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RESEARCH ARTICLE

Spatial-temporal Analysis Distribution of Buildings Martapura River Border in Banjarmasin City

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Abstract The role of the people of Banjarmasin City has long made the river a center of activity that has a dependence on river culture as a way of life, behavior, and adaptation the river boundary for generations, including the construction of buildings. This activity has an impact on the uncontrollability of buildings. And the function of the river. The study aimed to assess the extent of the distribution and non-conformity of buildings with river boundary regulations stipulated in Banjarmasin City Regional Regulation No. 31/2012 concerning the Determination of Regulation and Utilization of Rivers and Former Rivers. The method used is descriptive quantitative with spatial analysis techniques on visual image interpretation and river area buffering within 15 meters of the left and right banks of the river. Data analysis used an overlay technique to determine the number of buildings within the Martapura River boundary line in Banjarmasin City. The results showed that, over 15 years from 2008 to 2023, the built-up land area changed by an average of 1.30 hectares. Based on the type of built-up land, the most dominant is residential buildings. Non-conforming buildings in 2008 totaled 3,518 buildings, in 2013 totaled 3,365 buildings, in 2018 totaled 3,321 buildings, and in 2023 totaled 3,301 buildings. The decrease in non-conforming buildings occurred periodically in Central Banjarmasin District, and the increase in the number of non-conforming buildings was spread in South Banjarmasin District and North Banjarmasin District.

1. Introduction

Humans play an inseparable role in their lives with land use. Land use is defined as a form of human interference with land resources, either fixed or permanent, as a cycle aimed at meeting material and spiritual needs (Bičík et al., 2015; Ramadhanty, Krisantia, & Pangaribowo, 2019; Somantri & Nandi, 2018). Land use change is caused by physical and human factors that are spatially distributed (Rakuasa, Salakory, & Latue, 2022), like natural geographic elements, socio-economic conditions, and anthropogenic activity (Susilo, 2017; Wu et al., 2024). One of them is built-up land as an appearance on the earth's surface that has experienced human intervention (AA, 2024) and has certain functions for human life, limited and with built-up physical appearances (Zahra, Yesiana, Anggraini, & Harjanti, 2021a).

Many factors, including demographics, economic activities, and regional development influence the phenomenon of a higher urban population. Now, this phenomenon can be seen in many cities in the world. The increase in urban population has led to high density in many cities(Lu, Shang, Ruan, & Jiang, 2023; Poerwati, Reza, & Widodo, 2020). Rapid population growth and economic development have driven rapid changes in the urban structure, creating new sub-centers, and the emergence of large cities, part of developing regions (Latue, Septory, & Rakuasa, 2023; Renita & Hidayati, 2024). But, high population growth results in conflicts of interest over land use and impacts the incompatibility of land use with its designation zoning plan (Eko & Rahayu, 2012b; Kucukali & Kuşak, 2018; Arie Zella Putra Ulni, Dasrizal, Zuriyani, Rezki, & Juita, 2023).

In South Kalimantan, there was an issue: land use discrepancies were triggered by the economic conditions of people from the lower middle class who could not build according to valid building permits, so they built residences in road and river areas. Economic conditions force lower-middle-class individuals to construct informal housing in vulnerable areas, exacerbating land use incompatibility and compromising sustainable development due to a lack of legal building (Ginting, Hajar, & Pelly, 2019).

Martapura River is the longest river that divides Banjarmasin City, with a length of 25.066 m2. The main part of the Barito watershed is a trade and service city, and the river is its leading sector. The Banjarmasin City medium-term development plan 2021-2026 mentions the strategic issue of revitalizing the existence of rivers that will be restored to their function as protected areas and river transportation infrastructure. Efforts to regulate the rivers were revitalized by conducting both concrete and natural embankments so that there were no more buildings on the riverbanks and also to limit the occupancy of the riverbanks by the community, which caused the narrowing of the river. The percentage of compliance with the spatial pattern and structure of the Banjarmasin City regional spatial detail plan has not yet reached the target of around 25%, which means that space

utilization has not been by the spatial pattern and structure of the regional spatial detail plan (BAPPEDA Kota Banjarmasin, 2023). Forms of non-conformity of space utilization regulated in the spatial planning law of river border areas are not allowed and have certain conditions. The location of buildings not under the detailed city spatial plan will cause problems with users of the riverbank (Ihda, Sudarsono, & Awwaluddin, 2015), likely environmental, safety issues, socioeconomic disparities, and health risks (Andersen Cirera, 2022; Soemarno, 2010; Trisnaini, Faisya, & Idris, 2020).

Banjarmasin City's people depend on river culture, defined as the way of life, behavior, and adaptation of people who have lived by the river for generations. Regarding the typology of riverbank utilization, Banjarmasin City is generally dominated by settlements (Mentayani & Hadinata, 2020). The existence of relatively dense buildings closed the condition of the land on the banks of the river, which is dominated by settlements. The river unanges, as seen from the direction of the building towards the center, impact the width of the river, which narrows due to being covered by buildings. The activities of people living on the riverbank will affect the quality of the environment.

Government Regulation No. 38/2011 about Rivers defines the river boundary line as a virtual line on the left and right of the riverbed that is set as a river protection boundary. Local regulations stipulate efforts to control the river border area in Banjarmasin City No. 31/2012 on the determination of the regulation and utilization of rivers and former rivers and the spatial planning of Banjarmasin City, which regulates the zoning of river boundary lines with restrictions on embanked and unembanked rivers. The Banjarmasin City government and related agencies are trying to organize river space with regulations that have been made about river boundary lines by giving status to the river *quo* on riparian areas that have become built-up land.

The technologies provide comprehensive data and analytical tools that facilitate understanding land use changes, environmental monitoring, and urban planning. The development of remote sensing technology and geographic information systems makes it possible to study large areas with spatial patterns (Driptufany, _, Kusuma, & Guvil, 2022). Spatial patterning can be detected by identifying changes in an object or phenomenon through observations at different times, by quantifying temporal influences using a series of data collected multiple time (Ihsani & Araswati, 2023). Through multi-time intermediaries, it is possible to interpret remote sensing images from Google Earth with a combination of secondary data that can process data spatially. Based on the need for spatial analysis information about built-up land in the river border, the focus of this research aims to analyze the distribution of buildings in the Martapura River border of Banjarmasin City from 2008 to 2023 and analyze the incompatibility of buildings in the Martapura River border zoning regulations area of Banjarmasin City from 2008 to 2023.

2. Methods

The research area is in the Martapura River basin in Banjarmasin City, as shown in Figure 1. Geographically, Banjarmasin City is situated between 3°16'46"-3°22'54" South latitude and 114°31'40"- 114°39'55" East Longitude.

The Martapura River is the longest river that crosses Banjarmasin City with a length of 25.066 m^2 as part of the main tributary of the Barito River watershed, which has an important role as a supporter of the economy, transportation tourist attractions of Banjarmasin City and Banjarmasin City was known as the city of a Thousand Rivers. The Banjarmasin City Government and related agencies seek to organize river space with regulations that have been made about river boundary lines so that areas that are still natural and do status quo on river boundary areas that have become built-up land.
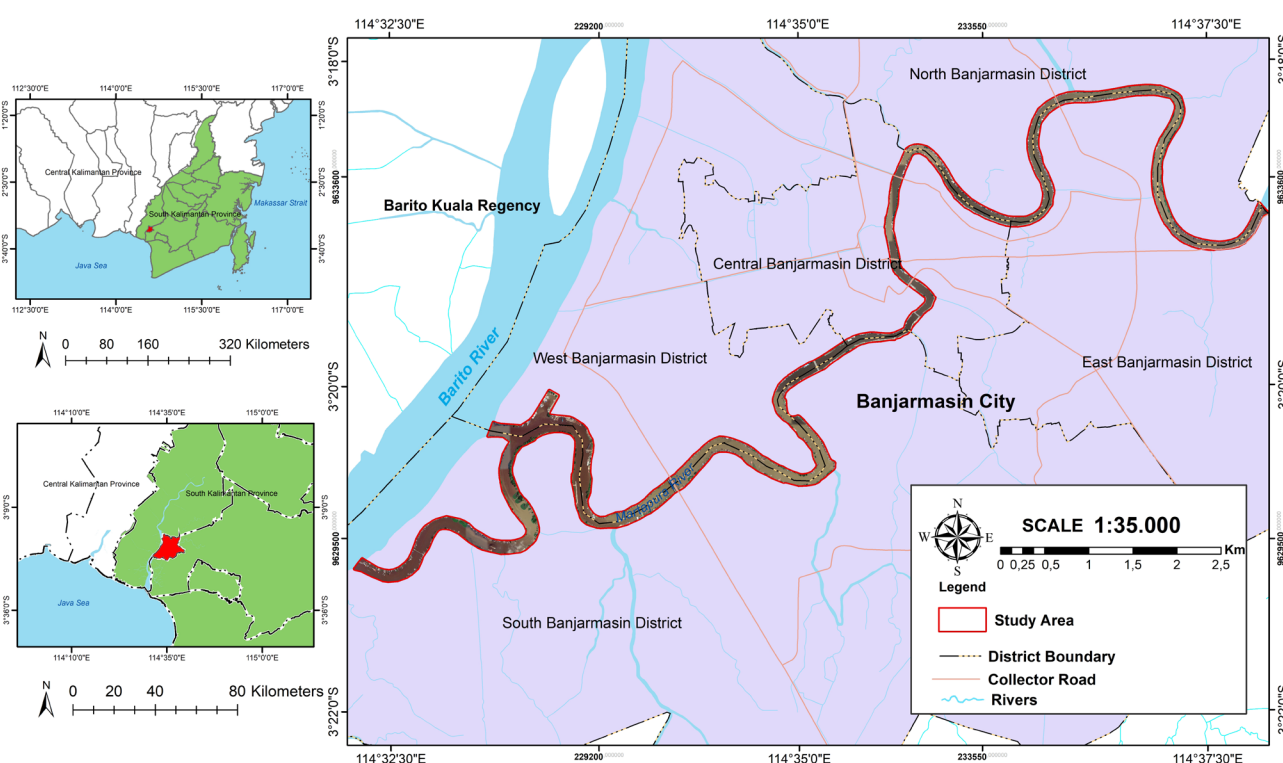

Figure 1. Research Area

Use Data Analysis of buildings on the Martapura river border in Banjarmasin City using high-resolution satellite image data to create shapefile data to form building blocks. The data is processed using ArcGis 10.8 to process the data spatially. Some data usage is presented in Table 2.

The parameters are used to determine the type of built-up land in the riparian zone and to identify the types of buildings that are visible and changing along with the land classification. The classification of built-up land is a generalized land cover category at level I, so there is a more detailed division of built-up land in level II. The parameters used are the land use classification and land cover for developed land according to the USGS (United States Geological Survey) year 1979, created by Anderson (1972). A classification system based on standardized remote sensing imagery referred to by various other countries is presented in Table 3.

Image interpretation is an analytical effort to interpret objects visible on the image and objects not visible. Interpretation of visible objects can directly detect, identify, and analyze objects on built-up land on riverbanks, as shown in Figure 4. Image analysis includes image processing and processing aimed at manipulating the appearance of the original image to adapt the image to the intended use of information presentation (Sugianto & Rusdi, 2017).

Digitization of 2008, 2013, 2018, and 2023 imagery to create shapefile data forms building digit data. Building digit analysis is realized by means of interpretation, then the elements of interpretation are needed, so that image images and digit data can become data and information. Through this element of image interpretation, building types can be identified and classified based on the land cover parameters. The built-up land is obtained from the calculation of the area included in the area. The spatial data analysis used consists of Buffer and overlay. Buffer as a technique to limit the river zone that contains the building area included in the line is analyzed referring to the boundaries of river border zoning,

which is regulated in Regional Regulation No. 31 of 2012 Determination, Regulation of Utilization of Riverbanks and Former Rivers by taking a distance of 15 meters. Furthermore, the area, distribution, and number of built-up land buildings in the river border area are obtained from the results of overlay analysis by clipping and intersecting the river border area data of built-up land.

The process of providing accuracy points for image data collection in image years 2008, 2013, 2018, and 2023 taken from Google Earth does not yet have coordinate values. The georeferencing process carries out efforts to provide coordinate point values. The accuracy test with georeferencing applies only to areas that have become measurement areas using the calculation technique of the value of RMSE ≤ 1. The digitation accuracy test was conducted by testing the overlap and gap errors. The accuracy of digitation is measured using the topology test. Through the elements of visual image interpretation, building types can be identified and classified based on the land cover parameters of the building in Table 3. The use of process techniques in data processing consists of buffers and overlays. Buffer is used as a technique to limit the river zone and overlay as an overlap that loads buildings into the line referring to the boundaries of river border zoning, which is regulated in regional regulation No. 31/2012 determination, regulation of utilization of riverbanks and Former Rivers with 15 meters retrieval.

Data analysis techniques use image interpretation accuracy test with actual conditions in the field. Samples using the random systematic sample method based on four categories of built-up land cover classes. According to Congalton and Green (1999), 20% of the population or at least 50 samples in each category. If the area is more significant than 1,000,000 hectares or more than 12 categories, there should be 75-100 samples per category. Sampling from a small area, while a large area may be under-sampled. The number of samples can be adjusted to accommodate class size and variability variations.

Table 2. Data and Source

No	Name	Type	Source	URL
1	High-resolution satellite imagery 2008 , 2013, 2018 and 2023	Raster	Google Earth Pro	https://earth.google.com/web
2	Shp Building	Vektor	Open Street Maps	https://export.hotosm.org/id/v3/
3	Shp RBI Banjarmasin City	Vektor	Ina-Geoportal	https://tanahair.indonesia.go.id/portal-web
4	Shp Boundary Administrative City/Regency	Vektor	Indonesia Geospasial	https://www.indonesia-geospasial.com/
5	Shp River	Raster	Google Earth Pro	https://earth.google.com/web

Source: Data Processing, 2024

Table 3. Land Cover Classification USGS 1979

Land Cover	
Level I	Level II
	1.1 Residential
	1.2 Commercial and Services
Urban or Built-Up Land	1.3 Industrial
	1.4 Transfortation, Communications and Utilities
	1.5 Industri and Commercial Complexes

Source : Danoedoro, (2012) ; (Sugiarto, 2018)

Figure 4. Processing Digitization

Table 6. Built-Up Land Area by Land Type

No.	Built-up Land Type	Area Size (ha)			
		2008	2013	2018	2023
1.	Residential	22,86	20,08	18,95	18,66
2.	Commercial and Services	2,53	3,25	2,62	2,45
3.	Industrial	1,60	1,16	1,40	1,29
4.	Public Facilities	0,22	0,36	0,74	0,93
	Total	27,21	24,85	23,71	23,30

Source: Analysis Data Result, 2024

In determining the validation sampling under the provisions, the sample is defined as having as many as 41 points scattered in Martapura river boundary Banjarmasin City under the criteria (McCoy, 2005). Testing the accuracy of image interpretation with field results using the overall accuracy method from Thomas M. Lillesand, 1993 (Soma, Reski, Arsyad, Wahyuni, & Bachtiar, 2021). Image classification is acceptable with an accuracy level of at least 85% with the following formula :

$$OA = X/N \times 100\%$$

Description :
X = Sum of the diagonal values of the matrix
N = Sum of sample matrices

Calculation of the accuracy of the survey points, as many as 36 points out of 41 total points, so that the level of accuracy is found to be 87,80%. The interpretation of field results is accurate, exceeding 85%, so the data can be used. Data accuracy indicates that the research is descriptive and quantitative, providing a more detailed description of a phenomenon based on data presented as numbers and percentages. The process of remote sensing transformed into GIS analyzed based on image interpretation, buffering, and overlay techniques in determining the distribution and number of buildings by the Banjarmasin City river boundary regulations is divided into several data processing that can be explained in Figure 5.

3. Result and Discussion
Building Area and Distribution

The river-dependent nature of the people of Banjarmasin City has long meant that many buildings are scattered along the riverbanks. Beginning as a community settlement driven by population growth, land along the riverbanks was used to build houses, offices, facilities, infrastructure, and commercial services and industry developed along the Martapura riverbanks. According to the Banjarmasin City Statistics Agency, the Martapura River in Banjarmasin City is the longest river, with a maximum ebb of 4 meters and a maximum high tide of 10 meters.

This has an impact on changes in land use areas. The area and distribution of built-up land use in the Martapura river border of Banjarmasin City refers to the regulations made by the Banjarmasin City government No. 31/2012 concerning the provisions of the river borderline taken along the 15-meter line from the river bank, based on spatial analysis, which has an extensive amount based on the type of built-up land (table 6).

Judging from the table and graph, the relative decline is in the type of residential buildings. The types of built-up land that have increased are public facilities. The development of buildings on built-up land use is dynamic and randomly scattered in the riverbanks. The area of built-up land in the Martapura riverbank of Banjarmasin City is presented in Table 7.
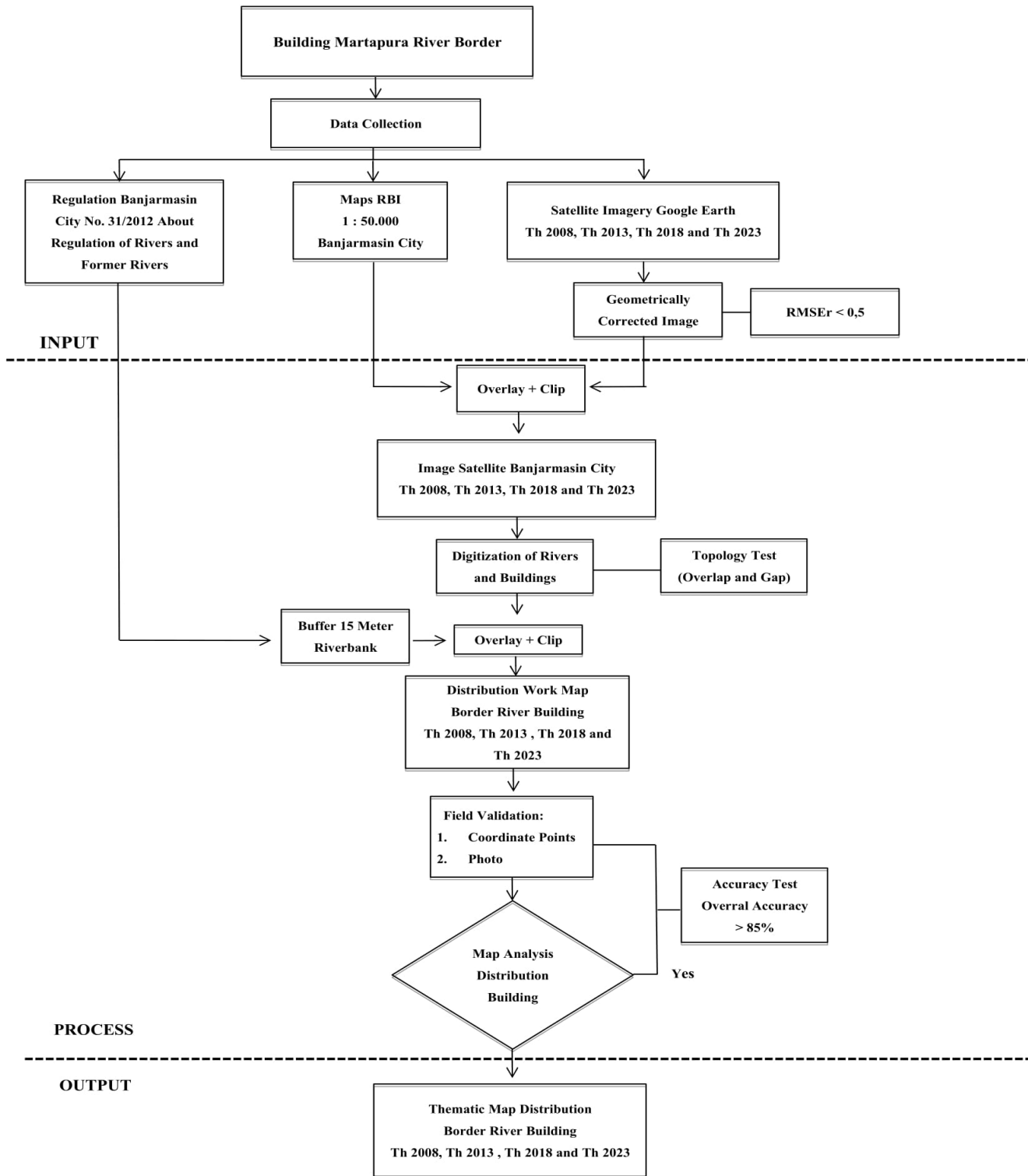
Figure 5. Flowchart of Research Analysis

Table 7. Distribution of Built Up Land Area by District

No.	District	Area Size (ha)			
		2008	2013	2018	2023
1.	South Banjarmasin	8,07	7,32	6,46	6,47
2.	East Banjarmasin	5,18	4,72	5,04	4,93
3.	West Banjarmasin	4,32	4,54	4,31	4,18
4.	Central Banjarmasin	4,91	3,70	3,38	3,14
5.	North Banjarmasin	4,73	4,57	4,52	4,58
	Total	27,21	24,85	23,71	23,30

The total area of buildings built in the Martapura River basin from 2008 to 2023 in Banjarmasin City is shown in Figure 8.

Total built-up land has an area change from 2008 to 2013 of 2.36 ha, 2018 of 1.14 ha, 2023 of 0.41 ha, and an average decrease of 1.30 ha. The area of buildings built in the five districts from 2008 to 2023 is a sub-district that has experienced a relative decline in area in the Central Banjarmasin district. The most significant increase in build-up land areas occurred from 2018 to 2023 in the North Banjarmasin district. The distribution of building types on the Martapura River border in Banjarmasin City based on the results of field validation data processing is presented in Figure 9.

Building Incompatibility

The incompatibility of buildings located in the Martapura River border area of Banjarmasin City refers to the river borderline categorization regulation of Banjarmasin City Regional Regulation No. 31/2012, which has three categories: 10 meters, 15 meters, and 30 meters. Retrieval is based on a distance of 15 meters from the riverbank through buffering area analysis based on the depth of the Martapura River, which is classified as above 4 to 10 meters, so the retrieval is classified as a distance criterion of 15 meters from the riverbank. A buffering area analysis then carries out the 15-meter criterion from the river body. The buffering area analysis provides a zoning distance around the river by loading buildings included
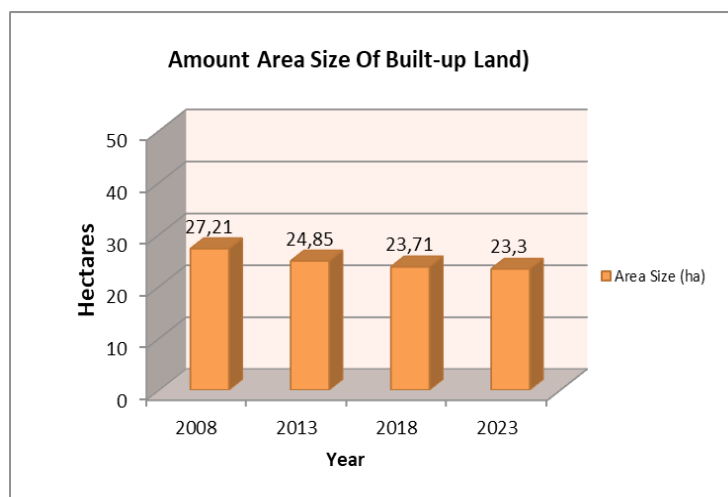

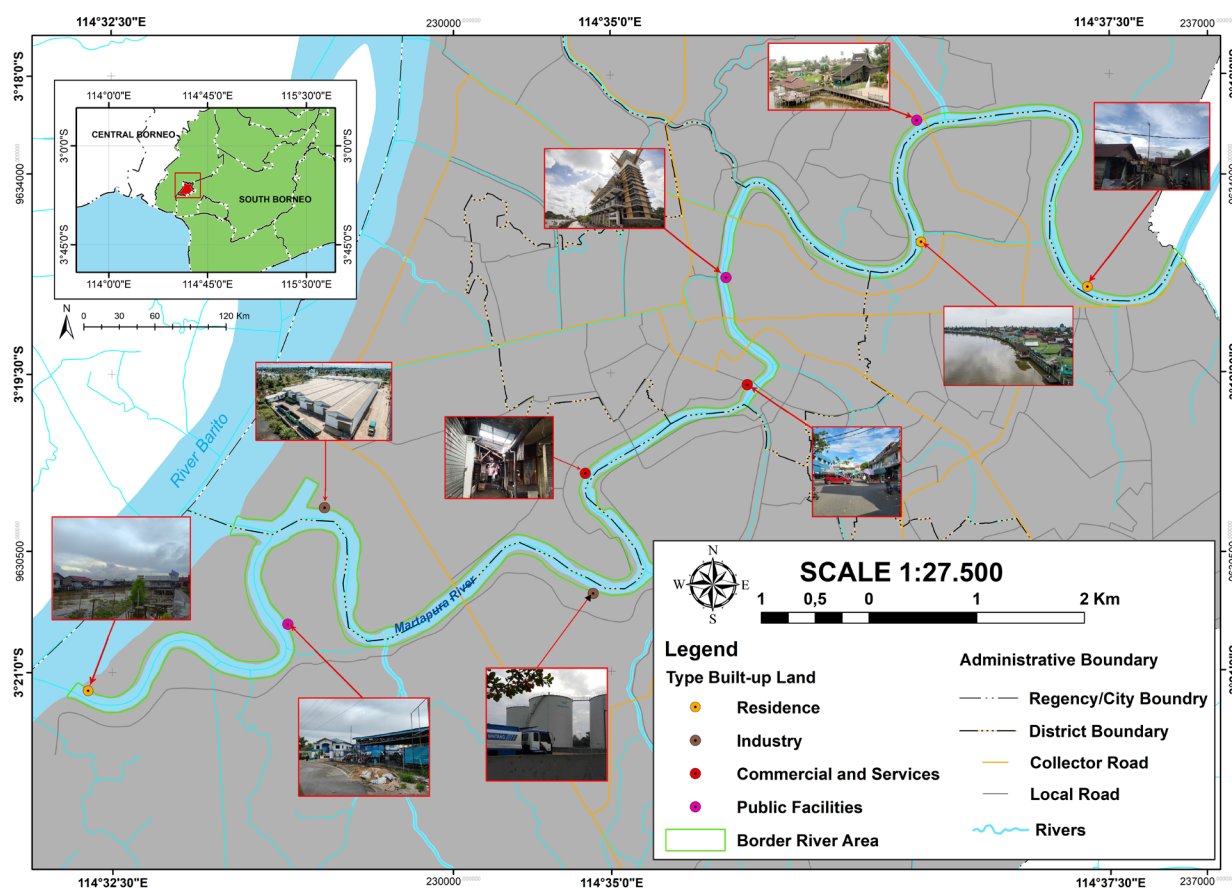Figure 8. Total Area Size Built-Up Land

Figure 9. Maps of Distribution Build Up

in the Martapura River border line in Banjarmasin City, which can be presented in Table 10.

Table 10 shows the areas with built-up buildings in the Martapura River border zone of Banjarmasin City. The most built-up land is in the South Banjarmasin district, dominated by a larger area than other districts. Buildings that have decreased are located in the Central Banjarmasin district as an urban center and are a priority program for building management and river revitalization.

When viewed from the table, the direction of building development is rapidly spreading towards two districts. Both districts experienced an increase from 2018 to 2023: the South Banjarmasin district, totaling 69 buildings, and the North Banjarmasin district, totaling 21 buildings, as in Figure 11.

The distribution of buildings whose area has experienced a dynamic increase from 2008 to 2018 in South Kalimantan has relatively decreased, including the range of 2023 experiencing an increase. The decrease is inversely proportional to the

Table 10. Total of Buildings Along the Martapura River in Banjarmasin City

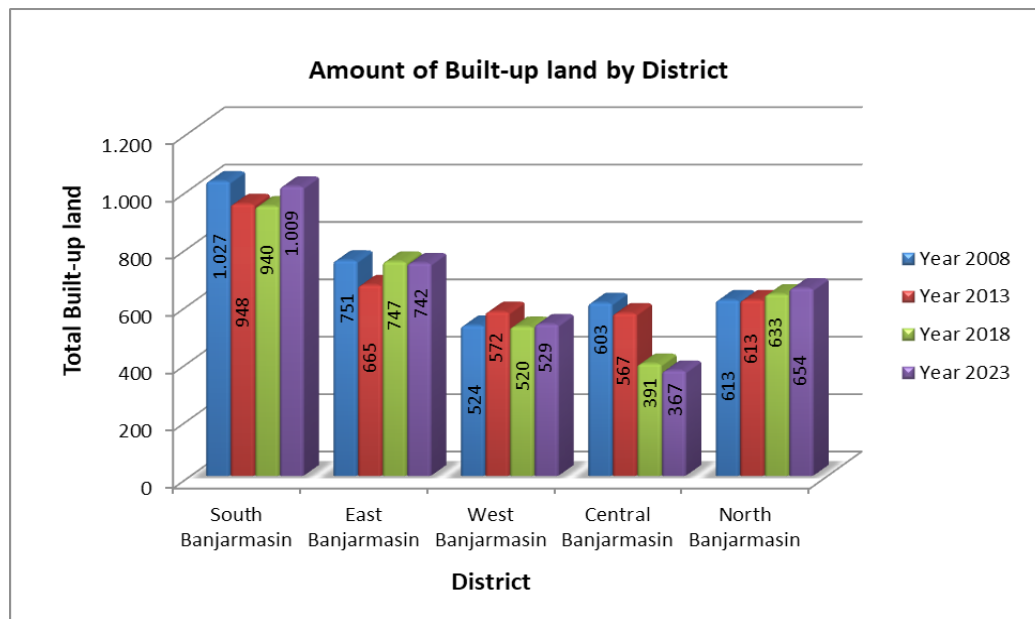| No.	District	Total of Building			
		2008	2013	2018	2023
1.	South Banjarmasin	1.027	948	940	1.009
2.	East Banjarmasin	751	665	747	742
3.	West Banjarmasin	524	572	520	529
4.	Central Banjarmasin	603	567	391	367
5.	North Banjarmasin	613	613	633	654
Total		3.518	3.365	3.231	3.301

Source: Analysis Data Result, 2024

Figure 11. Amount of Build-Up Land by District

Table 12. Total of Buildings by Type of Built-Up Land

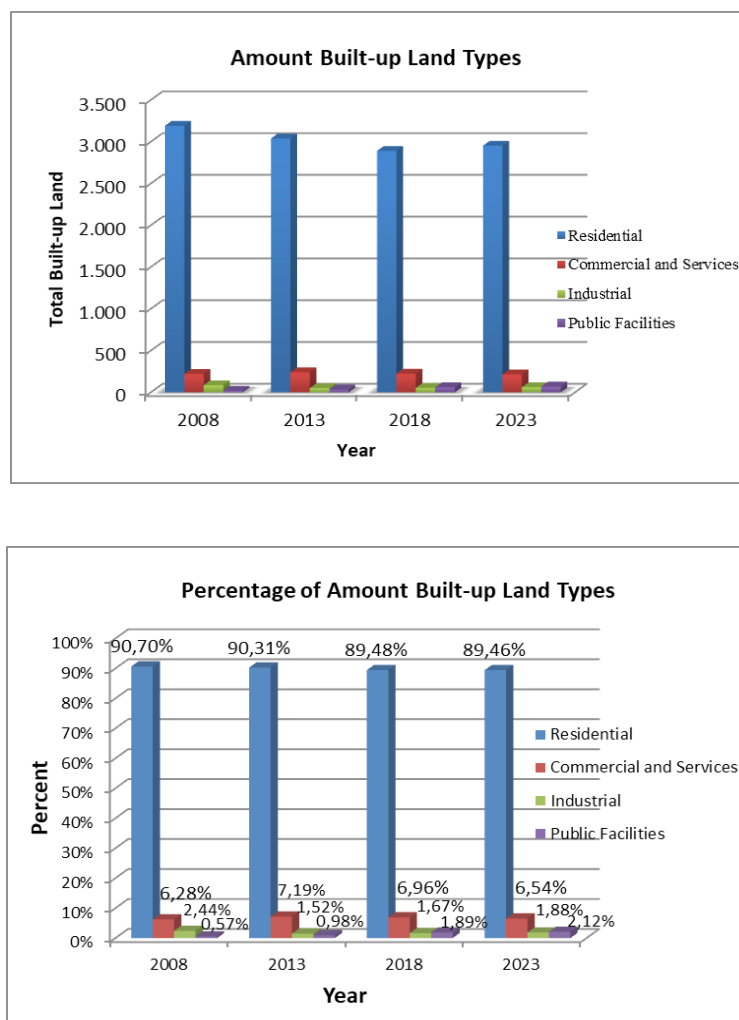| No.	Built-up Land Type	Total of Building			
		2008	2013	2018	2023
1.	Residential	3.191	3.039	2.891	2.953
2.	Commercial and Services	221	242	225	216
3.	Industrial	86	51	54	62
4.	Public Facilities	20	33	61	70
Total		3.518	3.365	3.231	3.301

Source : Analysis data results (2024)

Figure 13. Total of Bulit-up Land and Percentage Buit-up Land

Central Banjarmasin district, and the relative increase occurs in the North Banjarmasin district.

Table 12 shows building criteria based on the type of land built on the Martapura River border in Banjarmasin City.

From the table, all types of buildings are dynamic. Changes can occur in the decrease and increase of built-up land in all kinds of built-up land. Built-up land tends to increase in terms of public facilities. The increase in public facilities is insignificant as an infrastructure designation directed to its function. Meanwhile, settlement is a building that has dominated throughout the years. It had decreased from 2008 to 2018 but increased in 2023. The increase in residential buildings in the last year to 2023 is not too high in the 5-year period, which is experiencing a little slow, but it is worth monitoring because the previous years, 2013-2018, have decreased. This shows that supervision needs to be reviewed to fix the increase in buildings on the Martapura riverbank. The percentage of the number of buildings based on the type of built-up land is presented in Figure 13.

The diagram above shows that the dominance of buildings along the Martapura river border in Banjarmasin City is settlements which are at 89,46% - 90,70%, while commercial and service buildings are 6,28% - 7,19%, industrial buildings at 1,52% - 2,44% and public facilities and facilities 0,57%-2,12%. GIS plays a role in analyzing built-up land objects in the Martapura River border with accurate and fast image interpretation. Identification results from GIS data processing show that built-up land is unevenly distributed where there

are existing and non-existing buildings in the same place and different types. Temporally, the classification of built-up land in the Martapura River basin of Banjarmasin City is periodically dynamic from 2008 to 2023, as shown in Figure 14.

In 2008, there were 3.191 residential buildings, 221 commercial and services buildings, 86 industrial buildings, and 20 public facilities. The distribution of non-conforming buildings was 1.027 in South Banjarmasin district, 751 buildings in East Banjarmasin district, 524 buildings in West Banjarmasin district, 603 buildings in

Central Banjarmasin district, and 613 buildings in North Banjarmasin district. The distribution of non-conforming buildings in 2013 was 3.039 residential buildings, 242 commercial and service buildings, 51 industrial buildings, and 33 public facilities buildings. In 2013, buildings in South Banjarmasin District amounted to 948, East Banjarmasin District amounted to 665 buildings, West Banjarmasin District amounted to 572 buildings, Central Banjarmasin District amounted to 567 buildings, and North Banjarmasin District amounted to 613 buildings. The decrease in the type of built-up land in 2013 from the previous year occurred in residential buildings, which amounted to 152 buildings, and in industry, which amounted to 35 buildings. The increase in commercial and service buildings amounted to 21, and public facilities amounted to 13 buildings. The district that experienced the most significant decrease in 2013 was the South Banjarmasin district, which amounted to 79 buildings, while the increase occurred in West Banjarmasin district, which had 48 buildings.
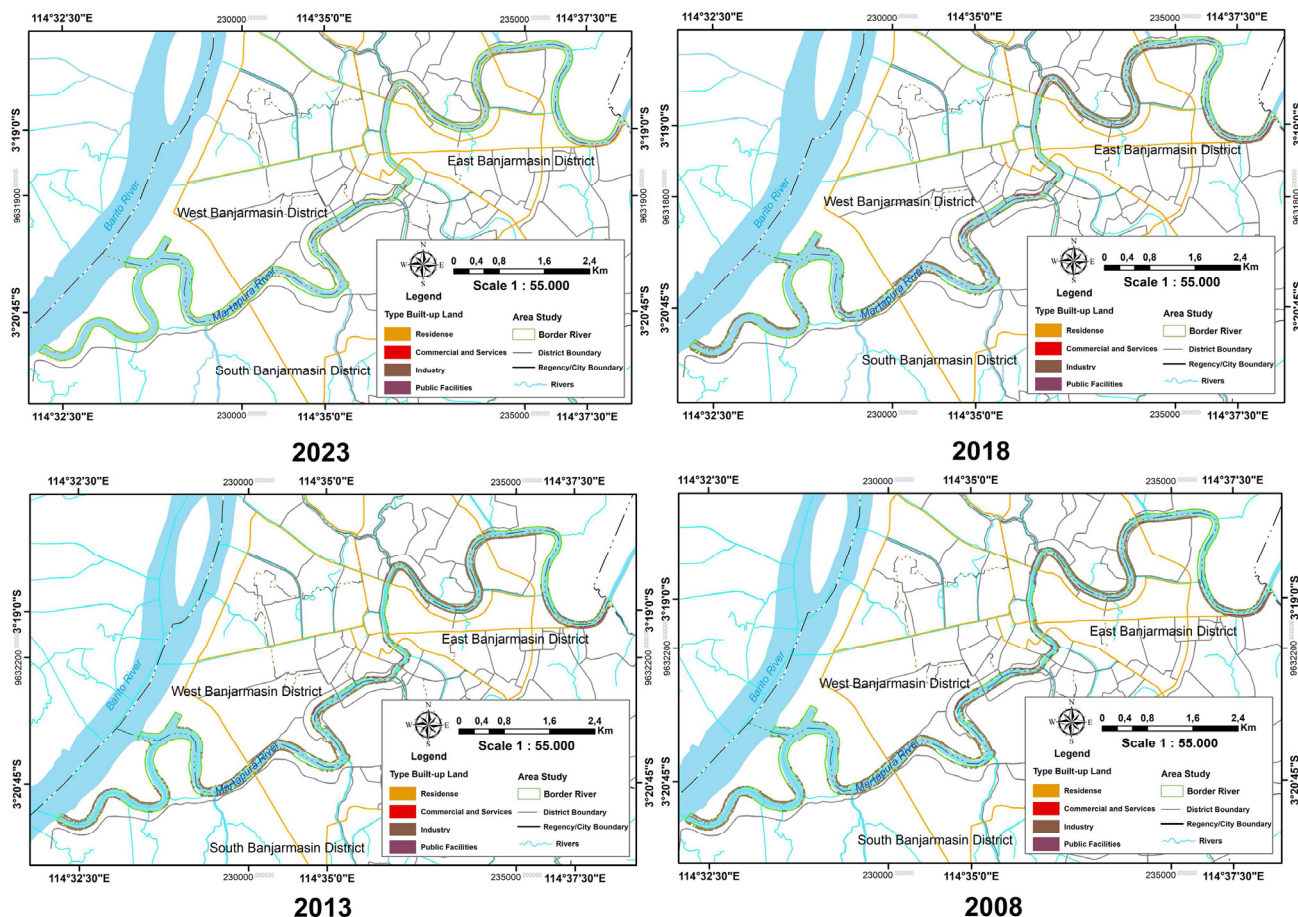
Figure 14. Temporal Map Built Up From 2008 to 2023

The distribution of non-conforming buildings in 2018 was 2.891 residential buildings, 225 commercial and service buildings, 54 industrial buildings, and 61 public facilities buildings. The buildings in 2018 were distributed in South Banjarmasin District amounted to 940 buildings; East Banjarmasin District amounted to 747 buildings; West Banjarmasin District amounted to 520 buildings; Central Banjarmasin District amounted to 391 buildings; and North Banjarmasin District amounted to 633 buildings. The decrease in the type of built-up land in 2018 occurred in residential buildings, which amounted to 148 buildings, and commercial and services, which amounted to 17 buildings. The increase in buildings occurred in industrial buildings, which amounted to 3 buildings, and public facilities, which amounted to 28 buildings. The district experienced the most significant decrease.

In 2018, the Central Banjarmasin district had 176 buildings, while the increase in East Banjarmasin district had 82 buildings. The distribution of non-conforming buildings in 2023 is 2.953 residential buildings, 216 commercial and service buildings, 62 industrial buildings, and 70 public facilities buildings. Buildings in 2018 distributed in South Banjarmasin District amounted to 1.009 buildings; East Banjarmasin District amounted to 742 buildings; West Banjarmasin District amounted to 529 buildings; Central Banjarmasin District amounted to 367 buildings; and North Banjarmasin District amounted to 654 buildings. The decrease in the type of built-up land in 2023 is only commercial, and services amounted to 9 buildings. The increase in buildings in settlements amounted to 62 buildings, industry amounted to 8 buildings, and public

facilities and facilities amounted to 9 buildings. The district that only experienced the most significant decrease in 2023 was the Central Banjarmasin district, which amounted to 24 buildings, and the highest increase occurred in the South Banjarmasin district, which amounted to 69 buildings.

Building Incompatibility Against River Boundary Zoning Regulations

Image interpretation used when recognizing buildings on the riverbank can predominantly be recognized in the shape, size, and pattern with different characteristics for each type of building. The attributes of objects depicted in the image and used to recognize objects are called elements of image interpretation. The elements of image interpretation include nine aspects, namely hue/color, shape, size, texture, pattern, height, shadow, site, and association (Hadi, 2019). Image interpretation on the Martapura River border building in Banjarmasin City is recognized as elongated following the flow of the road or river. There is a road, so the building follows the flow of the road and river. This supports the result of previous research that the pattern of community settlement buildings along the riverbanks tends to be elongated or linear following the shape of the river, like the community settlement of the Ogan Malay and the Musi River, leading to a tendency for buildings to be oriented and positioned closer to the riverbank (Arifin & Rahman, 2020; Fitri, 2019; Gunawan, Soemardiono, & Septanti, 2022).

The distribution of buildings on the Martapura riverbank in Banjarmasin City has been triggered by the role of local culture since the old days, which inhabited the riverbank as a

place to live and perform daily activities before the regulation. The dominance of buildings on the riverbanks of Martapura River in Banjarmasin City is represented by houses or settlements classified as semi-permanent. The condition of the buildings located at the river boundary is shown in Figure 15.

Buildings located on the Martapura River border in Banjarmasin City have several additional buildings both to the side that are still empty and to the back, forming overlapping buildings. This condition also has buildings, especially settlements, that lead closer to the middle of the river, which has a risk of life danger and can threaten health. This phenomenon can be seen in the buildings built relatively recently because of economic factors. Economic factors and the high land cost triggered people on the side of the river to widen their yards. The economic factors and high land prices have indeed influenced the expansion of yards along riverbanks, as evidenced by various urban development trends and socio-economic dynamics (Ramli, Bagiartha W, & Ashari, 2018). This behavior may stem from the need to adapt to the pressures of urban growth and the desire to secure a more stable living situation amidst rising costs. Consequently, such actions can lead to informal settlements and exacerbate urban planning challenges.

The buildings located on the border of the Martapura River in Banjarmasin City have several additional buildings both to the side that are still empty and to the back, forming overlapping buildings. This condition also has buildings, especially settlements, that lead closer to the middle of the river, which has a risk of life hazards and can threaten health. This phenomenon can be seen from the buildings that are built still classified. The government established Rivers as protected

areas with various policies to maintain stability and avoid catastrophic environmental damage that can harm residents.

The establishment of buildings on riverbanks has been regulated through government regulation No. 38 /2011 concerning rivers, which have the status of land buildings that have already been established on riverbanks and are declared status quo, meaning that they cannot be changed, added, and repaired. Government regulation No. 38/2011 on rivers mandates that within 5 (five) years from the date this government regulation comes into effect, the mayor must establish boundary lines on all rivers under his authority. In response to government regulation No. 38/2011, the government of Banjarmasin City issued local regulation No. 31/2012 on the regulation, determination, and utilization of rivers and former rivers. The regulation of river boundary lines in Banjarmasin City No. 31 of 2012 can be described in Table 16.

The main purpose of establishing zoning regulations is to ensure that development will achieve minimum local quality standards (health, safety, and welfare). It aims to ensure that new development does not interfere with existing space users or users, maintain property values, maintain the environment, determine its quality value, and provide uniform rules for each zoning (Kautsary & Shafira, 2019). Banjarmasin mayor's regulation No. 31/2012 stated that the number of non-conforming buildings stands at the river boundary with a boundary distance of 15 meters from the river. The dynamics of building non-conformity cannot be separated from the factors that led to the establishment of the building and the lack of supervision from the government. Public knowledge about spatial planning, especially river boundary zones, is

a) New Building Addition

b) Building to Center River

Figure 15. Condition of the Buildings Located in the River Boundary

Table 16. Classification Buffer Zone River

River	Buffer Zone River	
	Classification	Border Width (m)
Unembanked River	Depth of River ≤ 3 m	10 m
	Depth of River 3-20 m	15 m
	Depth of River > 20 m	30 m
Embanked River	-	3 m from Embankment Foot

Source: Regulation Banjarmasin City No. 31/2012

specific, so not everyone understands and understands. The lack of socialization from the government also causes the level of community knowledge to be classified as low (Gjura Godec & Nikšič, 2023).

The development of buildings along riverbanks is unavoidable because it is the right of local communities to utilize the river. Building incompatibilities will increasingly result in the closure of water bodies that can damage the image of Banjarmasin City, known as the city of a thousand rivers. This happens if the city government is considered not firm in implementing policies in building infrastructure by the City of a Thousand Rivers. The more widespread development of residential settlements without regard to natural behavior and environmental insight, including the construction of shops, malls, supermarkets, and shop houses that sometimes use banks, leads to silting, narrowing, and shutting down water flow, negatively impacts pro-environmental behaviors, leading to environmental degradation (Zuo, Cai, Huang, Wang, & Wang, 2023). The phenomenon of buildings scattered on the border of the Martapura River in Banjarmasin City is dynamic. Banjarmasin City is currently developing an imbalance between population growth and land demand. This has led to the development of legal housing and the illegal utilization of vacant land by the community, such as land along riverbanks (Firdaus, Ristiawati, & Saphira, 2021). Building development in some areas of some sub-districts tends to remain fixed, and in other sub-districts has increased. The increase in the number of buildings can threaten the sustainability of the riverbank environment, as unbuilt buildings will become illegal built-up land without a permit. The government's efforts as a controller not to grant building permits because land in the river border has been prohibited by regulations even though the community continues to build their houses, which assume that the land they occupy is their own .

The development of building increases spread to the South Banjarmasin district and North Banjarmasin sub-district. The phenomenon of the condition of the number of buildings in the river border is a form of non-conformity of space utilization that has been regulated in the spatial planning law that the river border area may not and has certain conditions used as a cultivation area, including settlements, industry, trade, services, shops, offices, and public facilities and is not by Banjarmasin City regional regulation No. 31/2012 concerning determination, regulation, and utilization of rivers and former rivers. Therefore, the need for the government to prevent the construction of buildings not by the detailed city spatial plan will cause problems with riverbank users (K.U., Sudarsono, & Awaluddin, 2015). Through integrated supervision, this can be done by minimizing the rapid construction of buildings in the Martapura River basin of Banjarmasin City.

4. Conclusion

Spatial analysis of buildings in the Martapura river border of Banjarmasin City against the river border zoning of Banjarmnasin City regional regulation No. 31/2012 concerning regulation, determination, and utilization of rivers and former rivers with a distance line of 15 meters from the river bank there is a decrease in the average area of built-up land change by 1.30 ha based on the type of built-up land, the most dominating non-conformity is settlements. Building non-conformity in 2008 amounted to 3.518 buildings, in 2013 amounted to 3.465 buildings, in 2018 amounted to 3.231 buildings, and in 2023 amounted to 3.301 buildings. The increase in built-up land

occurred from 2018 to 2023 in South Banjarmasin and North Banjarmasin districts. Built-up land that has decreased is still in the Central Banjarmasin district, which is the city's center, so the program for handling slums, building supervision, and river revitalization is running well.

From these results, it is advised not to build and add buildings on the Martapura riverbank in Banjarmasin City because it can disrupt the function of the river and endanger life and health. Advise the government to re-implement regulations that are still less assertive in implementing rules, as evidenced by the fact that until now, many buildings in the Martapura River border area of Banjarmasin City have still been built and are not by the regulations. For the following research, the study's accuracy is only slightly above the minimum limit, so it is recommended to use other methods of accuracy and sampling of image interpretation so that the level of accuracy is higher and very accurate. For further research, using different techniques and variables, such as community perceptions of river boundary regulations and the behavior of people who survive in river boundaries, is recommended.

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