URBANIZATION AND ITS IMPACT TO THE ENVIRONMENT IN THE GEORGE TOWN CONURBATION, MALAYSIA

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ABSTRACT

Transformation on physical land use is inevitable due to rapid urbanization. Urbanization caused by natural population growth and migration has brought positive impact since it improves public facilities and creates employment opportunities within urban areas. However, the increasing number of urban population has generated demand for land in order to accommodate the need of growing population. This phenomenon has brought negative impacts on the environment, thus created new challenges to urban planners and policy makers. This paper aimed to monitor urban expansion in George Town Conurbation, and evaluate its impact on the environment. The study used Geographic Information Sciences (GIS) and Remote Sensing (RS) to monitor urban expansion and mapped areas underwent land use transformation. Questionnaires were used to assess the responses of society of the neighboring regions towards urban development and its consequences to the environment. This study was carried out in Sungai Petani in Kedah, Kerian in Perak, and Bayan Lepas in Penang where 550 respondents were interviewed. Results indicated that respondents in Bayan Lepas encountered many negative environmental impacts compared to respondents in Sungai Petani and Kerian. 73.4 percent of respondents in Bayan Lepas agreed that urbanization has polluted their environment compared to respondents in Kerian (59.6 percent) and Sungai Petani (46.3 percent). The findings provided invaluable insights for planners and decision makers and as guidance towards appropriate policies for controlling and managing urban expansion thus reducing the impact on the environment.

Keywords: Community, environment, geographic information sciences, land use changes, remote sensing, urbanization.

INTRODUCTION

Urbanization is indispensable and it has drawn serious attention throughout the world. It has occurred since the 1970s and continues to display an exponential growth until today [8]. Urbanization is one of the major processes that has shaped land use and is a major concern in planning and policy-making [6]. This phenomenon, however, has reached its stable state in most developed countries, but gave serious challenges to many developing countries [2]. Malaysia is no exception to this phenomenon and according to the World Bank [9], Malaysia is classified as amongst the most urbanized countries in East Asia after Japan, Korea and Singapore. Urbanization brings many economic opportunities especially in trading and business [1].

Increasing employment opportunities and modern lifestyles generated from urbanization have upgraded the urban areas into a more favorable place to stay for many people [1]. Government and urban developers will develop an urban area by improving public facilities and building more residential areas to satisfy people's basic needs. This resulted in promoting industrial and commercial activities which generated income to the state through taxes.

Although urbanization offers positive impacts to a country in general, there is a price to its benefits. It has been reported that urban land area in Malaysia has increased from 3,900 square kilometers to 4,600 square kilometers in 2010 [9]. This increment, however, is not enough to accommodate the increasing number of urban population and natural population growth. In 2010, urban population has become 15 million with a population growth rate of 4.0 percent per year. Population density is estimated as 3,300 people in one square kilometer for that year. At the same time, urban population which is projected to increase gradually from year to year will also increase urban area density. The escalation of urban population and natural population growth has consequently generated an inflated demand for land to accommodate the need of growing population [6]. Samat (2014: 2) highlighted that agriculture land and natural resources tend to be encroached by urban areas when these lands seemed less beneficial than urbanization. Therefore, proper planning and monitoring need to be implemented to manage the expansion of urban areas in order to avoid unnecessary encroachment into agricultural and natural land to reduce its impact on the environment. Thus, this paper aimed to monitor and map the expansion of urban areas in the George Town Conurbation, Malaysia and evaluate its impact to the environment.

BACKGROUND OF THE STUDY

Geographic Information Systems (GIS) and Remote Sensing have become popular tools in monitoring land use changes. These technologies become important tools for planners and decision makers in managing urban expansion and investigating land use changes [1, 3, 7]. The study by Deng et al. [1] for instance, used GIS to explore evolution of land use change in response to the rapid urbanization in China from 1996 to 2006. The study revealed that cropland and water were the major land use types developed for urban sprawl and dominant transition from agricultural land use to urban land use. In Malaysia, for example, recent study by Samat et al. (2011) investigated the expansion of built-up areas using GIS. Those studies showed that GIS could be useful in managing urban spatial growth and formulating appropriate urban planning policies.

The proposed study was conducted to monitor expansion of urban areas in the George Town Conurbation, Malaysia comprising the Penang State and parts of its neighboring states of Kedah and Perak as proposed by Penang State Department of Town and Country Planning [5]. It is located in the northwest coast of Peninsular Malaysia between latitude 4^o 50' N and 5^o 52' N and longitude 100^o 10'E and 100^o 51'E, with an area approximately 3,938 square kilometers (see Figure 1). This area has experienced rapid growth mainly due to the spillover of rapid development from the George Town city [4].

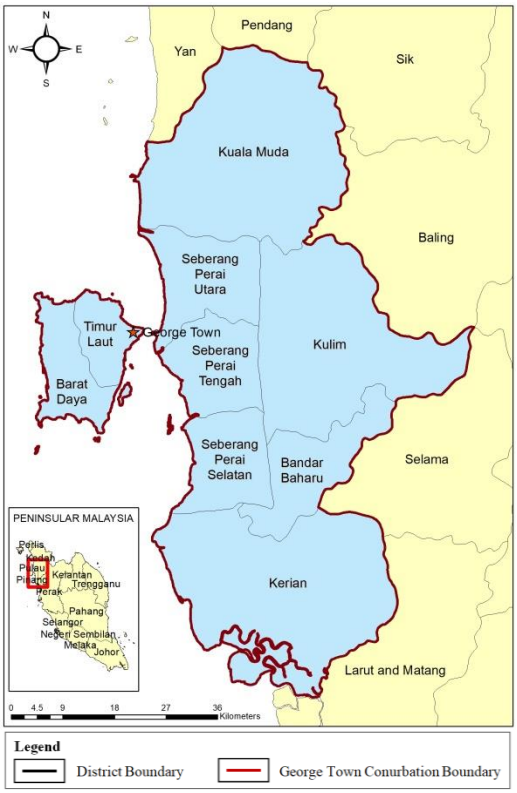

Figure1: The Study Area

A field survey is conducted to evaluate the impacts of urban development on the environment. Two identified neighboring regions, namely Kerian (in Perak) and Kuala Muda (in Kedah) including one in Penang namely Bayan Lepas were selected as the survey areas. Bayan Lepas is selected to represent the general views of Penang communities and to ascertain the difference of opinions between the societies in Penang (Bayan Lepas) and the neighboring region (Kerian and Kuala Muda).

DATA AND METHODOLOGY

Data

Raw images of year 2002, 2006, 2010 from Landsat 7 and year 2014 from Landsat 8 available from the United States Geological Survey (USGS) website (see Figure 2) were selected and downloaded based on the location of the study area. These images have minimum cloud covers and are processed using Erdas Imagine 2014 software. Moreover, these images were referenced on UTM-47N with Upper Left, X = 630210, Lower Right, X = 706680, Upper Left, Y = 648900, Lower Right, Y = 550860 and have spatial resolution of 30 meter x 30 meter (Figure 2). Erdas Imagine 2014 software is popularly used to extract information regarding land cover activities, especially from satellite or landsat images. After the extraction of land cover information, the processed images are then imported and displayed in ArcGIS 10.1 software. This software is proprietary software available at School of Humanities, Universiti Sains Malaysia, commonly used to analyze processed image.

Methodology

Landsat images (raw images) obtained from the USGS which were geometrically corrected will undergo image enhancement (eg. noise reduction, histogram equalization, and etc.) to produce reliable images for extraction of good land use information. After the images were classified into 4 major land use (ie. Agriculture, Forest, Urban and Water Body), the classified images were assessed for their classification accuracies. Once the accuracy exceeds 80 percent, the classified images were then exported into shapefile to be used in GIS land use mapping.

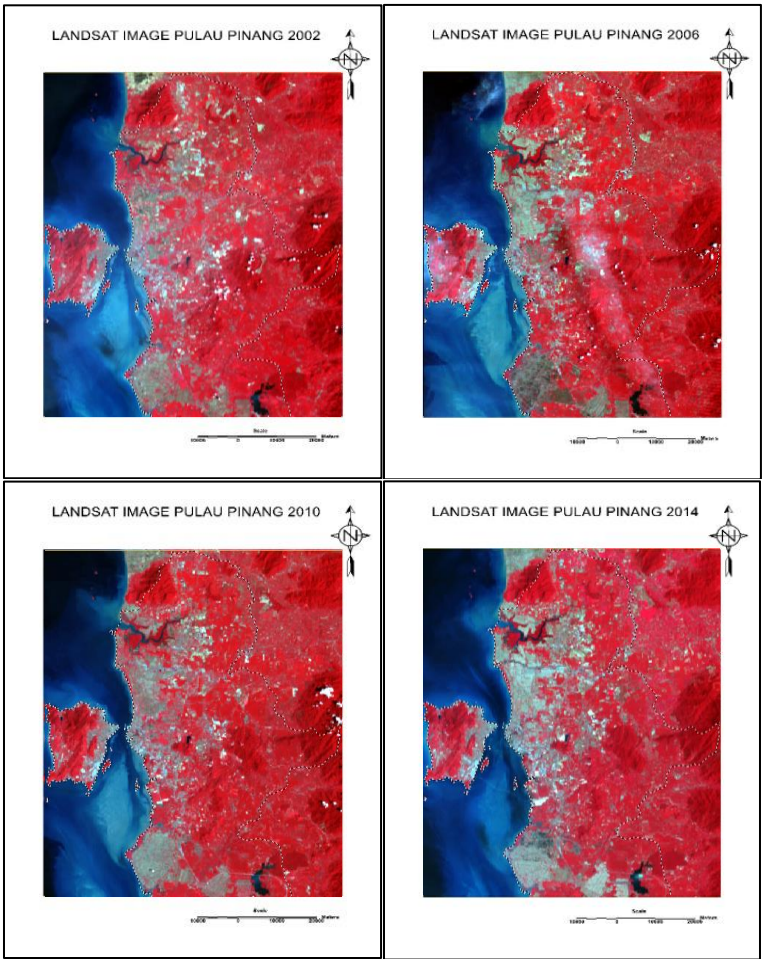

Figure 2: Landsat Images (Raw Images)
Source: https://earthexplorer.usgs.gov/

For data survey, local people living within these areas are chosen as respondents for both quantitative and qualitative surveys. A total of 550 respondents have been selected using cluster sampling and interviewed using questionnaires designed for the assessment of views and situations experienced by the local community. Out of the 550 respondents, 208 or 41.6 percent are from Kerian, 214 or 42.8 percent are from Kuala Muda and 128 or 25.6 percent are from Bayan Lepas. In addition, other related primary data such as meetings with urban planners from Kerian (Kerian District Council) and Kuala Muda (Sungai Petani Municipal Council) are used to access their preparations and roles conducted by the local authorities in managing rapid development of the study area.

RESULT AND DISCUSSION

Classified Image

Land use in the George Town Conurbation was divided into four classes namely Agriculture, Forest, Urban, and Water Body. Figure 3 (a-d) are results of image classification for each period after processing using supervised classification in Erdas Imagine 2014 while Table 1 shows the accuracy assessment of the classified images. Based on the table below, the accuracy obtained for all classified land cover maps are good with overall accuracy for all images exceeding 80 percent. The land cover information extracted from these images is reliable for the study area.

Table 1: Accuracy Assessment of the Image Classification

YEAR	OVERALL ACCURACY (%)	KAPPA STATISTIC
2002	82.50	0.7620
2006	83.00	0.7714
2010	88.00	0.8339
2014	80.00	0.7306

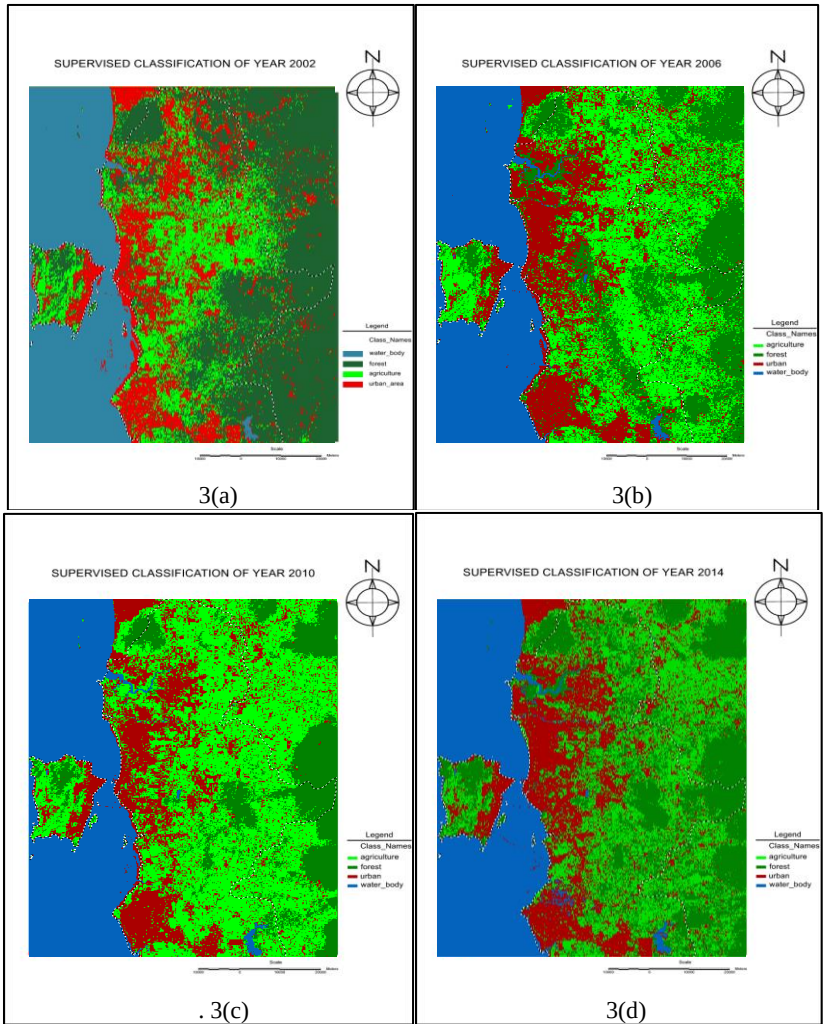

Figure 3: Land Cover of year 2002, 2006, 2010 and 2014

Based on Table 2, total urban area or built-up area has increased by 21.9 percent from year 2002 to 2014. This is probably due to the spillover of rapid development of George Town city that has expanded into the neighboring region. Figure 3(d) revealed that many latest development projects occur at Batu Kawan and Seberang Perai Selatan as the new 2nd Penang Bridge, connecting the mainland (Batu Kawan) and Penang Island (Bayan Lepas) is developed. However, this development has caused a loss in forested area by 59.7 percent. Agriculture area showed an impressive increment to 55 percent. This is perhaps in view of the local majority still preferring to work on their agriculture land. Water body in the classified images is calculated together with sea water. Hence, the change is mainly affected by the rise of tides and rain making it less important to the study.

Table 2: Area of Classified Land Cover between 2002 and 2014

YEAR	AGRICULTURE (square kilometers)	FOREST (square kilometers)	URBAN (square kilometers)	WATER BODY (square kilometers)
2002	1,266.65	3,006.08	1,398.12	1,840.67
2006	2,354.18	1,889.49	1,504.61	1,898.01
Change	**+1,087.53**	**-1,116.59**	**+106.49**	**+57.34**
2006	2,354.18	1,889.49	1,504.61	1,898.01
2010	2,799.28	1,306.01	1,502.74	1,897.38
Change	**+445.10**	**-538.48**	**-1.87**	**-0.63**
2010	2,799.28	1,306.01	1,502.74	1,897.38
2014	2,815.06	1,212.54	1,704.47	1,815.57
Change	**+15.78**	**-93.47**	**+201.73**	**-81.81**
Total Change	**+1,548.41**	**-1,793.54**	**+306.35**	**-25.10**

Based on the results obtained, line graphs were produced to display changes within the study periods. As shown in Figure 4, urban area experienced a steady increase of approximately 30,635 hectares. Similarly, agriculture area too has increased by more than 150,000 hectares from year 2002 to 2014. However, forest area showed a decline and the decrease is estimated to be nearly 180,000 hectares. This finding should serve as an alert to the responsible planners and policy makers, where forest area has to be managed more efficiently by controlling the spread of newly-developed urban areas.

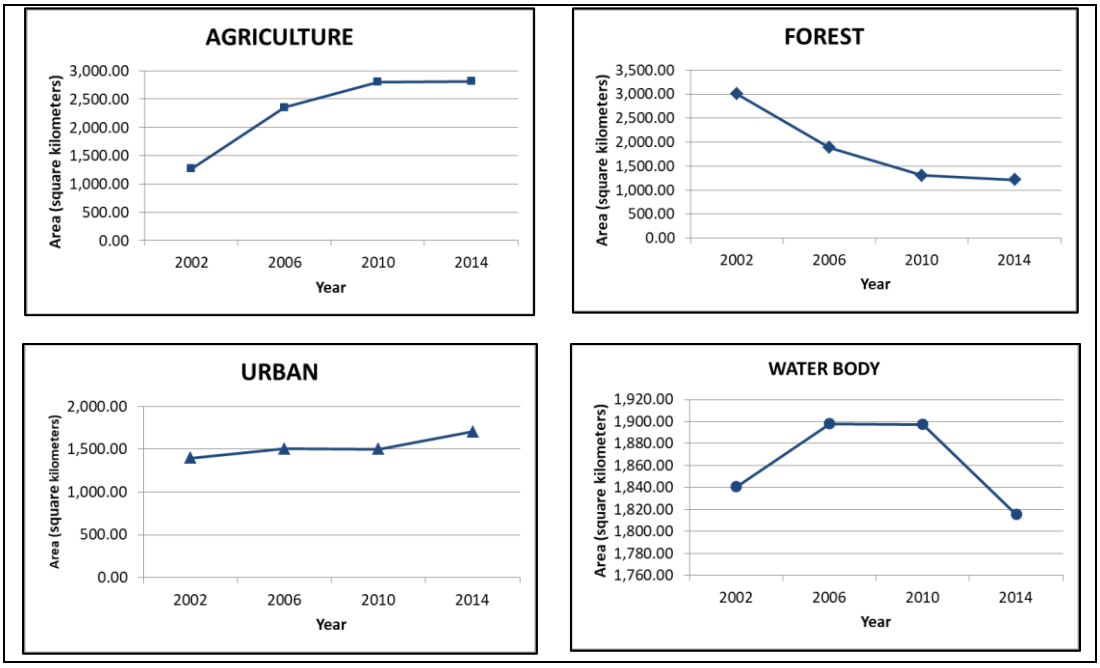

Figure 4: Line Chart of Classified Class

Findings

Based on respondence (See Table 3), majority of the Bayan Lepas community experienced various pollutions due to urbanization where 73.4 percent answered 'yes' when the appropriate question was asked. The respondents added that pollution occurred at their area due to constructions of buildings and road widening. This situation also occurs at Kerian where almost 60 percent claimed they experienced similar kind of pollution. However, a different perspective is obtained from the community in Kuala Muda where 52.8 percent answered 'no' to the same question implying pollution is still at its minimum in their area.

Table 3: Respondent Perspectives

Study Area * Pollution occurred in your area						
			Is there any pollution occur in your area?			Total
			Yes	No	Not applicable	
Study Area	Kerian	Count	124	83	1	208
		Percentage	59.6%	39.9%	0.5%	100.0%
	Kuala Muda	Count	99	113	2	214
		Percentage	46.3%	52.8%	0.9%	100.0%
	Bayan Lepas	Count	94	34	0	128
		Percentage	73.4%	26.6%	0.0%	100.0%
Total		Count	317	230	3	550
		Percentage	57.6%	41.8%	0.5%	100.0%

Despite the fact that the community has experienced the pollution, they still believe that urbanization can bring benefits to the society especially in increasing job opportunities to the young generations. It boosts the society's economy which helps them living in a more challenging life. They urged responsible authorities to try minimize pollution or environmental problems from occurring and at the same time escalate the economy by bringing urbanization to their area.

CONCLUSION

The study has demonstrated that Geographic Information Sciences and Remote Sensing is useful in monitoring urban expansion in the George Town Conurbation, Malaysia and to map areas that underwent land use transformation. It can be concluded that limited land area on Penang Island has caused the Penang Mainland and neighboring regions to undergo urbanization at a rapid rate. George Town city acted as a center to the conurbation which held major commercial and administrative activities in attracting more rural population to migrate into the neighboring regions. This consequently gives benefit to urban developers to further develop areas with higher urban populations. However, agriculture and natural resources should not be easily transformed into urban areas as these areas also played important roles in mitigating many environmental problems. The observed trend of urban expansion in this study provided invaluable information to urban planners and the formulation of appropriate urban planning policies.

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