Utilization of remote sensing imagery data to determine the priority location of green open space as child-friendly integrated public space in Palembang City

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Abstract. Palembang is a metropolitan city in Indonesia. As the second largest city in Sumatra, the population of Palembang in 2016 was 1,602,071 people, with a population density of 3,999 people / km². Meanwhile, the area of green open space has been reduced every year. Based on Minister of Public Works Regulation Number: 05/PRT/M/2008 concerning Guidelines for the Supply and Utilization of Green Open Space in Urban Areas, the percentage of urban areas used as green open space is a minimum of 30% of the total urban area, consisting of 20% public green open space and 10% private green open space. The existence of remote sensing imagery and geographic information systems, could help in determining the priority location of green open space as a child-friendly integrated public space in Palembang. The imagery that used in this research is Landsat 8 imagery, analyzed using ArcGIS 10.3. The research method is a quantitative method using a tiered approach. In general, the final result of the study is in the form of a map of priority locations for child-friendly integrated public space. The 5 Ulu urban village is the location that has the greatest potential to be developed into a child-friendly integrated public space.

1. Introduction
City is a concentration area of population with high density. Central of government, education, health, shopping, entertainment, etc. that are mostly located in the city. Focused activities in urban areas attract many villagers to move to the city. A city means a concentration of population in a particular geographical area which feeds itself relatively permanently from economic activities in the region [1].

Economic and population growth in urban areas is growing so fast, the need for land will also increase. The more land is built, the vegetation land will be decrease. Meanwhile, the existence of vegetation is very useful for supplying oxygen, absorbing carbon dioxide, also as a water storage. In essence the existence of urban green spaces can be used as a place for various types of vegetation to grow, whether in the form of urban forests, city parks, public cemeteries, green roadways, agricultural areas, and for other uses.

Green Open Space (RTH) is a longitudinal/lane and/or clustered area, its use is more open, place for plants to grow, both plants that grow naturally or intentionally planted [8]. Green open space is one component whose level of availability, both in quality or quantity, must always be maintained and considered in urban planning. The more reduced green open space due to limited land, the level of pollution in a city will be increase. According to [7] the loss of green open space in urban areas causes
psychological, emotional, and dimensional instability, so that the movement of people to move and think becomes confined.

Regulations regarding green open space in Indonesia were initiated by the Second Summit in Johannesburg, South Africa in Earth Summit II 2002 which agreed that cities must provide RTH, at least 30% of the city for ecological balance. It means that, provision of RTH to balance the ecosystem is useful for clean air provision, carbon dioxide absorption also reducing the greenhouse effect and urban heat island at once. Meanwhile, the Indonesian Minister of Public Works (PU) make a guideline for the provision and utilization of green open space in urban areas in the Minister of Public Works Regulation no: 05/PRT/M/2008, the percentage of urban areas that used as green open space is minimum 30% of the total urban areas, which consist of 20% public green open space and 10% private green open space. In fact, many cities in Indonesia tend to ignore these regulations.

The population of Palembang in 2016 is 1,602,071 people. According to city classification based on population, Palembang is categorized as a Metropolitan city. Palembang always experiences population growth every year. This matter cause a lot of land built, while RTH has been increasingly neglected. Quoted from one of the online newspaper media pages, Executive Director of the Indonesian Environment Forum (WALHI) of South Sumatra, Hairul Sobri, said that the green open space in Palembang City until May 2018 is still lacking, currently WALHI continues to ask the city government to add it. Based on government regulations (PP) no. 23 of 1998 the total area of Palembang city is 400.61 km². This means that the city of Palembang must provide open space of 120.19 km² consisting of an area of 80.12 km² of public green open space and 40.07 km² of private green open space. One form of green open space development is the Child-Friendly Integrated Public Space (RPTRA). RPTRA is expected to help increase public space facilities to fulfill children's rights in urban areas. Based on data from the Ministry of Women's Empowerment and Child Protection (KPPPA) until the end of December 2015 in South Sumatra province there were 12 district/cities from 17 district/cities that had initiated the development of KLA, but no one district/cities awarded as KLA (Child-Friendly District/City).

The term of RPTRA may not be known by most of people. Since August 2017, the City of Palembang together with 16 other districts/cities have declared child-friendly districts/cities. One form of support to the government's commitment to guarantee the fulfilment of children's rights so that they can grow and develop optimally according to their abilities, and get protection from violence, it is necessary to establish a Child-Friendly Integrated Public Space (RPTRA). RPTRA supporting Palembang City in realizing Child-Friendly City. Child Friendly City is a city that has a child rights-based development system through the integration of commitment and resources of the government plans, community and business world in policies, programs and activities to ensure the fulfilment of rights and protection of children.

In order for the development of child friendly integrated public spaces on target, it is necessary to determine where the potential location for development is. Determination of potential locations can be done by using remote sensing data and geographic information systems (GIS). Geographic information systems become a tools in processing, manipulating, analysing, and presenting data from remote sensing imagery. Remote sensing and geographic information systems must be integrated in order to obtain optimal information so the priority areas for the development of green open spaces can be obtained more accurately.

The purpose of this study is to determine the green space needs based on the area and to determine its availability, and to determine the potential location that can developed as a child-friendly integrated public space in the city of Palembang.

2. Research Methodology
This study uses a quantitative method with a tiered approach. This tiered quantitative approach gives different values for each parameter used in the analysis. Each parameter is given a value for its analysis, assuming that each parameter has an influence on each object that analysed. This approach has limiting factors for each component that composes it. The boundaries are not absolute but tiered, have class levels and their respective values.
The data used in this study are primary and secondary data. Primary data is obtained from observation and digital imagery interpretation. Secondary data in the form of regional data in figures obtained online. The weighting process using the Analytic Hierarchy Process (AHP) method. The analytic hierarchy process (AHP) is a structured technique for organizing and analysing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Salty in the 1970s and has been extensively studied and refined since then. Each parameter has different weights, according to the strength of its influence on the object under study. Weighting is using Expert Choice v11 software. To get the total score, each parameter is multiplied by the weight that has been obtained, then totalled and classified to get the priority class.

3. Results and Discussion
Palembang is the oldest city in Indonesia and is one of the oldest cities in the Malay Archipelago and Southeast Asia. Palembang was once the capital city of Sriwijaya kingdom, a powerful Malay kingdom which ruled many parts of the western archipelago and controlled many trade routes especially in the Strait of Malacca. At 2° 59′ 10″ S and 104° 45′ 20″ E, Palembang occupies 366.81 km² of vast lowland area east of Bukit Barisan Mountains in southern Sumatra with average elevation of 8 meters (26 feet), approximately 105 kilometres (65 miles) from nearby coast at Bangka Strait. One of the largest rivers in Sumatra, the Musi River, runs through the city, dividing the city into two major parts which are opposite Ilir in the north and across Ulu in the south. Palembang is located in the confluence of two major contributors of Musi River, which are Ogan River and Komering River. The river's water level is influenced by tidal cycle. In rainy season, many areas on the city are inundated by the river's tide. Palembang's topography is quite different between Seberang Ilir and Seberang Ulu area. Opposite Ulu topography is relatively flat, meanwhile across the topography is more rugged with altitude variation between 4 and 20 meters (13 and 66 feet). Palembang is located in the tropical rainforest climate with significant rainfall even in its driest months. The climate in Palembang is often described with "hot, humid climate with a lot of rainfall throughout the year". The annual average temperature is around 27.3 °C (81.1 °F). Average temperatures are nearly identical throughout the year in the city. Average rainfall annually is 2,623 millimetres. During its wettest months, the city's lowlands are frequently inundated by torrential rains. However, in its driest months, many peatlands around the city dried, making them more vulnerable to wildfires, causing haze in the city for months.

Administratively, according to Regional Regulation of Palembang City no. 19 year 2007 concerning extension of urban village of Palembang Subdistrict Regulation no. 20 year 2007 on district expansion, the region of Palembang city administration to change the number of subdistricts and urban village, where the current number of subdistricts in Palembang city into 16 subdistricts and 107 urban villages that were previously only 14 subdistricts and 103 urban villages. Two new subdistricts are wide reed Subdistrict which is an infraction of the Sukarami subdistrict and Sematang Subdistrict which is a fraction of the Sako Subdistrict. While the four new villages are Talang jambe, which is the contraction of Talang Betutu urban village, Sukodadi, which is the contract of Alang-Alang Lebar urban village, Sako Baru which is fraction of Sako urban village. And the last, Karya Mulya urban village which is fraction of Sukamulya urban village (Palembang Municipality in Figures, 2017). However, based on the latest data, the number of subdistricts currently (2018) has increased to 18 subdistricts. Subdistrict data that used in this study came from poses with the number of subdistricts, namely 17 sub-districts, but the number of urban village remained the same, 107 urban villages.
Palembang is roughly divided by Musi River into two major areas known as Seberang Ilir in the north and Seberang Ulu in the south. Seberang Ilir is the main economic and political centre in Palembang. Some areas such as 16 Ilir, Cinde, and Km 5 are the major retail hub in Palembang while other areas like Ilir Barat Permai, Campus, and Patal Pusri are growing into major business centres contained a prominent portion of the city's highrises. Major residential areas in Seberang Ilir such as Tangga Buntung, Bukit Besar, Sekip, Pakjo, Kenen, Pasar Kuto, and Lemabang. Seberang Ulu is divided into three main neighbourhoods which are Plaju, Kertapati, and Jakabaring. Seberang Ulu is less developed than its counterpart, but this area is undergoing massive development, especially in Jakabaring, with the construction of business centre, government building, and the most notably is the construction of the city's sport complex, Jakabaring Sport City.

3.1. RTH Needs Based on Area

Based on the Indonesian Minister of Public Works (PU) make a guideline for the provision and utilization of green open space in urban areas in the Minister of Public Works Regulation no: 05/PRT/M/2008, the percentage of urban areas that used as green open space is minimum 30% of the total urban areas, which consist of 20% public green open space and 10% private open space. The administrative borders used in this study are based on the Regional Spatial Plans of Palembang 2012-2032. To calculate the total area as a whole, the calculation can be done using imagery and certain geometric formulas. From the results of imagery processing, the total area of Palembang city including the watershed is an area of 366.81 km². The total area designated as green open space is 110,043 km² (30% of the total area of Palembang) consists of 73,362 km² public open spaces and 36,681 km² of private open space.
3.2. Availability of Palembang City Green Open Space in 2017

To find out the availability of green open space can be done by processing satellite imagery. The imagery that used is satellite imagery data from Landsat 8, path 124 row 061. Compared to the previous versions, Landsat 8 has several advantages, especially related to the specifications of the bands owned and the length of the spectrum of electromagnetic waves captured. The object colour in the imagery is composed of 3 basic colours, namely red, green and blue (RGB). With the increasing number of bands as RGB composite composers, the object colours become more varied. This Landsat 8 imagery is used to calculate the availability of green open space in the city of Palembang. The classification process is carried out using a supervised classification technique to produce land cover data. According to [9] this supervised classification involves analyst interaction intensively, where the analyst guides the classification process by identifying objects in the imagery (training area). Then the sampling needs to be done by considering the spectral pattern at each particular wavelength, so that a good reference area is obtained to represent a particular object.

Based on the analysis of Landsat 8 imagery data regarding the availability of green open space, the imagery shows the availability of Palembang's green open space in 2017 in each subdistrict in Palembang. The following is the percentage of land cover in Palembang in 2017 that has changed compared to previous years.

Table 1. Land cover of Palembang city 2017 in the percentage form

| No. | Landcover     | Area (km²) | Percentage (%) |
|-----|---------------|------------|----------------|
| 1   | Vegetation    | 123.83     | 33.76          |
| 2   | Watershed     | 19.02      | 5.19           |
| 3   | Non-Vegetation| 223.95     | 61.06          |
| Total|               | 366.81     | 100.00         |
The total area of green open space reaches 123.83 km². When compared to the availability of green open space in 2007, in 2017 the area of green open space decreased by an area of 105.76 km². Meanwhile, the development of Palembang city over the past ten years has experienced rapid growth. Many green open lands transform into land build. Economic growth and the increasing number of populations contributed to the conversion of the land. The increasing of various economic activities such as the tourism economy, trade and services, as well as the construction of various other important facilities became an attraction for the people around Palembang to live in Palembang [10]. Meanwhile, based on population projection in 2016, the population of Palembang City is 1,602,071 people consisting of 802,990 male inhabitants and 799,081 female inhabitants. Compared to the 2015 population projection, Palembang's population growth 1.36 percent. The more of population, the more for settlements need will be, so that a lot of green open space will turn into a residential area.

Figure 3. Classification of land cover in Palembang city in 2017

3.3. Determination of Priority Urban Village
Determining the location of priority for the development of green open spaces child-friendly integrated public space, first elections were made to urban villages that have potential classes 1 and 2 for further research, so the research more detailed. Determining the potential urban village, the parameters used are slum level, poor population density, school-age child density, and level of vulnerability to crime (material by the park and funeral service of DKI Jakarta). The data used is the result of more advanced processing of data on village potential in 2016 and Palembang in figures in 2017. The following are maps and classifications:
From the four parameters above, the overlay is then performed by determining the weight weights of each parameter using Analytical Hierarchi Process (AHP). According to [4] AHP is a multicriteria decision making with the support of a methodology that has been recognized and accepted as a priority which can theoretically provide different answers to the problem of decision making and rank alternative solutions. Data processing uses Expert choice v11 software. Next is the weighting.

### Table 2. Parameter weighting

| No. | Parameter                                   | Weight |
|-----|---------------------------------------------|--------|
| 1   | Slum level                                  | 21.50% |
| 2   | Poor population density                     | 30.00% |
| 3   | School-age child density                    | 40.50% |
| 4   | The level of vulnerability to crime         | 8.00%  |
|     | Total                                       | 100.00%|

From the table above can be seen, the parameter that has the greatest weight is the density of school-age child is 40.5%, then the weight density of the poor population is 30%, the slum level is 21.5%, and the crime rate is 8%. The level of inconsistency in weighting is 0.05, meaning that the data used is consistent and can be used as a weighting in the overlay process. The overlay process is done using ArcGIS software version 10.3. The following is a map of priority urban villages that potential to be developed as RPTRA.

After obtaining five potential urban village classes, the clipping process was then carried out on two potential classes, namely potential 1 and 2. The urban villages were 1 ulu, 10 Ilir, 11 Ilir, 11 Ulu, 12 Ulu, 13 Ilir, 13 Ulu, 14 Ilir, 18 Ilir, 2 Ulu, 20 Ilir DIV, 22 Ilir, 23 Ilir, 24 Ilir, 26 Ilir, 27 Ilir, 29 Ilir,
3/4 Ulu, 32 Ilir, 36 Ilir, 5 Ulu, 7 Ulu, 9/10 Ulu, Kuto Batu, Plaju Ilir, Plaju Ulu, and Tuan Kentang. The following is a map of priority urban villages for the development of RPTRA.

Figure 8. RPTRA potential urban village
Figure 9. Map of RPTRA priority urban villages

3.4. Determination of RPTRA Priority Locations
Determination priority locations that can be developed as RPTRA, researchers used four parameters. These parameters are land cover, vegetation density, land surface temperature, and range of distance from the road.

Land cover in priority urban villages is done through processing data obtained from the Indonesian earth map from the scale of 1: 50,000 from the Geospatial Information Agency (BIG). The classification standards used by BIG are prepared based on the UNFAO and ISO 19144-1 land cover classification system. The use of the UNFAO land cover classification system allows monitoring and reporting of land cover changes in a country that has acceptance at the international level. The more detailed classes are arranged, the more classes will be used. Land cover classes in this group are classified into three classes by giving scores from the highest to the lowest, namely 5, 3, and 1.

To measure the land surface temperature, researchers used imagery in Landsat 8 on band 10. The Land Surface Temperature (LST) is the radiative skin temperature of the land surface, measured in the direction of the remote sensor. It is estimated from the Top-of-Atmosphere brightness of the infrared spectral channels of a constellation of geostationary satellites. LST is a mixture of vegetation and bare soil temperatures. Because both respond rapidly to cover and aerosol load modifications in incoming radiation and cloud diurnal variation of illumination, the LST displays are quick variations too. In turn, the LST influences the partition of energy between ground and vegetation, and determines the surface air temperature. The surface temperature of a region can be identified from Landsat satellite imagery extracted from thermal bands. In remote sensing, ground surface temperature can be defined as an average surface of a surface, which is described in the range of a pixel with different types of surfaces. The following are the classes in LST with scoring from highest to lowest with average class temperatures between 24-27 °C, 27-29 °C, <24 °C, 29-31 °C, and> 31 °C.
In determining the distance range from the road, researchers used proximity analysis with buffering techniques. Buffering is the process of building a supporting layer around the layer within a certain distance to determine the close relationship between the properties of the existing part. The closer distance range from the road, the score is greater. Roads used in this study are primary arterial roads, secondary arteries, primary collectors, secondary collectors, and local roads obtained from the regional spatial plan of Palembang city in 2012-2032. The following is the range of distance from the road from the highest score of 0-100 meters, 101-200 meters, 201-300 meters, 301-400 meters, and > 400 meters.

Maps that have been processed above are then given a score in accordance with the provisions. The map is overlayed to obtain over-stacking data from each parameter. Next, the data is overlayed by using a tools of union. Union is combining/overlaying two features/data. Merging these two features will produce a new feature, where all the following features will be included in the attributes. But keep in mind that only polygon data can be combined using union functions. The resulting polygon is a combination of all polygons that participate in the union process. Overlay in GIS is the ability to place a graph of one map on top of another map graphic and display the results in the form of a composite map of several parameters stacked together, and have attribute information from the maps overlayed. Whereas union is combining features from an input theme with polygons from the overlay theme to produce output that contains levels or attribute classes. Each score of each parameter will be added by multiplying it first on the weight of each parameter. Determination of weight is done using AHP. The following are the weights of each parameter. The land cover weight is 43%, vegetation density is 29%, land surface temperature (LST) is 9%, and the range of land coverage is 19%. Here are the maps (Fig 10-13).

The following is the formulation in the classification of RTH priority locations as RPTRA. Interval class

\[ \sum \text{Interval class} = 1 + 3.3 \times \log n = 1 + 3.3 \times \log 4 = 1 + 3.3 \times 0.602059 = 2.98 \approx 3 \]
Range class \( i \) = \( \frac{(\text{highest score} - \text{lowest score})}{\text{number of interval class}} \) = \( \frac{376 - 118}{3} \) = 86

Distribution of interval classes
1. Class a (lowest score value + value i)
2. Class b (class a value (+1) + value i)
3. Class C (greater than class B limit)

Table 3. Priority classification of RPTRA locations

| No | Score | Information            |
|----|-------|------------------------|
| 1  | 118-204 | Priority 3 (not prioritized) |
| 2  | 205-290 | Priority 2 (prioritized)    |
| 3  | 292-376 | Priority 1 (very prioritized) |

Figure 14. RPTRA development priority locations

At the map above, can be seen that the red area is the priority area 1, the yellow area is the priority area 2, and the green area is the priority area 3. Based on visual observations on the map, the potential area is kelurahan 5 ulu, 3/4 Ulu, 7 Ulu, 9/10 Ulu, 23 Ilir, 32 Ilir, and a few others are in other urban villages. However, the greatest potential urban village to be developed as RPTRA based on its area is the urban village of 5 Ulu. Administratively, the 5 ulu urban village is located in Seberang Ulu I subdistrict. It has a relatively low topography, between 0-3. Elevation 0-3 is the widest elevation, which about 1579.82532 ha (93.75%). Most of the plains in the opposite subdistrict of Seberang Ulu I are relatively flat with a slope of around 0-2% [5]

The population of the Seberang Ulu I subdistrict based on BPS in 2017 amounted to 179,164 people. Subdistrict which has the largest population in the city of Palembang. According to [3] the cause of the high population in Seberang Ulu 1 subdistrict due to the high birth rate caused by people who still adhere to the principle of many children is plenty of sustenance, the high rate of young marriage is due to the assumption that girls 12 years old are considered not sold. In addition, there is a high level of migration, which is caused by easier access the Seberang Ulu 1 subdistrict from Ogan Komering Ilir and Ogan Ilir districts.
The 5 Ulu urban village, which is the second highest urban village with the highest population, has a population of 26,506 people, consisting of 13,438 men and 13,068 women. The population density of the 5 Ulu urban village reaches 77.50 people/ha. Meanwhile, quoted from the Reference Data page of the Ministry of Education and Culture (http://reference.data.kemdikbud.go.id/), the number of students based on the location of the schools in the 5 Ulu urban village reached 2,430 students. The 5 Ulu urban village is one of the most appropriate areas to be developed as a child-friendly integrated public space. In addition to having a high population density and the number of high school age children, the 5 Ulu urban village also has untapped vacant land. Based on monitoring using Google Earth Imagery Date 5/24/2018, there are quite a number of potential areas that have the potential to be developed as integrated child-friendly public spaces.

![Potential Location of RPTRA](image)

**Figure 15.** RPTRA Potential Location in 5 Ulu urban village (*Source: Google Earth*).

### 4. Conclusion

Palembang is a metropolitan city that continues to experience economic growth and population growth. As a result of it, the area of green open space continues to decrease every year. Based on Minister of Public Works Regulation Number: 05/PRT/M/2008 concerning Guidelines for the Supply and Utilization of Green Open Space in Urban Areas, the percentage of urban areas used as green open space is a minimum of 30% of the total urban area, consisting of 20% public green open space and 10% private green open space. The total area that should be designated as green open space is 110,043 km² (30% of the total area of Palembang) consists of 73,362 km² public open spaces and 36,681 km² of private open space. Meanwhile, based on the analysis using the Lansat 8 satellite image in 2017, the availability of green open space area reached 123.83 km². When compared to the availability of green open space in 2007, in 2017 the area of green open space decreased 105.76 km². For the availability of green open space in urban areas to be fulfilled, it is appropriate to protect it. One way to keep it is to determine where the right location to be used as green open space. From the 107 urban villages in Palembang, there are 27 priority urban villages of RPTRA. The location of RPTRA is done by overlaying the parameters based on land cover characteristics, vegetation density using the SAVI index, land surface temperature, and the range of distance from the road. The final map shows there are 6 urban villages which can be categorized as the first priority area. The location in the 5 Ulu urban village is the location of the urban village that has the greatest potential to be developed as a child-friendly integrated public space.

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