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Identification of Land Change in Makassar City

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ABSTRACT :

Utilization of built-up land in urban areas tends to experience a very significant increase. This is due to very high population growth so that the need for land for housing, construction of facilities and infrastructure and other supports will increase. As a result of this development there is the potential for land conversion to occur. The conversion of land use can cause a reduction in water catchment areas and can result in disasters such as floods. The development and transfer of land also occurred in Makassar City. The development of land into built-up areas in Makassar City is developing rapidly. One of the reasons why this city has developed rapidly is because this city is the gateway to Eastern Indonesia. The aim of this study; 1) to identify changes in open land use and development in 2012 – 2022, 2) to identify the distribution of land use changes in 2012 – 2022, 3) to identify the characteristics of land use changes in 2012 – 2022 in Makassar City. The method used isdescription through a spatial approach by performing a visual-manual image interpretation in 2012 - 2022.The results of this study are 1) changes in open land to be built are the most dominant where the changes reach 26.98% from 2012 - 2022 in Makassar City; 2) Land changes in 2012 – 2022 occurred in almost all sub-districts in Makassar City, where the sub-districts that had the most significant changes were Tamalanrea, Biringkanaya and Manggala Sub-Districts; 3) The most dominant characteristic of land change that occurs is agricultural land being built up to reach 38% in 2012 – 2022.

KEYWORDS *land, Land Change, Makassar, Spatial*

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I. INTRODUCTION

Land is a certain expanse (area) on the surface of the earthvertically including climate components such as air, soil, water and rocks that are underground as well as vegetation and human activities in the past or present that exist above the ground and the earth surface. Land is a very limited natural resource. Almost all production, recreation and conservation activities require land. Land use for various interests from various sectors should always refer to the physical potential of the land, socio-economic factors, and local socio-cultural conditions as well as the land legality system. Therefore, in the use of land use, land use planning is needed so that the land use can be carried out optimally.

Land use in urban areas tends to be very complex due to dynamically moving activities. One of the most influential factors in urban land use is population growth.The trend of rapid population increase will also be followed by the draining of natural capabilities, the sacrifice of resources, and the confiscation of environmental resources. One of the effects of increasing population and development is reflected in the conversion of land from open areas to built-up areas(Akhiruddin, 2006).

Land conversion in the sense of changing land use, is basically unavoidable in the implementation of development (Lisdiyono, 2004). The rapid population growth and the increasing demands of the community's need for land often result in conflicts of interest over land use and the occurrence of discrepancies between land use and its allotment plan (Khadiyanto, 2005). While the land itself is limited and cannot be added except by reclamation activities (Sujarto, 1985 in Untoro, 2006). Limited land in urban areas also causes cities to develop physically towards the outskirts of the city.

Regarding the land use, suburban areas are regions that have significant changes in land use, especially the conversion of agricultural land into non-agricultural land due to the influence of nearby urban development (Rahayu, 2009). The reduction in the area of agricultural land in this region needs special attention as this will have a negative impact on both urban life and rural life. Considering that this area is an area that will turn into a city entirely in the future, commitment from policy makers is needed to manage and organize the Peri-Urban Area so that it can becomes an ideal city according to the concept of a sustainable city (Yunus, 2008).

Makassar City had a population of 1,352,136 in 2012, while in 2023 it increased to 1,432,189 people. The trend of rapid population increase will also be followed by the draining of natural capabilities, the sacrifice of resources, and the confiscation of environmental resources. One of the effects of increasing population and development is reflected in the conversion of land from open areas to built-up areas. This is evidenced by the significant change in land use in Makassar City which leads to land cover (built-up areas). Change occurs due to the increasing need for services, such ashousing, industry, and other developments to support human life. The potential for land transfers such as from agriculture to built-up areas has a major contribution to reducing water catchment areas in this city. Based on field facts for the last 10 years, Makassar City has often experienced flooding when the rainy season arrives due to reduced water catchment areas.

The limitationof natural resources towards the availability of land will be disastrous for the development itself if the utilization exceeds the limit. Therefore, it is necessary to identify changes in land use that can function to monitor the potential for land development that will occur so that land conversion can be avoided. Geographic Information Systems (GIS) plays a crucial role in monitoring changes in land use. Through this application, optimal spatial information data input, analysis, processing, and display can be utilized.

Based on this explanation, it is necessary to identify changes in land use in Makassar City so that it can anticipate the transfer of land use functions that have the potential to occur in the future. The purpose of this research is to:

a) identify changes in the use of open land and become built-up areas in 2012 – 2022 in Makassar City,
b) identify the distribution of changes in land use changes in 2012 – 2022 in Makassar City
c) identify the characteristics of land change in 2012 – 2022 in Makassar City

II. METHODOLOGY

The method of this research is a descriptive analysis method of secondary and primary data with a spatial approach supported by the Geographic Information System (GIS) application. The stages of the method used to achieve the objectives of this study consist of two stages: Image Interpretation and Testing the Accuracy of Image Interpretation Results.

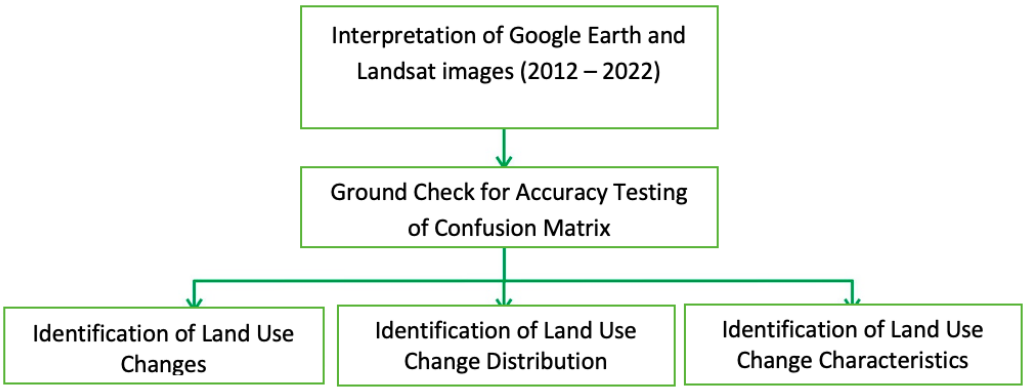

Figure 1. Flow of Research Methods

1. Method of Data Interpretation

Image visual interpretation is carried out by digitizing directly on the monitor screen (digitize on screen) based on spatial recognition of object characteristics in order to standardize land cover classification data (SNI 7654, 2010)

2. Accuracy Testing of Data Interpretation

This test is conducted to determine the level of accuracy of the image interpretation that has been done previously. Accuracy testing is done by comparing the results of image interpretation with field conditions.

Ground check location points are determined using a purposive sampling technique, which choosing a location by considering the accessibility factor of each selected land cover and observing the distribution of each land cover/use class. The number of samples in this study was determined using the Slovin formula as follows:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Information:

n =Number of samples (ground check)
N =Total population (number of polygons in the image interpretation results)
e = Tolerance error limit

This tolerance error limit is expressed as a percentage. The error tolerance limit used in this study is 10% (value of e = 0.1).

Accuracy testing of image interpretation results is done by using the confusion matrix technique. The confusion matrix is a matrix that is used to calculate every error and suitability for each form of land cover from the results of the image classification process (Arsyadi, 2018). The confusion matrix filling format can be seen in table 1.

Table1.*Confusion Matrix for Land CoverChecking*

Land Cover Class		Reference Data (Existing Field)				Total
		A	B	C	…	
Image Interpretation Result Data	A'	Xn				∑ Xn
	B'					
	C'					
	…					
Total		∑ Xn				N

Source: Buhari, 2016

Information
A B C… = Datareference (land cover in the field)
A B C'…. = Image interpretation result data
Xn = Data tested (diagonal matrix)
∑ Xn = Total of each reference data (image classification)
N = Total of datatested

After obtaining the confusion matrix table data, the accuracy testing will then be conducted using the overall accuracy calculation.

Calculation of Overall Accuracy:

$$Overall\ Accuracy = \frac{X}{N} \text{x } 100\% \quad (2)$$

Where X = Total of diagonal matrix values
N =Total of matrix samples

The accuracy standard used refers to the United States Geological Survey (USGS) standard, which is 85% or more to be used for various purposes (Yanti et al, 2020).

III. RESULTS AND DISCUSSION

1. Research Sites

This research was conducted in Makassar City, South Sulawesi Province, Indonesia. Makassar City, which is the capital city of South Sulawesi Province, geographically has a strategic position because it is located at a crossroads, both from north to south and from west to east. With this position, Makassar City has great potential to become the Gateway to Eastern Indonesia. The city of Makassar is located at coordinates 119° 18' 30.18" to 119° 32'31.03" East Longitude and 5° 00' 30.18" to 5° 14' 6.49" South Latitude and is located on the West Coast Sulawesi Island.

Administratively, Makassar City is divided into 14 districts with 142 villages. The northern part consists of Biringkanaya, Tamalanrea, Tallo and Ujung Tanah sub-districts. The southern part consists of Tamalate and Rappocini sub-districts. The eastern part consists of Manggala and Panakukkang sub-districts. The western part consists of Wajo sub-district. Bontoala, Ujung Pandang, Makassar, Mamajang, and Mariso.

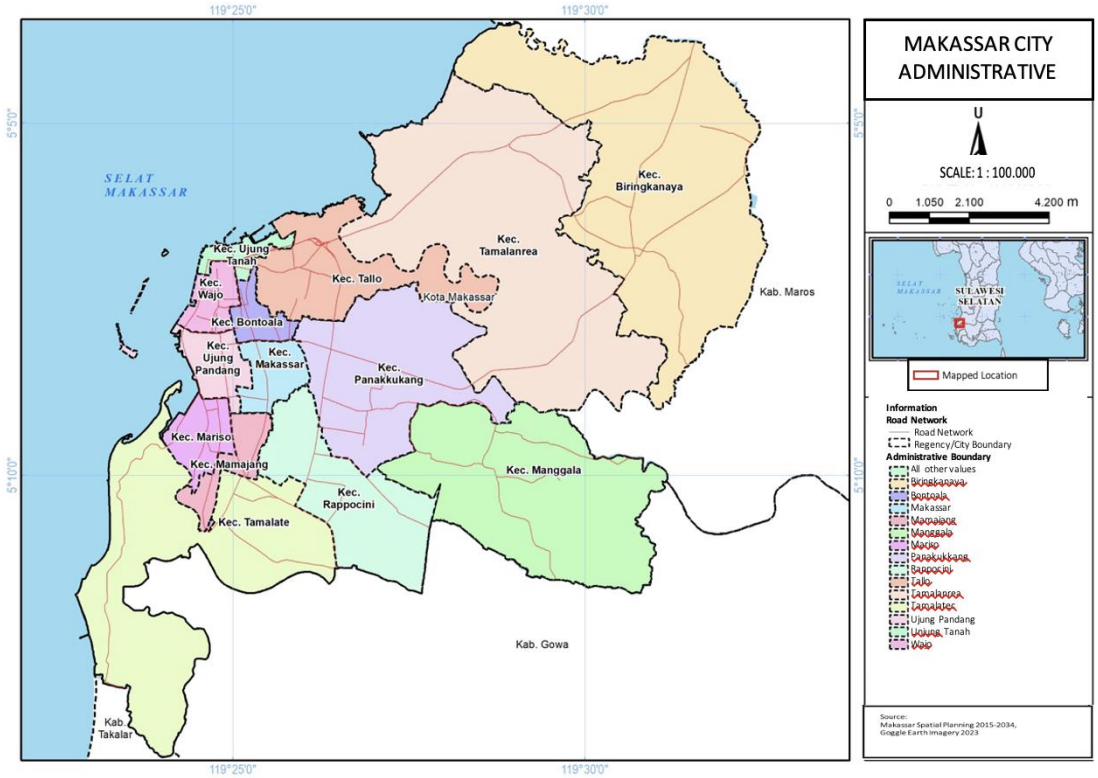

Figure 2. Image of Makassar City Administrative Map

2. Makassar ImageInterpretation

The method used is a visual-manual image interpretation technique which will be digitized using images from Google Earth with GIS software with the help of Landsat imagery composite bands to facilitate identification of land use. The basis for determining the cover class used inInterpretationofimageappearanceisbasedon SNI number 7645 of 2010aboutlandcover/useclasses. The combination of the 2012 imageisdonebycombining band 6, band 5, and band 4 (RGB) in theLandsat 8 image.

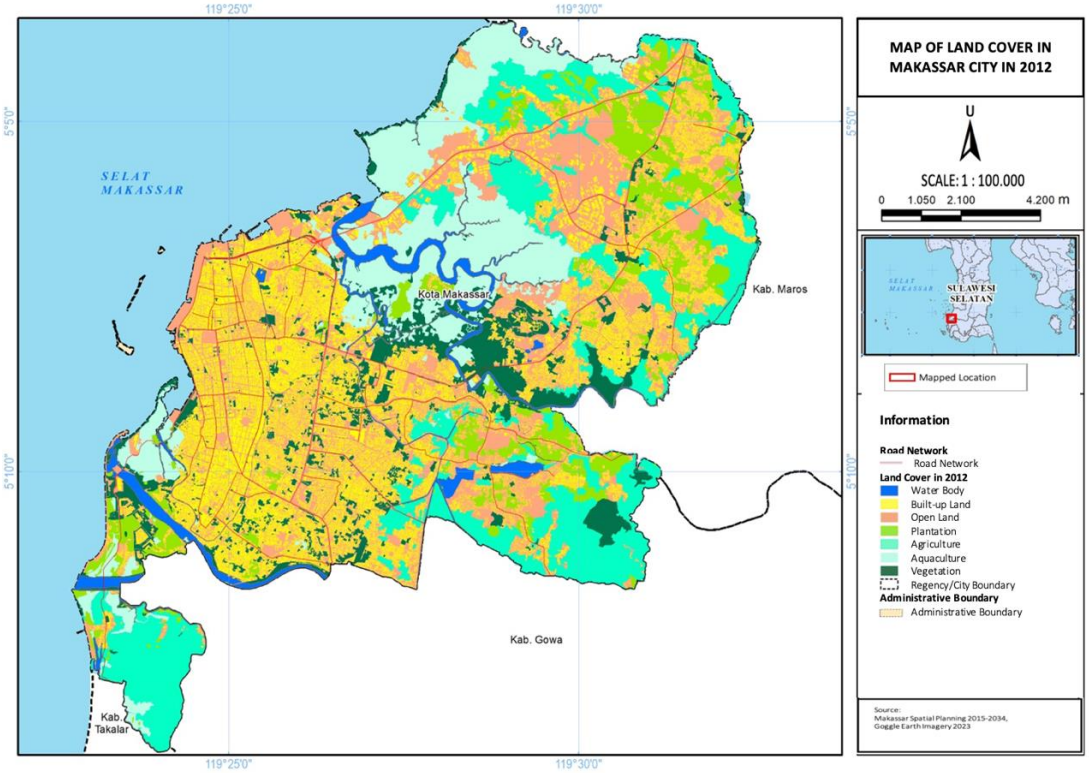

Figure 3. Makassar City Image Digitization Results in 2012

Meanwhile, the bands in the 2022 image are done by combining band 5, band 5, and band 3 (RGB) in the Landsat 7 image. This combination produces a "false color" which produces several contrasting colors that distinguish between land covers, such as dark blue on the body. water and dark blue with bunds on wetlands.

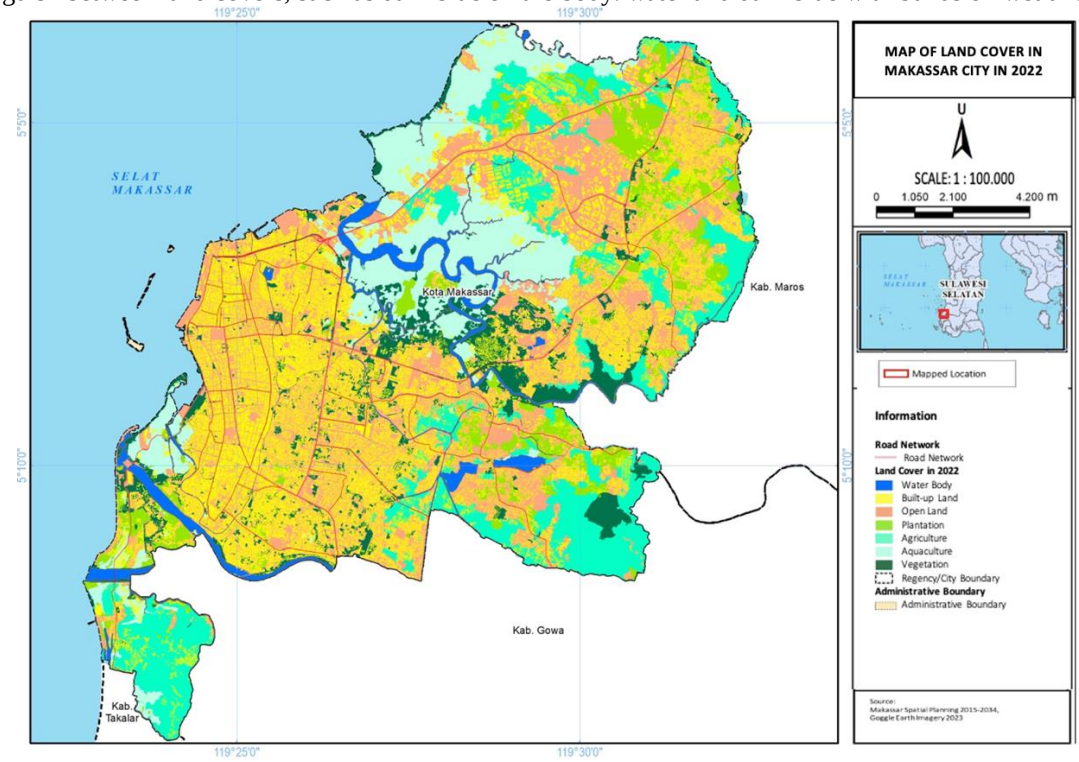

Figure 4. Results of Image Digitization of Makassar City in 2022

3. AccuracyTestof Makassar Image Interpretation

This test is carried out to determine the level of accuracy of the image interpretation that has been done previously. The accuracy test is done by comparing the results of image interpretation with field conditions.

The ground check location points are determined using a purposive sampling technique, namely choosing a location by considering the accessibility factor of each selected land cover and looking at the distribution of each land cover/use class. The number of samples in this study was determined using the Slovin formula with a total of 100 samples. This fault tolerance limit is expressed as a percentage. The error tolerance limit used in this study is 0.1 or 10%.

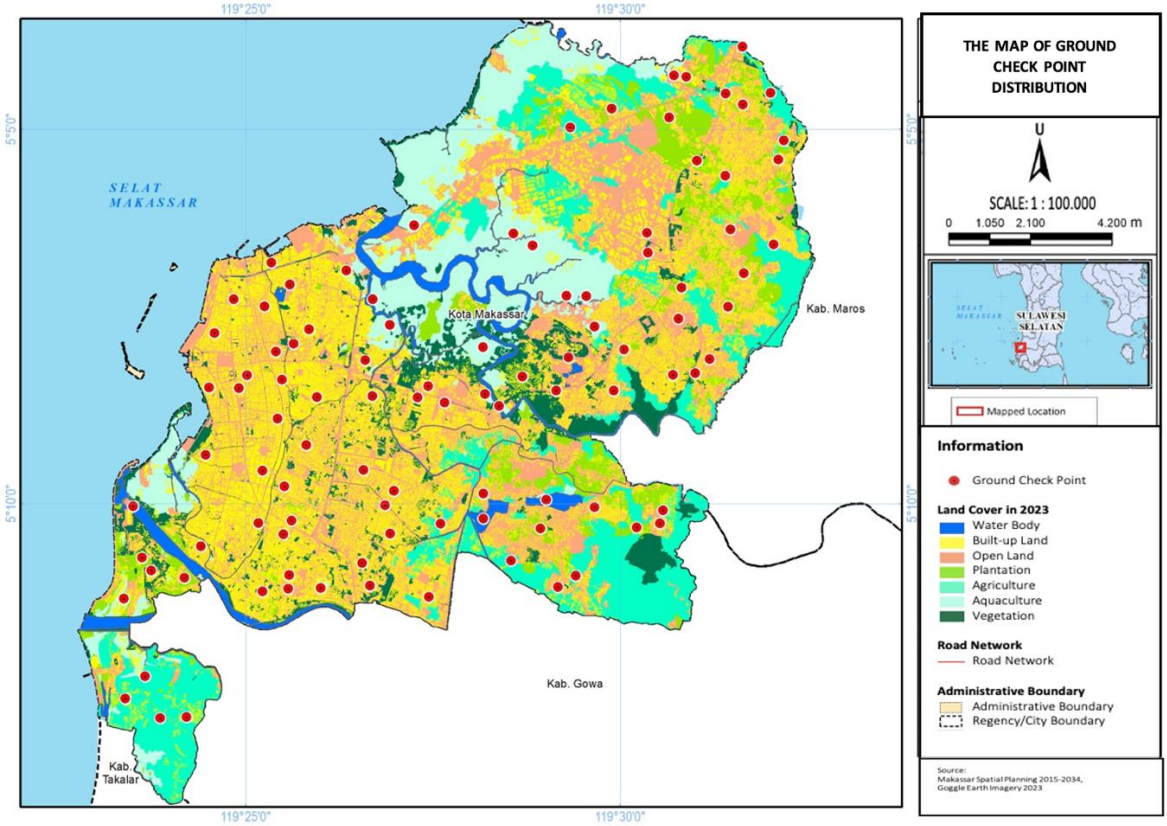

Figure 5. Distribution of Sampling for Ground Check

4. Land Use Change

The current rapid development of Makassar City, especially the development of housing infrastructure, requires a very large area of land. This is evidenced by changes in land use that are increasingly widespread. Changes in land use led to land cover. Makassar as the Center of South Sulawesi and Eastern Indonesia, has experienced a change in land use which has led to land closure from open areas to built-up areas. Based on the results of image interpretation, there has been a significant change in land use in Makassar. It can be seen in table 1 below:

Table 1 Area of Land Use Change in Makassar City in 2012 - 2022

No	Land Cover	2012		2022		Difference	
		Ha	%	Ha	%	Ha	%
1	Water body	619.75	3.55%	619.75	3.55%	0.00	0.00%
2	Built-up Land	3789.81	21.72%	4812.36	27.58%	1022.54	26.98%
3	Open field	4961.32	28.43%	4851.27	27.80%	-110.05	-2.22%
4	Agriculture	2795.54	16.02%	2470.72	14.16%	-324.82	-11.62%
5	Plantation	1444,17	8.28%	1215.45	6.97%	-228.72	-15.84%
6	Aquaculture	2353,32	13.49%	2222.98	12.74%	-130.34	-5.54%
7	Vegetation	1484,43	8.51%	1255.81	7.20%	-228.61	-15.40%

No	Land Cover	2012		2022		Difference	
		Ha	%	Ha	%	Ha	%
Total		17448,34	100%	17448,34	100%	-	-

Source: Results of Data Processing

The table explains that the only land cover that did not experience any change was water bodies, while the increase in land use area has occurred in the built-up land sector by1.022, 54 Ha, then the reduction in land area occurred in open land, agriculture, plantations, aquaculture and vegetation, each of which was as large as110.05 Ha, 324.82 Ha, 228.72 Ha, 130.34 Ha and 228.61 Ha, respectively.

5. Distribution of Land Use Change

The results of data processing using the GIS application show that there has been a change in land use which is generally dominated by the changeto built-up land in all sub-districts.Thechange into built-up land occurred in all of these sub-districts, three of which were Biringkanaya, Manggala, and Tamalanrea.The impact of this increase in area is the decrease in the area for other uses, such asopen land, agriculture, plantation, aquaculture (fish pond) and vegetationas listed in table 2 below:

Table 2 Area of Land Use Change in Makassar City in 2012 – 2022per Sub-district

Subdistrict	Year	Land Cover Area (Ha)						
		Water body	Built-up Land	Open field	Plantation	Agriculture	Aquaculture	Vegetation
Biringkanaya	2012	17,68	661,26	1148.06	731.80	732.94	306,40	80,62
	2022	17,68	943.54	1111.81	608.30	636,26	289.25	71.87
Bontoala	2012	1.32	68.04	94.59	-	-	-	9.85
	2022	1.32	69,67	94,24	-	-	-	8.57
Makassar	2012	2,42	163,63	86.85	-	-	-	12.46
	2022	2,42	168,84	86.56	-	-	-	7,54
Mamajang	2012	2.70	161.13	80.44	0.00	-	0.87	5,73
	2022	2.70	163.80	79,72	0.00	-	0.86	3.78
Manggala	2012	91.35	277.97	572.91	330,37	856.97	12,16	149.75
	2022	91.35	420.05	556.88	284.61	788.97	10.83	138.78
Mariso	2012	6,61	113.79	104,25	1.76	0.65	28.58	26,25
	2022	6,61	118.25	103.77	1.54	0.65	27,67	23,40
Panakkukang	2012	52,61	450.88	490.86	53.05	2.54	208,81	309.01
	2022	52,61	504.87	489.70	50,71	2,31	204.01	263.55
Rappocini	2012	6,93	424,46	441.61	9.05	100,20	0.43	113.67
	2022	6,93	486.85	436.77	5,48	78.25	0.19	81.87
Tallo	2012	95.28	268,67	254.96	32.03	0.03	253.93	56,86
	2022	95.28	288,24	248,31	30,33	0.00	248.54	51.06
Tamalanrea	2012	139.86	455.71	984.66	74,25	515.55	1233,11	453.95
	2022	139.86	730,43	921.51	61.00	443,44	1166.34	394.51
Tamalate	2012	201.60	456.88	401.40	211.86	586,67	309.02	246.89
	2022	201.60	653.91	395,49	173,47	520.84	275,28	193.37
Ujung Pandang	2012		120.74	136.87	-	-	-	10.69
	2022		122.71	135.68	-	-	-	9,91
Ujung Tanah	2012	1.40	57.97	70,73	-	-	-	5.80
	2022	1.40	66,67	63,19	-	-	-	5.05
district Wajo	2012		108,68	93,14	-	-	-	2.90
	2022		113.45	88.72	-	-	-	2.55

Source: Results of Data Processing

Based on table 2 above, land changes in BiringkanayaSub-district resulted in a change in built-up land area of 282.26 Ha where in 2012 the built-up land area was 661.26 Ha and increased in 2022 to 943.54 Ha. TamalanreaSub-district has a change in built-up land area of 274.72 Ha where in 2012 the built-up land area was 455.71 Ha and increased in 2022 to 730.43 Ha. Meanwhile, ManggalaSub-district has a change in built-up land area of 142.08 Ha where in 2012 the built-up land area was 277.97 Ha and increased in 2022 to 420.05 Ha.

6. Land Use Characteristics

The results of data processing show that the characteristics of changes in land use are dominated by a change from agricultural land to built-up land (38.93%). While the characteristics of the change from open land to vegetation, ie0.00% means that there has been no change at all, howeverplantation to vegetation, aquaculture (fish ponds) to vegetation only 0.03-0.04 %. The change fromagricultural land to open landis only 0.06%, as presented in table 3 below:

Table 3 Characteristics of Land Use Change

No	Characteristics of Change	Ha	%
1	Open Land to Built-up Land	149.3786	17.90%
3	Land Open to Vegetation	0.03323	0.00%
4	Plantation to Built-up Land	228.7246	27.41%
5	Plantation to Vegetation	0.375343	0.04%
6	Farm to Built-up Land	324.8157	38.93%
7	Agriculture to Open Land	0.490239	0.06%
8	Aquaculture to Built-up Land	130,337	15.62%
9	Aquaculture to Vegetation	0.254136	0.03%
10	Vegetation to Built-up Land	228.6147	27.40%
Amount		834,4088	100%

Source: Results of Data Processing

Based on table 3, the change in land use to open land from 2012 to 2022 has changed by 99.89%. The details are as follows: the conversion of open land to built-up land of 149.37 Ha or 17.90%, the transfer of plantation land to built-up land of 228.72 Ha or 27.41%, the conversion of agricultural land to built-up land of 324.81 Ha or 38.93 %, the transfer of aquacultural land to built-up land was 130.337 Ha or 15.62% and the transfer of vegetation land to be built-up area was 228.4 Ha or 27.40%. This of course greatly affects the water catchment area which functions to drain water, especially when the rainy season arrives.

IV.CONCLUSION

This research resulted in three findings from land use change in Makassar City:

1. The increasing trend of built-up land use in Makassar City from 2012 to 2022 reached 26.98%. While the decreasing trend was observed in open land (2.22%), agriculture (11.62%), plantations (15.84%), aquaculture(5.54%), and vegetation (15.40%).
2. Land use changes in Makassar City from 2012 to 2022 occurred in almost all sub-districts, where the sub-districts that had the most significant changes were Tamalanrea, Biringkanaya and Manggala Sub-Districts
3. The most dominant characteristic of land use change was the conversion of agricultural land to built-up land, which reached 38% from 2012 to 2022

based on the results of the conclusions, there are several suggestions that need to be considered as a result of land change that occurred in Makassar City, which are:

1. Development in Makassar City must be carried out in a sustainable manner so that the balance of the ecosystem is maintained.
2. The carrying capacity of the land should be taken into account in the development process.
3. The water catchment area should be expanded to reduce annual flooding in Makassar City.

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