Distribution Of Slums, Building Configuration, And Land Cover Composition In Banjarmasin City, South Kalimantan Province, Indonesia Using A Geographic Information System

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Research Article

Distribution Of Slums, Building Configuration, And Land Cover Composition in Banjarmasin City, South Kalimantan Province, Indonesia Using a Geographic Information System

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Abstract

On This research aims to analyze the distribution of slums, building configuration, and land cover composition in Banjarmasin City, South Kalimantan Province, Indonesia by using a geographic information system. Material and methods: To determine the existing conditions of space utilization for various types of designation, a Geographic Information System (GIS) is used with an overlapping technique (overlay). The map of land utilization used is the 2014-2019 map. Result: In 2019 it is also known that the distribution of slum areas in Banjarmasin City is evenly distributed with the category of light-slum and is divided into 52 locations in 5 Districts. In 2019 it was discovered that all land on the riverbanks has been covered by buildings. The settlement areas in Banjarmasin City continues to grow, in 2014 the area was 3712.28 ha (37.70%) while in 2019 the area was 5182.20 ha (52.63%). The use of water bodies especially swamp, began to decrease due to the expansion of the settlement areas. The use of water bodies in 2014 was 677.73 ha (6.88%), this use was reduced by about 2% in 2019 to 675.53 ha (6.86%). The use of land as dry agricultural land also decreased very drastically. In 2014 the area was 2441.94 ha (24.80%), while in 2019 the area was 911.30 ha (9.26%). Conclusion: The overlay results from land utilization and building configuration are very helpful in formulating policies for spatial planning and slum settlements in Banjarmasin City. Based on the results of the analysis, it is known that the area of settlements is increasing, and it reduces the use of water bodies, especially swamp. This can affect the quality of the river's carrying capacity in terms of its spatial and ecology.

Keywords
Distribution of slums, building configuration, land cover, Banjarmasin City

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Introduction

Slum settlements are a problem faced by almost all big cities in Indonesia, even big cities in other developing countries. Slum settlements are settlements that are unfit for habitation due to building irregularities, high building density levels, building quality, as well as facilities and infrastructure that do not meet the requirements (Law No.1 of 2011). One of the factors in the formation of slum settlements is urbanization which has an impact on the increasing number of poverty in urban areas. The high population living in urban areas causes the expansion of built up areas, in addition, the rapid physical development of urban areas in suburban areas also has an impact on the creation of slum pockets in urban areas (Bah, Faye, & Geh, 2018; Daniel et al., 2015; Michiani & Asano, 2019; Nakamura, 2014; Pedro & Queiroz, 2019; Quattri & Watkins, 2019).

The increase in population accompanied by high urbanization causes development problems in terms of providing housing facilities to become increasingly urgent, especially in urban areas. The high price of land in the city center and low-per capita income cause people to tend to look for settlements in suburban areas with inadequate environments and supporting facilities. Some of the problems associated with slum settlements are inadequate sanitation, poor hygiene practices, overcrowding and contaminated water, all of which can create unsanitary conditions. Diseases related to this include dysentery, cholera, diarrhea, typhoid, hepatitis, leptospirosis, malaria, dengue fever, scabies, chronic respiratory diseases, and intestinal parasitic infections that occur in these slum areas (Bah et al., 2018; Nakamura, 2014; Olthuis et al., 2015; Roy & Lees, 2020).

Banjarmasin as one of the big cities in South Kalimantan Province also has slum areas that contain various physical, social and economic problems. These slum areas become pockets of poverty in urban areas which always cause social and economic problems. Slum areas in Banjarmasin are scattered throughout the city by occupying marginal land such as riverbanks, road borders, commercial/trade and service areas, as well as urban legal land such as state land, green land/lane, vacant land does not belong to the government. Nearly 40% of the slum areas in Banjarmasin City are located on swampy land (wetlands) and riverbanks with an average altitude of 0.16 m below sea level, with relatively flat land conditions and slopes ranging from 0 - 3% (Annisa, Prasetia, & Riduan, 2019).

The slum area in Banjarmasin City has a dense and irregular population. The slum residents insist on occupying these places because it gives them the possibility to stay and live in the city. Their settlement areas which are located in the center or suburbs of the city provide the best accessibility to the workplace. The factors or problems of slum settlements in Banjarmasin City include the problems of environmental facilities and infrastructure such as housing with unsanitary and temporary lighting, air or toilets condition, this causes the settlement to be very susceptible to fire and environmental health problems (Dahliani, 2016; DAHLIANI, 2018).

In order to prevent negative impacts on the environment, before development activities are carried out, its feasibility needs to be identified from a bio-geophysical perspective, so that the suitability of the use of each location can be determined. One way to solve the problem of slum settlements is the principle of geographic information systems (GIS). The advantages of using this system are that the data is easy to update at any time and because it is spatially based, the data can be accessed in real terms in the field because it has a clear geographical address in the form of coordinates and can be easily overlaid with other spatial themes so that it is easy to analyze, and can produce other new spatial data (Adulkongkaew et al., 2020; Annisa et al., 2019; Bajjali, 2017; Bhattacharya, Chatterjee, & Das, 2020; Chowdhury, Hasan, & Al-Mamun, 2020; Muchadenyika & Waiswa, 2018; Prasetia et al., 2021; Riduan, Prasetia, & Annisa, 2019; Schaefer & Thinh, 2019; Singh, Bhardwaj, & Verma, 2020; Tadese et al., 2020; Tateosian, 2015; Wang, Kuffer, & Pfeffer, 2019). With the use of GIS technology, it is hoped that detailed and comprehensive information on the conditions of slum settlements in Banjarmasin City can be obtained. This information will be used to determine recommendations for suitable and efficient land management.

Materials And Methods

Area Studies

This research is focused on the city of Banjarmasin. Astronomically, Banjarmasin City is located at

3 ° 16 '46 " - 3 ° 22' 54" South Latitude and 114 ° 31 '40 " - 114 ° 39' 55" East Longitude, with a land area reaching up to ± 98.46 km or 0.26% of the total area in South Kalimantan Province. The city of Banjarmasin located at an average altitude of 0.16 m below sea level with a relatively flat, marshy area. During high tide, almost the entire area is inundated by water. Banjarmasin City is located on the east side of the Barito River, split by the Martapura River and has many river brooks which are spread almost evenly throughout the city. In general, the geographical condition of Banjarmasin City is a lowland area with a relatively flat surface. The general condition of Banjarmasin City is a swampy area that is highly influenced by tides, located at an altitude of 0.16 m below sea level, brackish water, relatively flat topography, hot temperature (28-35 ° C), high rainfall (2,400-3,500 mm/year), and is dominated by alluvial soils (Dahliani, 2016).

The Process of Evaluating the Distribution of Slums, Building Configuration, And Land Utilization

To determine the distribution of slums, existing conditions, and space utilization in various types of designation, a Geographic Information System (GIS) is used. This analysis was performed using an overlapping technique (overlay). Geographic Information System (GIS) is an information system used to enter, store, recall, process, analyze, and generate geographically referenced data or geo-spatial data to support decision making (Bajjali, 2017; Tateosian, 2015). Data relating to the research area include:

1. Earth Map of Indonesia, Scale 1: 50,000, BIG in 2018
2. Base Map of Banjarmasin City
3. Interpretation of the 2019 Google Satellite Imagery

Spatial Dimensions

To analyze a pattern based on spatial dimensions requires uniformity of the analysis unit so that the spatial distribution can be shown consistently. There are several approaches that can be implemented, but in this research an administrative approach was used with consideration of the availability and ease of obtaining data. This approach seeks to analyze the spatial distribution of land utilization changes through an administrative analysis unit (Bajjali, 2017; Tateosian, 2015). The operational procedure is carried out in four stages, namely:

(1) Displaying the administrative boundaries (R.T /Sub-Village/Village/District) located in the research area. In this research the district administration unit was used as the basis for analysis.
(2) Calculating the area of land utilization per administrative unit in year (t1) and year [t2].
(3) *Matching* between land area data at point [t1] and land area data at point (t2) in the administrative unit is used as the basis for analysis.
(4) In-depth analysis of each form of land utilization in each district, among others:

(a) the area of open land utilization forms;
(b) the area of settlement land utilization forms;
(c) the area of dry agricultural land utilization forms;
(d) the area of dry agricultural land mixed with shrubs utilization forms;
(e) the area of rice fields utilization forms.

Data Analysis and Processing

Data analysis and processing were performed on QGIS Chugiak 2.4.0 software. After going through the digitization process, the data that has been obtained are classified in advance so that it can be used as attributes for database compilation. Digitization in general can be defined as the process of converting analog data into digital format. Objects such as roads, houses, rice fields, etc. that were previously in raster format on a high-resolution satellite imagery can be converted into digital format by digitizing. Each of the variables in the compilation of land cover categories will produce one spatial data which will then be overlaid, either in the form of intersection or union to obtain a new spatial data (Adulkongkaew et al., 2020; Annisa et al., 2019; Bajjali, 2017; Chowdhury et al., 2020; Prasetia et al., 2021; Riduan et al., 2019; Tateosian, 2015).

Geometric correction or rectification is a step so that imagery data can be projected according to the coordinate system used. The reference for this geometric correction can be in the form of a base map or previously corrected imagery data. After the process above, the Cropping Area process is conducted, which is the process of cutting the research area according to its administrative boundaries, making it easier for the next process. Accuracy Calculation is a comparison between the classification result data with field conditions. In other words, the process is by conducting checking and taking several samples in the field as a comparison (Bajjali, 2017; Bhattacharya et al., 2020; Muchadenyika & Waiswa, 2018; Singh et al., 2020; Tadese et al., 2020; Tateosian, 2015).

Results And Discussion

General characteristics of Banjarmasin City

South Kalimantan is one of the Provinces in Indonesia which possesses many rivers and natural resources. Banjarmasin City possesses various types of cultural potential, especially those related to the existence of the river as an icon of this city, which is why the city is known as "the City of a Thousand Rivers". Banjarmasin City is located on Borneo Island which is geologically formed by alluvial deposits from the Barito River and the Martapura River. The city of Banjarmasin is about 23 km from the coast and is in the lowlands at an average altitude of minus 16 cm below sea level, and is influenced by the tides. The relatively sloping landscape of the city has resulted in the formation of wetland areas in the form of swamp, namely tidal swamps and there are hundreds of waterways both natural and artificial in the form of rivers and canals (Dahliani, 2016; RAHMAN, 2019).

The city of Banjarmasin is located about 50 km from the estuary of the Barito River and is split by the Martapura River, so that in general the morphological conditions of Banjarmasin are dominated by relatively flat areas and are located in the lowlands. This area is located below sea level with an average of 0.16 meters above sea level (MASL) with a slope of 0-2%. This condition is very supportive for urban development as a built-up physical area. However, the altitude of below sea level causes most of the city of Banjarmasin to be inundated swamps which are highly influenced by tidal conditions (Dahliani, 2016; RAHMAN, 2019).

Most of the lands in Banjarmasin City are tidal swamp. The river becomes a container for water flow so that when the tide rises, water will not enter the land. Canals (artificial rivers) that connect the two main rivers will be made to simplify and shorten the time of water transportation and to irrigate agricultural areas. So that in the city of Banjarmasin there are many rivers to anticipate flooding during high tides and heavy rains.

Topography that is considered in the land evaluation is the shape of the area (relief) or slope and the altitude of above sea level. Relief is closely related to land management factors and erosion hazards. Meanwhile, the factor of altitude above sea level is related to the requirements for plant growth related to air temperature and solar radiation. The altitude of a place is measured from sea level (MASL) as a zero point (Hillel, 2004; Prasetia et al., 2016).

Slope is the angle between the horizontal plane of the earth's surface (topography) to a line or plane drawn from the lowest point to the highest point in a certain area of land. From the observations in the field, it is known that Banjarmasin City has flat topographical conditions and the influence of the tidal overflow of sea water is more or as strong as the overflow of river water, which is fixed according to the cycles of the moon.

The architecture of houses in Banjarmasin City generally uses the construction of houses on stilts made of ironwood and galam wood rods (Dahliani, 2016). The construction of houses on stilts is a form of adaptation of housing to water bodies (Olthuis et al., 2015). The same can be seen in the adaptation of the community in the slum settlements in Lagos, Nigeria (Africa IRIN, 2006; Agence France-Presse in Lagos, 2014; Basckin, 2012; Mruaya, 2014), in Iquitos, Peru (Faldetta et al., 2014), or Dhaka, Bangladesh (Jabeen, Johnson, & Allen, 2010). This form of construction shows how slum settlements have adapted to flood risk by building stilts. Materials vary from wood to bamboo, depending on availability. This technique further incorporates seasonal adaptability. In the Belen slum in Iquitos, stilt housing is set up during the dry season (Faldetta et al., 2014; Olthuis et al., 2015).

From the geological structure, especially the lower part, Banjarmasin City is dominated by clays with fine sand inserts and alluvium deposits consisting of soft grayish-black clay. Generally, the soil

has a low pH (Dahliani, 2016). Soil with a low pH indicates that the soil contains Al which is poisonous and binds to P so that it cannot be absorbed by plants. A low pH value indicates that the soil acidity level is high and C-organic is also high for organic soils (Prasetia et al., 2016).

Distribution of Slum Settlements, Building Configuration, and Distribution of Total Population

Banjarmasin City is located at 3 ° 15 'to 3° 22' South Latitude and 114 ° 32 ' East Longitude, with an altitude of 0.16 m below sea level and almost the entire area is inundated by water at high tide. Banjarmasin City is located in the estuary area of the Martapura River which empties into the east side of the Barito River. Banjarmasin City is located almost in the middle of Indonesia. The city is located on the east bank of the Barito River and is split by the Martapura River. The city of Banjarmasin is influenced by the tides of the Java Sea, so it affects the drainage of the city and gives its own characteristics on the community life, especially the use of rivers as one of the water transportation infrastructures. Settlements in Banjarmasin City originate from settlements on the riverbanks, so that the settlements on the riverbanks have historical and cultural values for the city of Banjarmasin as a characteristic of a city of a thousand rivers. At the beginning of its development, the river was the main means of transportation. The development of the settlement arrangement on the riverbanks changed from a river as a front area to a rear area. Where the increase in settlements makes development increasingly push into the mainland because of limited settlements land and the increase in population decreases the quality of settlements so that slums are formed (Heldiansyah & Apriliani, 2019).

Slum areas in Banjarmasin City are determined based on the Decree of the Mayor of Banjarmasin Number 460 of 2015 concerning the Determination of the Location of Slum Settlements of Banjarmasin City of 2015. Based on the decree, the location of the slum settlements in the city of Banjarmasin is 549.7 ha. Based on the GIS analysis, the distribution of slum areas in the city of Banjarmasin is seen to be evenly distributed with the category of light-slum and is divided into 52 locations in 5 districts (
Figure *1*). The results of this analysis are in accordance with the data from the Department of Housing and Settlements Area of Banjarmasin City in 2020 which states that some settlements in the Banjarmasin City area are classified as light-slum categories. In detail, the area of slum settlements in each district can be seen in Table 1.
Based on the results of the GIS analysis, it is also known that most of the riverbank areas in the city of Banjarmasin are covered with very tight buildings (Figure 2). The results of this research are in line with what is stated that all land located along the riverbanks in the Banjarmasin area has been covered by buildings. This can affect the quality of the river's carrying capacity in terms of its spatial and ecology. Functionally, the designation of land utilization in Banjarmasin is influenced by the resident activities in settlement areas. From the analysis of the diversity of land utilization, it can be seen that the land utilization pattern in the research area is linear with a focus close to rivers and roads as the center of orientation.

Table 1.
Recapitulation of Slum Areas in Banjarmasin City Based on District

No	Districts	Slum Areas (Ha)	Criteria
1	West Banjarmasin	48,45	Light-Slum
2	South Banjarmasin	126,12	Light-Slum
3	Central Banjarmasin	48,86	Light-Slum
4	East Banjarmasin	59,05	Light-Slum
5	North Banjarmasin	61,32	Light-Slum
Total		343,79	

Source: (Department of Housing and Settlement Areas of Banjarmasin City, 2020)

Population growth is the main cause of an increase in settlements in an area, including the city of Banjarmasin. Based on population analysis, the District of Central Banjarmasin has a very dense population. South Banjarmasin District has a relatively smaller population. Visualization of

population size can be seen in Figure 3. The population growth of Banjarmasin City which reaches 1.2% per year causes an increase in the need for settlement lands. The development of housing and settlement in Banjarmasin City aims to improve the quality of family and community life. In addition, a good environment around housing and settlements will create an atmosphere of harmony in life and social solidarity in the community (DAHLIANI, 2018; Michiani & Asano, 2019; Wimardana, 2016).

In 2014, the land utilization area in Banjarmasin City for settlement lands was 3,712.28 ha. The increase in land cover for settlements in Banjarmasin City was seen to be quite significant in 2017 to 5,137.89 ha. The rate of residential land cover increased by more than 50% in 2019 compared to 2014. The use of land for settlements has complex problems and management (Bah et al., 2018; Olthuis et al., 2015). Muta'ali and Nugroho (2019) added that there are simultaneously dominant factors that influence it, namely the increase in population and the industrialization process.

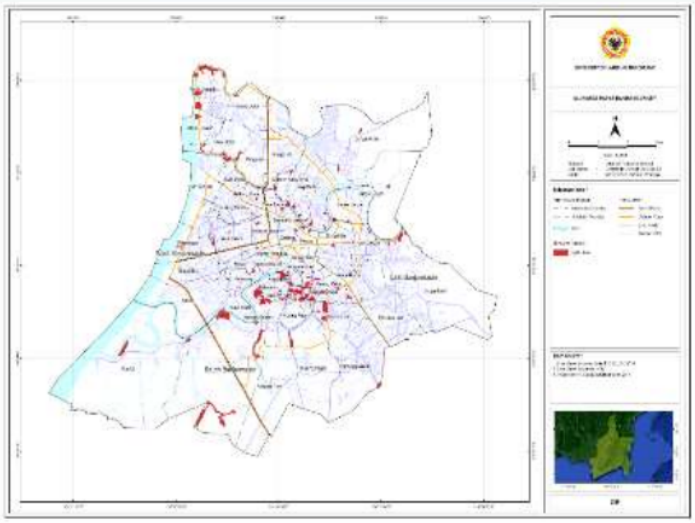

Figure 1. Distribution of Slum Areas in Banjarmasin City

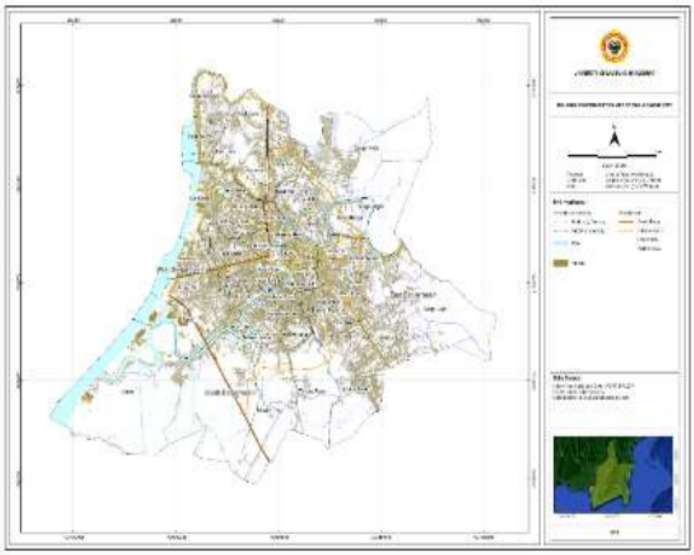

Figure 2. Building Configuration of Banjarmasin City

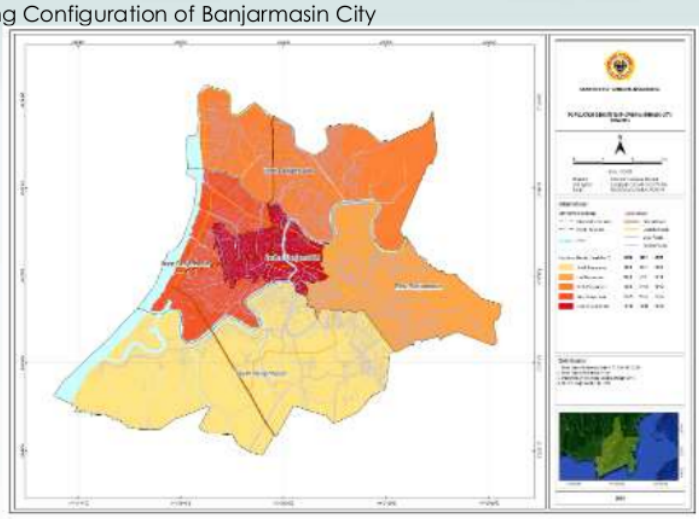

Figure 3. Population Density of Banjarmasin City Based on District

Land Utilization in Banjarmasin City

The geographical factors in this case include the layout and availability of land. Land in urban areas, especially in the housing sector, will be increasingly expensive and difficult to obtain. Difficult access to land for low-income communities, among others, is due to the results of land speculation, excessive land ownership rights from certain parties, legal aspects of ownership and unclear government policies in dealing with existing land problems (Muta'ali & Nugroho, 2019). Although the need for land is very much needed, especially the provision for low-income community housing, positive efforts and the government in developing countries to overcome this problem have not been evident. Urban planners as well as policymakers in local and central government do not usually see the need for land provision efforts for low-income community housing. They tend to reject the fact that low-income communities really need land for housing in the cities for their survival (Debnath, Bardhan, & Sunikka-Blank, 2019; Meredith & MacDonald, 2017; Muchadenyika & Waiswa, 2018; Pedro & Queiroz, 2019; Wang et al., 2019).

This is the reason for the emergence of slum settlements in big cities, especially in Indonesia, which is inseparable from the phenomenon of population mobility, which is indicated by the presence of centripetal and centrifugal movements. Centripetal and centrifugal movements refer to the *dynamic forces theory*. In his theory, Colby argues that a *dynamic force theory* will affect a change that occurs in land utilization, especially as a settlement/residential area in a city and in the surrounding suburbs (Colby, 1933). This dynamic power theory states that in a city there are two kinds of movements that play a major role in influencing the changing conditions of land utilization, especially for settlement lands, these movements are centripetal and centrifugal movements (Muta'ali & Nugroho, 2019).

Both of these movements occur because of the factors of centripetal (*centripetal force*) and centrifugal (*centrifuge forces*) where centripetal and centrifugal are forces that act as a pulling and driving force. The two forces have opposite properties and both play a role simultaneously in creating both centripetal and centrifugal movements. Centripetal and centrifugal movements in *dynamic force theory* according to Colby is a centrifugal movement that is emphasized on monocentric urban areas so that the suburban areas is not considered as focus of analysis (Christiawan, 2019; Colby, 1933).

Referring to the Banjarmasin City Regional Spatial Plan (RTRW) of 2013-2032, it has an administrative area of 9,953.88 ha consisting of 5 districts and 52 sub-districts. Based on the RTRW, the spatial plan for the Banjarmasin city area is divided into 2 (two), namely: Protected Areas and Cultivated Areas (Department of Housing and Settlements Area of Banjarmasin City, 2020). The cultivation areas stated in the RTRW include national cultivation areas and urban cultivation areas. The urban cultivation areas include 8 (eight) areas, one of which is a settlement areas. The

development plans for the settlement areas of Banjarmasin City in the 2013-2032 RTRW include:
a. High density housing with an area of 160.91 ha located in the downtown area, covering the area of Seberang Masjid, Pekapuran and Kelayan.
b. Medium density housing with an area of 1,018.08 ha located in the West Banjarmasin area.
c. Low density housing with an area of 3,594.54 ha located in the Andai River Area, North Banjarmasin District and Mantuil and Basirih Area in South Banjarmasin District, Lulut River Area, East Banjarmasin District.

The next visible aspect of land utilization is the land distribution pattern. This distribution pattern will take a look at the distribution pattern of land functions which will encourage the creation of various interactions of community activities within. At the location of the observation the land utilization pattern is based on the activity patterns which is based on the ease of connection between residents and the reach of road infrastructure so that it affects the orientation of the buildings (Muta'ali dan Nugroho, 2016).Based on the results of the GIS analysis, it is known that the area of settlements in Banjarmasin City continues to grow, in 2014 the area was 3712.28 ha (37.70%) while in 2019 the area was 5182.20 ha (52.63%). In its development, the settlements were more landward due to the formation of land roads. Water transportation is becoming obsolete, while road transportation is growing. Land conditions have also changed. The use of water bodies, especially swamp, began to decrease due to the expansion of the settlement areas. The use of water bodies in 2014 was 677.73 ha (6.88%), this use was reduced by about 2% in 2019 to 675.53 ha (6.86%). This condition, according to Dahliani (2016) can reduce the water catchment areas and makes water cannot flow freely.

The use of land as dry agricultural land also decreased very drastically. In 2014 the area was 2441.94 ha (24.80%), while in 2019 the area was 911.30 ha (9.26%).
Table ***1*** explains in full the types of land use in Banjarmasin City in 2014-2019. Visually, land cover in 2014 can be seen at
Figure **4**, land cover in 2017 can be seen at
Figure **5**, while the land cover in 2019 can be seen at
Figure **6**.

Table 1.
Types of Land Utilization in Banjarmasin City in 2014 – 2019

No	Types of Land Utilization	Land Utilization in 2014 (ha)	%	Land Utilization in 2017 (ha)	%	Land Utilization in 2019 (ha)	%
1	Water Bodies	677.73	6.88	676.87	6.87	675.53	6.86
2	Dry Agricultural Land	2441.94	24.80	955.33	9.70	911.30	9.26
3	Dry Agricultural Land Mixed with Shrub	103.90	1.06	105.26	1.07	103.92	1.06
4	Rice Fields	2838.91	28.83	2970.64	30.17	2963.43	30.10
5	Settlements	3712.28	37.70	5137.89	52.18	5182.20	52.63
6	Open Land	71.24	0.72	-	-	9.63	0.10
	Total	9846.00	100	9846.00	100	9846.00	100

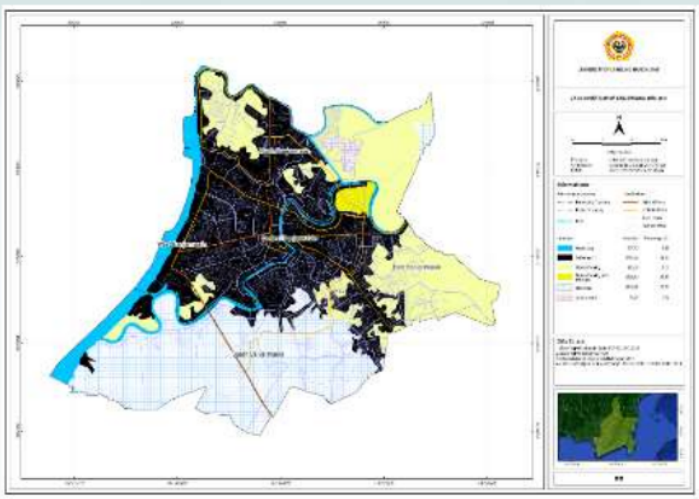

Figure 4. Land Cover of Banjarmasin City in 2014

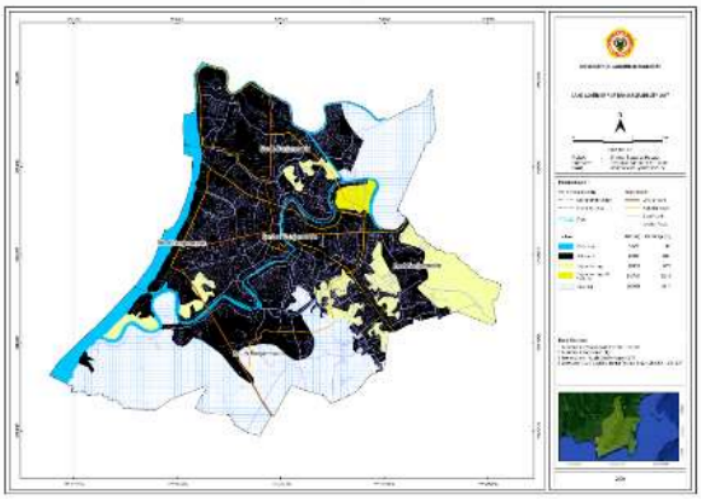

Figure 5. Land Cover of Banjarmasin City in 2017

Conclusion

This research presents demonstration results from GIS and remote sensing to evaluate land cover composition and building configuration in Banjarmasin City, South Kalimantan Province, Indonesia. The overlay results from land utilization and building configuration are very helpful in formulating policies for spatial planning and slum settlements in Banjarmasin City. Based on the results of the analysis, it is known that the area of settlements is increasing, and it reduces the use of water bodies, especially swamp. This can affect the quality of the river's carrying capacity in terms of its spatial and ecology.

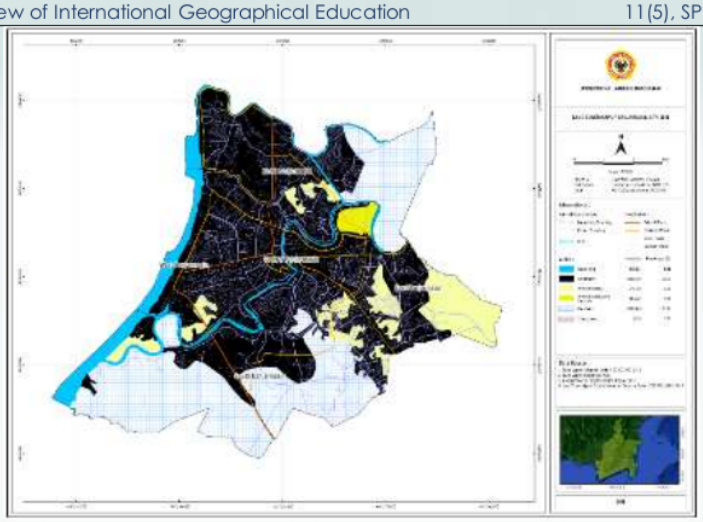

Figure 6. Land Cover of Banjarmasin City in 2019

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