

A GIS Based Method for Assessing the Association Between Urban Development and Crime Pattern in Sungai Petani, Kedah Malaysia

Nur Suhaili Mansor, Helmi Zulhaidi Mohd Shafri, Shattri Mansor



Abstract: Physical development plays a vital role in the urban area that consists of the needs of the physical structure and social process that challenges towards the improvement of the local's well-being. The research evaluates the relationship between urban development and crime pattern using spatial analysis. The research uses satellite imagery data and remote sensing technique to detected urban changes from 2000 until 2013 in Kedah, Malaysia. The result of the research is generated a spatial analysis that identified the hotspots and directional of criminal activities in the study area. The result indicated that they are a positive relationship between urban development and criminal activities, particularly violent crime, property crime and drug abuse case. The result from in-depth interview with the locals indicated that majority of locals in the study area felt unsafe with criminal activities occurring within their neighborhood and negatively impacting their well-being. Industrial and commercial area identified as the hotspot of the criminal activities in the study area. The research can help government and police department to curb the increasing number of criminal activities within the urban setting and achieved their aim to reduce criminal activities index annually.

Index Terms: Crime, Spatial, GIS, Remote Sensing

I. INTRODUCTION

Urban development is a challenge towards well-being due to the changes in urban development. Well-being element is too broad, and many variables are involved in measuring well-being. It may be narrowed down in certain issues to understand specific problems. Public safety or crime is one of the elements that can be studied as a measure of well-being. This article intends to focus on public safety in the light on the incidents of crime in Sungai Petani urbanizing area, Malaysia. Apart from that, it is also to provide foundational knowledge on the subject of socio-spatial processes in the context of a fast developing country like [1]. As Malaysia offers needs to the Millennial Development Goals (MDGs) which

incorporate manageable advancement being developed approach.

The post-1970 century saw a high rate of improvement that transforms the growing and mechanical subsistence, populated by the poor into a centre class and a rustic life to a cosmopolitan attached to private enterprise, globalization and the digital world. East Asia's Changing Urban Landscape a Decade of Spatial Growth from World Bank report in 2015. After Japan, Republic of Korea, and Singapore, Malaysia is among the urbanized countries. With population growth of 15 million (53 percent of population aggregate) from 10.2 million. The rapid urban development is challenge in social changes and social transformation [2]. Therefore, urban development has attracted increasing attention on criminal activities. Crime has long been thought to be intimately associated with the physical environment [3]. The past decade has seen the rapid development of urban area related to criminal activities. Review by [4] related to urbanization and crime that many researchers discussed the impact of urbanization is related to drug abuse and crime. Drug abuse as factors found to be influencing crime have been explored in several studies by [5;6]. Hence, the changes in urban area affected changes in routine activities for neighborhood area. Unfortunately, routine activities closely related to crime opportunities [7]. Within this context, Sungai Petani experiencing a rapid rate of urbanization, which has begun to function as the administrative centre for the districts of Kuala Muda in early century to 2000 [8]. In line with the development of road transport systems and railways and industrial area, causing Bandar Sungai Petani continues to grow rapidly. Thus, this study will examine the impact analysing spatial crime pattern and its impacts on urban development. The aim for this paper is to determine movement pattern of criminal activities in Sungai Petani, Kedah.

II. URBAN DEVELOPMENT

A large and growing body of literature has to explain the relationship between criminal activities and urban setting, physical and environmental variables such as land use and spatial data. [9] found that the relationship between physical structure change and crime incident is not well understood. The physical structure in this study helps to decrease crime such as developing safer public housing, erecting obstacles and altering road patterns,

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controlling access to buildings, schools, parks, government housing or other trouble spots using controlled entry and establishing safer public areas. For example, increasing the lights in neighborhoods and streets. Moreover, [10] concluded that Impact of land use type on crime by distinguishing between commercial and residential land use because their result showed that the location of crime gives a potential opportunity for incidents to happen. Furthermore, [11] studied about the link between commercial and population density with robbery rate. The data that have been used in this study has been taken from 164 respondents of households and the study area at Columbus, Ohio. Addition to that, deep interview has been done to ask about the fear of crime and crime prevention for each individual who happened being victim or being experiencing to see the robbery happened. Location have been chosen from reported have been made to the near police station. Thus, this research investigated hypothesized relationship between Crime Prevention through Environmental Design (CPTED) using Structural Equation Modeling (SEM) to analysis the result. The findings showed the powerful connection between CPTED and victimization, with greater concentrations of CPTED correlating with reduced rates of victimization of crime. [12] have discussed the link between urban extension and crime rate in four cities in Saudi Arabia. They have chosen different cities where two cites had large urban increase with 80%, while the increase in the other city was low with around 8%. They found a measurable link between urban extension and crime rate. This link was stronger where there has been greater urban extend. [13] Presented evidence linking the design of suburban neighborhoods with residents' feelings of safety using land use information. These suburban neighborhoods were located in Medellin, Columbia. This town growth across a narrow valley with 93.4 percent of the population from 1985-2005, which comprises white offspring of mixed Spanish and American descent, while another 6.5 percent claim African descent. The research focus on homicide crime that happened near river valley. Hence, there are relationship between both urban area and criminal activities, which found in Social crime ecology theories that explained geographical perspectives and criminal activities. The method that have been used was analysing the relationship between land use and homicide rates. Image processing was used to see the information of land use and the econometric homicide rate model as a function of socio-economic factors to evaluate whether the variables added to the model for remote sensing were important and had the predicted sign. The results appear to be consistent with the broken windows theory and CPTED in the sense that urban design is more heterogeneous and disordered. [14] observed urban layout using high spatial-resolution images (VHR) which have very high resolution. The study was conducted at Trento, Italy. These satellite imagery image were used to construct an analytical region-level database of variables. The image was a composition of 0.60 m of spatial resolution RGB of a Quickbird scene captured in May 2008. Moreover, [15] reviewed the "Validating the Remotely Sensed Geography of Crime" that focuses on forensic case, murder and others that use a high-resolution satellite image to detect the crime scene area. The crime scene area is located in the earth land surface

or water surfaces. Using remote sensing technique, all images gathered from satellites, aircraft, helicopter and by drones which can detect crimes and capture the images from above facilely period. [16] has used Landsat TM to determine the area and attribute of the location where crime incidents happened geographically. The hotspot of criminal activities are located in commercial area and government institution and the area that less sensitivity by the police. Geographic profiling tool can detect location and track crime offenders based on GIS technique for crime detection, control and prevention. Using GIS tool for monitoring hotspot of crime incidents to detect criminal activities, control the crime happened by sharing the hotspot analysis to the policeman and locate the policeman at hotspot area that recognized by GIS tools to prevent the crime. There is paucity of research about land-use changes/urban changes with crime rates and perception of safety surround the neighborhood area [13]. This paper concentrates on the impacts of urban increase on crime rate in Sungai Petani, with the high crime rates in Kedah, Malaysia. Also, it focuses on the urban development with aspects of social life and land-cover changes relative to the development management. The purpose of this investigation is to explore the relationship between changes on urban development and criminal activities with neighborhood safety perception in Sungai Petani, Kedah

III. URBAN DEVELOPMENT AND CRIME IN MALAYSIA

Research into urban development in Malaysia has a long story. Therefore, Malaysia's urban is divided into three phase of changes of urban in Malaysia. These phase are urban growth, development and urbanisation that based on their form, structure and functions of urban centre. The existing literature on urban growth in Malaysia [17] is extensive and focuses particularly on three major periods. The preliminary years after the independent, the rose of urban growth, development and the urbanisation in years 1957 – 1969, followed by, urban explosion and urban areas as growth centre from the booming of industrialization from year 1970-2019 (present). Recently, there has been renewed interest in Millennial Development Goals (MDGs) for Malaysia which incorporate supportable improvement being developed approach. Over the past century, there has been a dramatic increase in socioeconomic from agriculture sector to industrialization. Recent industrial advances have resulted in a renewed interest in social well-being. The era of a precarious class in the general public is produced by one of the biggest problems of social disparity between rich and poor and the minimization of voiceless and ground-breaking.

This indicates a need to understand the various perceptions of social disparity that exist among local community tend to involved in criminal activities. This paper provided an important opportunity to advance the understanding of urban development and crime incidents and well-being. Around the early 2000s, small-scale research and case studies began to emerge linking between urban development and crime in Malaysia by [18].



Addition to that, the increasing of crime rate in Malaysia between year 1980 and year 2004 is about 90% [19]. It has conclusively been shown that Malaysia is rank 63 out of 81 countries in term crime per capita with average of 6.85 per 1,000 people [20]. There are two types of index crime which property and violence crime. Property crime include theft of van, lorry, motorcycle, motor car and bicycle, housebreaking and theft and others form of theft. Meanwhile, types of violent crime are murder, robbery, rape and causing hurt [18]. As reported by [21], the total of violent crime cases are 41,270 crime cases and 169,914 of property crime cases. These figure show that property crime is higher than violent crime.

IV. METHODOLOGY

In this paper, information planning and pre-preparing are the stages to accomplish the goal of the study. The information readiness taken is to see the changes in different years in addition to the statistical analysis for increase of urban growth based on their population and crime perception. The classification of land cover from the satellite pictures would allude unequivocally to the statistical analysis for growth based on their percentage of changes happened in 13 years from year 2000 until year 2013 and crime which include violence crime, property crime and drug cases perception of the range existing beyond the limits of each urban establishment. Addition to that, the social variables including income, education and occupation produced from the study information (independent) would allude exactly to the qualities of the actors responsible for making land-use decisions within the comparing spatial unit. Thus, from data of criminal cases that is obtained from the Police Department of Kuala Muda, we correlate the facts of the insecurity and perception of the safety in the in-depth interview to the residents in the Sungai Petani. A questionnaire's question related to the crime and perception of crime, level of well-being has been done.

A. Study Area

Sungai Petani is one of Kedah’s towns. It is located in North of Peninsular Malaysia and the south of Kedah State. Sungai Petani is 50km away from Alor Setar, the capital city of Kedah. Sungai Petani is considered as the fastest development of the industrial city and the largest city in Kedah State figure (2).

Before this, Sungai Petani is a vegetation area including rubber plantations which becomes the centre of the rubber collection and the surrounding area. Nowadays, Sungai Petani is called industrial and commercial area. There a lots industrial area, commercial and business opportunities.

The study area, Sungai Petani Municipal Council or Majlis Perbandaran Sungai Petani (MPSP), covers Sungai Petani town specially and Kuala Muda District generally 22. The population of MPSP is estimated at 443,448 people in 2010 [23]. The housing sector is booming included Bandar Ambangan Heights, Bandar Laguna Merbok, Bandar Puteri Hill Park, Bandar Aman Jaya, Bandar Mutiara, Legenda Heights, Bandar Puteri Jaya, Bandar Sri Cendana, Darulaman Perdana, Bandar Utama and Bandar Sri Astana.

Table 1: Total Number of Population in Sungai Petani

Municipal	1980	1990	2000	2010
Sungai Petani	192,308	254,372	339,898	456,605



Figure 1: Satellite Image of Sungai Petani, Kedah (Source: Earthstar Geographics)

As a result of rapid growth in the 1990’s, the population increase from 192,308 people in 1990 to 456,605 people in 2010. Many new cities and settlements have been established. Sungai Petani is very easy to be contacted with networks, roads, and rail and air routes from Alor Star airport. The expressway road network that easy to connected to other cities such as just 50km to Alor Star city from Sungai Petani. Furthermore, the Electronic Train Service (ETS) also provided in Sungai Petani Rail Station. The airport that near to Sungai Petani is Sultan Abdul Halim Airport located in Alor Star. Sungai Petani is the second largest city in Kedah, after Alor Star.

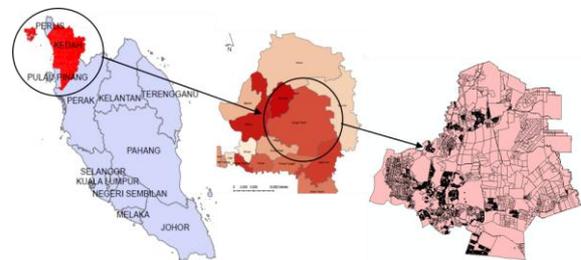


Figure 2: Map of SungaiPetani

B. Data Collection

Because The three data sets (2000, 2006 and 2013) consisting of primary data (Satellite imagery SPOT-5), Demography data included population, Crime rate and resident’ survey data have been mutually related to comparing the result from each source in order of the research. Due to the size of the three data sets used for the study, the following section only presents an overall result from the primary data. This is done in order to detect changes over the period 13 years, so that the pattern and activity throughout the land, crime incident data from 2000, 2006, 2013 and questionnaires survey on safety and fear of crime among resident which highlight numbers and sources could be seen.



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Information from the primary data and survey/questionnaire data has been used in the discussion section. A short questionnaire was designed to ascertain the participants' in neighbourhood of Sungai Petani with selected of 444 people to ask about the crime and fear of crime in their neighbourhood. The questions asked participants to rate how strongly they agreed with each statement that ask about fear of crime and well-being in their neighbourhood's area. Data management and analysis were performed using SPSS 20.

The crime data included, drug crime, violent crime (Murder, Rape, Robbery with gangs (Weapons), Robbery with gangs (without Weapons), Robbery (Weapon), Robbery (without Weapons), Hurt), property crime (Thief Lorry, Van, Car, Motorcycle), Graze and Housebreaking). The data are given by the Police Department of Kuala Muda, Kedah to see the total of crime for the year 2000, 2006 and 2013 in the Sungai Petani area.

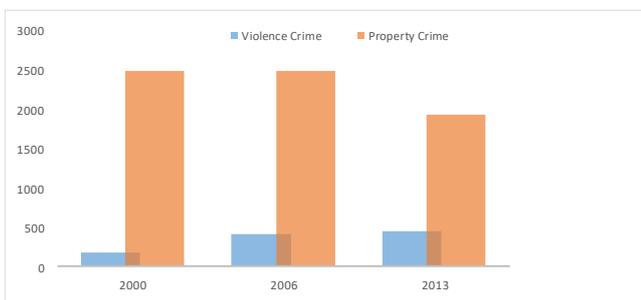


Figure 3: The total number of Crime Incident in Sungai Petani for year 2000 until 2013.

C. Technique

Because Firstly, data preparation task is to see the changes detected (2000-2006, 2006-2013 and 2000-2013); using SPOT-5 Satellite Imagery. The methodology consists of displaying on the screen the rectified / registered picture representing distinct categories of land use, based on picture features such as tone, texture, color and pattern translated into land use, attributes [24]. Then, Interpretation method, preferable to conventional classification, is based on satellite imagery for identification of modifications using supervised classification. Overall, an urban development change is determined by the quality of satellite imagery and using software ERDAS 2011, which is then re-checked using land use map produces by (JPBD, 2013). However, using GIS analyst tools to see hotspots and movement pattern of criminal activities. The first step in this process was to define the hotspot of crime incidents. Following, the movement analysis pattern was calculated using Mean centre and Standard Deviational Ellipse (SDE) technique. SDE technique defined how the criminal offenders choose their target location which analysed by year categories. The measurement can have calculated as following equation;

$$SD = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{X})^2}{n} + \frac{\sum_{i=1}^n (y_i - \bar{Y})^2}{n}} \quad (1)$$

Where x_i and y_i are coordinate of the location crime

incidents i , \bar{X} and \bar{Y} represent mean centre of the crime incidents and n is total number of crime incidents.

V. FINDINGS AND DISCUSSION

A. Land Use Changes

Land use change detection analyzed about causes of urban development and their economic and social effects [24]. Generally, the town Sungai Petani is planned by the local authorities of Kuala Muda. The development planning was arranged based on the local structure plans which scrutinizes the aspect of environmental care and the local communities' healthy lifestyle.

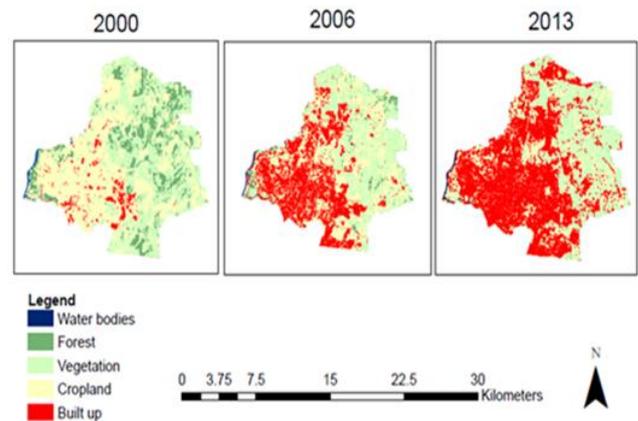


Figure 4: Land Use Changes for year 2000, 2006 and 2013 in Sungai Petani

However, there is a problem when asked about well-being, the participants were unanimous in the view that well-being of the local citizen has not in good to achieve the satisfying level because their still feel fear to crime near their neighborhood area. This is proven by a research which was made randomly among the citizen of Sungai Petani. Urban development changes analysis shows that exponential development from 3.1% to 24.17% from year 2000 to year 2013. The analysis done by remote sensing technique as shown in Figure 4. The urban extension during the study period was going to south, because it's near to Pulau Pinang.

B. The Rate of Crime

Number Crime in a bounded open space, such as a town, has different dynamics than in residential and neighborhood environments where socio demographic, and land use variables are important.

There are types of crime, violent crime (Murder, Rape, Robbery with gangs (Weapons), Robbery with gangs (without Weapons), Robbery (Weapon), Robbery (without Weapons), Hurt), property crime (Steal (Lorry, Van, Car, Motorcycle), Graze and Housebreaking). This crime data obtained from the year 2000, 2006 and 2013 in Sungai Petani. Fig 5 bellow shows that the incidents of crime in Sungai Petani.

The results obtained from the spatial analysis of criminal activities in year 2000, 2006 and 2013 are presented in Figure 5 (a) and (b) below.



The highest violent crime in 2013 respected to 127 cases, followed by 2006 is 102 cases and 43 cases for the year 2000. The property crime in the year 2000 is 772 cases; year 2006 is 752 cases and decrease to 736 cases in 2013. The total crime in 2000 is 815 cases, increased to 833 in the year 2006 and decrease to 736 in the year 2013. There were six police station around Sungai Petani, where Sungai Petani has the higher crime rate in Kedah state as said by police at IPD Kuala Muda, Kedah.



Figure 5: The hotspot of crime incidents in Sungai Petani 5(a) and the Direction of Ellipses of Crime in Sungai Petani 5(b).

The results of this study show that hotspots of criminal activities in located in town of Sungai Petani at commercial and industrial area mostly. This study supports evidence from previous observations from [26]. These result match those observed in earlier studies. [26] showed that movement pattern analysis by time. This differs from the findings presented here, where this study shows the movement pattern analysis by year 2000 until 2013. In observational studies, there is a potential for bias from with physical structure may donate some form of concentration in criminal activities.

According to these data, we can infer that the map illustrates the pattern of criminal activities movement to the south of Sungai Petani, toward Kulim and Penang area. Kulim and Penang are familiar as industrial city. Further studies, which take these variables into account, will need to be undertaken.

C. Level of Well-being (Safety Perceived)

Number The respondents are classified into white collar class half, bring down class 33% and the upper at 18% as far as instructive, occupation and pay level. Their everyday issues confronted are typical cost for basic items, the offices in their lodging region and the increasing expense of training of their youngsters. A large portion of the respondents figure out how to defeat these day by day issues. The participants experience a slight vertical social portability in contrast with their families and grandparents.

A minority of the surveyed participants felt that there were no social problems and violations in their neighborhoods. The table 2 below provides an overview of level of safety perceived in Sungai Petani. What is interesting about the data in this table is that, the resident worried much about the house can breaking by someone to steal and walk around at night in neighbourhoods'. Further analysis showed that, more than

50% of respondents agreed about fear of crime in their neighbourhood. Surprisingly, only a minority of respondents feel safe at night in their neighbourhood. Some of respondents are live in gated community area. Together these results provide important insights into how their fear of crime and they know a lot criminal activity in their neighbourhood. They likewise feel happy with the well-being condition in this town in general.

The perception of the situation in Sungai Petani about the rapid urban growth that gives impact on social life in their lives now, also concern with security and their perception of the city these days. The highest percentage of respondents indicating they were satisfied with life in the present, some say no choice of their lives a little tense. Most of the residents said that their living situation was peaceful as 49% and no choice 41.3%. Only 9.7% stated that the living was intense situation which fear of crime that might happened to their self (Table 2).

Table 2 Safety Perceived of Sungai Petani Residents

Results of the survey demonstrated that every one of the respondents considered their group to be a safe place to live. Most of those reviewed felt insecure, 55.8% said that individuals in Sungai Petani could not walk around without fear of being assaulted or disturbed, while 88.3% said that individuals who live in Sungai Petani have to worry about somebody breaking into their home to take things. Only 11.8% apparent Sungai Petani feels safe in their neighborhood.

Questions	%
Fell worry about someone breaking into your home to steal stuff	
Yes	88.3
No	11.7
Walk around at night without fear of being attacked or disturbed	
Yes	55.8
No	44.2
Is neighborhood area safe at night?	
Yes	11.8
No	88.2

Prior studies that have noted the importance of social ecology for each planning urban or rural area. Therefore, local authority must be planning about social ecology term for each urban or rural area that being developed. The achieved sustain for local community, we must have located the residential area with commercial area and leisure area, also infrastructures for local. Unfortunately, the industrial area must a little far from the residential area. This is will help the well-being of neighbourhood area and achieved sustainable development for the local community. This study set out with the aim of assessing the importance of social well-being in Sungai Petani's town specially. In general, therefore,

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it seems that to achieved level of well-being in our neighbourhoods' area that each resident that share same local territory is related to local environment must concerned about their social ecology. A possible explanation for this might be that, to see the pattern of residents 'behaviour and characteristics of neighbourhood between urban ways of life are existed.

D. Impact of Urban Growth of Crime Perceptions (Well-being)

Use Rapid urban growth is challenging to the crime and social problems. Crime has affected all communities in the neighborhood and given impact to the social well-being. A relationship of urban growth and crime is developed in Fig 3 to explain the correlation between both variables, where it is arguable that urban growth gives impact to social well-being, where crimes in urban are occurring more frequently. R^2 of the relationship is 0.7113. It is shown that there is a correlation between crime factor and urban growth changes.

Hence, the government, urban planners, public authority and community should consider activities that can reduce the crime and social problems for better future well-being.

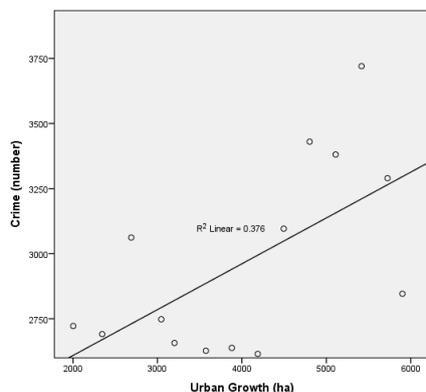


Figure 7: The relationship between urban growth and crime in Sungai Petani.

Further work is required to establish the viability of crime prevention for the local community. Crime Prevention through Environmental Design (CPTED) is an internationally acknowledged set of indoor and outdoor design concepts for the built environment. Proper lighting on the street is important, security camera and build a team to solve neighbourhood problem like Rukun Tetangga community to watch the suspicious activity in the neighbourhood.

VI. CONCLUSION

One of the challenge in urbanization is in the present-day world-wide development has given many opportunities to increase the economy of every individual. With the growth of industrial area that give job opportunities for locals that can boost their economic status. There are many benefits to the locals, but there is some drawbacks with this rapid urban growth. The disadvantages that, there a lot of social problem that tend to involved in criminal activities.

This study was undertaken to analysis the hotspot and defined the movement pattern analysis of crime pattern in urban area of Sungai Petani, Kedah. Using spatial analysis, we examined the potential area hotspot for criminal activities. The hotspot area is in commercial and industrial area.

According to 11th Malaysia Plan, the government aims to reduce 5% of crime index annually. Government also want to increase perception of feeling safe to 60% in 2020, from 39% in 2014 [27].

Although this study focuses on crime pattern, the findings may well have a bearing perception of feeling safe in the local community. The findings from this study make several contributions to the current literature. First, contribution to body of the knowledge and existing methodology adopted. The present study lays the groundwork for future research into thinking about all possible factors that will be include to be a better area of living.

This research has thrown up many questions in need of further investigation. Other contribution related to application of this approach, which combines capabilities of different disciplines while analysing spatial crime pattern and its impacts on urban development, includes understanding the concept of urban development as an instrument to measure the social changes occurring within an urbanized and urbanizing space. Further modelling work will have to be conducted in order to determine the urban crime model using geospatial analysis. Hence, the study's results have a number of significant consequences for future practice.

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extraction from satellite imagery, spatial decision support system, UAV-based remote imaging, disaster management, and early warning system.

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