International Journal of Engineering Trends and Technology
ISSN: 2231–5381 / https://doi.org/10.14445/22315381/IJETT-V72I6P137
Volume 72 Issue 6, 421-431, June 2024

Original Article

Implementation of Aerotropolis Concept in the Development of the Areas Around Sultan Hasanuddin International Airport

Abdul Azis Jamaluddin[1], Herman Parung[2], Kurniaty[3]

[1,3] *Department of Regional Planning and Development, Graduate School, Hasanuddin University, Indonesia.*
[2] *Hasanuddin University, Faculty of Engineering, Indonesia.*

[1] *Corresponding Author : abdulazisjamaluddin@gmail.com*

Received: 19 February 2024 Revised: 03 June 2024 Accepted: 08 June 2024 Published: 29 June 2024

Abstract *- The development of the airport position, which is usually planned separately from the development of the city is changed into a unified planning between the airport and the surrounding area as an airport city or aerotropolis. The development of Sultan Hasanuddin International Airport as a service center can influence the spread effect on the economic growth of surrounding areas through land use arrangements and transportation infrastructure. The pace of regional development marked by the shifting land use can be caused by land limitation or competitive land use, so land use needs to be planned to create sustainability in regional development. To implement a successful aerotropolis concept, this study's goal is to ascertain the potential land use to formulate directions in the development of the area around Sultan Hasanuddin International Airport with the implementation of the aerotropolis concept. This research uses the method of spatial analysis of weighted overlay and simulation with the cellular automata approach to determine the potential land in terms of the number and spatial direction of land use distribution patterns as a basis for consideration of the formulation of the development direction of the aerotropolis concept. Based on the results of the study showed the ability of the land is suitable and has no physical barriers to the development of the concept of an aerotropolis, and simulation results showed potential land in the development of the concept of an aerotropolis with land changes in the commerce and service area until 2042 amounted to 1.741 hectares which growth occurs in paddy fields, open land, shrubs, moor, the plantation, and ponds which direction of land use change predominantly occurs in Mandai District Maros Regency by 725 hectares.*

Keywords *- Aerotropolis, Airport, Geographic information system, Land use, Regional development.*

1. Introduction

The growth and development of urban areas are accelerated by economic growth [1], increasing population, and human mobility [12], which is characterized by shifts in land use and can be caused by land limitation and competitive land use. The need for land increases along with increased mobility and regional concentration. Where one of the areas that have the potential to become a new economic growth center is the center of transportation services, so land use needs to be planned to create sustainability in regional development. Airport development, which is usually planned separately from city development, is transformed into a planning unit between the airport and the surrounding area as an airport city or aerotropolis [7]. Aerotropolis is a new urban form characterized by cities built around the airport [9] to increase effectiveness, efficiency, and sustainable economic development that places the airport as a growth center, connectivity with global markets [8], and views that the airport is not only a means of air transportation but can have a spread effect on the economic growth of the area around the airport [3,13]. The development of Sultan Hasanuddin International Airport is increasing in line with the increase in development activities in Eastern Indonesia and especially in South Sulawesi Province, so it has the potential to have a spread effect on the development of the surrounding area where Sultan Hasanuddin International Airport becomes a new economic center. However, this potential can be a threat to spatial planning and the environment and cause impacts on land if land use does not follow the ability and suitability of the land [6]. The need for land suitability is a process of determining the feasibility of specific land conditions to support certain activities or land uses. [11] wrote that land use planning activities are key and play a major role in achieving sustainable development. To direct future projections to determine potential land use, a spatial decision-making system will be used by simulating with a cellular automata approach utilizing ArcMap 10.8 and LanduseSim software. LanduseSim is a software that processes raster data to create simulations and spatial modeling, with the main base being land use data [15]. LanduseSim can perform planning scenarios in land use improvement, is flexible in setting rules and resolutions on the map, and can adjust to the boundary zone to be set. Users can control factors in the simulation process, such as desired growth targets, designing planning scenarios, determining driving factors, zoning, multi-land use simulation, and the capacity to generate novel cell configurations while simulating [16]. To apply the aerotropolis concept, it is necessary to determine the potential land use in terms of the number and spatial direction of land use distribution patterns as a basis for consideration of the formulation of directions in the development of the area around Sultan Hasanuddin International Airport with the implementation of the aerotropolis concept.

2. Materials and Methods

2.1. Research Area

The research area is 11.584 hectares in Biringkanaya District in Makassar City and Mandai District, Maros Baru District, Marusu District, Moncong Loe District, Tanralili District, and Turikale District in Maros Regency. The research area also refers to the Flight Operation Safety Area (KKOP).

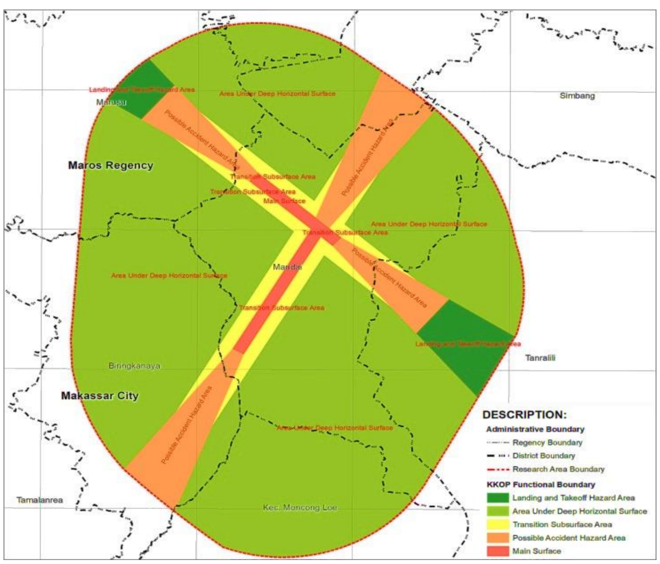

Fig. 1 Research area

This research uses a quantitative approach that is used for the implementation of the concept of an aerotropolis around the Sultan Hasanuddin International Airport area through a spatial analysis process consisting of several stages, namely knowing the characteristics of the area around the airport, the ability and suitability of land, simulation of potential land use development direction around the Sultan Hasanuddin International Airport area based aerotropolis. The data required in this research is in the form of primary data collected by observation and interviews and secondary data using literature research and data collection from several related agencies.

Table 1. Land capability class and development classification

Total Value	Land Capability Class	Land Capability Classification
32-58	Class A	Very Low Development
59-83	Class B	Low Development
84-109	Class C	Medium Development
110-134	Class D	High Development
135-160	Class E	Very High Development

2.2. Land Capability and Suitability Analysis

The need to know the characteristics of the area around Sultan Hasanuddin International Airport based on the principle of aerotropolis, then performed analysis tools on ArcMap 10.8 and pivot tables on microsoft excel. Analysis of land capability and suitability refers to Minister of Public Works Regulation No. 20/PRT/M/2007, which is used to recognize land characteristics so that land use in regional development planning can be completed as effectively as possible while paying attention to the balance of the ecosystem for sustainable regional development. To classify land capability, the Land Capability Unit (SKL) that was created by multiplying the level of land capability in each SKL by its weight one at a time is displayed. This creates a map of the total number of final values multiplied by the weight of all SKLs. This analysis is called a score (score = final value x weight). From the total score, several classes are made that pay attention to the minimum and maximum values of the total score. From the figure above, the minimum possible value is 32, while the maximum possible value is 160.

Land suitability analysis is one part of the control points to assess the suitability of space utilization with spatial plans. Land evaluation is in the form of alignment of current land use conditions with future land allocations that are generally contained in spatial plans (space allocation plan). Evaluating the suitability of land use against spatial plans is important in achieving optimal land use. Indication of conformity or non-conformity is done by looking at deviations that occur in land use against areas that have been allocated and determined in the Regional Spatial Planning (RTRW). If the existing land use is per the space allocation plan then the land is called suitable. Land use that is not suitable and is permanent should be accommodated in the review and revision of RTRW improvements. Land suitability analysis was conducted with overlay analysis in ArcMap 10.8 and pivot tables in microsoft excel between existing land use and the RTRW space allocation plan.

2.3. Model and Simulation of Potential Land Use

Modeling potential land use development uses a cellular automata approach, where all units are in the form of cells. The modeling process begins with identifying driving factors, creating an initial transition potential map, determining neighborhood filters, creating transition rules, and conducting simulations [16].

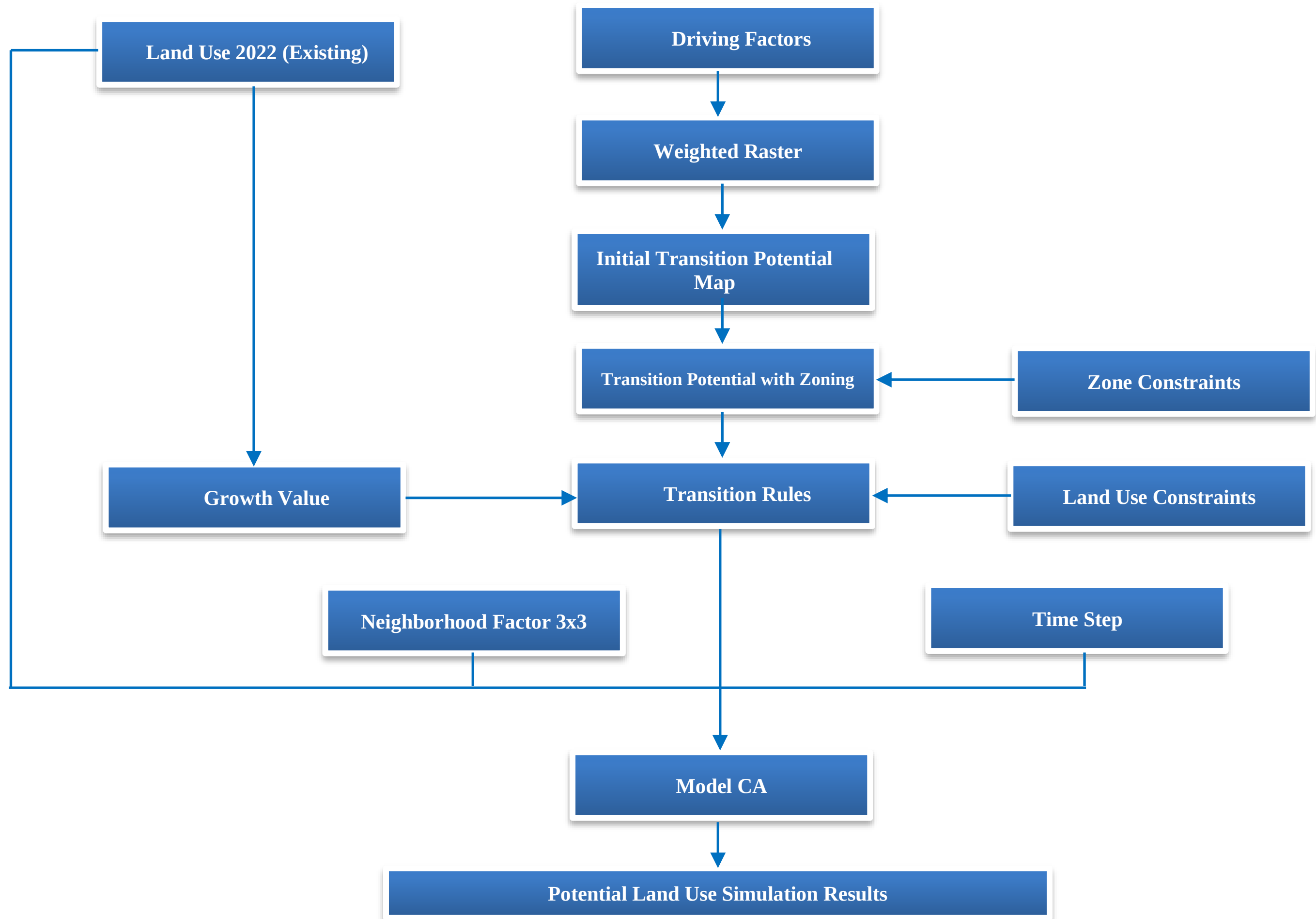

Fig. 2 Potential land use simulation framework

All simulation processes will be processed using LanduseSim and ArcMap 10.8 applications. LanduseSim is a raster-based application that uses cellular automata algorithms to perform spatial simulations that give users complete control over every aspect of the simulation process, including growth targets, cell size, determination of driving factors, and creating several planning scenarios. Simulation in LanduseSim starts with the adjacency process where this process the input map as an initial transition map into a transition potential map. The initial transition map is prepared using a weighted overlay mechanism and SMCE (Spatial Multi-Criteria Evaluation) approach from several suitability maps. Simulation in the LanduseSim application is done by following Equations 1 and 2 [16].

$$TPcs_{(x,y)} = \sum_{z=0}^{n}(Ncs_{(z\rightarrow n)(x,y)}.ITPcs_{(z\rightarrow n)(x,y)}) \quad (1)$$

$TPcs_{(x,y)}$: Potential benefits of changing land use for services and commerce *(cs)* on certain cells *(x,y)*.

$Ncs_{(z\rightarrow n)(x,y)}$: The neighborhood filter method uses a specific filter and its buildup in the cell's center *(x,y)*, where *n* is the total number of neighborhood cells, whether or not they have a cell center.

$ITPcs_{(z\rightarrow n)(x,y)}$: The initial value of the transition potential map for a specific land use *cs*.

The geographic information and Multicriteria Evaluation (MCE) system is used to compile a development potential transition map by combining a suitability map and a constraint zone map.

$$LUcs^{t+1}_{x,y} = f\,(LU^{t}_{x,y},TPcs_{x,y},Gcs_{x,y},Ccs_{x,y},Zcs_{x,y},TS) \quad (2)$$

$LUcs^{t+1}_{x,y}$: The recent expansion of land usage *cs*, *t+1* on certain cells *(x,y)*.

$LU^{t}_{x,y}$: The prior land use class's condition before simulation on a particular cell *(x,y)*.

$TPcs_{x,y}$: Potential transition map for land use *cs* on certain cells *(x,y)*.

$Gcs_{x,y}$: Number of projected cell expansion at that period calculated using land use maps *(t+1)*.

$Ccs_{x,y}$: Land growth constraint (class of land use that cannot be changed by land use *cs*).

$Zcs_{x,y}$: Land use plans and growth promotion zones.

TS: Time step of research.

3. Results and Discussion

3.1. Area Characteristics

The role of land use is very important as a functional space where activities take place. According to Figure 3, the classification of land use in the research area consists of 25 types, which are dominated by paddy fields of 3.150 Ha (27%), settlements of 2.044 Ha (18%), and moor of 1.249 Ha (11%). The intensity of building utilization in the research area with a total of 84.533 buildings. The district with the highest number of buildings in the Biringkanaya District, with 45.583 units (54%).

According to Figure 4, the building functions it is classified as diverse, which is divided into 15 building functions with the largest number of buildings, that is, settlements totaling 75.622 units (89%), then commerce buildings totaling 5.435 units (6%). Based on the land use and building functions in the research area show that it is not by the principles of aerotropolis, which leads to the main designation of the function of commerce and service area and the provision of business areas. There is no mixed-use area integrated with the airport, so land use and building functions have not supported the implementation of the aerotropolis concept.

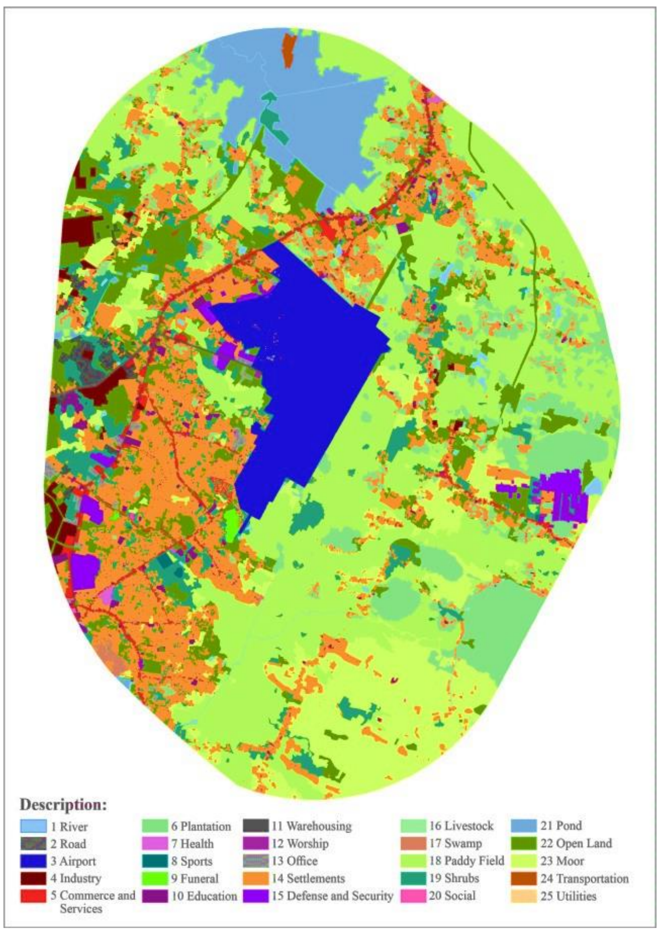

Fig. 3 Land use

Table 2. Average land capability level

Class	Land Capability Classification	Area	
		(Ha)	(%)
Class C	Medium Development	179	2
Class D	High Development	11.314	97
Class E	Very High Development	91	1
Total		**11.584**	**100**

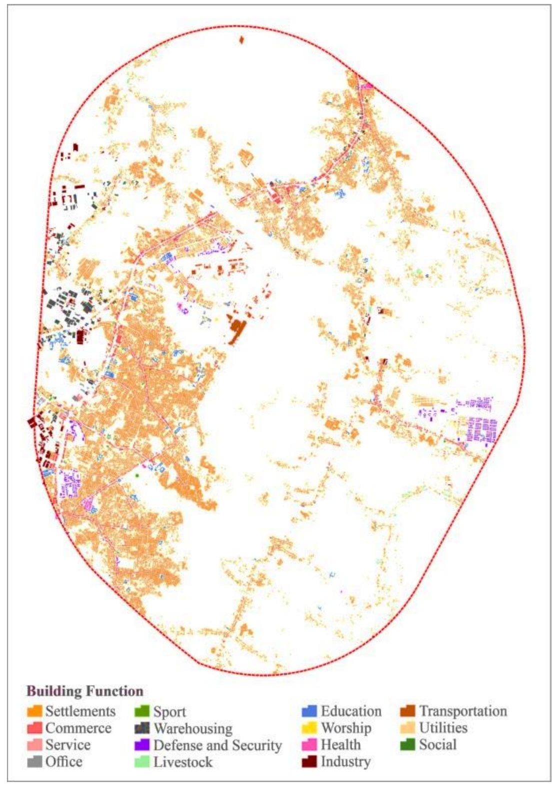

Fig. 4 Building functions

3.2. Land Capability and Suitability

Land capability analysis is used to determine the level of land capability so that the direction of land allocation does not cause problems, such as development activities that are not in accordance with physical aspects and environmental carrying capacity. The score of each land capability unit is the final value multiplied by the weight of each Land Capability Unit (SKL). Based on the results of the weighted overlay analysis by combining 9 SKL variables and multiplying the weight with the final score, there are 3 classifications of land capability in the research area that is Class E with a very high development land capability, Class D with a high development land capability, and Class C with a medium development land capability. Based on the results of the analysis, the land capability class in the research area is dominated by Class D with a high development land capability with an area of 11.314 hectares or 97% of the research area (Figure 5). A land capability that is suitable for use as land for urban area development and has no physical barriers, in this land capability can be developed into cultivation areas and the development of urban area service centers.

Fig. 5 Land capability map

The land capability with high development is found in the use of paddy fields with an area of 3.151 hectares, moors with an area of 1.189 hectares, open land with an area of 1.061 hectares, the plantations an area of 870 hectares, and shrubs an area of 646 hectares. These land uses can be considered for conversion to progress land as well as in supporting the development of aerotropolis-based urban areas.

The assessment of land appropriateness takes the form of matching the land use circumstances that exist today with the land allocations that will be made in the future, which are typically found in regional spatial plans. To assess the suitability of space utilization contained in the 2015-2034 Makassar City Spatial Plan and the 2012-2032 Maros Regency Spatial Plan, a match was made between the space allocation plan and land use. Indication of suitable or not suitable is done by looking at deviations that occur in land use against areas that have been allocated and determined in the spatial pattern of the regional spatial plan. If the existing land use is in accordance with the space allocation plan then the land is called suitable. The percentage identified as suitable and space utilization that is still in line with the space allocation of the regional spatial plan is 63% (Figure 6). Land use mismatches generally occur on land planned as wetland food agricultural areas and dryland agricultural areas into built-up areas. This is closely related to changes in economic structure, urbanization flows, and population growth that require land area, resulting in many land changes for various development purposes.

Table 3. Land suitability in the research area

Space Allocation Plan	Area of Space Allocation Plan (Ha)	Land Suitability with Land Use	
		(Ha)	(%)
Residential	3.235	1.876	58
Airport	386	359	93
Industrial	207	101	49
Warehousing	21	9	41
Health	5	5	98
Education	18	15	85
Commerce and Service	44	30	69
Worship	3	3	85
Office	41	23	56
Defense and Security	25	15	61
Plantation	1	0	47
Food Crop	4.882	2.636	54
Horticultural	2.026	912	45
Aquaculture Fishery	519	394	76
River	9	3	34
River Border	19	16	82
Green Open Space	143	46	32
Average Land Suitability Level	**11.584**	**7.298**	**63**

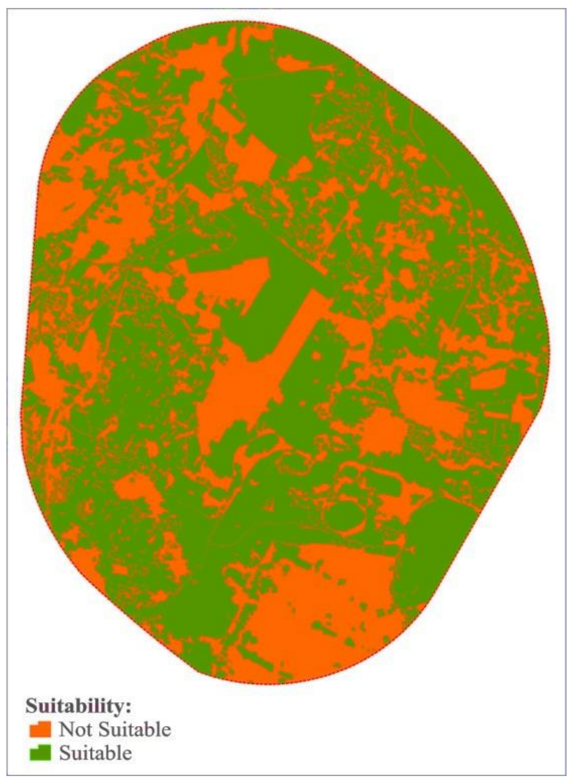

Fig. 6 Land suitability map

3.3. Modeling and Simulation of Potential Land Use

Potential land use development can be caused by many factors that have a relationship to a type of land use. In the process of land use change, some factors influence it because these factors interact and correlate with each other [12]. Factors that influence the simulation of land use development in the development area around Sultan Hasanuddin International Airport based on aerotropolis are divided into 2, namely the driving factors that will affect the development of land use [10] and limiting factors that will maintain the development of land use to be more controlled [14], each class of land use has constraints to be developed which means land use will not develop or convert land [16].

Based on the consideration of aerotropolis principles [4,13], the factors used in the modeling of potential land-use changes in the vicinity of Sultan Hasanuddin International Airport, namely for driving factors consisting of primary arterial roads, toll roads, primary collector roads, secondary collector roads, railroad networks, airport areas, mixed-use activities, existing commerce and service areas, high and very high development land capability, driving space allocation plan, service routes, and transportation facilities.

The limiting factors consist of KKOP areas, the possibility area of accident hazards, medium development land capability, and land use including the river, roads, built-up areas, and green open spaces. The simulation period used is 20 years, from 2022 to 2042, by the planning year carried out in the spatial plan and regional development plan. Furthermore, it determines the land that will be predicted to experience growth, namely commerce and service land, which is then converted in the form of cell size based on the simulation period until 2042. In Table 4, the prediction of land growth by looking at existing commerce and service land and the average per five years of passenger growth obtained from the Sultan Hasanuddin International Airport Master Plan document. To find out the area of land needed, a land projection is carried out referring to [5] the regulations for urban residential environment planning, which uses projections for commercial areas.

The amount of space and land requirements according to the classification of types of commercial facilities include shopping and commercial centers, a service scale = 120.000 residents, and the required land area is 36.000 m^2. The analysis's findings, the estimated amount of land needed for the development of the area around Sultan Hasanuddin International Airport until 2042 amounted to 1.484 hectares.

The predicted area of land growth is then converted into raster data with a cell size of 5x5. The number of cells used in predicting land growth until 2042 amounted to 593.784 cells.The direction of change of a specific land use function is determined by the driving factor's distance, which has varying effects on different land use functions. A land use function has the potential to change the closer it is to a driving factor [15]. The formation of the range map is done through distance-based analysis in LanduseSim using a fuzzy set: linear, monotonically decreasing where the value will have a range between 0 to 1. Each of these factors has a proximity effect, which indicates that the closer to the value of 0 or the red color hue, the reach area is to the factor that has the potential to grow faster and experience land change [16].

Then, in the formation of the transition map, it is necessary to determine the weight of each driving factor that most affects land growth based on the level of influence. Based on the results of interviews with several experts, namely academics, practitioners, and government, the level of influence of each driving factor is obtained, which will be used in determining the weight, and then the weight is calculated to a value of 1. The weights obtained are proximity to primary arterial roads (0,04), primary collector roads (0,02), secondary collector roads (0,02), toll roads (0,02), railroad networks (0,02), airport areas (0,36), mixed-use areas (0,17), existing commerce and service areas (0,09), land capability (0,04), space allocation plan (0,09), service routes (0,04), and transportation facilities (0,09). The map of the driving factor coverage area was then converted into real numbers, valued between 0 (the farthest distance) and 1 (the closest distance), using the fuzzy value method in the fuzzy set tool in LanduseSim.

Table 4. The prediction of passenger growth sultan hasanuddin international airport and land requirement for commerce and services

Research Area	**Service Standard (people)**	**Land Requirement Projection**							
		2027		**2032**		**2037**		**2042**	
		Passengers	**Needs**	**Passengers**	**Needs**	**Passengers**	**Needs**	**Passengers**	**Needs**
	120.000	21.024.000	175	30.836.000	257	40.159.000	335	49.482.000	412
Total Land Requirement (Ha)	3,6	631		925		1.205		1.484	
Cell Size 5 x 5		**252.288**		**370.032**		**481.908**		**593.784**	

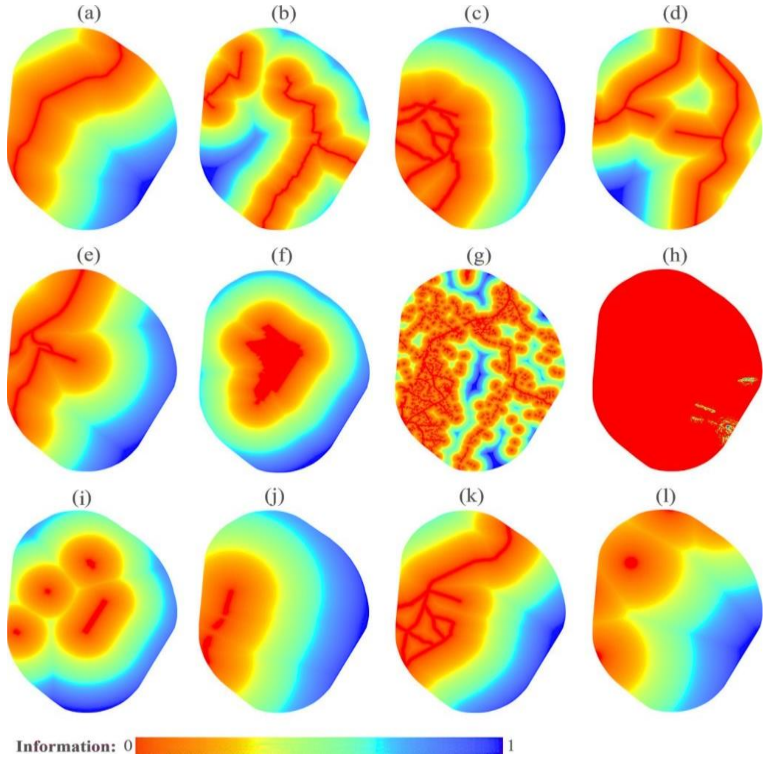

Fig. 7 Distance map of driving factors. (a) Distance to primary artery road, (b) Distance to primary collector road, (c) Distance to secondary collector road, (d) Distance to toll road, (e) Distance to railway network, (f) Distance to airport area, (g) Distance to existing commerce and services area, (h) Distance to land capability, (i) Distance to mixed-use area, (j) Distance to the area allocation Plan, (k) Distance to transport routes, and (l) Distance to transportation facilities

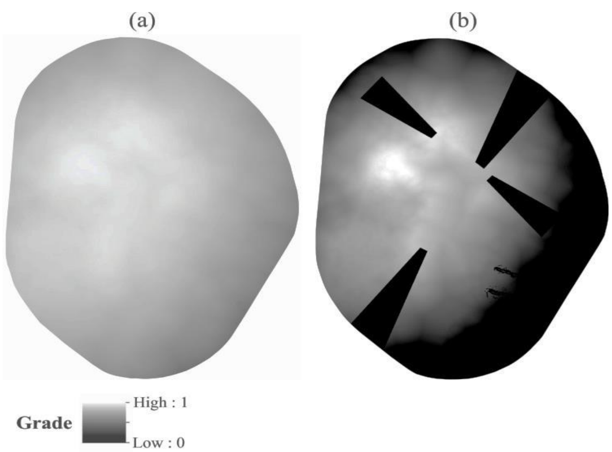

Fig. 8 (a) Suitability map, and (b) Transition potential map with zone constraints

The cell value on the suitability map will show the potential for development or change for each growing land use function. To show the suitability map of land growth is depicted if the whiter the color hue of the map, it has the higher the cell value, otherwise if the blacker the color hue of the map, it has the lower the cell value. The formation of a constraints zone using union overlay analysis to maintain land designated as a constraints zone. Then, the formation of the potential growth transition map with the boundary zone is carried out by overlay analysis by combining the boundary zone with the suitability map, with the map results showing that the more white the color hue of the map, the higher the potential for land to be converted. Simulation results are obtained by preparing several forming parameters, namely the projection range used from 2022 to 2042, the initial land use used in 2022 based on the results of satellite image interpretation, neighborhood filter, and set of transition rules that were employed under the findings of earlier research, namely NF 3x3 [2] and a time step of 20 years. The simulation results of land use change in the development of potential land use can be seen in Figure 9. Based on cellular automata, the simulation results depict the spatial pattern distribution of potential land use with a limitations zone till 2042 in the development of the aerotropolis area, demonstrating the expansion of land used for commerce and services. Land use change in 20 years obtained a total land area that experienced land change amounted to 1.482 hectares. For the simulation results, the potential land for land growth in the commerce and service area is from 259 hectares in 2022 to 1.741 hectares in 2042. Technically, simulations and models using cellular automata have demonstrated that their application is not restricted to evaluating upcoming issues regarding the state of regional development. [1]. The models and simulations inform the distribution of land use patterns that can be of practical use depending on their application in assessing the impact of planning actions or for preparing strategic plans and detailed spatial plans to avoid the effects of planning inconsistencies.

Based on the rate of development of potential land use from 2022 to 2042 shows the growth of commerce and service land each year. The growth of commerce and services land based on the simulation results of land use change in the period leads to the entire vicinity of Sultan Hasanuddin International Airport except in the area of possible accident hazards in KKOP and leads to the administrative area of Biringkanaya District, Mandai District, Marusu District, and Turikale District. In the extensive changes in the development of the area around Sultan Hasanuddin International Airport with the aerotropolis concept, the district with the largest land change is in the Mandai District, with an area of 725 hectares, then there are land changes in the Biringkanaya District with an area of 378 hectares, Marusu District of 343 hectares, and Turikale District of 32 hectares. The growth of the land area has the consequence that there is a decline in the land area in other land functions because the area is fixed or will not change. Land functions that experienced a decline were paddy fields of 526 hectares (-5%), open land of 388 hectares (-3%), shrubs of 277 hectares (-2%), the moor of 137 hectares (-1%), the plantation of 109 hectares (-1%), and the pond of 45 hectares (-1%).

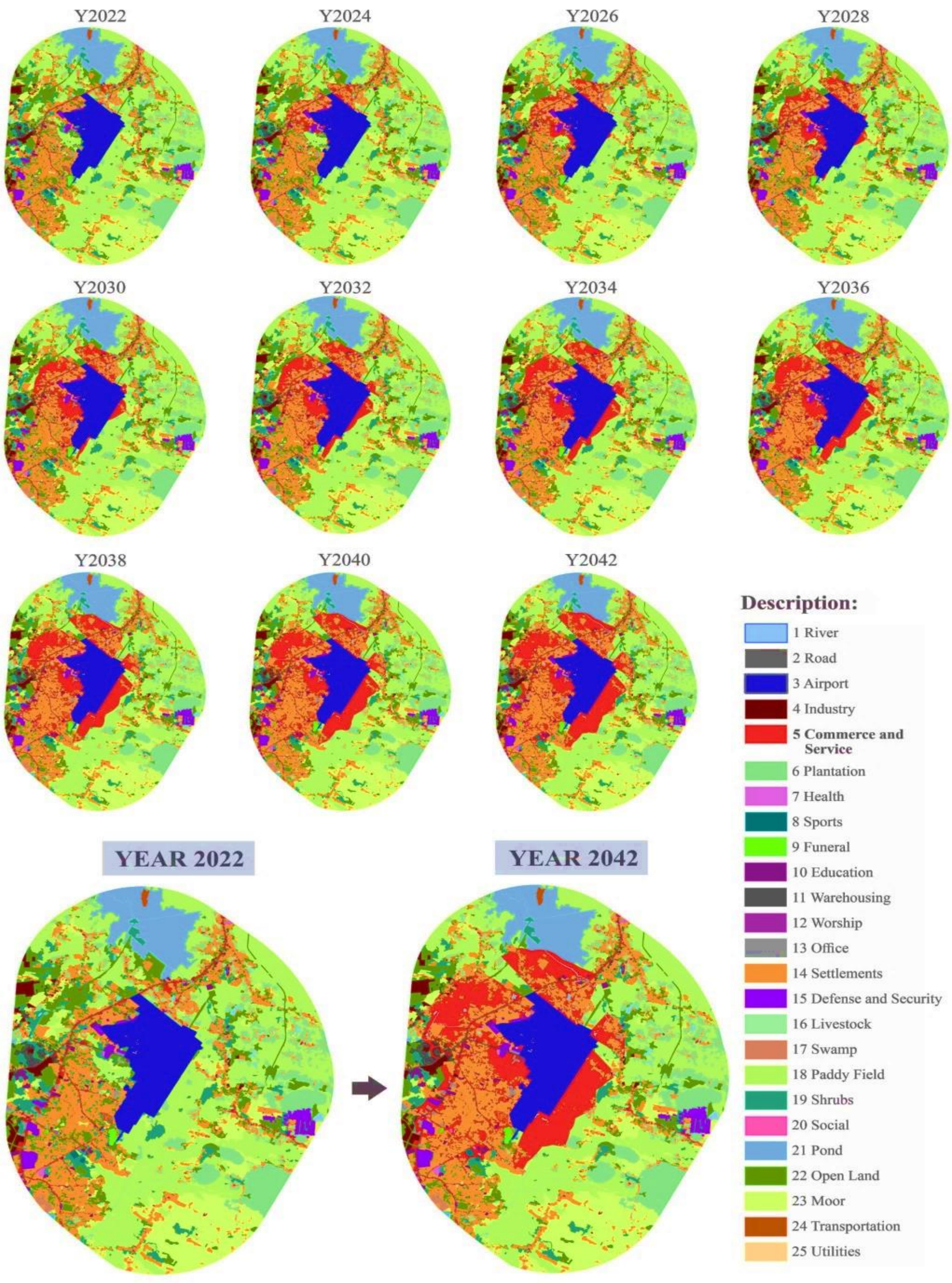

Fig. 9 Map of simulation results of potential land use development in the 2022-2042

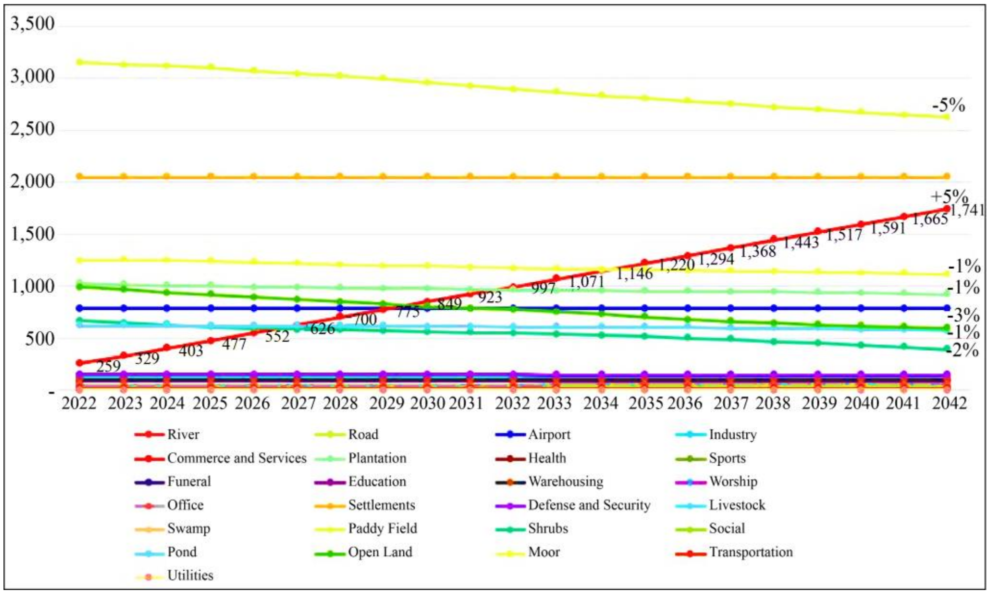

Fig. 10 Development rate of potential land use in 2022-2042

There is a significant increase in land use during the simulation year so the main needs required and become the direction of planning priorities in supporting the development of the area around Sultan Hasanuddin International Airport until 2042 with the concept of aerotropolis. The need to encourage Sultan Hasanuddin International Airport as a new service center based on the aerotropolis is encouraged to continue to grow and develop to create an economic spread effect from the area around Sultan Hasanuddin International Airport, the need for service coverage for economic facilities and services to be integrated into one area to increase effectiveness and efficiency in transportation system services.

It is expected that there will be integration in supporting services between the urban center with Sultan Hasanuddin International Airport so that it can be integrated with other strategic areas such as industrial and tourism areas. Currently, the integration between Sultan Hasanuddin International Airport with Makassar Urban Center with the existence of toll roads leading to the airport, and there is a railroad network plan, Makassar - Takalar toll road plan, and Sultan Hassanudin Airport Access section, monorail network plan across Makassar to the airport.

To implement the aerotropolis concept, transportation facilities are needed to accommodate access to Sultan Hasanuddin International Airport and provide a special section within the airport for bus and/or train transportation modes to support integration between modes of transportation and passenger movements to and from the airport.The potential land of the research area is directed to be integrated and connected, supported by planned public transportation according to population phasing, including airport connections, rail corridors, BRT Direct Service, which is integrated with supporting services between the city center, regional business centers, strategic areas, and airports and needs to have a special route so that it can be considered for transportation planning that is fast, affordable, and easily accessible is directed to have a separate route separated from the public road network.

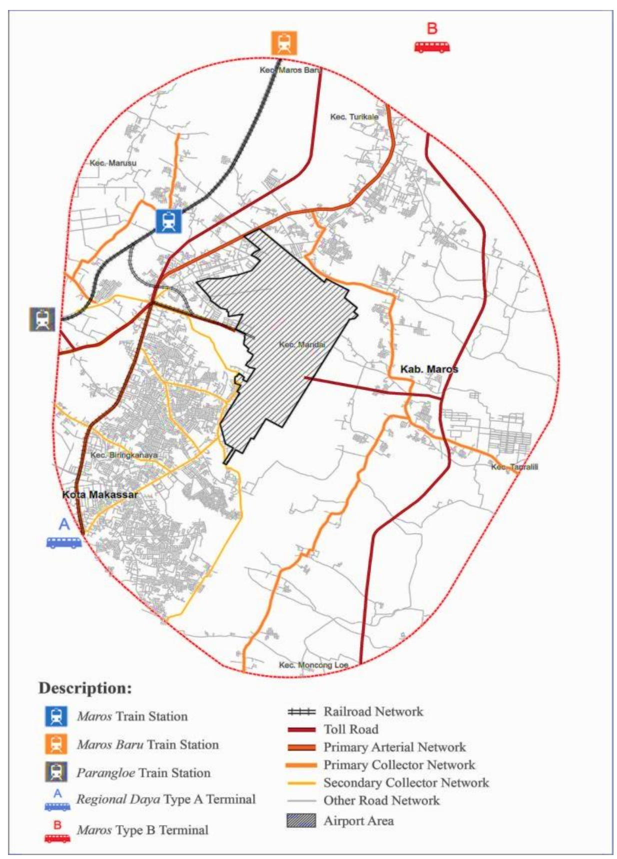

Fig. 11 First development direction map in implementing the aerotropolis concept

Spatial planning in the research area with an increase in commerce, services, and business areas in the aerotropolis area is centered and oriented directly to the airport within a radius of 0-4 km. The direction in the implementation of the aerotropolis concept in Figure 12 directs to 3 new growth centers that become the priority of future development by considering the results of potential land modeling the direction of aerotropolis development principles.

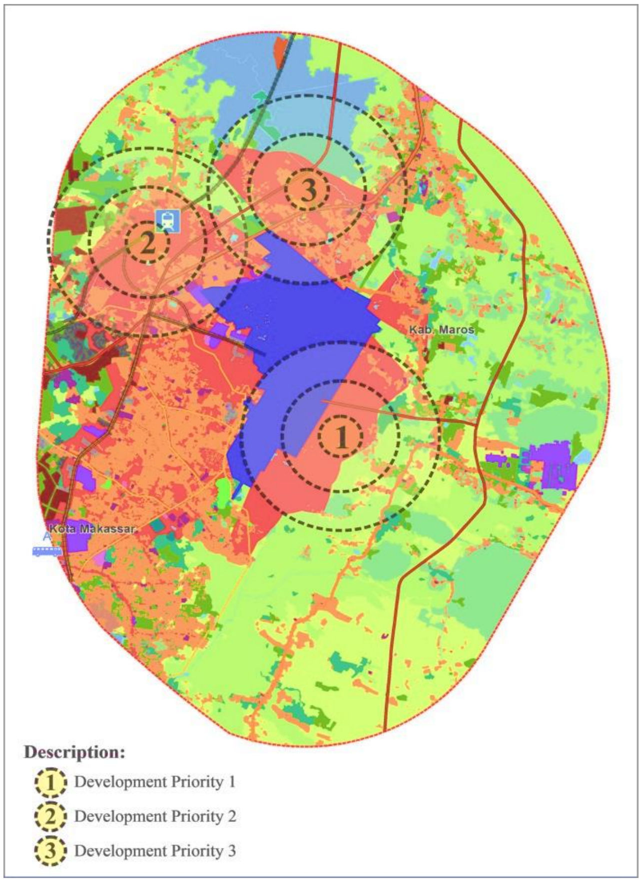

Fig. 12 Second development direction map in implementing the aerotropolis concept

4. Conclusion

Characteristics of the area around Sultan Hasanuddin International Airport are not yet by the principle of aerotropolis, which leads to the main designation of the function of commerce and service area and the provision of business areas, but the ability of the land is suitable and has no physical barriers to be utilized as land for the development of urban areas with a land suitability level of 63% so that it is a consideration for the local government in revising the RTRW and the preparation of special RDTR as a legal aspect of planning directed to the development of areas with the concept of aerotropolis.

The outcomes of the possible land use model and simulation distribution patterns in the implementation of the aerotropolis concept until 2042 showed a land change into a commerce and service area of 1.741 hectares with an increase of 13%, which growth occurred in paddy fields, open land, shrubs, moor, the plantation, and ponds. The direction of potential land use development is dominated in the Mandai District by 725 hectares around the airport due to the intervention of driving factors and limited by the constraints zone. Priority directions in supporting the implementation of the aerotropolis concept, namely making Sultan Hasanuddin International Airport a new service center that has the role of a transportation node and the economic gateway, driving the activities of the surrounding area to be integrated into one area to increase the effectiveness and efficiency in transportation system services. The potential land is directed to be integrated and connected by public transportation in supporting services between the city center, strategic areas, and the airport and providing special transportation facilities within the airport to support integration between modes of transportation and passenger movements to and from the airport that is fast and easily accessible. Spatial planning with increased commerce and service areas, business areas centered and oriented directly to the airport within a radius of 0-4 km by considering KKOP and potential land simulation results by the direction of aerotropolis development principles.

References

[1] Yazid Al-Darwish et al., "Predicting the future Urban Growth and it's Impacts on the Surrounding Environment Using Urban Simulation Models: Case Study of Ibb City – Yemen," *Alexandria Engineering Journal*, vol. 57, no.4, pp. 2887-2895, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[2] Carolynn Amujal, "*Using Cellular Automata to Analyze and Model Urban Growth A Case Study of the Greater Copenhagen Area from 1990 to 2010*," Thesis, Aalborg University, Aalborg, Denmark, pp. 1-121, 2015. [Google Scholar] [Publisher Link]

[3] Stephen Okoth Oduol et al., "Effect of Airport Expansion on Business Opportunities in Kisumu," *International Journal of Business and Behavioral Sciences*, vol. 3, no. 2, pp. 55-59, 2013. [Google Scholar] [Publisher Link]

[4] Yonanda Rayi Ayuningtyas, "*Principles of Aerotropolis Planning*," Thesis, Universitas Gadjah Mada, Yogyakarta, Indonesia, 2014. [Publisher Link]

[5] Badan Standardisasi Nasional, *Procedures for Planning Housing Environments in Urban Areas (SNI 03-1773-2004)*, pp. 1-58, 2004. [Publisher Link]

[6] Sumbangan Baja, *Land Use Planning in Regional Development with a Spatial Approach and Its Applications*, ANDI, Yogyakarta, 2012. [Google Scholar] [Publisher Link]

[7] Reza Banai, "The Aerotropolis: Urban Sustainability Perspective from the Regional City," *The Journal of Transport and Land Use*, vol. 10, no. 1, pp. 357-373, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[8] Usman W. Chohan, “*The Concept of the Aerotropolis: A Review,*” CASS Working Papers on Economics and National Affairs, 2019. [Google Scholar] [Publisher Link]
[9] Miroslav Drljača et al., “The Role and Position of Airport City in the Supply Chain,” *Production Engineering Archives*, vol. 26, no. 3, pp. 104-109, 2020. [CrossRef] [Google Scholar] [Publisher Link]
[10] Rivan Aji Wahyu Dyan Syafitri, and Cahyono Susetyo, “Modeling the Growth of Built-up Land as an Effort to Predict Changes in Agricultural Land in Karanganyar Regency,” *ITS Engineering Journal*, vol. 7, no. 2, pp. 255-262, 2019. [CrossRef] [Google Scholar] [Publisher Link]
[11] Issahaka Fuseini, and Jaco Kemp, “A Review of Spatial Planning in Ghana's Socio-Economic Development Trajectory: A Sustainable Development Perspective,” *Land Use Policy*, vol. 47, pp. 309-320, 2015. [CrossRef] [Google Scholar] [Publisher Link]
[12] Salem S. Gharbia et al., “Land Use Scenarios and Projections Simulation Using an Integrated GIS Cellular Automata Algorithms,” *Modeling Earth Systems and Environment*, vol. 2, no. 3, pp. 1-20, 2016. [CrossRef] [Google Scholar] [Publisher Link]
[13] John D. Kasarda, *The Evolution of Airport Cities and the Aerotropolis*, Insight Media, London, England, pp. 1-39, 2008. [Google Scholar] [Publisher Link]
[14] Xia Li, and Anthony Gar-On Yeh, “Modelling Sustainable Urban Development by the Integration of Constrained Cellular Automata and GIS,” *International Journal of Geographical Information Science*, vol. 14, no. 2, pp. 131-152, 2000. [CrossRef] [Google Scholar] [Publisher Link]
[15] Nursakti Adhi Pratomoatmojo, “LanduseSim as a Spatial Modeling and Simulation Application of Land Use Changes Based on Geographic Information Systems in the Context of Regional and City Planning,” *Seminar Nasional Cities*, pp. 1-12, 2014. [Google Scholar]
[16] Nursakti Adhi Pratomoatmojo, “LanduseSim Algorithm: Land Use Change Modelling by Means of Cellular Automata and Geographic Information System,” *IOP Conference Series: Earth and Environmental Science*, vol. 202, no. 1, pp. 1-12, 2018. [CrossRef] [Google Scholar] [Publisher Link]