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Research article

Investigating the Spatial Relation between Landuse and Property Crime in Kuching, Sarawak through Location Quotient Analysis

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Abstract

Urban areas are often associated with higher crime rates, which is a growing concern among communities. This study aims to investigate the spatial relation between landuse and property crime in Kuching, Sarawak through location quotient analysis. Three methods were applied in this study: multiple buffer analysis, Pearson's correlation, and location quotient. Based on initial findings, there is an observed increase in crime levels as the distance from the centroid extends from 150 to 750 meters and decreases beyond 750 meters. The study findings reveal a strong and consistent positive correlation between property crime and land use areas across 2015-2017. Property crime is more prevalent in urban and associated areas compared to other land use categories. Offenders in Kuching often utilise various tools to break into houses and dig holes, break locks, climb gates, engage in snatch theft using motorcycles, and break car windows to steal handbags that are placed on the right seat. In certain locations, CCTV cameras are positioned far away from the target areas. All of these factors contribute to creating opportunities for offenders. Property crimes were more common during the daytime than at night as during the daytime, which may be attributed to more people being active outside their homes, providing criminals with easier targets. At night, people tend to stay home, and the opportunity for property crimes decreases. The study provides crucial geographic crime information to the Commission of Kuching North City Hall and the Council of the City of Kuching South to enhance urban safety.

Keywords: Spatial relation; landuse; property crime; buffer; location quotient analysis.

1. Introduction

Corcoran *et al.* (2021) discovered that when commercial areas are located near each other, the amount of crime experienced can differ significantly. Additionally, the patterns of crime distribution throughout the day and week can also vary. Quick *et al.* (2017) found the impact of landuse on crime patterns in more significant when looking at the physical location of crimes. This study also found that previous studies have discovered that there is a positive relationship between the spatial distribution of property crime and non-residential land uses, such as commercial areas and public transit stations. Clouse (2022) has shown property crime like theft and burglary are more likely to occur in places like shopping areas, transportation centres, and industrial zones. On the other hand, violent crimes such as assault or robbery are more common in commercial areas, places with many residential buildings, and areas designated for civic, institutional, and recreational purposes. According to previous research, property crime tends to be concentrated in commercial areas. However, to determine the specific property crime situation in Kuching, Sarawak, a localised study would be necessary. Before delving into a specific topic, it is important to understand the cities in general.

Cities are experiencing a significant increase in population worldwide. In 2012, more than half of the global population, specifically 52.5 per cent, resided in urban areas. This proportion was expected to rise to 56.9 per cent by 2022. The urban population percentage tends to be higher in developed regions, reaching 79.7 per cent in 2022, compared to the developing world, where it stands at 52.3 per cent (UNCTAD Handbook of Statistics, 2023). The high population contribute to urbanisation growth. Urbanisation refers to the growth of the urban population and the shift from rural to urban areas, typically accompanied by an increase in the urban workforce, such as manufacturing jobs replacing agricultural ones. This process often involves converting non-urban land into urban land to accommodate the expanding settlement areas and meet the growing spatial demands of urbanisation (Nuissl & Siedentop, 2020). Urban area expansion is one of the most critical types of worldwide change, and most urban areas are experiencing increased growth in population and infrastructure development. Urban change leads to many changes in the daily activities of people living within affected areas (Algahtany & Kumar, 2016). The crime rate tends to be influenced by the number of towns and districts will trigger the crime rate dues to location

factors. From a structural standpoint, an increase in population numbers creates more opportunities for social interaction, which increases the occurrence of crime (Amirusholihin *et al.,* 2024). While the exact extent to which crime rates are higher in cities compared to less urbanised areas remains uncertain, there are several social and physical characteristics of cities that may contribute to conditions favourable for criminal activity

Urban environments are often characterised by factors such as high population density, social mobility, diverse socioeconomic classes and ethnicities, and weakened family structures (Errol *et al.,* 2021). When these characteristics are present to a significant degree and combined with factors like poverty, physical decay, limited education, the concentration of industrial and commercial activities, unemployment, low-skilled labour, economic dependency, instability in relationships, and a cultural minority facing social disadvantages, it is generally believed that deviant behaviour is more likely to occur (Sijuwade *et al.,* 2014). Crime is not solely influenced by geographical location but can also be exacerbated by the prevailing socio-economic conditions (Oyenike *et al.,* 2016).

Differences in crime occurrence across various land uses can be attributed to the specific types of daily activities that take place and the opportunities they create for criminal behaviour (Brunsdon *et al.,* 2021). There is a general consensus that various factors, including socio-economic conditions, demographic characteristics, and the physical environment of high-crime areas, impact urban crimes. These crimes tend to be geographically concentrated, meaning they occur in specific spatial locations within urban areas (Wang *et al.,* 2019). Research suggests that crime rates are typically higher in urban areas compared to non-urban areas (Knox and Pinch 2009). As a result, it has become widely believed that urban spaces, including urban open green spaces, are more susceptible to experiencing elevated levels of criminal activity.

Previous studies related to crime and land use found crime mainly concentrated near commercial, recreational, and residential areas, as well as alcohol outlets, clubs, and cultural facilities (Dutkowska and Leitner, 2017). There are several methods that some researchers have used to identify the spatial relationship between crime and land use, such as logistic regression, crime location quotient, buffering, global colocation patterns, local colocation patterns and ordinary least squares (Sadeek *et al.,* 2019; Yue *et al.,* 2017; Brunsdon & Corcoran 2022; Mburu & Mutua., 2023). Oka (2023) uses location quotient to measure residential segregation. Temurcin and Dziwornu (2016) employed the Location Quotient of Crime (LQC) as a tool to pinpoint and illustrate clusters of robbery, assault, and threat incidents, as well as identify neighbourhoods that are at a higher risk of these crimes. Hashim *et al.* (2018) used LQC to identify hotspot schools in Mukim Petaling and Klang. Zhou and Wang (2024) used LQC to identify spatial relation characteristics and patterns of commercial and residences in the city of Beijing. This research focuses specifically on the spatial relationship between property crime and landuse in Kuching, Sarawak, through location quotient analysis. While previous studies have used location quotient analysis to examine crime patterns or identify high-risk areas, this research aims to explore how landuse types influence property crime rates in Kuching, Sarawak. Additionally, this study also focuses on property crime on the specific police station boundaries in Kuching, Sarawak, which may have unique characteristics compared to the locations examined in the previous studies, such as Mukim Petaling, Klang and Beijing.

From 2015-2017, Kuching, Sarawak had one of the highest property crimes among the districts in the state, accounting for 81.3% of the total cases. Additionally, violent crime made up 18.6% of the overall crime rate during the period (Police Kuching District Headquarters, 2018). This study aims to identify the spatial relation between land use and property crime through Location Quotient Analysis. This study uses Location Quotient analysis to explore this relationship, which could provide new insights into the factors influencing property crime rates in landuse boundaries. While past research has conducted, a study on property crime in Kuching is using Getis Ord Gi*, Kernel density estimation, Local Indicator Spatial Autocorrelation, and Global Moran's I (Norita Jubit *et al.,* 2019; Norita Jubit *et al.,* 2020a; Norita Jubit *et al.* 2020b; Norita Jubit *et al.,* 2021). However, there is still a gap in research when it comes to applying location quotient analysis to study crime related to landuse in Kuching, Sarawak. Thus, this study is the first to specifically investigate the impact of land use on property crime in Kuching, Sarawak, using Location Quotient analysis. Based on the current literature, there is a gap in research regarding the spatial relationship between land use and property crime in Kuching, Sarawak, specifically through location quotient analysis. No existing studies have been identified that directly investigate this specific topic in the context of Kuching, Sarawak.

The importance of this research is understanding the spatial relationship between landuse and property crime, which can provide valuable insights for crime prevention strategies, urban

planning decisions, and landuse policies. It can encourage residents, business owners, and community organisations to take proactive steps to enhance safety and security in their neighbourhoods through the visual analysis result. This study also contributes to knowledge of the interpretation of location quotient analysis in understanding the spatial relationship of landuse and property crime in Kuching, Sarawak.

Amirusholihin *et al.* (2024) show that land use can influence crime rates. However, it is important to note that the study conducted in Malaysia, specifically focusing on motorcycle theft in Putrajaya from 2012 to 2014, did not utilise police station boundaries as the unit of analysis. The result of the geographical information system (GIS) and statistical analysis revealed a strong link between land use, spatial distance, and theft. Incidents were concentrated near commercial, recreational, and residential areas. The study suggests implementing spatial prevention measures in these areas to reduce theft. Sadeek *et al* (2019) numerous studies have linked land use to crime rates, often examining spatial autocorrelation and using socio-economic data (Kalantari *et al.,* 2016; Tavares & Costa, 2021; Ahmad *et al.,* 2024).

However, most focus on crime locations, neglecting areas where crime has not occurred. Transportation accessibility's role in linking crime and land use is also considered, but more research is needed. This study offers a new approach, using a GIS map to geocode the crime-land use connection. It uses different mesh sizes to mark crime occurrence or non-occurrence. Logistic regression is used to determine the optimal mesh size for explaining the crime-land use relationship, and a support vector machine identifies land use combinations prone to crime or relatively safe. This can help reduce urban crime, allocate law enforcement resources, and design environments that naturally deter crime.

Dutkowska and Leitner (2017) explore the relationship between land use and crime in an urban area. Using multiple buffering with crime location quotient and crime data from Szczecin, Poland, the researchers identified specific land use types that influenced the spatial distribution of nine crime types. Commercial crimes and theft of property were most concentrated within a 50-meter radius of alcohol outlets, clubs, cultural facilities, and commercial buildings. Conversely, land use types such as grandstands, cemeteries, green areas, and depots deterred crime. Yue *et al.* (2017) focused on investigating the associations between three types of crime and 22 types of landuse in Wuhan, China. The research methodology involved two main steps. Firstly, the study examined global colocation patterns to understand the overall spatial relationships between crime and land-use features. Secondly, the recently developed local colocation quotient was employed to analyse local colocation patterns, allowing for a more detailed assessment of the results. The findings indicated that different types of crimes exhibited varying levels of association with different land-use features, with some land-use types encouraging certain crimes while discouraging others. Moreover, the analysis of local colocation patterns revealed spatial inhomogeneity, highlighting the importance of considering local variations in crime-land use relationships.

Brunsdon and Corcoran (2022) investigated the relationship between crime and landuse in Wuhan, China. It utilised both global and local colocation patterns to understand the spatial associations. The findings showed that different types of crimes were linked to specific land-use features, with some encouraging or discouraging certain crimes. The analysis also revealed spatial variations, emphasising the importance of considering local patterns in crime-land use relationships.

Mburu and Mutua (2023) investigate the relationship between land use, alcohol outlet density, and crime in the Juja sub-county, Kenya. Crime data spanning multiple years (2017-2021) were obtained from the Juja Police Station. Land use categories, including commercial, agricultural, forest, grassland, industrial, residential, and waterbody, were identified through land use land cover classification. Zonal operations were conducted to summarise land use characteristics in each zone (n=233). Alcohol outlet density was also calculated at the zonal level.

Additionally, population was considered as a factor influencing crime. Using an ordinary least squares (OLS) model, the study identified the four most significant factors associated with crime: residential areas, agricultural areas, population, and off-premise alcohol outlet density. The analysis revealed a statistically significant negative relationship between off-premise alcohol outlet density and crime, while residential areas showed the highest statistically significant positive relationship with crime. Although on-premise alcohol outlet density had the highest positive coefficient, this relationship was not statistically significant. This suggests that while on-premise alcohol outlets may explain crime in areas with high concentrations of such establishments, they may not explain crime in other areas of the sub-county with equally high crime rates. The study used the random forest algorithm to predict crime based on these factors.

2. Research Methods

According to the Department of Statistics Malaysia (2020), Kuching is the most populated city in Sarawak and serves as the urban centre and capital of the state. The city has a population of 702.7 thousand, which represents 24% of the total population in Sarawak. Miri follows with a population of 352.3 thousand (12%), and Sibu has a population of 284.5 thousand (10%). Kuching also recorded the highest property crime rate compared to other cities in Sarawak (Police Kuching District Headquarters, 2018).

2.1. Data

This study used property crime data from 2015-2017, which was taken directly from the Police Reporting System at the Kuching district police station. Attribute data consists of the date of incidents, month, types of property crime, time of crime occurrences, police station, and address of incidents. This study also uses Google API to geocode coordinates (x, y) based on the address of incidents. All of these property crime data was sorted in Excel and saved as Excel 97-2003 workbook. In contrast, spatial data comprises of landuse which includes aquaculture, beach sand/river sand, cleared land, coconut, dense forest, grassland/lallang, hill forest, mangrove, market gardening, mixed horticulture, nipah, oil palm, pepper, plantation forest, ponds and lake, River/canal/waterway/drain, rubber, sparse forest, swamp forest, urban and associated areas, wet paddy as shown in Figure 1. Landuse data was obtained from the Landsurvey Department of Kuching, Sarawak.

2.2. Method

2.2.1. Multiple Ring Buffer Analysis

This study selects attributes of urban and associated areas and then creates a feature to point to get the centroid point of landuse. Nine buffers at the following distances: 150m, 300m, 450m, 600m, 750m, 900m, 1050m, 1200m and 1350m from the centroid point of landuse types. The purposes of using buffer analysis is to measure the distance radius of centroid points of urban and associated areas with property crime in the police station boundaries of Kuching, Sarawak. Buffer analysis is a commonly used tool for analysing the spatial relationship and proximity between different geographic objects. Here is the mathematical expression of buffer qqqqqqqqqqq 1.

$$B_1 = (x: d(x_1, O_1) \leq R \quad (1)$$

Where Oi is the object, R is the neighbourhood radius, d is the minimum Euclidean distance, and Bi is a set of all points whose distance from Oi is less than or equal to R (Cui *et al.,* 2023). However, Fondevila *et al.* (2021) used buffer analysis (1 km interval around each police station) to determine whether there is a consistent decrease in crime as victims move further away from police stations or if there is a specific buffer zone around police stations where crime is affected. Xu *et al.* (2022) conducted a study in South Anhui, China, to analyse the distribution characteristics of tourism attractions in an international cultural tourism demonstration region. Buffer zone as a tool to examine the spatial relationship between these attractions.

2.2.2. Pearson Correlation

In this study, Pearsons's correlation (Equation 2) analysis conducted using SPSS (Statistical Package for Social Sciences) is a statistical method used to determine if there is a relationship between variables to measure the strength and direction of the association (Bawaria and Pasupuleti, 2023). In this study, Pearsons's correlation analysis is applied to identify spatial relations between property crime distance and the radius of centroid point of land use in Kuching, Sarawak.

$$r = \sum((X - \bar{X})(Y - \bar{Y}))/sqrt\left(\sum(X - \bar{X})^2 \times \sum(Y - \bar{Y})^2\right) \quad (2)$$

Where n is the sample size, xi & yi are the ith sample points and $\bar{x}$ & $\bar{y}$ are the sample means for the random variables X and Y, respectively.

2.2.3. Location Quotient Crime

This study employed a location quotient crime to study the spatial relationship between property crime and land use in Kuching, Sarawak.

The equation for LQC is represented by Equation 3

$$LQC_{in} = \frac{{C_{I_n}}/{C_{t_n}}}{{\sum_{n=1}^{N} C_{i_n}}/{\sum_{n=1}^{N} C_{i_n}}} \quad (3)$$

n = represents the number of neighbourhoods under study

N = is the total number of neighbourhoods in the city

Ci = is the count of crime i in each neighbourhood

Ct = is the total count of all crimes in each neighbourhood

The location quotient allows for simple comparisons between sub-areas within an area. A value of 1.0 means that the level of crime within the sub-area is the same as the overall study area. If there are no crime types, it has an LQ above 1.0, suggesting crime is less concentrated in this environment compared to the rest of the city. While a value below 1.0 suggests that the sub-area has lower crime levels, and a level above 1.0 suggests that the sub-area has higher crime levels (Hodgen & Wuschke, 2023).

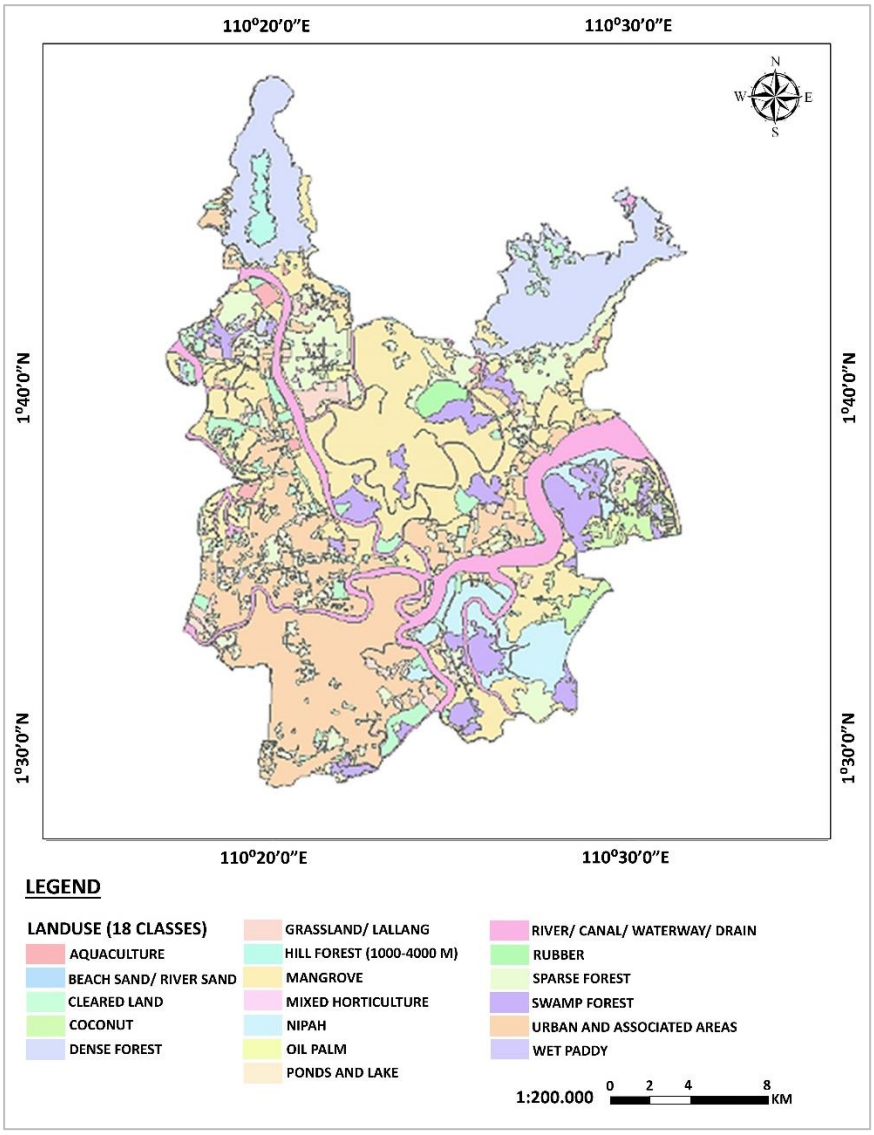

Figure 1. Landuse Areas of Kuching, Sarawak.

3. Results and Discussion

3.1. Result

Figure 2 shows the distance radius of the centroid point of urban and associated areas with property crime in the police station boundaries of Kuching, Sarawak, from 2015 to 2017. Based on the data provided for the distance from the centroid of urban land use points and the corresponding

crime values, there appears to be a relationship between the distance (in meters) and the crime levels. As the distance from the centroid increases, the crime levels initially increase but then decrease towards the end. From the data, we can observe that as the distance from the centroid increases from 150 to 750 meters, the crime levels steadily increase. However, beyond 750 meters, the crime levels start to decrease again.

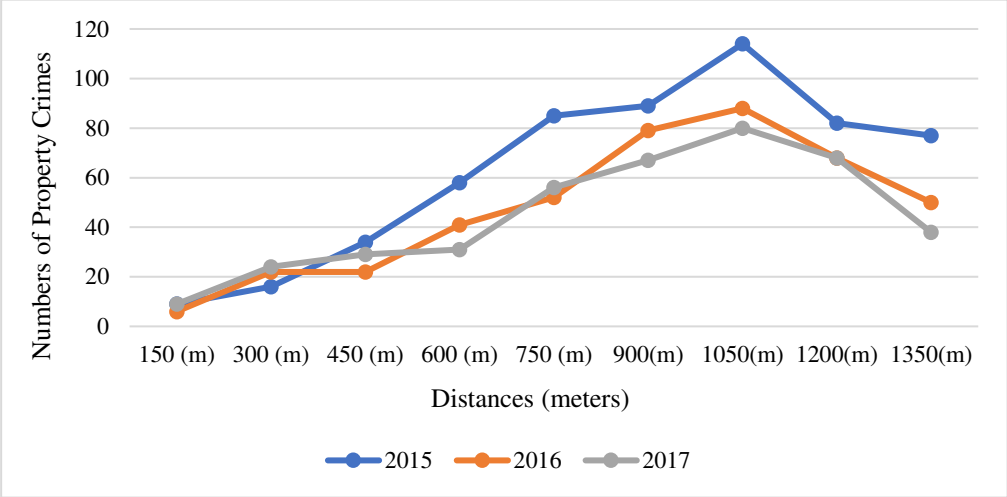

Figure 2. Distribution of property crimes within the distance radius from the centroid point of urban and associated areas in 2015-2017.

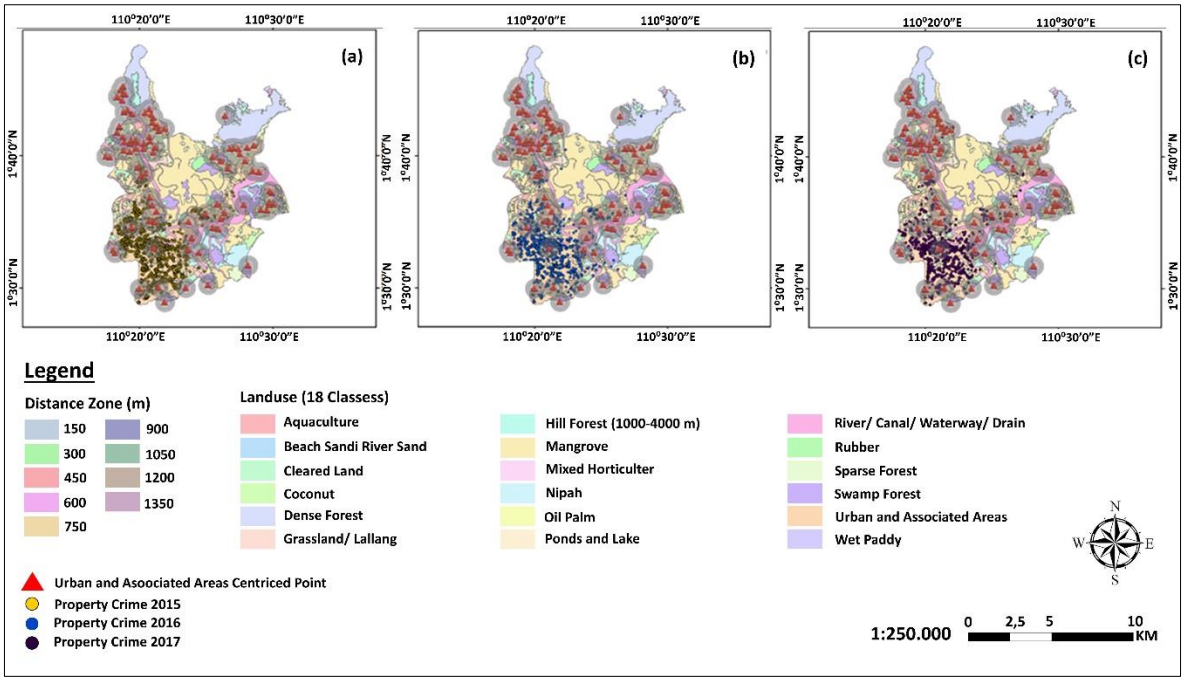

Figure 3. Spatial distribution of property crimes within the distance radius from the centroid point of urban and associated areas in (a) 2015, (b) 2016, and (c) 2017 by using multiple ring buffer analysis.

This relationship between the distance from the centroid of urban and associated areas points and the corresponding crime levels suggests that there may be a spatial pattern or distribution of crime in relation to urban land use. The increasing crime levels at closer distances could indicate higher crime activity near the centroid, potentially due to factors such as higher population density or more commercial areas. As the distance increases, the crime levels may decrease, possibly reflecting a decrease in crime activity as one moves away from the central urban areas. Zhou *et al.* (2024) in Changchun, offenders in the central urban districts tend to engage in short-distance local robberies, while those in the suburban counties tend to commit long-distance non-local crimes. As the population density increases, there is a direct correlation with a higher proportion of local robberies taking place. Torres-Tellez (2024) conducted research, and the results showed that specific structural and environmental aspects of housing have a positive association with crime rates. Notably, the absence of adequate lighting and overcrowding emerge as significant factors displaying a positive and statistically significant connection with crime.

Tobler's First Law of Geography, proposed by Waldo R. Tobler, states that "everything is related to everything else, but near things are more related than distant things." This principle highlights that geographical phenomena are often interrelated, and this relationship is typically stronger for items that are closer together in space.

Relating Tobler's Law to this result, the crime levels seem to follow a spatial pattern in relation to the distance from the centroid of urban land use points. As the distance from the centroid increases, the crime levels initially increase, reaching a peak around 1050 meters, and then start to decrease again. This phenomenon could be interpreted as a manifestation of Tobler's Law, as the crime levels appear to be more closely related (either higher or lower) to the areas that are geographically closer to the centroid of urban land use. In other words, the areas closer to the centroid (urban centre) show a stronger correlation with crime levels, which decrease as they move further away. This condition could be due to various factors like population density, economic activity, or other socioeconomic factors that are often more concentrated near urban centres.

Table 1. Landuse and Property Crime Correlation 2015.

		Property crime 2015	HA
Property_crime2015	Pearson Correlation	1	.937**
	Sig. (2-tailed)		<.001
	N	85	85
HA	Pearson Correlation	.937**	1
	Sig. (2-tailed)	<.001	
	N	85	85

**. Correlation is significant at the 0.01 level (2-tailed)

The Pearson correlation coefficient is used to measure the strength and direction of the linear relationship between two variables. In this case, the correlation coefficient between property crime in 2015 and landuse is 0.937. The correlation coefficient ranges from -1 to 1, where -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. The correlation coefficient of 0.937 suggests a strong positive correlation between property crime in 2015 and landuse areas. This correlation coefficient means that as the value of one variable increases, the value of the other variable also tends to increase. The correlation is statistically significant at the 0.01 level, which means that the likelihood of observing such a strong correlation by chance is very low.

Table 2. Landuse and Property Crime Correlation 2016.

		Property crime 2016	HA
Property_Crime2016	Pearson Correlation	1	.887**
	Sig. (2-tailed)		<.001
	N	60	60
HA	Pearson Correlation	.887**	1
	Sig. (2-tailed)	<.001	
	N	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Landuse and Property Crime Correlation 2017.

		Property_Crime2017	HA
Property_Crime2017	Pearson Correlation	1	.920**
	Sig. (2-tailed)		<.001
	N	28	28
HA	Pearson Correlation	.920**	1
	Sig. (2-tailed)	<.001	
	N	28	28

**. Correlation is significant at the 0.01 level (2-tailed).

In the dataset for property crime in 2016 and landuse areas, the correlation analysis reveals a significant and strong positive correlation between the two variables. The Pearson correlation coefficient of 0.887 indicates a robust linear relationship between Property crime in 2016 and landuse areas. This means that as the value of one variable increases, there is a tendency for the value of the other variable to increase as well. The correlation coefficient of .887 is statistically significant at the 0.01 level, indicating that the likelihood of observing such a strong correlation by chance is very low. This suggests that there is a meaningful association between property crime in 2016 and landuse areas.

The correlation analysis conducted on the dataset for Property crime in 2017 and landuse areas reveals a significant and strong positive correlation between these two variables. The Pearson correlation coefficient of 0.920 indicates a robust linear relationship between property crime in 2017 and landuse areas. The correlation coefficient of 0.920 is statistically significant at the 0.01 level, indicating that the likelihood of observing such a strong correlation by chance is very low. This suggests that there is a meaningful association between property crime in 2017 and landuse areas.

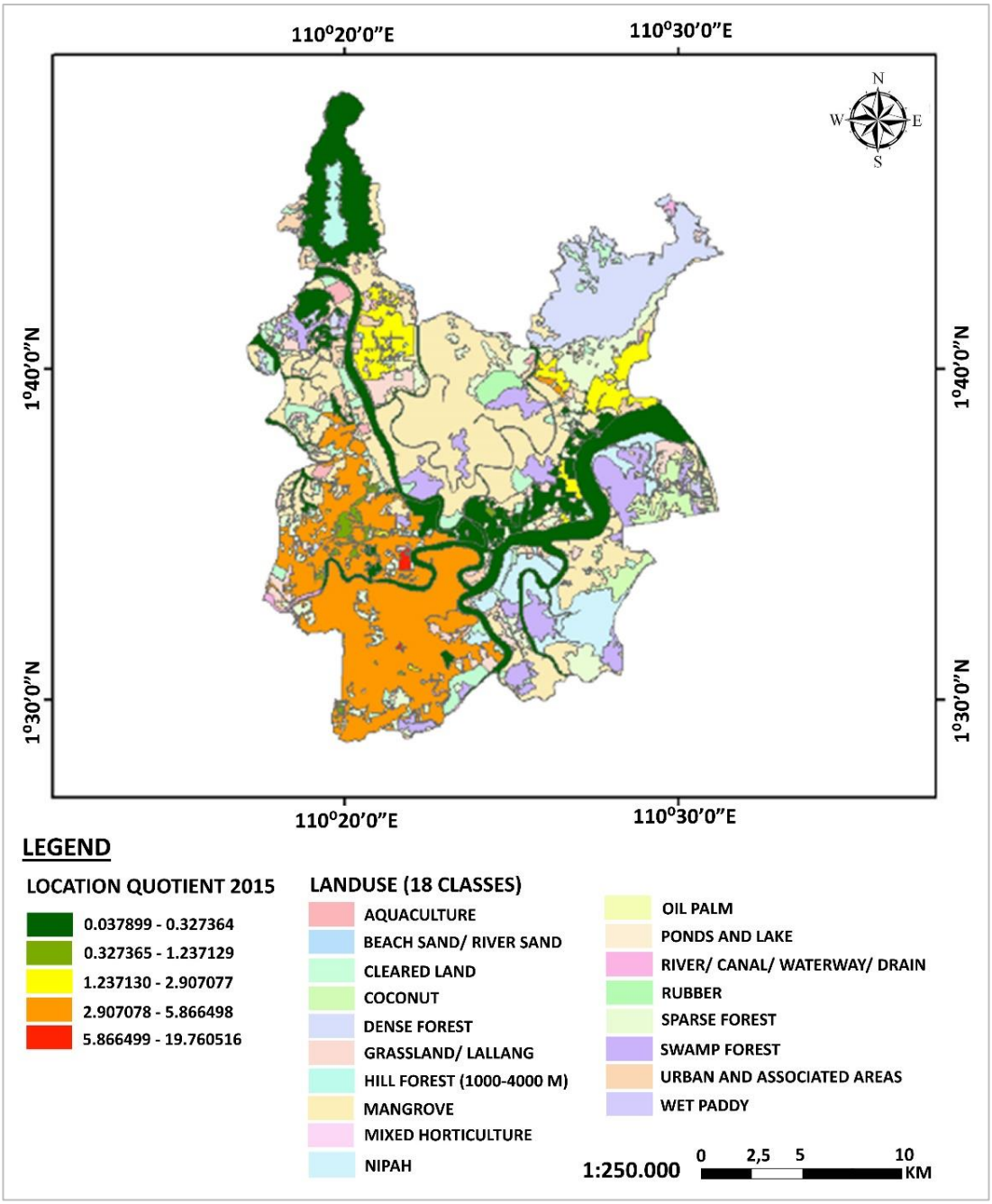

Figure 4. Location Quotient Analysis of Spatial Relationship of Landuse and Property Crime in 2015.

Figure 4 shows the results of the spatial relationship of landuse and property crime in Kuching Sarawak for 2015 using location quotient analysis. From this visual, most property crime was concentrated in urban and associated areas with a range between 2.90-5.86, which is greater than 1. Therefore, it can be concluded that the sub-areas with orange colours show higher property crime rates than the overall study area. This study also found that property crime was detected higher at the Gita police station boundary (sector 7) with a red colour. This result suggests that the property crime hot spots are concentrated in Gita (sector 7), whereas the green colour is less than 1, which suggests that the areas of property crime are cold spots. The lower crime rate was mostly detected far away from urban areas in Kuching, which was located in the Santubong area.

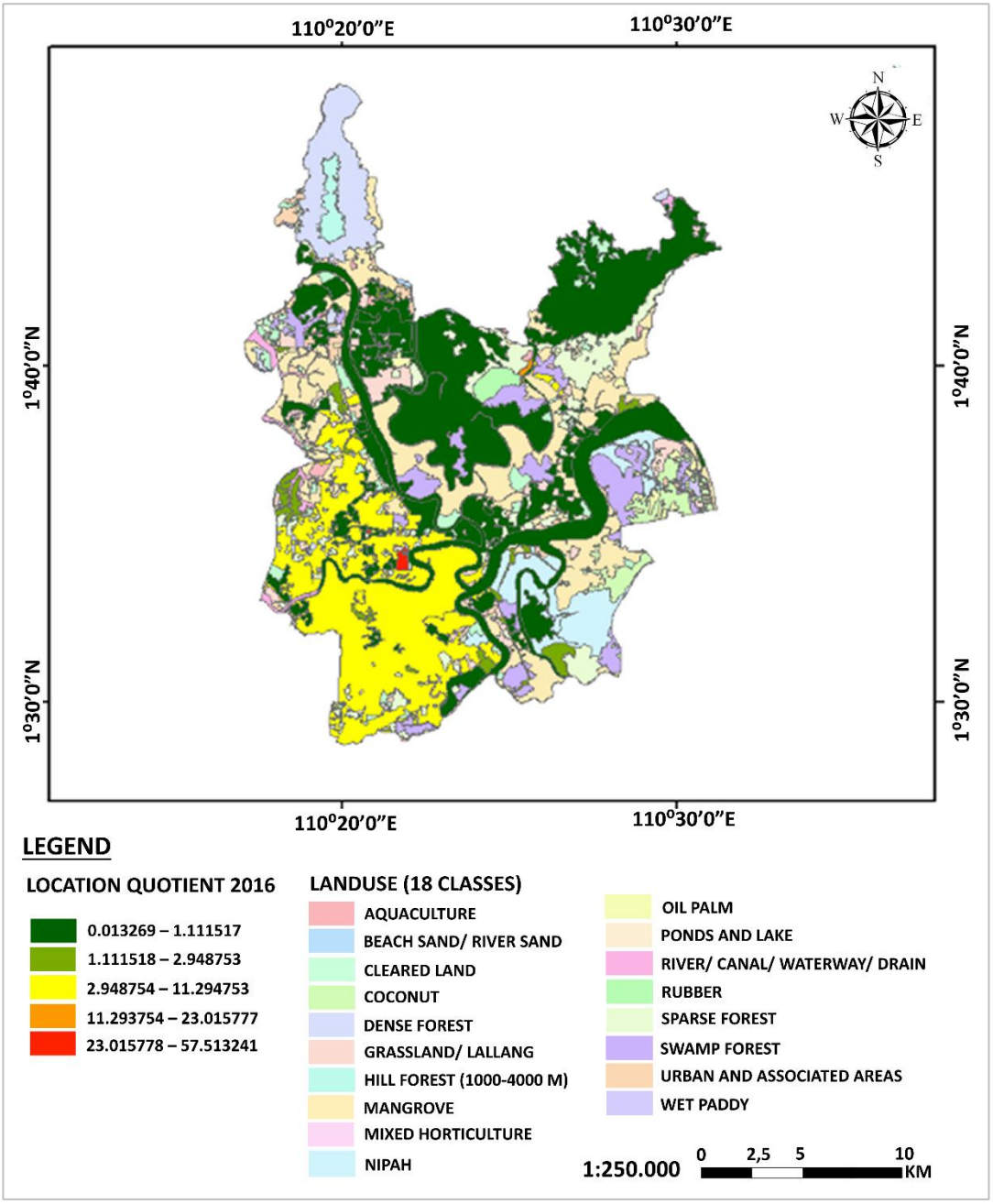

Figure 5. Location Quotient Analysis of Spatial Relationship of Landuse and Property Crime in 2016.

The location quotient values for property in aquaculture range from 0.308 to 0.698, indicating variations in the concentration of property in these areas compared to the overall average within the land use categories, while cleared land ranges from 0.029 to 57.513, suggesting significant variations in the concentration. Higher values indicate a higher concentration of property in these areas compared to the overall average within the land use categories. The location quotient value for property in coconut areas is 0.494, suggesting a relatively lower concentration. The location quotient values for property in grassland/lallang range from 0.112 to 11.293, indicating variations in the concentration. Higher values suggest a higher concentration of property in grassland/lallang areas compared to the overall average within the land use categories. The finding also found that mangrove areas range from 0.075 to 7.300, suggesting a higher concentration of property in mangrove areas compared to the overall average within the land use categories. However, the Nipah area is 0.096, suggesting a relatively lower concentration compared to the overall average within the land use categories. The location quotient values for property in urban and associated areas range from 0.013 to 46.571, indicating significant variations in the concentration. Higher values suggest a higher concentration of property in these areas compared to the overall average within the land use categories. The location quotient values for property in sparse forest areas range from 0.133 to 4.965, indicating variations in the concentration. Higher values suggest a higher concentration of property in sparse forest areas compared to the overall average within the land use

categories. The location quotient value for property in swamp forest areas is 0.057, suggesting a relatively lower concentration compared to the overall average within the land use categories. The location quotient value for the property in river, canal, waterway, or drain areas is 0.059. The location quotient value for property in dense forest areas is 0.271, indicating a relatively lower concentration.

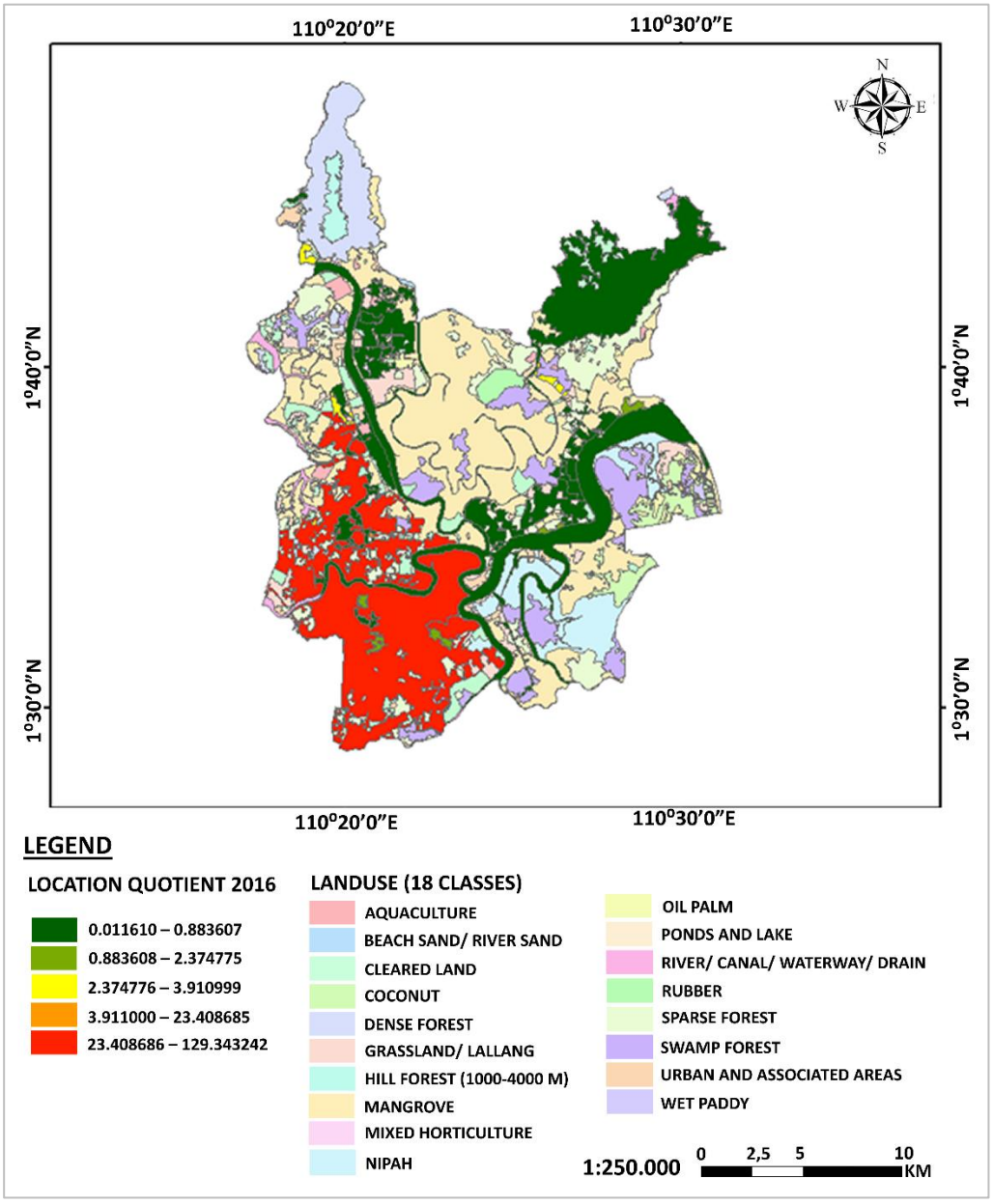

Figure 6. Location Quotient Analysis of Spatial Relationship of landuse and Property Crime in 2017.

The location quotient value of 0.140 for property crime in cleared land suggests that the concentration of property crime (2017) in these areas is relatively lower compared to the overall average across all land use categories. On the other hand, the location quotient value of 2.375 for property crime in grassland/lallang indicates a relatively higher concentration of property crime. For mangrove areas, the location quotient value of 0.664 suggests a relatively lower concentration of property crime compared to the overall average within the land use categories. The land use category of urban and associated areas shows significant variation in location quotient values for property crime, ranging from 0.012 to 129.343. Higher values indicate a higher concentration of property crime in these areas. The location quotient values for property crime in sparse forest areas range from 0.067 to 3.499, indicating variations in concentration. Higher values suggest a higher concentration of property crime in sparse forest areas. In river, canal, waterway, or drain areas, the location quotient value for property crime is 0.024, indicating a relatively lower concentration compared to the overall average within the land use categories. For dense forest areas, the location quotient value of 0.181 suggests a relatively lower concentration of property crime. From this

result, hot spot areas were detected in Padungan, Bintawa, Gita, Sekama, Sungai Maong, Satok, Sentral and Tabuan Jaya police station sector boundaries. The hot spot areas were detected to be covered in large areas in 2017 compared to 2015 and 2016.

3.2. Discussion

The study reveals a notable correlation between crime levels and proximity to urban land use centroids. Initial findings indicate an increase in crime levels as the distance from the centroid extends from 150 to 750 meters. However, crime levels appear to decrease beyond the 750-meter mark. This pattern suggests a spatial distribution of crime in relation to urban land use, with higher crime activity near the urban centre, potentially due to factors such as population density or commercial areas. The decrease in crime levels with increased distance could indicate a reduction in crime activity as one moves away from central urban areas in Kuching, Sarawak. This finding was supported by Kim and Hipp (2021), who found that areas with a higher concentration of businesses tend to experience more criminal activities. Gerell (2021) frequently states that city centre locations with high volumes of people tend to be areas that are prone to increased criminal activity. Saraiva and Teixeira (2023) found that nearly half of the street crimes in the city (46%) occurred within a 5-minute walk from greenspaces. However, these crimes were concentrated in smaller urban gardens located in the inner city, which had a higher density of street crimes, often referred to as hotspots. Fondevila *et al.* (2021) discovered that crimes are not randomly spread out across an area. Instead, crime tends to be concentrated in specific locations. As the distance from the nearest police station increases, the number of crimes increases rapidly. However, once the distance reaches around 500-600 meters, the number of crimes starts to decrease again. Having police stations nearby seems to prevent criminals from committing crimes. Stenger (2022) found that property crime and violent crimes were more heavily concentrated within buffer zones of 1600 feet around drinking establishments compared to the overall crime density in the Wilmington Metropolitan area. Crimes like theft and violence were more common in areas close to places where people go to drink compared to other parts of the city. The differentiation of this study on investigating the spatial relationship between land use and property crime in Kuching, Sarawak, compared to previous research, lies in the utilisation of centroid points of land use for conducting buffer analysis to measure the count of crime. These findings, reminiscent of Tobler's First Law of Geography, highlight the interrelation of geographical phenomena, with closer items showing stronger correlations. In this instance, areas closer to the urban centre exhibit a stronger correlation with crime levels. Higher location quotient values in urban and associated areas suggest a higher concentration of property crime compared to the overall average. This condition indicates that property crime is more prevalent in certain urban and associated areas compared to other land use categories.

The significant variation in location quotient values for property crime in urban and associated areas could be attributed to various factors such as population density, socioeconomic conditions, availability of targets (properties), and law enforcement efforts. These factors can vary greatly within urban areas, leading to variations in the concentration of property crime. Based on routine activity theory, the likelihood of a crime occurring increases when a potential offender, a vulnerable target, and the lack of a capable guardian coincide in both time and location (Cohen & Felson, 1979). According to this viewpoint, crime tends to concentrate in areas where these three elements consistently converge. Property crime is frequently concentrated in urban areas in Kuching due to the chance that attracts offenders to commit a crime. Kuching is one of the most densely populated areas in Sarawak compared to other districts. Thus, the potential target in urban areas is higher. According to the Kuching police report (2015-2017), offenders often utilise various tools to break into houses and dig holes, break locks, climb gates, engage in snatch theft using motorcycles, and break car windows to steal handbags that are placed on the right seat. In certain locations, CCTV cameras are positioned far away from the target areas. All of these factors contribute to creating opportunities for offenders to carry out their actions. Yogzaw *et al.* (2023) revealed that physical characteristics such as commercial centres and poorly illuminated roads were positively associated at a statistically significant level, with the occurrence of property crime. According to a report by the Kuching police station, property crimes were found to occur more frequently during the daytime rather than at night between 2015 and 2017. During the daytime, more people are out and about for work or other activities, which might make it easier for criminals to target properties. On the other hand, at nighttime, people tend to stay at home, reducing the opportunity for property crimes.

In the methodology context, the location quotient is one of the methods to identify the clustering of property crime. The study employs location quotient analysis to identify the concentration of property crime in urban and associated areas compared to other land use categories. This analysis

provides insights into the specific areas where property crime is more prevalent, which can guide targeted interventions and resource allocation. These findings contribute to the existing literature on crime patterns, urban planning, and crime prevention strategies. They provide localised evi

dence and insights specific to Kuching, Sarawak, which can inform policy-making, urban development plans, and crime prevention initiatives in the region.

Location quotients also compare an area's landuse composition to that of a larger area (the whole landuse). One limitation is that the zoning pattern of the entire area influences the location and shape of hot spots identified by the Location quotient. This means that it may be less likely to identify hot spots that are located on the boundaries between different subareas. The way the area is divided into zones can affect the results of the analysis, which is known as the zoning fallacy. The location quotient method for identifying hot spots is affected by how the area is divided into zones (Lu, 2017). Therefore, from the result of the study, it is clear that urban areas in Kuching, Sarawak have become attractors and generators of property crime.

This finding suggests that moving away from central urban areas may lead to a reduction in crime activity. Overall, the methodology employed in the study contributes to the literature by providing a localised analysis of the correlation between property crime and urban land use in Kuching, Sarawak. It offers insights into spatial patterns, temporal trends, and factors influencing property crime levels, which can inform urban planning, crime prevention strategies, and future research in the field.

This study is limited to property crime data according to the Kuching police report from 2015-2017, as taking all these data from the PRS system takes a long time. This study solely utilises the property crime data reported by the Kuching police station. This paper also suggests studying the crime offender home location with the crime location. In the future, this paper recommends comparing the differences between various analysis methods such as the Location Quotient, Getis Ord Gi*, Kernel Density Estimation, and Local Indicator of Spatial Autocorrelation (LISA). Additionally, it suggests studying the correlation between the home location of crime offenders and the location of the crime itself. Future research can enhance the understanding of the predicted scenarios by incorporating additional factors such as the economic state of the neighbourhood, job opportunities in the surrounding area, and other socio-economic variables. This holistic approach will provide decision-makers with a comprehensive understanding of the landuse and property crime dynamics in Kuching, Sarawak, enabling them to make more informed and effective decisions for the region's development. Researchers can also utilise the Cellular Automata-Markov (CA-Markov) model to accurately predict landuse changes in Kuching, Sarawak, providing decision-makers with valuable insights into the future development of the area. By employing the DynaCLUE model, researchers can effectively forecast the future scenarios of landuse and property crime in Kuching, Sarawak. This model not only offers valuable insights but also serves as a valuable tool for decision-makers in shaping the development and security strategies of the districts.

4. Conclusion

The study provides important geographic crime information to the Commission of Kuching North City Hall (DBKU) and the Council of the city of Kuching South (MPKS) to increase urban safety, as both of these local authorities cannot access the property crime data directly from PRS system of Kuching Police Station. The identification of different modus operandi used by offenders to commit crimes can assist Sarawak's government and police in enhancing safety measures in residential and commercial areas in Kuching, thereby preventing crime. This finding also contributes to public awareness of property crime concentration locations and increases police patrol in those areas affected by property crime. The result of this study can also help urban planners plan urban areas of Kuching for future development. Besides that, this finding also contributes to the police in Kuching as they do not have expertise in using Geographical Information Systems. In addition, police station chiefs determine hot spots and cold spots of crime according to the total number of crimes as property crime in the police reporting system does not have coordinate (x, y) information but only has crime address location information. Thus, GIS can help detect the coordinates to distribute property crime on a map.

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Author Contributions

Conceptualisation: Ahmad A., Masron, T., & Soda, R.; **methodology**: Jubit, N.; **investigation**: Jubit N., & Ahmad, A.; **writing—original draft preparation**: Jubit N.; **writing—review and editing**: Jubit, N.; **visualisation**: Jubit, N. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

Data availability

Data is available upon Request.

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