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SPATIAL PROJECTION OF LAND USE AND ITS CONNECTION WITH URBAN ECOLOGY SPATIAL PLANNING IN THE COASTAL CITY, CASE STUDY IN MAKASSAR CITY, INDONESIA

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Abstract. The arrangement of coastal ecological space in the coastal city area aims to ensure the sustainability of the system, the availability of local natural resources, environmental health and the presence of the coastal ecosystems. The lack of discipline in the supervision and implementation of spatial regulations resulted in inconsistencies between urban spatial planning and land use facts. This study aims to see the inconsistency between spatial planning of the city with the real conditions in the field so it can be used as an evaluation material to optimize the planning of the urban space in the future. This study used satellite image interpretation, spatial analysis, and projection analysis using markov cellular automata, as well as consistency evaluation for spatial planning policy. The results show that there has been a significant increase of open spaces during 2001-2015 and physical development was relatively spreading irregularly and indicated the urban sprawl phenomenon. There has been an open area deficits for the green open space in 2015-2031, such as integrated maritime, ports, and warehousing zones. Several islands in Makassar City are predicted to have their built-up areas decreased, especially in Lanjukang Island, Langkai Island, Kodingareng Lompo Island, Bone Tambung Island, Kodingareng Keke Island and Samalona Island. Meanwhile, the increase of the built up area is predicted to occur in Lumu Island, Barrang Caddi Island, Barrang Lompo Island, Lae-lae Island, and Kayangan Island. The land cover is caused by the human activities. Many land conversions do not comply with the provision of percentage of green open space allocation in the integrated strategic areas, established in the spatial plan. Thus, have the potential of conflict in the spatial plan of marine and small islands in Makassar City.

Keywords: *spatial projection, land use, spatial planning, remote sensing, coastal city*

1 INTRODUCTION

As an archipelagic country, Indonesia has many urban areas located in the coastal areas. Indonesia has 150 cities which are situated in coastal areas. The number is increasing due to the trend of urbanization rate in the urban region (Rahmat *et al.* 2016). The rapid development of the coastal cities is an indicator of how attractive the region to the most people (Bambang 2012). However, the socio-economic growth in this region is not accompanied by good city planning (Baja 2012). Urban spatial planning in many coastal areas adopted the spatial planning base on land city. In fact, the characteristics of coastal areas are very different from areas that do not have the sea. Coastal boundaries between ecosystems where the conditions are affected by changes occurring at the sea and on the land (Article 1 of Law No. 27 of 2007 on the management of the sea, coastal, and small islands). High biodiversity levels, accessibility, and marine as the common properties cause the coastal areas to be vulnerable to damage and destruction. In addition, the consistency between policy and its implementation on the field is often low, so the concept of sustainability is very difficult to achieve.

To achieve the sustainability of coastal city system, it is important to understand the concept of sustainable spatial planning. By definition, sustainable development is a development to fulfill the needs of present human life without ignoring the necessities of human life in the future (Brundlandt 2001 in Suweda 2011). In principle, coastal spatial planning plays important role in defining development and goals needed to improve the welfare of communities with the need to protect, preserve and improve the quality of the environment and coastal ecosystems.

The initial step to achieve that is identifying the LUCC through image interpretation and spatial analysis. Land use/cover change (LUCC), as an important factor in global change, is a topic that has recently received considerable attention in the prospective modeling domain (Jean *et al.* 2014). Monitoring these changes and planning urban development can be successfully achieved using multi-temporal remotely sensed data, spatial metrics, and modeling (Yikalo and Pedro 2010). There are many approaches and software packages for modeling LUCC, many of them are empirical approaches based on past LUCC such as CLUE, DINAMICA, terrestrial ecosystems and marine CA_MARKOV and Land Change Modeler (both available in IDRISI) (Jean *et al.* 2014).

Makassar City as a coastal city in the last 15 years has been transformed into a metropolitan city parallel to other big cities in Indonesia. Common problems in coastal cities in Indonesia are also occurring in Makassar, such as floods, rob, traffic jams, and social problems. All these things happen because of inconsistent implementation of the spatial plan. Therefore, a study is needed to see how far the inconsistencies are, so that in the evaluation phase, a better management concept can be determined.

This study aims to describe the dynamics of the land use change in relation to the consistency of the implementation of urban spatial planning policy in the coastal area, so that it can be used as an evaluation material for better urban spatial planning.

2 MATERIALS AND METHODOLOGY

2.1 Location and Data

This research was done in Makassar City, located in the coastal area (Figure 2-1).

Multitemporal Landsat satellite imagery (1994, 2001, and 2015) was used in this study. These data were Landsat 5 (1994) path and row114/064, Landsat 7 (2001) path and row114/064, and Landsat 8 OLI TIRS (2015) path and row114/064.

2.2 Limitations of Analysis

Land use change analysis works on vector database, whereas for Projection simulation works based on raster database. Therefore, it is necessary to convert vector data to raster data. The size of the raster data used is 30x30 meters size adjusted to the raster size of the

Landsat satellite imagery used (Peruge *et al.* 2012).

Spatial data of the land use is obtained through multi-temporal landsat satellite image analysis and interpretation. Because using images with low spatial resolution, the determination of the type of land cover or land use is not very accurate. Land use interpreted by Landsat satellite imagery cannot be divided into clearer built up land types, so the zone division is only described in macro.

The study of land use change is focused on the change from the open area to the built up area, especially on agricultural and aquaculture land which is converted to industrial and settlement areas. In this study, open space area is categorized into: green open space (mangroves and terrestrial vegetation), non-vegetated open space, agriculture and aquaculture land, and water bodies (rivers and swamps). While the built up land is consists of: settlements, industrial and ware housing areas, and infrastructure (Purwanto *et al.* 2016; Amri 2017).

2.3 Land Use or Land Cover Analysis by Satellite Imagery Interpretation

Remote sensing and GIS techniques are the powerful tool to investigate, predict and forecast environmental change in a reliable, repetitive, non-invasive, rapid and cost effective way with considerable decision making strategies (Amiri *et al.* 2014). The advent of satellite data in the last few decades opened up a new dimension for the generation of land cover information. While the extraction of such information is possible using the 'traditional' approaches of surveying or digitizing, land cover information extraction that is based on image classification has attracted the attention of many remote sensing researchers (Lu and Weng 2007). But, the latter is now considered the standard approach (Farzaneh 2007).

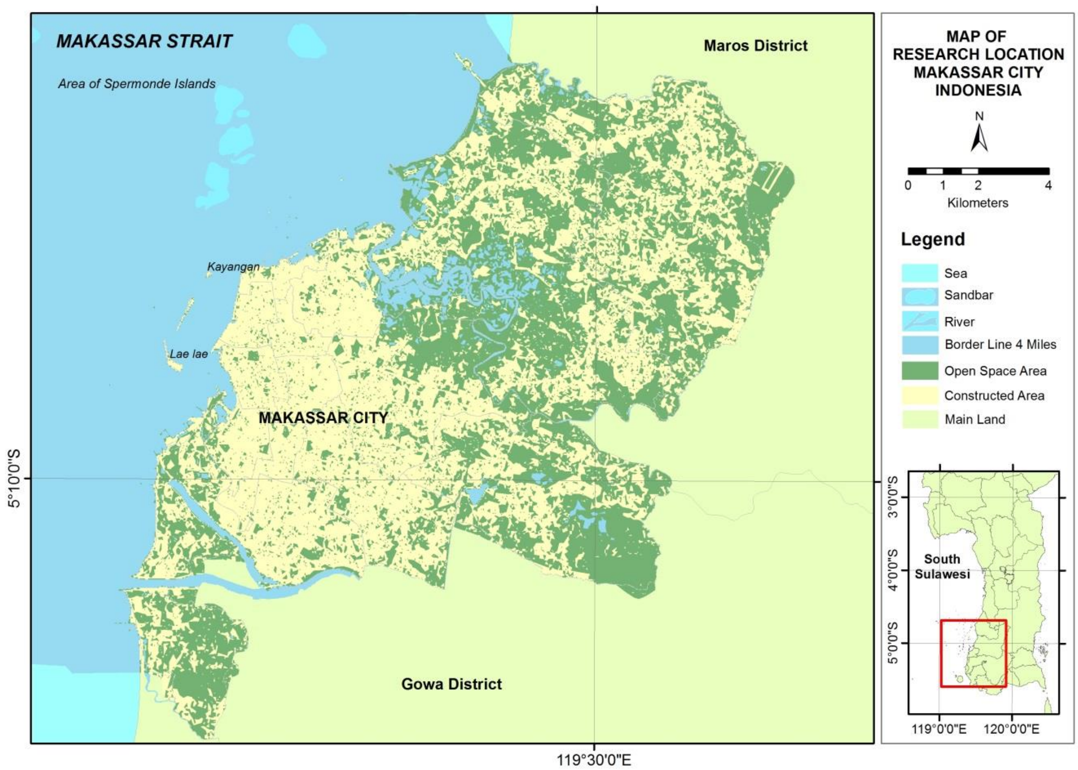

Figure 2-1: Map of research location in Makassar City

The method of LULC change detection and analysis was performed using a series of processes including data acquisition, data pre-processing, supervised classification and post classification (Boori *et al.* 2016a; Romero *et al.* 2013). Image preprocessing is the initials processing of the raw data and normally involves processes like geometric correction, image enhancement and topographical correction (Choudhary *et al.* 2017). Geometric correction was performed using UTM-WGS84 projection (Kaliraj *et al.* 2017; Choudhary *et al.* 2017).

Recently, several image classification techniques and algorithms have been developed extensively for the landuse and land cover analysis throughout the world (Kaliraj *et al.* 2017). These techniques are include vector machine (SVM), artificial neural network (ANN), Maximum Likelihood Classifier (MLC), fuzzy analysis, as well as segmentation and clustering (Kaliraj *et al.* 2017). Among them, the Maximum Likelihood Classifier (MLC) technique depends on a combination of ground samples and personal experience with the study area and is strictly used the field observed training samples of real ground surface (Purwanto *et al.* 2016; Amri 2017; Jayanth *et al.* 2015).

To verify the land cover data into land use data is done through ground truth, thematic map review, and guides from the high resolution satellite imagery (SPOT 5) to check the land use in 2001.

2.4 Spatial Projection Analysis

The model of land-use simulation (projection) in 2031 is done through the Cellular Automata - Markov Chain analysis (Trisasongko *et al.* 2009; Peruge *et al.* 2012). A Cellular Automata – Markov model is capable of simulating temporal and spatial dynamics of LCLU change by integrating remote sensing and GIS based data with biophysical and socio-economic data (Myint and Wang 2006; Courage *et al.* 2009; Tong *et al.* 2012). The Markov-CA model is also called combined Cellular Automata/ Markov Chain/ Multi-Criteria/ Multi-Objective Land Allocation land cover prediction method, which adds an element of spatial contiguity, specific decision from multi-criteria evaluation and also the knowledge of dynamic distribution from MC analysis (Sang *et al.* 2011).

The Markov Chain module produces a transitional or probability matrix which is the transition matrix of change from the previous year to the projection year (t_1-t_0). The Markov equation is constructed using the distribution of land use at the beginning and end of the observation period presented in a vector (single column matrix), and a transition matrix (Figure 2-2).

0	0	1	0	0
0	1	1	1	0
1	1	1	1	1
0	1	1	1	0
0	0	1	0	0

Figure 2-2: The pixel values at the filter 5x5

The contribution of the matrix in the simulation process is to provide information about the variation of land use change from a type of land use in the center pixel of the filter matrix 5x5. The filter matrix 5x5 is the translation of the neighborhood concept, meaning that land use change in the central pixel is affected by the land use at the surrounding of 24 pixels. The 30x30 meter pixel size indicates an effect radius of 60-90 meters.

Moving filter means that the neighboring analysis is performed on every window with 5 pixels horizontal and 5 pixels vertical. 5x5 value is used to normalize the land suitability (Munibah 2008; Peruge *et al.* 2012).

The next step is to run the Cellular Automata module to obtain a land use prediction in 2031. The data entered as input is the transition matrix and land use in 2015 as the base year of land use (t_0).

Predicted land use change obtained from the simulation results, need to be tested for accuracy. This accuracy test also acts as a validation of the simulation results. Validation was done by comparing the 2015 simulated land use with observed land use (satellite image analysis) of 2015, based on the value of Kappa (Jensen 1996):

$$K = \frac{N*\sum_{i=1}^{z} X_{ii} - \sum_{i=1}^{z}(X_{i+} * X_{+1})}{N^2 - \sum_{i=1}^{z}(X_{i+} * X_{+1})} \quad (2\text{-}1)$$

Where:

K = Kappa Value

X_{ii} = area of land use type to-i simulation results that corresponds to the area of the land use type to-i observation results (diagonal)

X_{i+} = area of land use type to-i simulation results

X_{+i} = area of land use type to-i observation results

N = total area of all types of land use

Z = number of land use types

The calculation result of Kappa value (K) shows the level of conformity between the land uses of simulation result with the land use of observation result. K value >0.75 or 75% means that the simulation or projection analysis can be proceed.

2.5 Spatial Consistency Evaluation

Spatial planning policy of Makassar City refers to the Spatial Plan of Makassar City (RTRW) for 2010-2030. Spatial Projection result in 2031 of Makassar City will be compared with RTRW (*Rencana Tata Ruang Wilayah*) of Makassar City then look for any spatial Incompatibility. This information then used to assess the level of sustainable utilization and management of land resources in Makassar City. Using the linkages matrix of the spatial utilization and the zonation plan of the coastal area and the small islands of Makassar City, it is possible to identify the potential conflicts in the future.

3 RESULTS AND DISCUSSION

3.1 Land Use

Land use is closely linked to human activities that involve utilization and management (Dwiyanti 2013). The high rate of population growth with all its social and economic activities has resulted in increased land demand. This then increased the complex functions of space in coastal city, whether as industrial centers, government, trade and services, settlement areas, natural resource production spaces and ecological spaces.

The spatial analysis shows that there has been a significant increase of open space during 21 years (1994-2015) (Table 3-1).

During the observation period, physical development was relatively spreading irregularly and indicated the urban sprawl phenomenon (Figure 3-1), a peripheral growth phenomenon that extends beyond its location and is not adjacent to the metropolitan area development center (Barnes *et al.* 2001). Urban sprawl is a complex phenomenon, which not only has environmental impacts, but also social impacts (Barnes *et al.* 2001).

Table 3-1: The LUCC of Makassar City in 1994 to 2015 and spatial projection in 2031

Year	Built-Up Area (ha)	Open Area (ha)	Water Body (ha)
1994	3.791	11.570	98,260
2001	6.478	8.738	98,190
2015	9.839	6.396	97.740
2031	11.600	5.654	97,290

3.2 Spatial Projection of Land Use in 2031

Validation is needed to find out how accurately the data projection can be acknowledged and be guaranteed to continue the projection analysis (Munibah 2008). Validation results show an 85.4% value, which means that between the land uses of simulation result and the land use of observed result show the value of the area and distribution that almost matched.

The Markov Chain module produces a transitional or probability matrix which is the transition matrix of change from the previous year to the projection year (t_1-t_0) (Munibah 2008). The Markov equation is constructed using the distribution of land use at the beginning and the end of observation period presented in a vector (single column matrix), and a transition matrix (Table 3-2).

The spatial projection results in 2031 indicate significant increase of built-up areas in suburbs areas, namely Biringkanaya and Tamalanrea Sub-district (Figure 3-2). This condition is caused by several things, among others, the expansion of Makassar industrial area (Tamalanrea and Biringkanaya), the highway of Sutami (Tamalanrea and Biringkanaya), the international airport of Sultan Hasanuddin (Biringkanaya), and the new road access of Mamminasata (Biringkanaya).

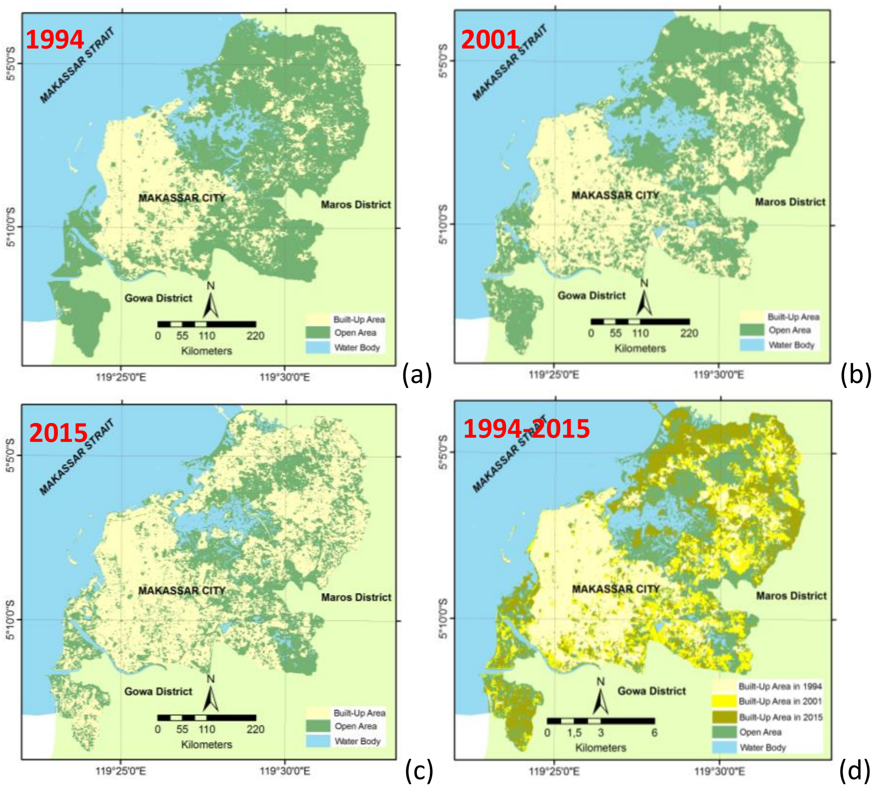

Figure 3-1: The land use of Makassar City in 1994 (a), 2001 (b), 2015 (c), and the trend of the land use in 1994 to 2015 (d)

Table 3-2: Probability matrix and land transition matrix

	Cl. 1	Cl. 2	Cl. 3		Cl. 1	Cl. 2	Cl. 3
Class 1	0.8046	0.1069	0.0884	Class 1	51834	6888	5697
Class 2	0.0394	0.4596	0.5010	Class 2	3358	39170	42691
Class 3	0.0052	0.2255	0.7693	Class 3	540	23523	80242

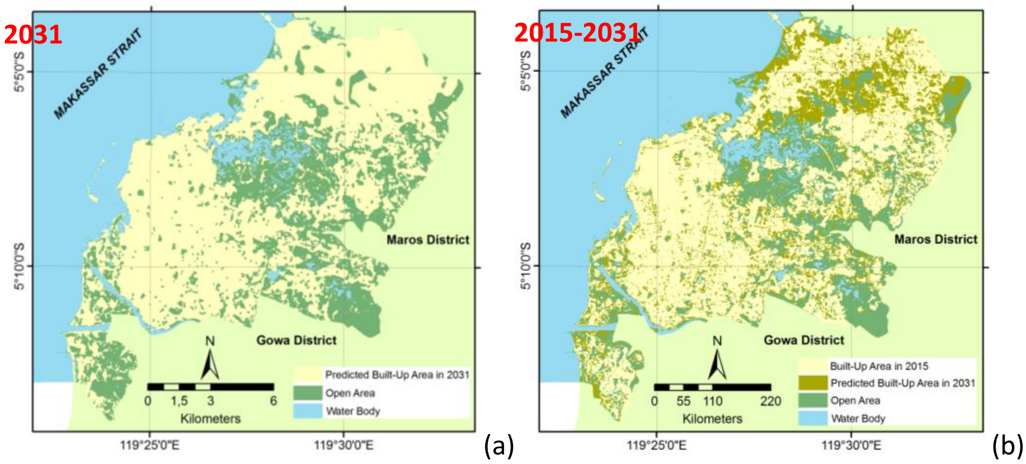

Figure 3-2: The result of spatial projection of land use of Makassar City in 2031 (a) and the trend of the land use in 2015 to 2031 (b)

Table 3-3: Comparison of population and built-up area in 2015 and projection in 2031 in Makassar City

Year	Land Use Area (hectares)				Population	Economic Growth (Million)
	Open Space		Built-up Area			
	Extensive (ha)	%	Extensive (ha)	%		
2015	7.682,40	44,99	9.392,49	55,01	1.547.941	88.740.213,15
2031	5.611,75	32,73	11.531,36	67,27	2.060.309	1.159.463.308

Source: Analysis Result (Amri 2017)

Based on the projection analysis, the built-up area in the mainland area of Makassar City in 2031 is predicted to increase to 11,531.36 hectares or 67.27%, while the remaining area is only 5,611.75 hectares or 32.73%. The number of built-up areas increased significantly compared to the conditions of land use in 2015. The increase is aligned with the projected population growth in 2031 of 2,060,309 people (Table 3-3).

Biringkanaya Sub-district adjacent to Maros District experienced the greatest land conversion, where the prediction of land use change in 2031 left 766.72 hectares or 22.95% of the total area in Biringkanaya Sub-District, and 39.58% for Tamalanrea Sub-District (Table 3-4). The area is far in comparison to the built-up area in 2015, where Biringkanaya Sub-District still leaves an open area of 50.66% and 56.82% for Tamalanrea Sub-District.

Meanwhile, for the archipelago areas within the administrative boundaries of Makassar City, there are 11 small islands namely, Lanjukang Island, Langkai Island, Lumu-lumu Island, Kodingareng Lompo Island, Kodingareng Keke Island, Bone Tambung Island, Barrang Lompo Island, Barrang Caddi Island, Samalona Island, Lae-lae Island, and Kayangan Island (Figure 3-3). The islands are all inhabited with the highest density present in Lumu-lumu Island with the density of 262 people per hectare and spread evenly across the island. The highest population is found in Kodingareng Keke Island (4,170 people), Barrang Lompo Island (3,563 people), Barrang Island Caddi (1,263 people), and Lae-lae Island (1,500 people). In 2015, the total area of the built-up area in the archipelago region in Makassar City is amounted to 55.7 hectares and open area of 66.83 hectares (Table 3-5). Based on the comparison of the island, the highest proportion of built-up areas is in Lumu-lumu Island which is 92.62% and the lowest is Lanjukang Island with only 10% of the built-up area.

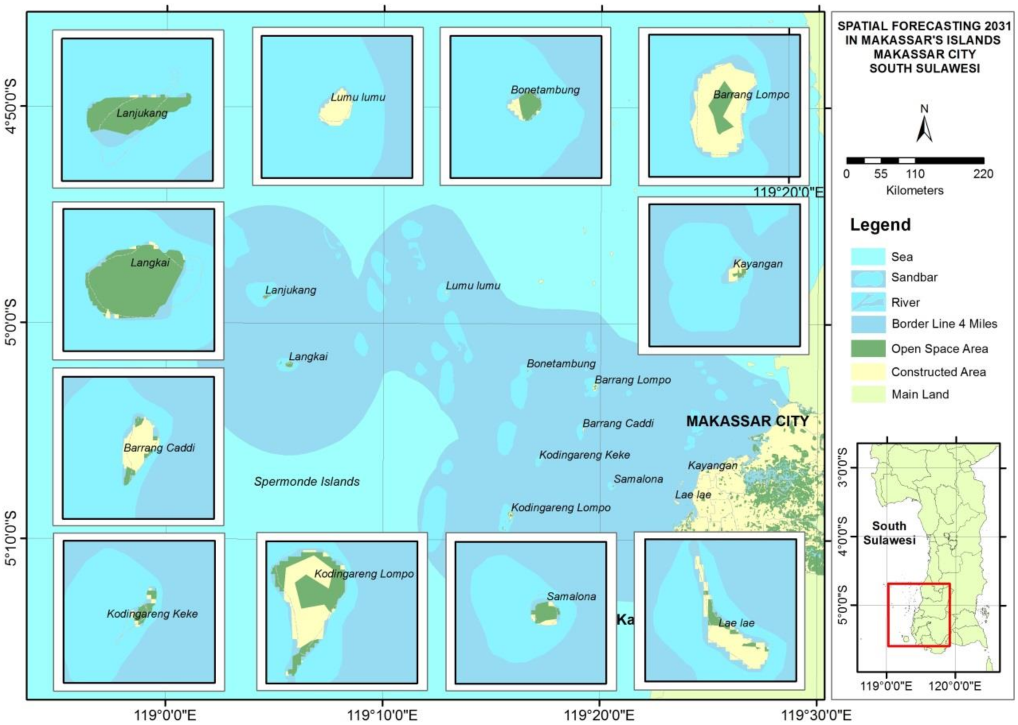

Figure 3-3: Spatial projection in the Makassar's islands in 2031.

Table 3-4: Number of population predictions in two peri-urban sub-districts and built-up area in 2031 in Makassar City

Projection Year	Population		Built-up Area (Hectares)		Open Space (Hectares)	
	Sub-District		Sub-District		Sub-District	
	Tamalan-rea	Biring-kanaya	Tamalan-rea	Biring-kanaya	Tamalan-rea	Biring-kanaya
2015	109.471	190.829	1.731,68	1.649,09	2.278,93	1.693,34
2031	148.997	338.883	2.429,35	2.574,27	1.591,66	766,72

Source: Analysis Results (Amri 2017)

Table 3-5: The condition of the land use in 2015 and spatial projection in 2031 in the archipelagic area of Makassar City

Islands	2015				2031			
	Built-up Area (Hectares)	%	Open Space (Hectares)	%	Built-up Area (Hectares)	%	Open Space (Hectares)	%
Lanjukang	1,54	10,00	13,82	90,00	0,27	1,90	13,97	98,10
Langkai	4,34	14,14	26,36	85,86	0,96	3,35	27,76	96,65
Lumulumu	3,60	92,62	0,29	7,38	3,78	100,00	0,00	0,00
Kodingareng Lompo		53,61	12,35	46,39	12,53	50,31	12,37	49,69
Bone Tambung	1,44	43,83	1,84	56,17	0,79	26,94	2,15	73,06
Kodingareng Keke	0,75	37,08	1,26	62,92	0,33	17,59	1,54	82,41
Barrang Caddi	4,60	72,70	1,73	27,30	5,25	83,33	1,05	16,67
Barrang Lompo	15,46	73,75	5,50	26,25	17,16	83,20	3,47	16,80
Samalona	0,85	34,69	1,61	65,31	0,78	29,37	1,88	70,63
Lae-lae	7,83	81,79	1,74	18,21	11,11	86,91	1,67	13,09
Kayangan	1,02	75,54	0,33	24,46	1,49	66,63	0,75	33,37

Source: Analysis Result (Amri 2017)

Table 3-6: The condition of the land use in the archipelagic area of Makassar City

Islands	Built-up Area		Open Space	
	Difference	Status	Difference	Status
Lanjukang	-1,265	Decrease	0,146	Increase
Langkai	-3,378	Decrease	1,404	Increase
Lumulumu	0,179	Increase	-0,287	Decrease
Kodingareng Lompo	-1,752	Decrease	0,020	Increase
Bone Tambung	-0,643	Decrease	0,308	Increase
Kodingareng Keke	-0,416	Decrease	0,276	Increase
Barrang Caddi	0,655	Increase	-0,675	Decrease
Barrang Lompo	1,701	Increase	-2,036	Decrease
Samalona	-0,072	Decrease	0,273	Increase
Laelae	3,279	Increase	-0,070	Decrease
Kayangan	0,470	Increase	0,417	Increase

Source: Analysis Result (Amri 2017)

The decrease and increase mean that several islands in Makassar City are predicted to decrease of the built-up areas and increased of the open areas, especially in Lanjukang Island, Langkai Island, Kodingareng Lompo Island, Bone Tambung Island, Kodingareng Keke Island and Samalona Island (Table 3-6). The condition is caused by the government policy that makes the islands as conservation and tourism area. Meanwhile, the increase of the built up area is predicted to occur in Lumu Island, Barrang Caddi Island, Barrang Lompo Island, Lae-lae Island, and Kayangan Island. The condition is caused by the increased number of populations, thus correspond to the land conversion.

Especially for Kayangan Island, both constructed and open areas are relatively increased. It is because Kayangan Island which is a government asset of Makassar City is managed by the private sector as tourist destination. They then build guest houses on the sea water. The words 'decrease' and 'increase' indicate an increase or decrease in the area due to human activities.

3.3 Relevance of Land Use Projection Year 2031 with the Spatial Policy of Makassar City

Coastal cities have certain limits and extents, but the demand of built-up area is always high. The land conversion is capable to change the natural configuration of urban land. Urban land use tends to ignore the existence of open space, which is often regarded as uneconomic. Whereas the open spaces, ecologically, is able to balance the functions and work of urban systems. Therefore, it is needed a policy tool that is able to regulate and maintain the existence of the open areas at optimum extent it is required.

In the city's urban spatial plan (RTRW 2010-2030), Makassar City has been divided into 12 Integrated Strategic Areas, namely City Center Area, Integrated Sports Area, Integrated Port Area, Integrated Settlement Area, Integrated Warehousing Area, Research and Integrated Education Area, Integrated Maritime Area, Integrated Cultural Area, Integrated Global Business Area, Integrated Industrial Area, and Integrated Airports Area (Figure 3-4). Each of these areas has been determined the optimal target area that will function as the green open spaces (Table 3-7). In 2015, the City Center has already been deficit in terms of open space area for 187.42 hectares and the spatial projection in 2031 is at392.48 hectares (Table 3-8). In the Integrated settlements area, there are still about 1.366.13 hectares of open space area or remained 297.67 hectares from the target allocation of the open space area. But in 2031, a drastic decline is predicted with 25.49 hectares remains from 1,068.46 Targeted hectares. Table 3-8 also shows several integrated strategic areas that will be deficit of open area in 2031, including the City Center, Integrated Ports, Integrated Warehousing, and Integrated Maritime Zones. These four areas are densely populated areas that require special environmental management, for example by utilizing the roofs or buildings as green areas and integrated waste management systems.

In general, the deviation from the urban spatial plan precisely starts from the inconsistency of government policy. It means that the government as the manager of urban spatial plan has not really referring to the spatial planning maps that have been previously defined. The main cause of ineffectiveness of spatial plan is the lack of inter-institutional coordination and community involvement, so that the aspirations of the people are not accommodated in urban spatial planning (Sunardi 2004).

Determination of a region with a certain purpose must be balanced with the supervision and affirmation. Development permits that are issued by the government often do not conform to the regional regulations, such as green open space areas are permitted for residential areas. The absence of sanctions against violations of the urban spatial plan indicates the uncertainty and inconsistencies of the urban spatial plan. For example, at the present time, Integrated Industrial Zones has many settlements, while the allocated area for open green areas are getting smaller. The issued construction permit should be aligned with the land allocation based on spatial plan of Makassar City. The data presented in (Table 3-8) shows that the Integrated Industrial and Integrated Warehousing Area has been experiencing a drastic increase of construction in 2031. This could happen not because of industrial and ware housing development, but filled by other land use.

Table 3-7: Land use conditions in Makassar City in 2015 and spatial projection in 2031 at each integrated strategic area

Integrated Strategy Region	Total Area (hectare)	2015		2031	
		Built-up Area (ha)	Open Space (ha)	Built-up Area (ha)	Open Space (ha)
Main City	2.935,22	2.516,39	399,62	2.721,91	194,56
Integrated Sport	883,49	305,65	556,85	308,31	550,80
Integrated Port	292,22	225,91	59,06	255,86	27,36
Integrated Settlement	5.342,28	2.841,57	2.434,59	3.109,76	2.162,41
Integrated Warehouse	1.968,22	860,06	979,13	1.507,44	334,78
Integrated of Research & Education	1.533,17	465,04	929,89	486,90	909,47
Integrated Maritime	354,56	145,32	162,19	246,95	61,58
Integrated Culture	48,02	13,58	34,19	12,70	34,90
Integrated Global Business	420,83	228,88	166,51	253,83	141,67
Integrated Industry	1.391,61	551,36	735,61	862,66	430,89
Integrated Tourism	374,76	192,43	174,20	207,81	158,05
Integrated Airport	1.836,04	919,79	913,73	1.399,49	431,66

Source: Analysis Result (Amri 2017)

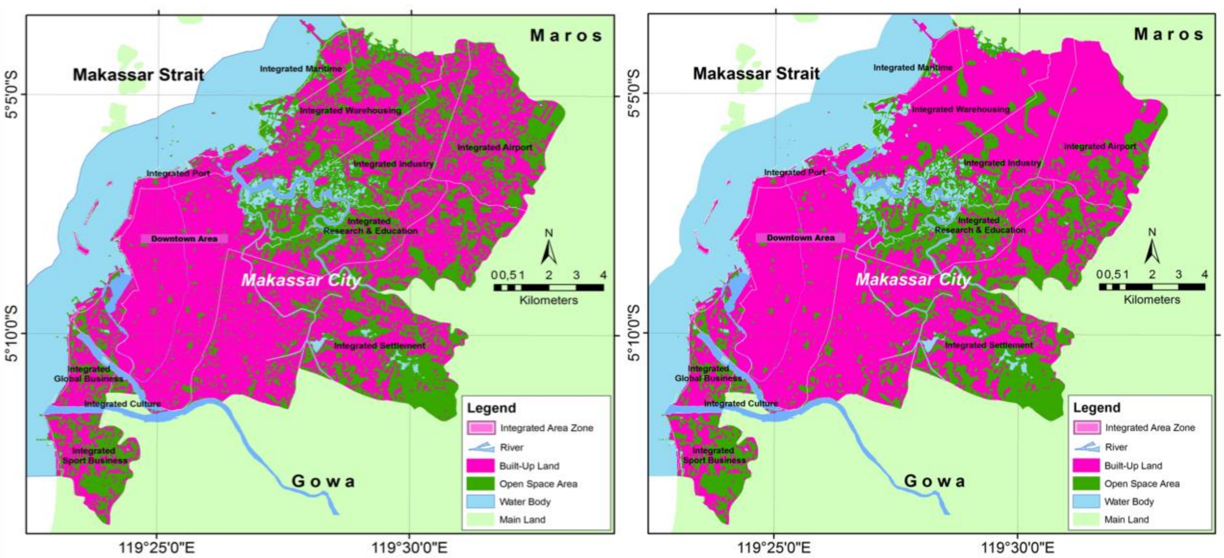

Figure 3-4: The built-up and open space area in 2015 and 2031 in Makassar City base on the integrated strategic area of Makassar City (RTRW 2010-2030)

Table 3-8: Percentage of green open space targeted at each integrated strategic area and realization of target in 2015 and 2031

Integrated Strategy Region	% Target		Difference From Target (hectare)*	
	%	ha	2015	2031
Main City	20	587,04	-187,42	-392,48
Integrated Sport	50	176,70	380,15	374,1
Integrated Port	30	58,44	0,62	-31,08
Integrated Settlement	30	1.068,46	1.366,13	1.093,95
Integrated Warehouse	20	393,64	585,49	-58,86
Integrated of Research & Education	47	306,63	623,26	602,84
Integrated Maritime	50	70,91	91,28	-9,33
Integrated Culture	50	9,60	24,59	25,3
Integrated Global Business	50	84,17	82,34	57,5
Integrated Industry	20	278,32	457,29	152,57
Integrated Tourism	50	74,95	99,25	83,1
Integrated Airport	47	367,21	546,52	64,45

Description : *) Minus (-) means it deviated from the plan target

Sources: Analysis Result (Amri 2017)

This condition would be a serious problem if not solved. The growing of the built-up area that is not proportional to the allocation of green open space, will decrease the carrying capacity of the coastal city (increased pollution, decreased ground water availability, increasing of temperatures, etc.), decreasing the natural beauty and cultural historical artifacts, and at the social level will reduce the urban security and public welfare.

Population density is determinant to the environmental quality of a coastal city. It is an indicator of the high socio-economic activity of the population. The more densely populated area will put greater pressure to the environment and become the cause of environmental degradation. To state how big a region's environmental quality is based on its population density, the Population Density Index (IKP) is used. The density index of Makassar City below 2015 is at 100, which means that the population density of Makassar City is still in the ideal level as recommended by the World Health Organization (WHO) reference (WHO 2014). In 2015 however, the population density index has reached 99.25 which means that the population density level is slightly over the ideal threshold, and this became a warning for Makassar City to more firmly restrict the land conversion efforts that do not consider the ecological factors. Because, if it doesn't start from now, based on the projection of population in 2031 with predicted population of 2,060,309 people, the population density index has reached 82.9. It means that the value indicate a serious pressure on the coastal city environments.

Management of marine areas and islands in Makassar City is regulated in the zoning plan of the coastal area and Small Islands (RZWP3K) for 2014. Spatial plan is very important to do because the marine and islands in Makassar City is a busy trade and high-traffic area of the ship. With many types of utilization in the sea will cause a lot of potential conflict. RZWP3K of Makassar City is based on the establishment of three utilization zones, among others are Public Utilization Area, Conservation Area, and Cruise Line which each region has zone and subzone (Table 3-9).

The linkages matrix between marine space utilization areas was done to see the connection and harmonization between space utilization and potential conflict (Table 3-10).

Fisheries, port, industry, and cruise line zones are the central of human activities and the ships traffic which are particularly vulnerable to waste disposal. Development of mariculture and conservation areas around the area above is very risky and will cause conflict, because the activities of port and ship traffic will leave an oil spill and fishing gear that can interfere with cultivation activities.

The existence of mariculture and marine tourism zones (especially water recreation zones) will interfere with each other or potentially conflict with the port activities, fishing zones and cruise line zones. Mariculture zones and marine tourism zones (diving and snorkeling) will be contaminated with the port activities, ship traffic, and fishing activities. Negative impacts that may arise are pollution and environmental changes such as the fishing activities that will leave traces of both fishing equipment that is caught in the rocks, oil spills and disposal from fishermen.

Table 3-9: Management of marine areas and islands in Makassar City in RZWP3K document 2014 in Makassar City

No.	Region	Zone	Sub-Zone
1	Common Use	• Aqua Culture	• Mariculture • Deep Sea Aquaculture
		• Fisheries	• Pelagic Fisheries • Demersal Fisheries
		• Port	• DLKp (Collector Port) • DLKr (Collector Port)
		• Tourism	• Water Tourism • Diving • Beach Tourism
		• Others Utilization	
2	Conservation	• Utilization Limited	• Utilization Limited BarrangCaddi Island • Utilization Limited BarrangLompo Island • Utilization Limited of Bonetambung Island
3	Cruise Line	• Cruise Line	• International Cruise Line • National Cruise Line • Regional Cruise Line

Source: Coastal zone planning & small island of Makassar City 2014 (Bappeda Kota Makassar)

Table 3-10: The linkages matrix between marine space utilization areas in Makassar City (Maesaroh *et al.* 2013)

Aqua Culture	Aqua Culture						
Fisheries	▲	Fisheries					
Port	○	□	Port				
Marine Tourism	○	○	○	Marine Tourism			
Beach Tourism	○	○	○	□	Beach Tourism		
Conservation	◄	◄	◄	□	□	Conservation	
Cruise Line	▲	○	□	○	○	▲	Cruise Line

Description: ○ potentially conflicting, ▲ threatening to Activities above, □ Positive impacting activities, ◄ Threatening activities on the left

Mariculture zones also have the potential to disrupt diving and snorkeling activities, because it can limits the movement for tourists. The beach recreation zone will also potentially be conflicted with the presence of ports and activities, but the presence of ports with tourism activities on the islands will be crucial as part of the supporting infrastructure for island tourism activities.

4 CONCLUSION

- There has been significant increase of open spaces for a period of 14 years (2001 - 2015). During this observation period, physical development was relatively spreading irregularly and indicated the urban sprawl phenomenon. Spatial growth and movements of the built up areas in 2015-2031 are predicted to be higher especially in two peri-urban sub-districts (sub-district Tamalanrea and Biringkanaya) which are an integrated strategic area for warehousing, industrial, maritime, airport and settlement interests.
- There has been open area deficit for the green open space in 2015, especially in the downtown area, whereas in 2031 it is predicted that land deficits will increase to several designations of integrated strategic areas, such as integrated maritime, ports and warehousing zones.
- Several islands in Makassar City are predicted to have its built-up areas decreased. Especially in Lanjukang Island, Langkai Island, Kodingareng Lompo Island, Bone Tambung Island,

Kodingareng Keke Island and Samalona Island. Meanwhile, the increase on built up area is predicted to occur in Lumu Island, Barrang Caddi Island, Barrang Lompo Island, Lae-lae Island, and Kayangan Island. The land cover is caused by the human activities.

- The plan of development areas or marine utilization zones in Makassar city based on the zoning plan of the coastal area and small islands has the potential of land use conflict, where the plan of conservation area development, maritime tourism and mariculture, will conflict with the port and industry activities, and fishing catch areas.

This study used low resolution to obtain the same spatial resolution at different times. For the future research, to obtain information on land use changes with more detailed land use classification, we recommend using satellite imagery with higher spatial resolution.

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