Spatial analysis of development pressure in the Langat Basin, Selangor, Malaysia

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Abstract. The process of globalization and urbanization is growing rapidly in Southeast Asia. In Malaysia, one of the fastest growing areas is in Langat Basin, Selangor. Outrageous process the city to the periphery is now growing towards the southern corridor. This article discusses the use of geographical information system to spatially analyze the development of the built-up area in the north of Selangor. The purpose is to identify areas experiencing high-intensity development. The development of the built-up area has affected the environment, society and economic development of the area. The result shows rapid development has increased pressure to the Langat basin since the 1990s. In 1996 the built-up area is about 23017.8 square km. It had increased to 119587 sq km in 2016. This shows that developed areas had increased 40.70% over the period of 20 years from 1996 to 2016. This indicates that the area has been experiencing high development pressure over the period. More importantly, the pattern of urban development was not evenly distributed throughout the study area. This situation needs to be addressed so that rural area is protected from further development pressure.

1. Introduction

In recent decades, the world has experienced unprecedented urban growth. In 2015, about 4 billion people (54 %) of the world's population lived in cities and that number increased to close 5 billion people by 2030 [1]. In line with the 11th Malaysia Plan, the Government adopted a balanced development approach emphasizing the economic growth and well-being of the people. In Malaysia, this aspect is manifested in quality health care, housing affordable, increased security and public order, improvement emergency services, strengthening social integration and unity, as well as widespread participation in sports. Better prosperity will also improve the productivity and progress of the people. Over four decades of sustained economic development to bring the country and its people out of the poverty syndrome since independence in 1957, has transformed the country from an agricultural to an export industrial economy.

The year 1970 was generally taken as the watershed year separating a dominant dual agricultural economy comprising peasant food production and a commercial agriculture based on the plantation for export to import substitution industry at first and followed later on by manufacturing industries for export [2]. With that transformation, Malaysia becomes increasingly more intertwined with countries in the global market [2].

Rapid urbanization has brought big challenges, including growing numbers of slum dwellers, inadequate basic services, increased air pollution and infrastructure, and unplanned urban sprawl, which also make cities more vulnerable to disasters. The overall impacts of that economic growth and socio-economic development are being registered on the environment in the form of land use [1]. Through time, land use of one period undergoes changes to a new one reflecting the dynamic of activities of the people at the time. The transition of land use from a pristine tropical forest to peasant and commercial agriculture, and further on to urban industrial complexes embodies dynamic cultural, social and economic adaptability and resiliency of the people and the environment. In order to come to grip with the dynamics of the development process, land use change can, therefore, provide the text from which to illustrate the broad transition from forest through agriculture to urban industrial dominance. According Katiman [3] the Klang-Langat Valley in Malaysia is categorized under Extended Metropolitan Region (EMR). The process of urban sprawl in the EMR tends to favour the southern corridor.

The percentage of the urban population that lives in developing country slums fell from 39 percent in 2000 to 30 percent in 2014. Despite some gains, the absolute number of urban residents who live in slums continued to grow, owing in part to accelerating urbanization, population growth and lack of appropriate land and housing policies. In 2014, estimated 880 million urban residents lived in slum conditions, compared to 792 million urban residents in 2000 [1]. According Abdullahi [4], compact urban development due to high density, rural development containment is known as the most sustainable urban forms. Şalap-Ayça [5] using the meta-modeling approach can significantly reduce the computational effort of carrying out spatially explicit uncertainty and sensitivity analysis in the application of spatio-temporal models.

This paper is about spatial analysis of development pressure in the Langat Basin, Selangor for the period 1996 and 2016. While urbanization is seen to have made progress in a country, this process also welcomes a negative environmental impact if it is not managed in a sustainable manner. Development that has been flooded by rapid urbanization increases the exposure of local communities to living in hazardous areas. However, changes in land use also contribute to environmental problems and have affected local communities in urban development.

2. Method

2.1 Study area

Langat Basin is located in the south of Selangor and north of Negeri Sembilan within the latitude 2°40'U to 3°20'U and longitude l01°10'E to 102000'E, with an area of around 2,394.38 km2 (Figure 1). In recent decades, the Langat Basin has undergone rapid urbanization, industrialization and agricultural development [6,7].The Langat Basin is also a main source of drinking water for surrounding areas, a source of hydropower and plays an important role in flood mitigation. Langat Basin has faced tremendous changes in the past five years. From a peripheral agricultural supply region that buffers core industrialization in the Klang Valley and the Seremban-Mantin industrial area, global forces have taken over and began to create yet another high development area. However, the twist of recent events has left many developments plans unfinished and uncertainty looms in the region. To ensure the sustainable development of the region, a management system that is sensitive to the cultural environment, as well as the physical ecosystem health is necessary.

2.2 The Demographic

Increased urban population increases demand for land for activity needs city. Therefore, development will spread to suburban areas. This makes city and non-city boundaries are no longer clear [8] and form a zone interaction between urban and rural areas [9] also known as 'desakota' [9].The suburban zone usually has sensitive environmental areas, good agricultural areas or swampy areas support urban ecosystem [10,11,12]. The zone becomes a residential area residents working in cities and non-urban (agricultural) activities also exist in them [13].

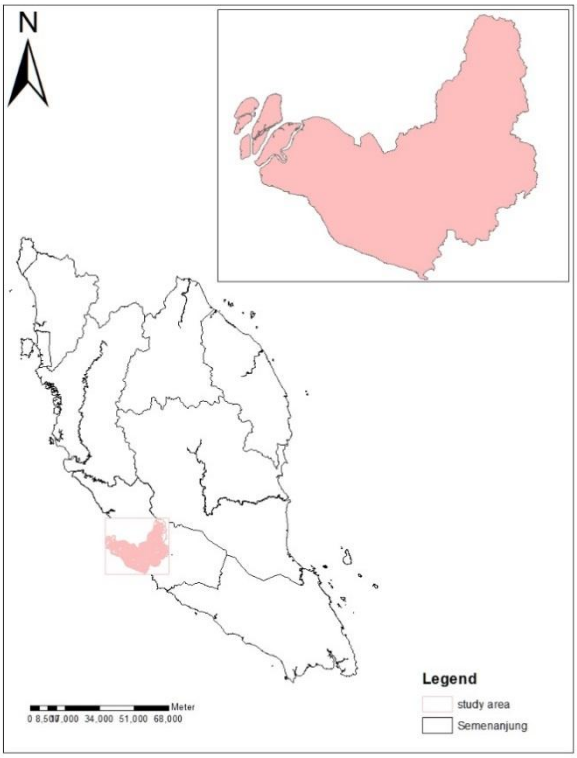

Figure 1. Study area

Given that this area is important in supporting urban activities, it is necessary carefully preserved and carefully designed to ensure that local communities benefit from development that goes ahead and can keep on living a good life [14,17]. Suburban zones are also often subject to developmental pressures as a result of urban overtures. Pressure this should be controlled to ensure that wastage does not occur in land use at suburban area.This trend is also reflected in the maturity of communities to be found within the drainage basin. The Hulu Langat district has many concentrations of new communities, reflected through the number of new housings in the area. Again the locus of development is within Mukim Kajang. Some development is also occurring within the Kelanang, Telok Panglima Garang, and Tanjung Dua Belas mukims in Kuala Langat, as well as in the Ulu Langat mukim [2]. In general, new communities within industrial surroundings can be found in mukims Kajang and Semenyih, while elsewhere in the basin, the communities are largely stable, established agricultural communities with pockets of industries scattered over the region. The development of Putrajaya and its surroundings can be expected to change the demographic scenario to create another population hub. What was not captured well, however, was the transient population that took advantage of the boom period between 1995 – 1998.

According [15], the highest population Petaling 35.98% follow by Ulu Langat, 21.19%, Klang (18.17%), and Gombak (12.37%). Selangor registered the highest population percentage in the country this year at 19.9%, followed by Sabah (12.0%) and Johor (11.5%).Malaysia's population this year (2016) is estimated at 31.7 million, a 0.5 million increase compared to 31.2 million people in 2015.In a statement, the Malaysian Statistics Department said the figures reflect a 1.5% annual population growth rate for the same period. The 31.7 million total population comprised of 16.4 million men and 15.3 million women in terms of gender composition, a ratio of 107 men to every 100. By ethnicity, bumiputera registered as the highest percentage of Malaysia citizens at 68.6%, followed by Chinese (23.4%), Indian (7.0%) and others (1.0%).Non-citizens accounted for 10.3% of Malaysia's total population. According to the department, distribution by age group this year showed no significant

difference compared to 2015.The population in the age group of 14 years and below decreased by 0.4% in 2016 (24.5%) compared to 2015 (24.9%).The working age population, 15 to 64 years old, increased by 0.2% in 2016 to 69.5% compared to 2015, and population aged 65 years and above also increased by 0.2% to 6.0% for the same period.

Table 1. Population By administrative District 2010

No	Administrative District	Population Number	Percent
1	Gombak	51057	12.37
2	Klang	75006	18.17
3	Kuala Langat	10459	2.53
4	Kuala Selangor	9643	2.34
5	Petaling	148491	35.98
6	Sabak Bernam	2580	0.63
7	Sepang	19941	4.83
8	Ulu Langat	87445	21.19
9	Ulu Selangor	8137	1.97
	Total	412759	100.00

Source: Department of Statistic Malaysia, 2010

However, this rapid development experienced during the mid to late 90s (before the recession) has increased the number of population (Table 1), especially in the Hulu Langat district and with it came increased demand for services and amenities. However, there is an understandable lag in the increased provision of needed public services. The findings showed the boom period was not complemented with increased basic facilities to cater for the growth. With the current onslaught of recession, these projects have also been placed in the back burner. To understand the impact of sudden growth on the Langat Basin, an overview of the local urbanization phenomenon is pertinent.

2.3 The changing urbanization process

The Langat basin is facing a different urbanization process than that which occurred in Klang Valley from before the 1970s to the mid-80s. Back then physical development and local population needs were more manageable, and perhaps more interrelated. The physical aspect of the urbanization process will be discussed in the land use section of this report. The current discussion limits itself to the changing urban demographics of the region. The urban was primarily service areas for the larger rural area. Any extended needs will result in travel either to Kuala Lumpur or Seremban. Thus the general scenario for the country in the 60s and 70s also held true for the basin. The urban was Chinese in composition, the agricultural plantations, the Indian, and the rural countryside's, Malay. Any sizeable urbanization of the Malay rural population then was mainly due to three government institutions, the military, police, and education, which created new enclaves with their own intrinsic social structure. The NEP started to progress in changing the spatial structure but slowly. While the mid-70s to early 80s have already seen increased movements in the urban areas, it was not until early 90s that the urbanization process picked up its pace. After the recession in the mid-80s, increased number of MNCs and local companies brought employment opportunities at a much higher level than before. Government policies, rent costs, and exhausted space brought industrialization closer to the rural areas of the Langat Basin. Working in the factories was beginning to be seen as the norm, instead of a stigmatized minority. This trend came to its pinnacle in the late 90s before the monetary crisis. Labour requirements of these industries opened up the area to a specific group of the population. The demographic structure of the urban areas has thus changed to include a larger proportion of young working singles with different social needs and aspirations.

Social problems are also on the rise in the region. Increasing transient population, young communities and established enclaves are all currently facing challenges common to rapid urban development. Established communities are experiencing rapid changes to what was before stable ways of life. Hundred years old plantations and other agricultural lands are suddenly turned into residential, commercial and industrial areas. These new residential areas brought together young individuals and families from different backgrounds. Uprooted from this traditional (rural) social structure, together with often inadequate social support mechanisms, these new entrants to the urban scene are slowly forming their own networks. Within that context, the social limbo that they encountered is conducive to negative social influences.

The increased population has also increased the burden on the environment, increasing the need for a more detailed attention be given to the ecosystem health of the region. Increased level of pollution from industries and the use of automotive vehicles, as well as increased use of insecticides and fertilizers, are among the environmental concerns of the basin along with direct development impacts such as erosion and forest clearing.

Based on land use data, this study calculates the statistical change of land use in the study area through formula 1 and formula 2 below:

$$\Delta\, LU_{i,j,r}^{t\rightarrow t+1} = LU_{i,j,r}^{t+1} - LU_{i,j,r}^{t} \quad (1)$$

That is, $\Delta\, LU_{i,j,r}^{t\rightarrow t+1}$ = changes of land use types r location I and j of the time t ke $t+1$

$LU_{i,j,r}^{t+1}$= changes of land use types r location i and j of the time $t+1$, and

$LU_{i,j,r}^{t}$ = land use types r location i and j of the time t

$$\%\, B_{i,j}^{t\rightarrow t+n} = \left(\frac{B_{i,j}^{t+n} - B_{i,j}^{t}}{B_{i,j}^{t}}\right) \text{x}100 \quad (2)$$

That is, $\%\, B_{i,j}^{t\rightarrow t+n}$ = Percentage change of land use from time to time t dan $t+n$, $B_{i,j}^{t+n}$= the area of development at the time $t+n$, and $B_{i,j}^{t} =$ development area on time t.

The above formula can provide information on the area, location and percentage of land use change for areas experiencing land use change from non-development areas to development areas.

3. Result and discussion

The urbanization process has left its mark on the land use scenario. Several patterns of growth, especially with respect to urban development, can be discerned. The first is development around pre-existing urban areas. Here development expanded outward from a core area, at places following a Hoytian sectoral expansion, while others conform to Harris-Ullman's multinodal pattern. These patterns of development are to be found mainly around the main development locus of south Kuala Lumpur – Kajang. Another growth pattern follows the linear development following existing road networks, albeit much less the case. These are most easily observable in the western section of Kuala Langat district. The most recent pattern, however, is the development of new growth nodes with the opening up of the international airport and the Putrajaya/Cyberjaya town ship at the southern part of Sepang district. These are the New Growth Centers which also include Pulau Indah in Klang, as well as Bukit Beruntung and Hulu Selangor, located outside the basin.

This study methodology to calculate land use change for the period of 20 years, from 1996 to 2016 and determines areas experiencing drastic changes. In addition, it assesses the stage of development and its impact on locals. Very little land use change has occurred before 1974. The urban land use only increased by 0.86 % per annum while other land uses such as agriculture and forested areas had minimal per annum change. By 1981 however, the increase in urban areas and agriculture, as well as the reduction of forests are becoming significant.

What needs to be considered also is the implications of land use changes taking place. The region which was primarily small rural agricultural communities have changed to agricultural supply regions, totally urban in function but located in a rural area. This change of rural place to urban space was exacerbated by the increasing number of industries, urban in both function and form. Thus the identity of the area itself has changed.

Type of land use in Langat Basin is divided into eight main categories, namely dipterocarp forest, Peatswamp, lowland forest,mangrove, bareland, develop area, agriculture and water bodies. The result of landuse change show in Table 2 and Figure 2 show landuse type different for 1996 and 2016. Landuse change of dipterocarps forest type for the year of 1996 was 16.24%, while on 2016 decrease to 15.52%. The amounts of peat swamp in 1996 and 2016 are 4.29%, 6.38% respectively. Lowland forest was 0.52% on 1996, while on 2016 increased to 2.21%. Landuse type for mangrove was 6.42% on the same year of 1996 and 10 year of 1996 and 10 years later on 2016 was 4.84%. Bare land was 2.71% on 1996, increased to 3.07% in a decade. For the same period, developed area was 7.85% increased to 40.70%. While landuse agriculture was 60.22% decreased to 25.68% on 2016. Landuse of water bodies 1.75% in immensity on 1996, decrease to 1.59% on 2016.

The highest land use changes in land use developed area of 418.47% area covering an area of 95669.1. Dipterocarp Forest is -4.43% for 10 years. Peat swamp, lowland forest, mangrove, receptively 48.72 %, 325% and -24.61%. Land use for bare land is 13.28%. Agriculture -57.36%, and water bodies are -9.14%. Here clearly shows that the growing area is growing in the wake of the various developing urban projects in Langat basin within 20 years.

Table 2. Distribution of landuse for 1996 and 2016

No	Landuse Types	1996		2016		Landuse change	
		Amount	Percent	Amount	Percent	Amount	Percent
1	Dipterocarp Forest	47643.1	16.24	45618.3	15.52	-2024.8	-4.43
2	Peatswamp	12571.9	4.29	18754.1	6.38	6182.21	48.72
3	Lowland Forest	1514.52	0.52	6491.43	2.21	4976.91	325.00
4	Mangrove	18841.7	6.42	14229.2	4.84	-4612.5	-24.61
5	Bareland	7950.51	2.71	9023.48	3.07	1072.97	13.28
6	Developed Area	23017.8	7.85	119587	40.7	96569.1	418.47
7	Agriculture	176640	60.22	75473	25.68	-101167	-57.36
8	Water Bodies	5132.52	1.75	4671.32	1.59	-461.2	-9.14
	Total Area	293312	100	293848	100		

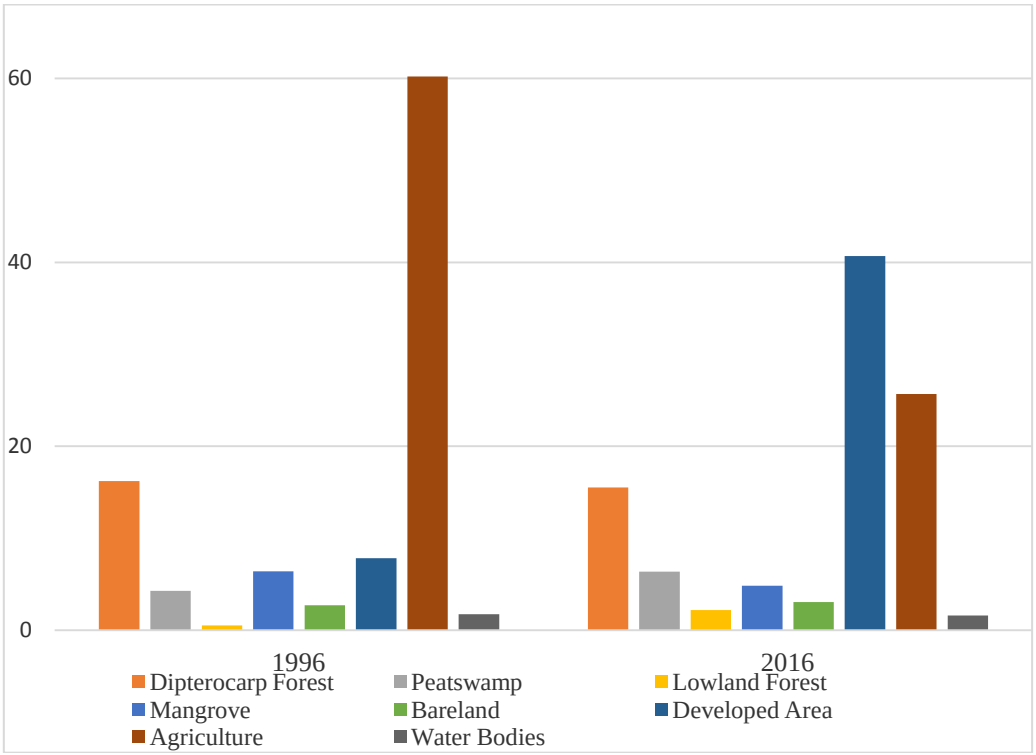

Figure 2. Landuse type different for 1996 and 2016

The Langat Basin was selected to represent the landuse change at a basin scale, implying of course a somewhat more detailed account of landuse and landuse change compared to the first scale. Figure 3 and 4 show landuse type different for 1996 and 2016.

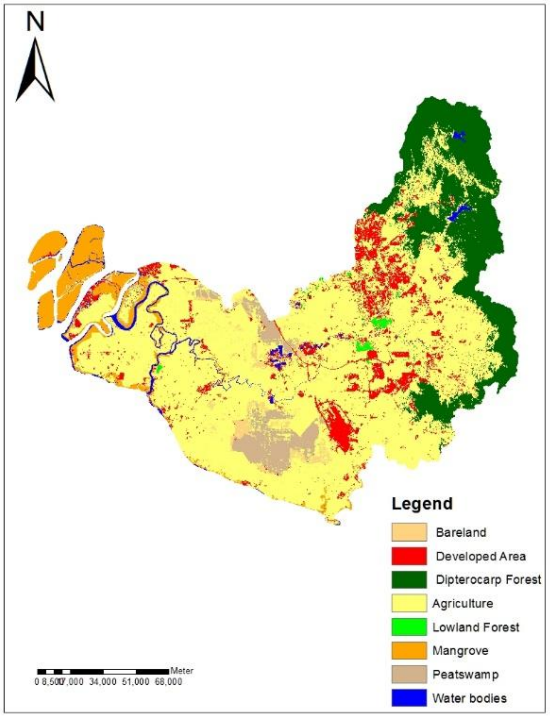

Figure 3. Landuse 1996

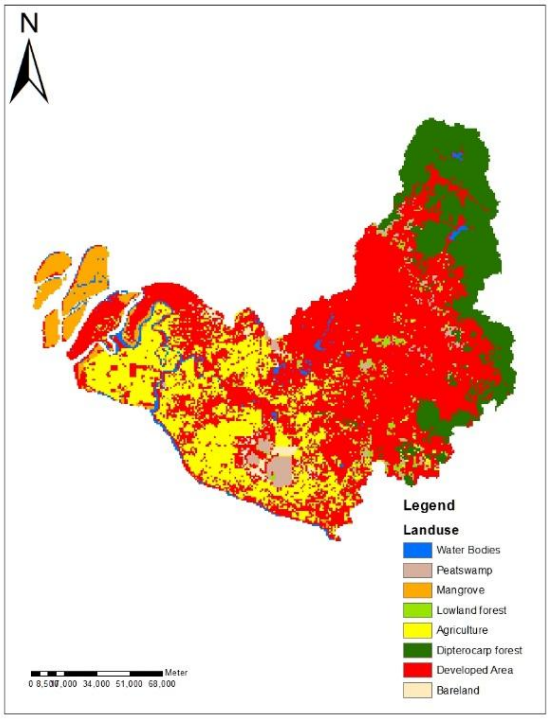

Figure 4. Landuse 2016

The Langat Basin ecosystem has and is still undergoing rapid changes. In the 1960's and 1970's much of its original lowland dipterocarp and peat swamp forests were lost through conversion to agricultural plantations, tin mining areas and human settlements [16]. Recently, its natural cover areas have come under increasing pressure from rapid urbanization and industrialization including the development of Putrajaya-the new Malaysian administrative center which was given the status of a Federal Territory along with the development of Cyberjaya and the high technological industrial area of the Multimedia Super Corridor that stretches to the KLCC in Kuala Lumpur –about 50 km long with a width of 20 km. Thus, the entire former agricultural estate was fully converted to make way for urban use. In the wake of the urban expansion agricultural areas in contiguous areas have become very vulnerable and always at risk to get converted to urban usage.

4. Conclusion

Development pressure in Langat Basin had increase with increasing of landuse change for the developed area in 2016. The study found that land use change was increasing in 2016 for a developed area, followed by lowland forest, peatswamp, and bareland. Meanwhile, the agricultural area has decreased over time. These changes that occur in different scales by year also affect the environment changes that ultimately if no attempt to understand the changes will leave a bad effect on the environment not only in the Langat Basin but also to nearby areas. Land use in the basins is still mixed with agricultural activities, housing, municipal and industrial are the main types of land use. Activity land use development in the construction sector such as municipal, industrial, and housing in the late 1990s has reduced forest areas covering natural forests and non-natural forests such as forests and forests secondary. Forest destruction has contributed to the problems of physical environment such as landslides and flash floods that often cause destruction of property and loss of life. Early stage development on 1960s to the 1980s only focused on the agricultural sector. The forest felled has been replaced with rubber and oil palm plants. However, land development activities should also be monitored to avoid environmental problems and pressure on population growth in an uncontrolled area. Control of land use activities is important in maintaining stability other physical environmental systems such as drainage systems, avoid soil erosion, reducing the problem of landslides and flash floods to keep the ecosystem alive and sustainable.

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