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Mapping of Affordable Housing Sustainability Level from Environmental Geospatial Aspect in Gombak, Selangor

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Abstract. Housing is important since it provides security, privacy, neighbourhood and social relations, status, community facilities and services, access to jobs and control over the environment. To enable everybody to afford a house, affordable housing was introduced and developed throughout the world. But there's an issues with current affordable housing development, especially the sustainability of these affordable housing, especially from environmental aspects. Several initiatives have been done to improve current sustainability, but current initiatives lack of spatial indicators to assess the sustainability level, from environmental aspects. This study focus on assessment of sustainability level from environmental aspect. The assessment method consists of 3 main components; the green space availability, proximity to water features, and proximity of flood areas. The results show that most of the affordable housing in this study area was less sustainable in term of environmental aspects. From this results, proper planning and development to sustain the affordable housing surrounding area can be done by government, or other stakeholders in the future.



1. Introduction

Affordable housing is referring to the suitable housing that is meet and needs of a range of household's income which range can be very low to moderate. In context of Malaysia, example of affordable housing scheme such as *Rumah Mesra Rakyat 1 Malaysia* (RMR1M), People's Housing Project (PPR), My Home, Federal Territory Affordable Housing Policy (RUMAWIP) and Rumah Selangorku or other low cost housing that develop by construction company as their requirement for developing housing [1], [2]. Moreover, it is also encourage enhancing the quality of the developing countries as the community able to receive a good housing quality.

Therefore, affordable housing plays roles in integrated social, physical and economic development, environmental sustainability, natural disaster mitigation and employment generation instead on only a providing a basic shelter to the community [1], [3]. Thus, affordable housing can be category as ones of the sustainability development. Sustainability development is that meets the needs of the present, without compromising the ability of future generations to meet their own needs, which consist of the three general pillar such as social, economic and environmental [4].

However, sustainability of the social and economic seems be a current priority of the affordable housing as existing schemes of affordable housing seems to fulfil economic and social sustainable of the target buyers and construction is follow minimum standard by related authorities to ensure there are profit of the selling housing even it been selling below market prices. Resulted these affordable housing could be disgrace the environmental sustainability as supported by [5] stated that, this could lead bad impact on the environment and quality of living even though the social and economic is sustain.

Environmental sustainability in affordable housing can be defines as ones of the issues that have taken less consideration by the construction companies as most of them tend to secure their profits rather than secure the environmental profits. This supported by [3]; Bogdon dan Boleh (1997), which they highly comment that the existing plan for affordability is more highlight on cost of the price compared to the quality or location of the house. Moreover, the effects of the environmental issues are happened on the affordable housing which forces the community live in this affordable housing tend to suffered or experience the effects.

The environmental issues that been discussed such as lack of green spaces in housing areas as, this can be seen as; some affordable housing does not have any space that useful for green space or park. The importance of this availability of the green space or park, not only work in the social sustainability for community, but it also leads to the environmental sustainability as, this enable to enhance and preserve the ecology in urban areas while helping the heat islands.

Next, development of housing near riparian zones is one of the environmental issues as there are housing was developing in riparian zone. Riparian zones act as buffers between upland areas and open water as they help filter pollutants, reduce stream bank erosion and maintain stable stream channel geomorphology. The proximity of housing within the buffer zone will increase the unsustainability of the environmental as it could affect the erosion of the stream, habitat destruction while harm the community live nearby.

Last, the development in the flood risk areas is one of the common issues that happened in housing development. Effect of this could lead to the environmental and consequences for communities and individuals. Immediate impacts of flooding includes loss of human life, damage to property, and deterioration of health conditions owing to waterborne diseases.

This study aim is to identify and assess the sustainability aspects of affordable housing in Malaysia, from environmental aspects, using spatial elements. The area of this study focusing on Selayang Area (figure 1), that is in Selangor State, Malaysia.

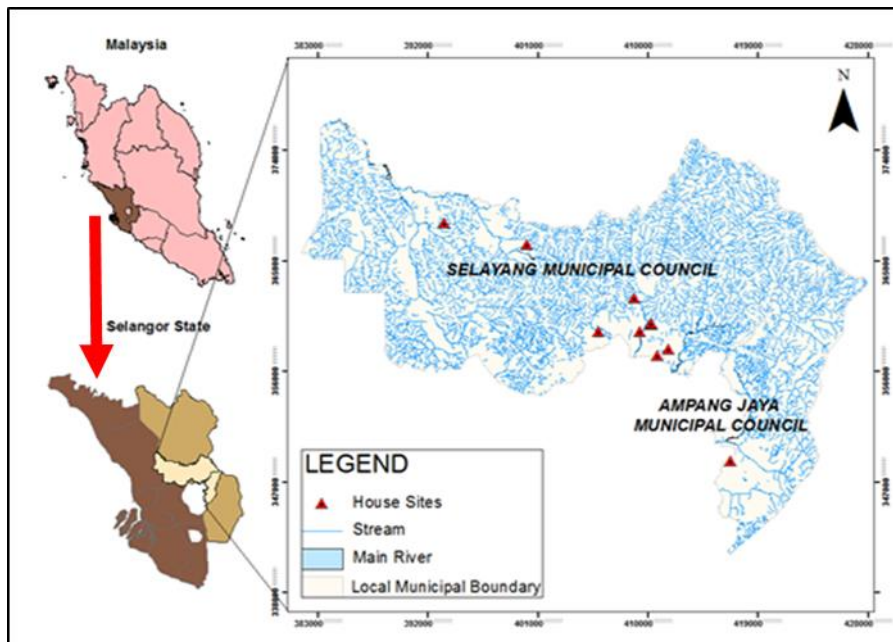


Figure 1. Study area.

2. Methodology

In order to assess the sustainability level of affordable housing from social aspect, this study uses Multi-Criteria Decision Making (MCDM): Analytical Hierarchy Process (AHP). There are 3 steps used in this study, which is identifying the spatial indicators in term of environmental to assess the sustainability level, analysis which include the spatial and non-spatial analysis, and lastly the discussion of the results. Figure 2 shows the study approach on how this research is being performed. Several steps needed to accomplish this study.

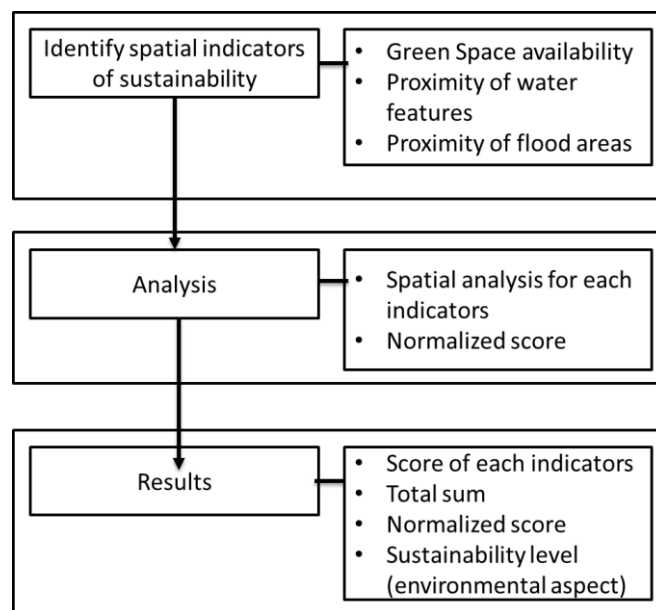


Figure 2. Study approach.

The first step is to identify the spatial indicators that are related to sustainability level in term of social aspects. To identify these indicators, review from various models from previous studies was conducted. For instance, Sustainable Development Goals (SDG) model from United Nation, MurniNet 2.0, *Indeks Kesejahteraan Keluarga Malaysia* (IKKM), National Housing Policy (DRN), and other related model. From these models, a list of indicators that are related to social aspects was listed and reviewed. From the reviewing process, 3 main indicators and 10 sub-indicators was selected in in this study (Table 1).

The second step is analysis. In this step, spatial analysis has been done from the list of sub-indicators. The spatial analysis conducted in this study aim to enhance the current model in assessing the sustainability level of the affordable housing from environmental aspects. The analysis will determine the sustainability level according to table 1.

Table 1. Indicators, condition, score and sources

Indicators	Condition	Score	Source
Availability of green space or public open parks	• Total areas of green spaces <15% of land area	1	GBH
	• Total areas of green spaces ≥15% of land area	2	
	• Total areas of green spaces ≥25% of land area	3	
	• Total areas of green spaces ≥35% of land area	4	
	• Total areas of green spaces ≥45% of land area	5	
	• Total areas of green spaces ≥55% of land area	6	
Proximity of water features	• Development within 30m	1	GBI, Jimmy H. et. al. (2015) & Johnson et. al. (1994)
	• No development within 30m	2	
Proximity of flood areas	• ≤500m	1	Anurag, O.(2010), Masirin Kaamin et. all (2016)
	• ≥1KM	2	

The last phase is the presentation of results of each indicator that will be presented in graph and also map. Based on spatial and non-spatial analysis.

3. Results and Discussion

Results of this study can be divided into 3 main results, based on main indicators. The 3 main results are the availability of green spaces, proximity of water features, and proximity of flood areas. The last result combining all these results, and presented as a sustainability level from environmental aspects, for affordable housing.

3.1. Availability of Green Spaces Area

The first analysis is the availability of green space around the affordable housing area. For this analysis, the score given to the green spaces base on view throughout satellite images. The results show in overall, only 30 percent (30%) of housing that consist of the green spaces while 70 percent (70%) of housing does not have green spaces. However, the existing of the green spaces in these 30 percent housing site is differently according to the total areas of the house.

According to the criteria of score of availability of green spaces, only percentages greater or equal 15 percent will start have score 1, 2,3,4,5 and less than 15 percent will be score as 0. Table 2 show that only PPR Palma Apartment and PPR Hiliran Ampang have 17 percent and 20 percent of green space based on the total areas of housing. These respectively shown that only both of these housing is score as 1 as it follows the condition of the scoring.

Results also shows that only PPR Hiliran Ampang have 10 percent additional availability of green areas instead of Pangsapuri Taman Setia that have only 10 percent of the availability of green areas. However, these both housing that have 10 acres will not have same score as, Pangsapuri Taman Setia is

scored as 0 while PPR Hiliran Ampang scored as 1. Significantly, based on the selected housing sites, total areas of housing that below 10acres shown that there is no availability of green spaces in each housing. Figure 3 show the location of affordable housing, and the score of green space area for each affordable housing.

Table 2. Percentage of available green space and score of each affordable housing

No.	Affordable housing name	Percentage of availability from land areas (%)	Score
1.	PPR Palma Apartment	17	1
2.	Pangsapuri Taman Setia	10	0
3.	PPR Selayang Mulia	0	0
4.	Apartment Cempaka	0	0
5.	Apartment Beringin	0	0
6.	Apartment Laksamana Jaya	0	0
7.	Pangsapuri Taman Samudera	0	0
8.	Apartment Fiona	0	0
9.	PPR Hiliran Ampang	20	1
10.	PPR Palma Apartment	17	1

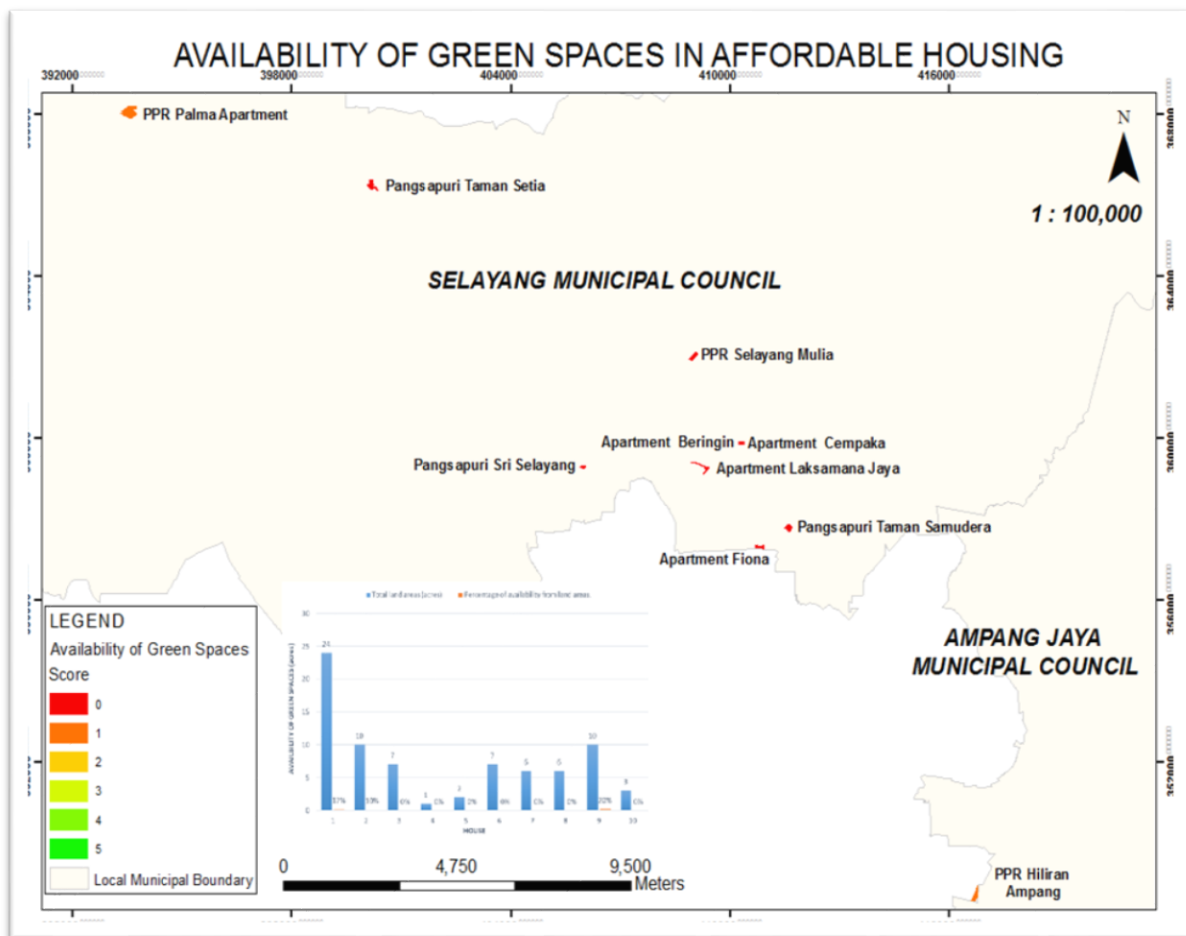


Figure 3. Mapping of green space score for the affordable housing.

3.2. Proximity of Water Features

Second analysis is to find the score of proximity of water features surrounding the affordable housing area. Proximity of water features used as indicator for identify the availability of any stream or river approximately in 30 meter with the developments or know as riparian zones.

Based on the table 3, the results show the score of proximity of water features in affordable housing. The result shown 50 percent of the housing located within the 30m of buffer zone while other half is located outside 30m of buffer zone. Thus, these housing located within 30m of buffer zone from water features have high tendency to experience the ecological destruction in future as it could be erosion and making loss natural habitat while harm the community that live nearby in these affordable housing. Figure 4 show the map of the score of proximity of water features.

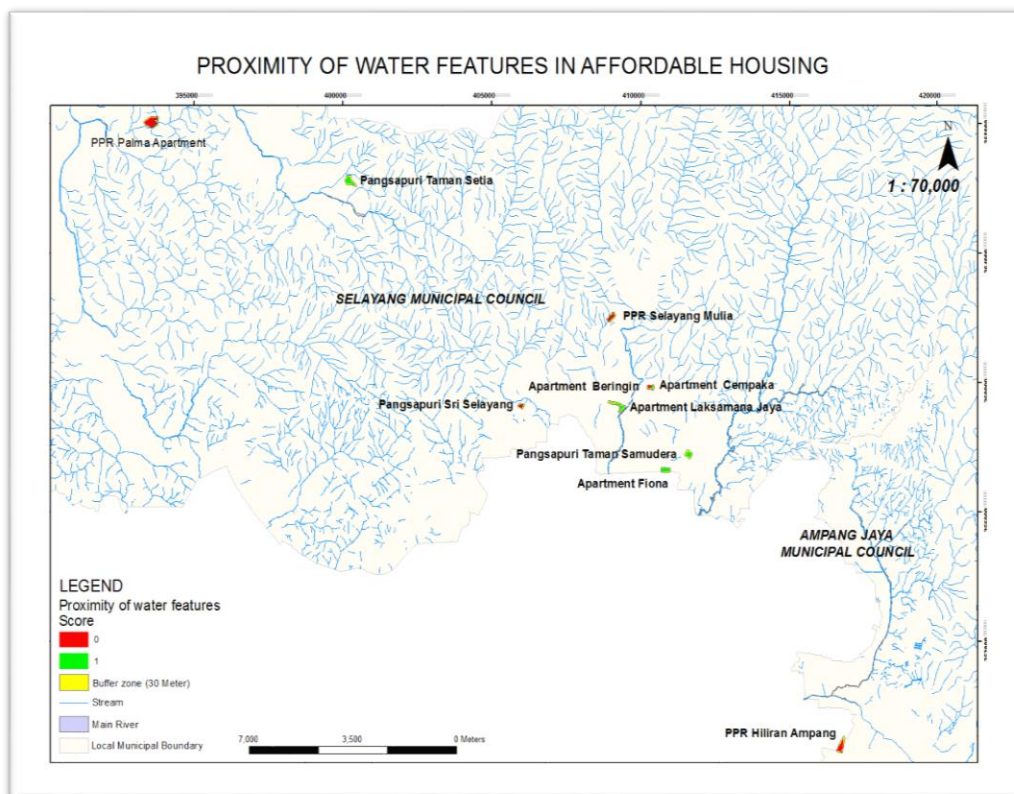


Figure 4. Mapping of proximity to water features score for the affordable housing.

Table 3. Score of proximity of water features in affordable housing.

No.	Affordable housing name	Distance of 30m with water features	Scores
1.	PPR Palma Apartment	Yes	0
2.	Pangsapuri Taman Setia	No	1
3.	PPR Selayang Mulia	Yes	0
4.	Apartment Cempaka	No	1
5.	Apartment Beringin	Yes	0
6.	Apartment Laksamana Jaya	No	1
7.	Pangsapuri Taman Samudera	No	1
8.	Apartment Fiona	No	1
9.	PPR Hilliran Ampang	Yes	0
10.	Pangsapuri Sri Selayang	Yes	0

3.3. Proximity of Flood Areas

Flood areas is ones of the indicator that used to identify the sustainability of affordable housing in term of environmental aspects, especially is risking areas. Therefore, the used proximity of flood areas indicator useful to identify which housing is located near to the disaster cause by natural phenomena. These points of flood areas are recognized as frequently happened in years according to the reference of JPS in Selangor State. The result is shown in table 4.

Table 4. Score of proximity of flood areas in affordable housing.

No.	Name	PFA	Total Score	Percentage of Sustainability
1.	PPR Palma Apartment	10	10	100
2.	Pangsapuri Taman Setia	10	10	100
3.	PPR Selayang Mulia	10	10	100
4.	Apartment Cempaka	2	2	20
5.	Apartment Beringin	2	2	20
6.	Apartment Laksamana Jaya	10	10	100
7.	Pangsapuri Taman Samudera	2	2	20
8.	Apartment Fiona	10	10	100
9.	PPR Hiliran Ampang	10	10	100
10.	Pangsapuri Sri Selayang	10	10	100
SUM		76	76	
Max Score PFA: 10				

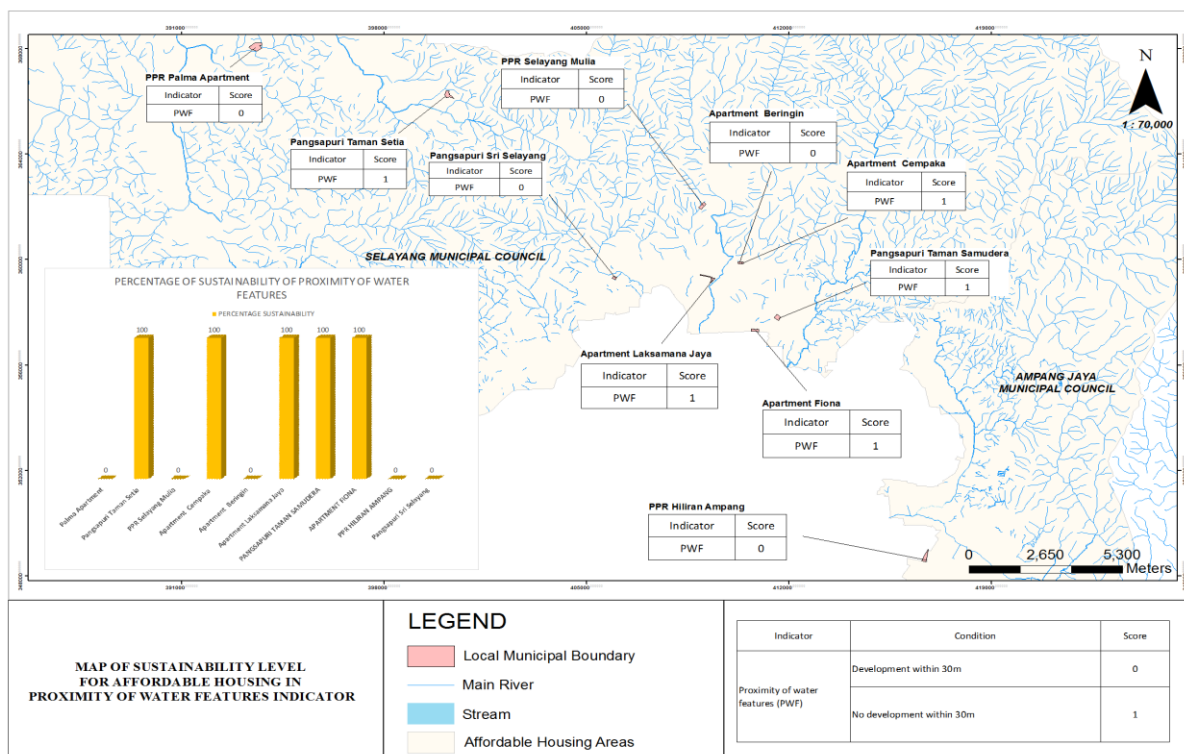


Figure 5. Mapping of proximity to flood area score for the affordable housing.

The results show the score of each affordable housing which only 30 percent of housing is located near to the flooded areas while 70 percent of each housing is located far from the flooded areas. This affordable housing is near flooded area, and set as within 500 meter and exceed this distance is known

as far. The nearest housing near to the flooded areas, it could be effect for the quality housing itself and their settlement.

In addition, the flooded areas also can be symbolic for a city with a very low quality of basic infrastructure, unplanned growth and rapid urbanization coupled with the effects of climate change means heavy rainfall can manifest as a catastrophic flood (Baker 2012; Global Footprint Network 2012). Thus, the nearest affordable housing near to the flooded areas can be shown that areas is in congested situation or consist problem on their water channel system that could be decreasing their sustainability. Figure 4.5 shown the map of the score of each housing.

3.4. Assessing Sustainability Level in Environmental Aspects of Affordable Housing

The final level of sustainability for affordable housing is calculated based on the total scores of all indicator used divided by total max score of all indicator used multiply by 100. These total max score for three used indicators is 16. The result is shown in Table 5 below.

Table 5. Sustainability Level for Affordable Housing from Environmental Aspects.

No.	Affordable housing name	AGS	PWF	PFA	Overall Total	Normalized Score
1.	PPR Palma Apartment	1	0	10	11	13.25
2.	Pangsapuri Taman Setia	0	1	10	11	13.25
3.	PPR Selayang Mulia	0	0	10	10	12.05
4.	Apartment Cempaka	0	1	2	3	3.61
5.	Apartment Beringin	0	0	2	2	2.41
6.	Apartment Laksamana Jaya	0	1	10	11	13.25
7.	Pangsapuri Taman Samudera	0	1	2	3	3.61
8.	Apartment Fiona	0	1	10	11	13.25
9.	PPR Hiliran Ampang	1	0	10	11	13.25
10.	Pangsapuri Sri Selayang	0	0	10	10	12.05
SUM		2	5	76	83	100.00
Total Max Score AGS, PWF, PFA		16				

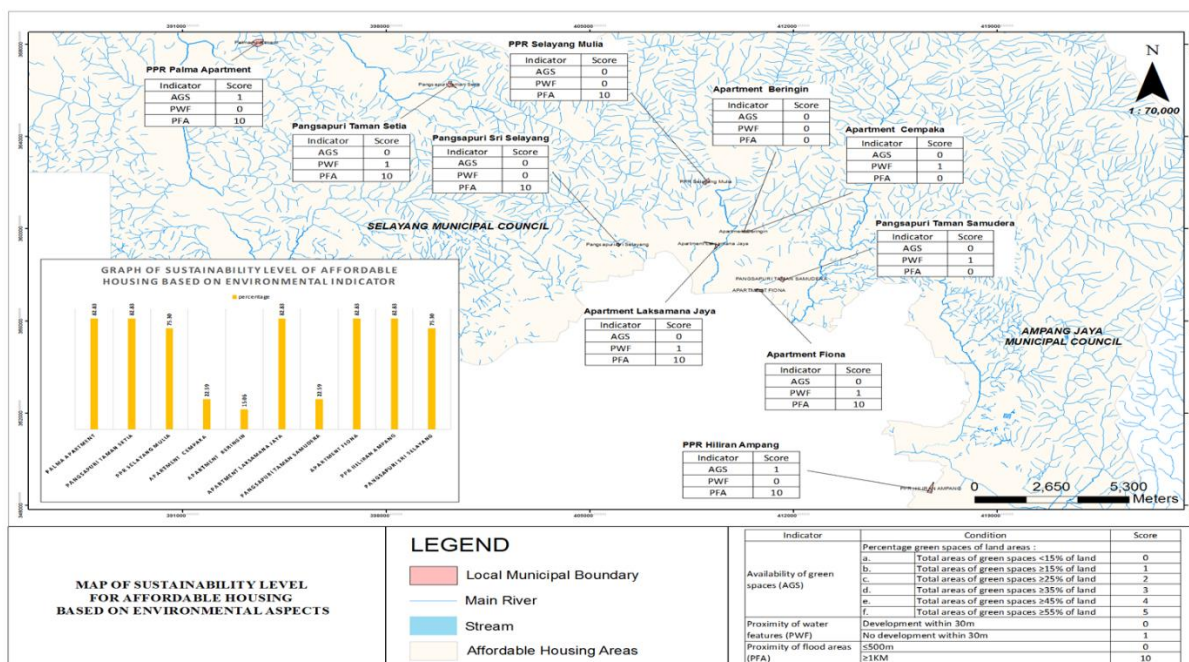


Figure 6. Map of sustainability level based on environmental aspect.

The results show that, the highest rated of sustainability level means, the more sustainable the housing areas. Based on the table, only 3 affordable housing is rated sustainability level below 30 percent while the other is exceed 50 percent for their sustainability level. However, housing with below 30 percent of sustainability level shown only Apartment Cempaka and Pangsapuri Taman Samudera have similar sustainability level at 22.59 percent while Apartment Beringin is 15.06 percent. Generally, PPR Selayang Mulia and Pangsapuri Sri Selayang shared the common sustainability level, which at 75.30 percent while PPR Palma Apartment, Pangsapuri Taman Setia, Apartment Laksamana Jaya, Apartment Fiona, and PPR Hiliran Ampang is rated at 82.83 percent of their sustainability level based on environmental aspects. Thus, it can be concluded that 82.83 percent is the highest sustainability level and the lowest sustainability level is 15.06 percent based on environmental indicators. Figure 6 show the map of sustainability level based on overall indicators (environmental aspect of sustainability).

4. Conclusion

Level of sustainability from the environmental aspect plays an importance studies in order to evaluate the environmental level in existing housing areas for future housing plan framework that environmental-friendly. From this study, this reliable information is essential for the government agency, local authorities to change, normalized the plan that meet environmental requirement for each construction companies, so that these companies will be more alert before the development started. The main aim of this study to measure the level of sustainability for the affordable housing based on the environmental aspects have been achieved.

For future recommendations, several aspects can be improving, including adding indicator of the noise pollution or air pollution can be used in analyze the level of the sustainability of the housing areas. Besides that, this study can be expanding by using flood risk vulnerability, and risk assessment for the flood risk assessment of sites studies instead of using point location of flood risk areas, as this suggestion capable to identify the which housing is effect based on the flood modelling.

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