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The Crime Ecology: Ambient Temperature vs. Spatial Setting of Crime (Burglary)

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Abstract

Surface temperature has been seen as factors inducing stress and discomfort. Patterns in the increasing of stress and discomfort among human are eventually related to crime convicted. Therefore, patterns in the crime rate are seems to be linked to the temporal and ecological factors. This study aims to investigate the potential use of remote sensing and GIS technology in identifying the highly potential crime rate area based on historical data of crime and its relationship to the ambient temperature. Based on this study, the relationship of crime convicted with heat or surface temperature is identified.

Keywords: GIS-crime; remote sensing; surface temperature; crime

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1. Background

The association of crime with the physical environment has been spelled out in several studies (Cotton 1986, Field 1992, Hipp et al. 2003). Land use, socio demographics, open spaces, residential and neighborhood does play an important role in affected people behavior, especially towards the type of crime and its intensity. Addressing crime using latest technology maybe widely used in other country but Malaysian perspective towards using technology in criminal analyses study has yet been widely utilised. This issue is probably due to the insufficient knowledge, skill and also funds to conduct a research and program in line with the subject matter. However, recent development of awareness in the local authority Malaysia is adopting Safe City Monitoring System (SCMS) (The Star, 2011). Prior to this crime in Malaysia is map through pin which is clearly not stable as it is easily dismantled and changed. SCMS enable crime to map dynamically through a technology called Geographical Information System (GIS) (Zainol et al.). The potential integration of GIS and remote sensing technology may be well benefited to the nation as well as permitting people to avoid and perhaps conducting self-control from becoming convicts. Besides, by looking at the enforcement agencies, a few studies have been conducted that shows crime committed can be based on emotional states and discomfort(Anderson 1987, Hipp et al. 2003). Looking at wider perspectives, this has been a major debatable subject and several factors can be seen as the major contributors to the increments number of crime committed. Thus, controlling crime does not necessarily depending on the enforcement agencies such as police but also by self-retrained and avoiding certain situation that may influence the stability of mind. This may include heat temperature derived from surface or an extreme climate change.

In 1984, two studies were conducted to test the linear and curvilinear hypotheses on the ambient temperature and violent crime (Anderson and Anderson 1984, Anderson 1987). Both studies yielded significant linear relationships and failed to demonstrate the specified curvilinear relationship. While in Rotton et.al (1979) shows that the aggression was higher even towards moderate exposure to odour. Given the timeframe, with the extreme global climate change, it is an urgency to see whether pattern of relationships and the level of significant between heat and crime are still similar?

According to (Siegel 2010), crimes are mostly reported during summer season which mean between July and August. This phenomenon happened due to various activities that commonly performed during summer i.e. school holidays where people usually left the house vacant leaving a great opportunity to the criminal, people tends to spend extra time outdoor and eventually makes them an easy target as the house is also become vulnerable when it is left empty. Two exceptions on these trends are murderers and robberies. Based on his statements, the climatology conditions does not directly related to the crime committed besides the fact that crimes most committed during heat season, but the focus is more on behavioural implications and activities that triggers the criminal actions. This maybe the case in UK or other European countries that has four seasons but for tropical country like Malaysia the association maybe different. On the contrary, several studies (Cotton 1986, Cohn 1990, Field 1992) has looked into the effect of weather on crime which suggested that physical environment indeed have certain magnitude towards the level of human behaviour. There are a few studies performed to see other factors that might also lead to an increasing number of crime such as unequality of income (Demombynes and Ozler 2005) where (Brush 2007) analysed it from an economical point of view, the causes of violent crime (Fajnzylber et al. 2002), burglary and income unequality (Chiu and Madden 1998). (Nilsson and institutionen 2004) found that the "proportion of relatively poor people" affected overall crime and specific types of property crime in Sweden. In contrast, a time-series regression by (Saridakis 2004), using national-level data for the United States, found a short-term but no long-run relationship between income inequality and crime.

Crime data can also be mapped and represented through several methods i.e geo-visualization, dynamic mapping and animation techniques. Brunsdon et. al, (2007), performed a study to compare various methods of crime mapping. The team has also employed animation techniques to explore the relationship between crime and ambient temperature in which every crime was assigned a temperature value and mapping was generated for every 0.1 K between 3 and 25 °C. (Murray et al. 2001) explored the spatial data analyses techniques in order to map crime. This technique is a common technique available in GIS technology. Despite of technique and technology used to map crime, there are also studies conducted to determine the relationship between physical environment and actual crime locations (Beavon et al. 1994, Loukaitou-Sideris 1999) and examined the occurrence and reoccurrence of the events of crime and its relationship with the spatial configuration by using Space Syntax methodolgy (Hillier and Sahbaz 2005, Nubani and Wineman 2005).

1.1. The Aims and Objectives

This study aims to investigate the potential use of remote sensing and GIS technology in identifying the highly crime rate area based on historical data of crime in Malaysia and its relationship to the surface temperature. In due respects to that, the research objectives are listed hereunder:

- To identify and process crime statistics spatially and identifying the highly crime rate area based on historical data of crime;
- To identify relationship between crimes committed to the ambient temperature.

1.2. Study Area

The study area selected to test the relationship is Shah Alam, Selangor. It is reported that the crime distribution in Shah Alam have been relatively increasing over the years. The data used for this used consist of a set of crime data collected from the year 2007-2009 and the spatial data of the locational setting of the committed crime. The study area land use consists of approximately 70 percent of residential area and the rest of 30 percent are mixed up between commercial and industrial area.

1.3. Methodology

The method adopted in this research is divided into 3 major phases (refer to Figure 1). These phases are preliminary stage, pre-processing and data preparation stage and processing and analyses stage. The preliminary stage involved major desk study to identify current status of crime rate at global scale to the regional scale and the climate condition of the study area. Its also involved data acquisition process which have mainly engaged to certain local authority such as Malaysia Royal Police Department (PDRM), Shah Alam Local Council (MBSA), the Malaysia Meteorological Department (MMD), Alam Sekitar Malaysia (ASMA) and finally International Research Centre on Disaster Prevention (IRCDIP). The data acquired from these agencies were then converted and processes so it could complement each other. Using software like Excel, Access and ArcGIS these data were integrated. Phase two involved the technical manipulation mainly involved GIS processing. All the text data like coordinate of the weather stations are plot into GIS format. Figure 2 show the workflow of the method and processes involves in all the stages.
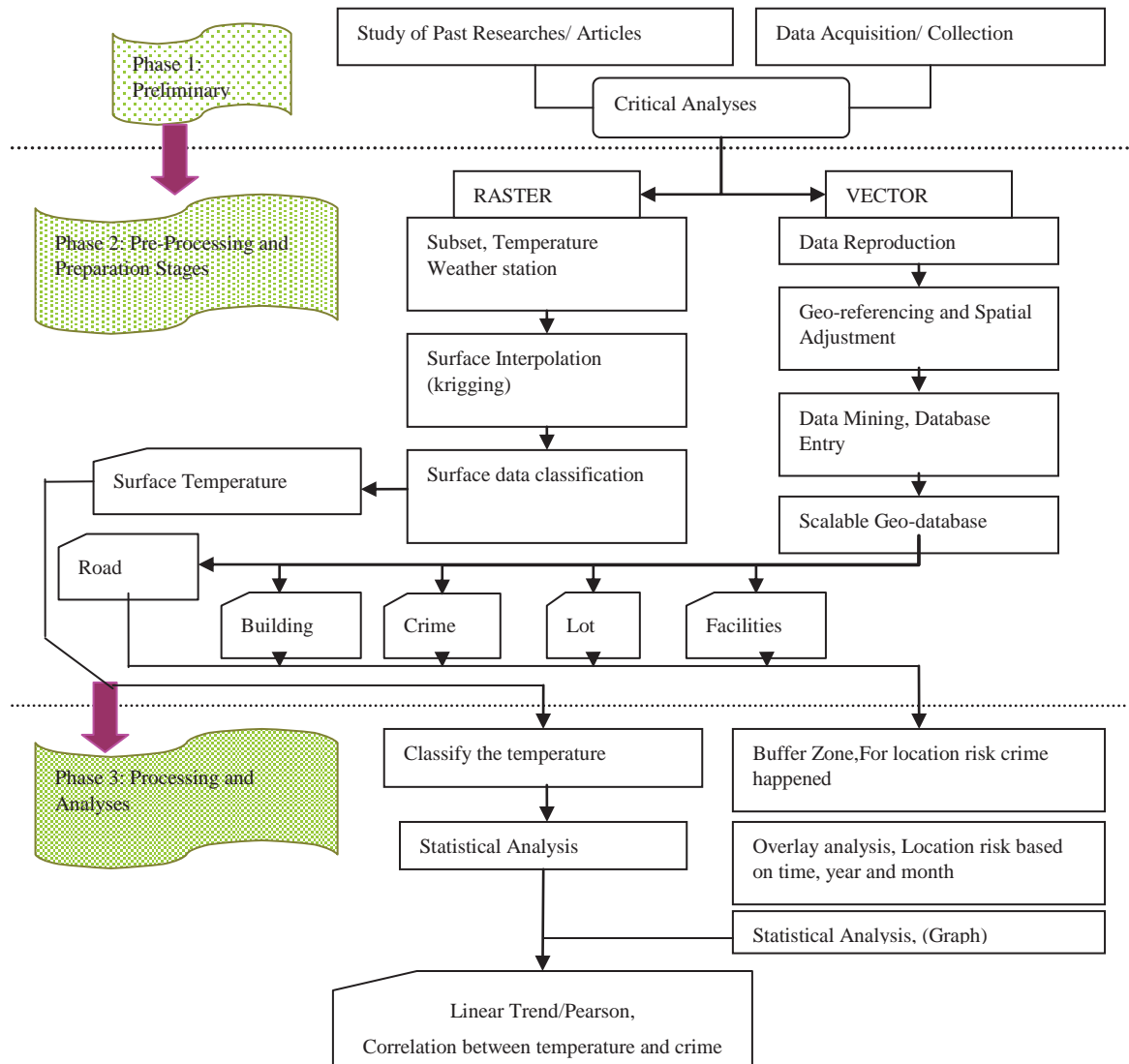
Fig. 1. Diagram of Research Method (*GIS manipulation)*

As can be seen in Figure 1, second stage involves some spatial interpolation like krigging, sub setting and spatial data reproduction. Then, the spatial data is converted into Scalable GIS format called Geo-database. The final phase is the analyses phase. It is generally divided into demographic analyses, hot spot analyses, pattern analyses and correlation analyses.

2. Result and Analyses

This section elaborated analyses performed in this study. The generated crime analysis and surface temperature map are also illustrated in this chapter. The two type's analyses that were conducted are the crime analysis and surface temperature analysis. Section 2.1 described crime analysis. These analyses were conducted by using geoprocessing techniques namely buffering and intersect and represented using graph tool. The following section demonstrated the relationship of surface temperature with regards to crime spatial setting. Based on methodology outlined above, the crime analysis tool is capable to identify the pattern of the crime. The following sections show the results of statistical crime analysis.

2.1. Demographic Crime Analyses year 2007 - 2009

This section presents the distribution of crime with respect to their location setting of the study area. Figures 2 and 3 showed the crime activities location for year 2007 and 2008 respectively. The map illustrates in Figure 2 indicates that the criminal activities are highly anticipated over the Section 4 of the study area.
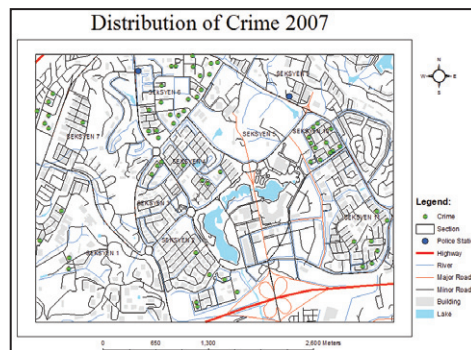

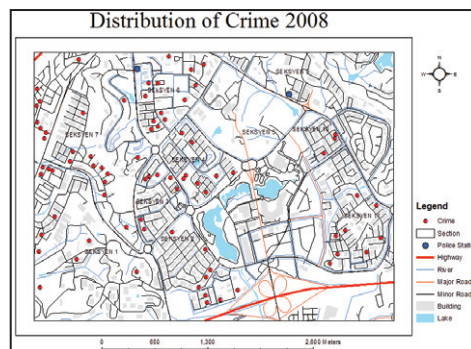Fig. 2. The Distribution of Crime (2007)

Fig. 3. The Distribution of Crime (2008)

While in Figure 3, there are a slight changes in term of crime happened. The pattern shows the intensity of the crime area has moves to Section 7.

In 2009, the dispersion of crime over the study indicates the reductions of criminal activities in Section 7 compared to the previous year. The scattering can be seen in Figure 4.
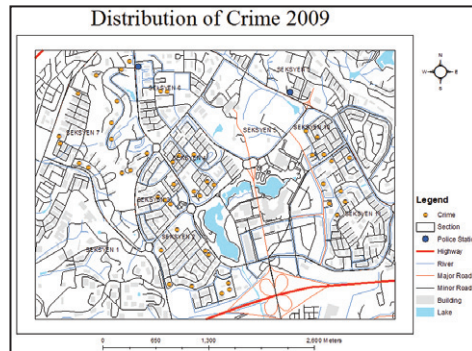

Fig. 4. The Distribution of Crime (2009)

The findings in this section suggested that there is multiple reoccurring of crime at the same location. This evaluation and indication suggest that the reoccurring area is highly risk for burglary activities. The community should be well-informed about this to ascertain pre-cautions need to be considered. The implications can strikes at various perspectives mainly in the fields of real estate, property marketing, local authority and local community. Figure 5 shows the graphs of crime happened in Shah Alam for the year 2007-2009.
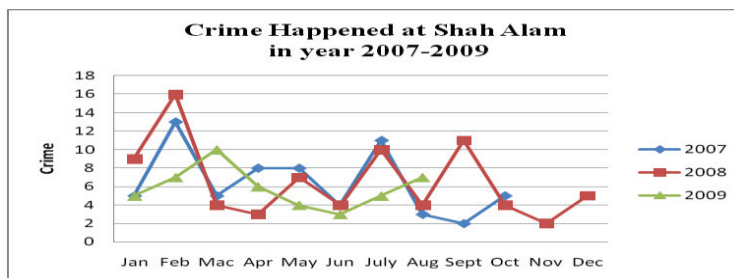

Fig. 5. The total crime that happened in Shah Alam for year 2007-2009

Figure 5 show the crime graph in the year 2007 with the highest incidence of criminal cases in February which is 13 cases and followed by July 11 cases, April and May both with 8 cases, 5 cases for January, March and December and the least crime occurred in November with 2 cases. While the crime graph in 2008 show the highest incidence of criminal cases in February with 16 cases followed by September with 11 cases, 10 cases in July and 9 cases in January also May and December 5 cases followed by April and May 8 cases, 5 cases for January, March and December and 4 cases in Mac, Jun, August and October for 4 cases followed by 3 cases in April and the least crime occurred in November with 2 cases. For 2009 crimes occurred in March with 10 cases, followed by January and February with 10 cases, April 6 cases, 5 cases for January and July, 4 cases for May and the least crime occurred in Jun with 2 cases.

2.2. Pattern Analyses

Pattern analysis used Average Nearest Neighbourhood which calculates nearest neighbourhood based on the average distance from each features to its nearest neighbouring features. The nearest neighbour index and associated Z score and p-value as derived output. The Z score and p-value are measures of statistical significance which tell you whether or not to reject the null hypothesis. For Average Nearest Neighbour the null hypothesis stated that features are randomly distributed. The nearest neighbour is expressed as the ratio of the observed distance divided by the expected distance. The expected distance is the average distance between neighbours in a hypothetical random distribution. If the index is less than 1, the pattern exhibits clustered; if the index is greater than 1, the trend is toward dispersion or competition. The following figures illustrate the pattern analysis for crime distribution location in a year.
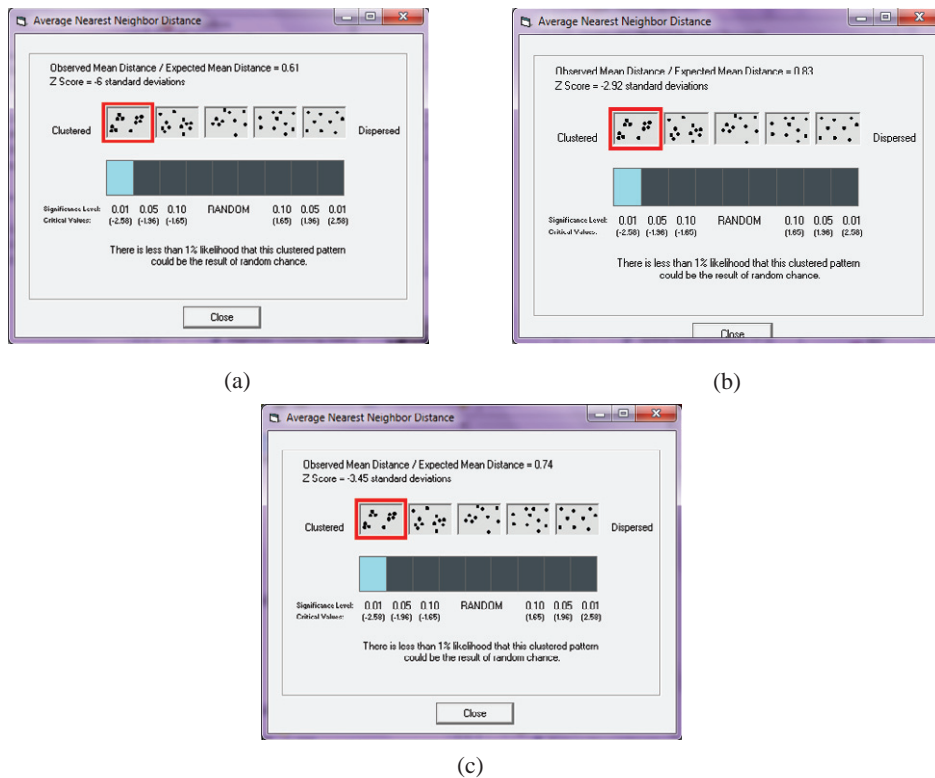
(a)

(b)

(c)

Fig. 6. The Pattern Analysis for Crime in year (a) 2007; (b) 2008 and (c) 2009

Figure 6 show the average nearest neighbor distance for crimes that happened in 2007 until 2009. The pattern of crime convicted in Shah Alam for three years is cluster pattern because of the observed mean distance/expected mean distance is 0.61, 0.83 and 0.74 for each year's which is less than 1, which mean the pattern is cluster. The standard deviation for 2007 is -6, 2008 is -2.92 and -3.45 for 2009. The p-value for all years is less than 1, meaning that the null hypothesis cannot be rejected for the average nearest neighbour distance.

2.3. Hot Spot Area Analyses

Hot Spot tool analysis is used to know the location crimes happened in year 2007 until 2009. The hotspot is calculated based on Euclidean distance to accurately measure distances. This analysis derived output Z score and output from the Hot Spot Analysis tool is a Z score for each feature. These values represent the statistical significance of the spatial clustering of values, given the conceptualization of spatial relationships and the scale of analysis. The Z score is based on the Randomization Null Hypothesis computation. Figure 7 illustrates the location of hot spot area based on section in Shah Alam for 2007. This is calculated using Z score. The green symbol showed the low Z score value which in Section 4 and 11 while the yellow symbol showed moderate Z score value is higher in Section 10 and 6. The high Z score value for hot spot area is in Section 6.
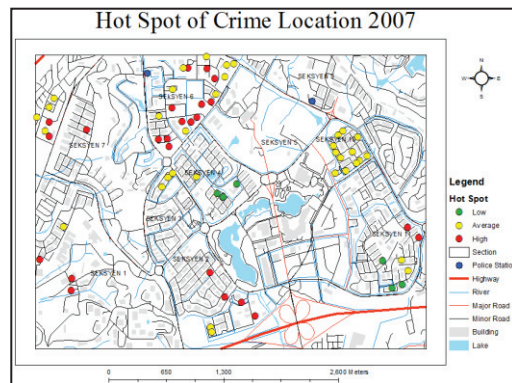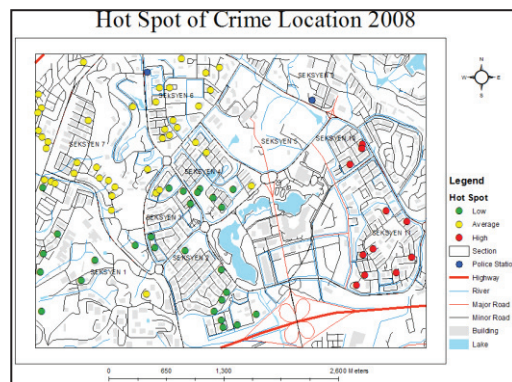

Fig. 7. The Hot Spot Crime Map in 2007

Fig. 8. Hot Spot of Crime Location Year 2008

Figure 8 shows the distribution of the hotspot in Shah Alam in 2008. The high hotspot area is in Section 10 and 11. The random points are shown for the low hot spot area that consist of Section 1, 2 and 3 while Figure 9 show the hotspot area for year 2009, covered by Section 10 and 11.
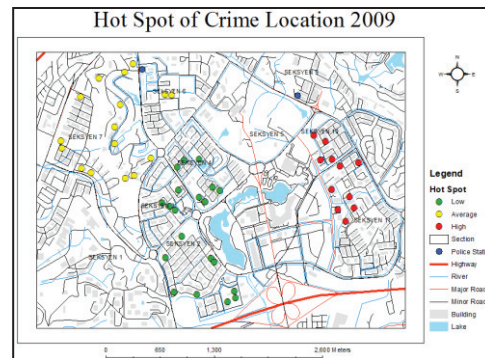
Fig. 9. Hot Spot of Crime Location Year 2009

2.4. Ambient Temperature Analysis

The following section demonstrated the relationship of surface temperature with regards to crime convicted. By using simple linear regression R^2 are calculated and interpreted the simple correlation between two variables, determining whether the correlation is significant or not and recognize the linear and nonlinear relationship between two variables. The temperature data that is coincide with the incidents area is the set acquired from UiTM Shah Alam weather station. Thus, this station start acquiring in 2009, only crime data over Shah Alam area that happened in 2009 were tested. The results show in the Figure 10.
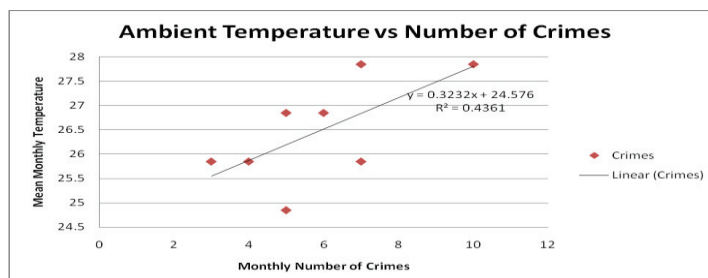

Fig. 10. The relationship between crime and ambient temperature

The linear trends in Figure 10 showed the relationship between ambient temperature vs. crime convicted in Shah Alam for 2009 because of the coefficient of determination, $R^2 = 0.436$. The R^2 value explained that there is correlation between the ambient temperature and the criminal activities. The Pearson correlation confirms this association at 0.660345. While from the temperature in 2009, the krigging has been plotted in interpolation to see the relationship between temperature and crime happened for each day.
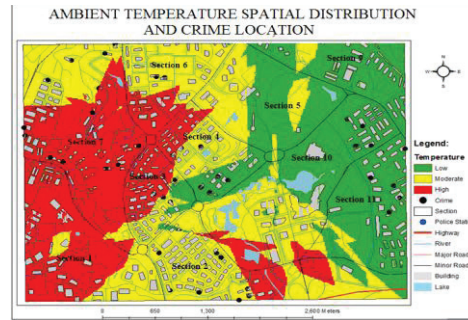
Fig. 11. Ambient temperature vs. Crime activities map

The map illustrated in Figure 11 showed the criminal activities and temperature for the location crime happened. The low temperature is between 24.75°C to 25.5°C, covered the crime location in the section 5, 10 and 11, while for moderate temperature from 25.°C until 26.5°C that cover crime activities from section 2, 4 and 6. The high temperature for 2009 in Shah Alam is ≥ 26.5, which cover section 1, 3 and 7 that happened in January, February and May in 2009.

3. Conclusion and Recommendation

This research has indicates some hot spot area from burglary activity and suggested that there is correlation between individual aggression activity with the surrounding climatology behaviour. It is seen in this study that there is an ample opportunity for further research to be done under the eco-psychology field in order to find the truth of folk wisdom whom suggested that uncomfortably hot environments promote increased interpersonal aggression (as quoted in Anderson and Anderson, 1984).

The surface temperature analysis on the other hand insinuated that reflect towards heat and temperature is relative to the predominant psychological deviation. This is comprehended from the result of regression analyses that demonstrated a strong connection between the numbers of crime convicted with the aggressive activities such as burglary. This observation shown the individual psychological aggression is mostly possible influenced by the heat and discomfortness of its surrounding area. This initial study is set to embark further research opportunity with respect to the ecological factors and influences towards the human psychology. It is recommended to have further field validation and various group and types of crimes to be investigated especially those crimes that are closely related with the criminal minds such as vandalism, rapist, murderer and domestic violence. With an encouragement and trust from the related organizations, this initial finding can be further expanded and verified. Thus, the community will be benefited and take necessary action into consideration. Nevertheless, this awareness possibly will generate a more safety community as well as pleasant environment.

Acknowledgements

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