district, and the high-risk area for sub-district was in Georgetown, which is also the capital state of Pulau Pinang. Most of the big cities in the selected states seem to be identified as the high-risk areas as well. For instance, Johor Bharu (Johor), Kota Bharu (Kelantan), Kota Setar (Kedah), Klang (Selangor) and Kuala Lumpur (WP Kuala Lumpur) were identified as high-risk areas. Obviously, the accessibility to illicit drugs are relatively easier in big cities. This is because illicit drugs are more available due to abundant supply in urban areas as compared to rural areas. Recent data from AADK also showed that most of drug addicts were from the urban centres such as Kuala Lumpur, Johor Bahru, Ipoh and Pulau Pinang, which could also be an indicative clue that more illicit drug supplies are present and available in these areas.

This study found that Pulau Pinang has the highest number of substance abuse cases as compared to the six other states. According to a research conducted by Usman (2005), Pulau Pinang had approximately shown higher figures than all the other states in Malaysia for drug abuse. The finding of this study is quite consistent with national figures where the statistics of drug abuse issued by the AADK in 2016 had also shown that Pulau Pinang has accounted for the 16.5% of the drug abusers reported in Malaysia for that year, and Kedah was in second place covering 12.5% of the whole statistic in 2016. In general, most of the high-risk areas for drug abuse cases according to districts and sub-districts are located near the state capitals and mostly are in cities with high population densities. According to the AADK's deputy director, Izhar Abu Talib, out of the 178 hot spots identified for drug addicts in Malaysia, 11 are in Pulau Pinang ("Penang Tops List of Drug Haunt", 2016). Overall, Pulau Pinang has recorded the highest number of drug addicts in the country in the past four years.

Conclusion

For many years, drug abuse has been one of the major problems in our country. It has affected the country's development in many aspects. Therefore, it is very crucial to take drastic measures to contain the problems. As the saying goes "prevention is better than cure", the geographical information system developed in this study may help the National Anti-

Drugs Agency to identify the high risk areas of substance abuse in a more efficient and effective way. Other than that, preventive educational programs should be organized for the respective groups from time to time. This drug fighting strategy can be done in multitude of various ways such as recognizing individuals or areas with high potential to be involved in drug abuse, or recognizing the culprit involved in distributing the drugs illegally. Apart from that, healthy lifestyle and sport activities should be held by responsible authorities to the public. This is to instill healthy living to the public and to reduce the potential risk of drug abuse, especially among youths. In the case of the people already involved in activities of drug abuse, authorities should take drastic measure of excluding these people from the public to avoid their influence to people around them, and to take the initiative to cure them in rehabilitation center. These people can be recognized from the result of urine test. If all these measures are in place, we believe that the substance abuse cases will definitely be controlled at a better level.

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