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GIS Application For Evaluation of Trade and Services Area Development in Serang City, Banten Province

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Abstract. *Trade and service area is an area that facilitates trade transactions and services between people in need (demand side) and people who sell services (supply-side). In determining trade areas and services, SMCE or Spatial Multi-Criteria Evaluation or spatial evaluation techniques consider many different criteria when making decisions. The method used in this paper is SMCE with Weight Overlay technique using four variables, namely roads, slopes, settlements and rivers. Weighting carried out in the analysis was made with various simulations, namely Simulation A with the same weight weighting on each variable 25%, simulation B with dominant weighting on one of the variables with a composition of 55%:15%:15%:15% and simulation C gave the highest weight to the most influential variables and gave the lowest weight to the variables that were less influential for the Trade and Service Area. In this Simulation, the road network's weight is 30%, settlements are 25%, slopes are 25%, and the rivers are 20%. The total area of 23.5 Km2 or about 8.8% of Serang City area located in the city centre with excellent accessibility, not far from residential areas, a safe distance from the river, and an area with flat marbles.*

Keywords: *Service Area, Spatial Model, Evaluation, GIS, Serang City*

1. Introduction

Development planning activities used to develop various terms from sectors that carry out planning such as economic planning, environmental planning, social planning, city planning, regional planning, and other term (Wibowo & Semedi, 2011). Regional development in a region spurs socioeconomic development, reduces gaps between regions, and maintains environmental sustainability (Dewang & Irawan, 2012). Regional development policy is necessary because the physical condition of geographical, social, economic and cultural communities is different from one region to another (Kementerian Pekerjaan Umum dan Perumahan Rakyat: BPSDM, 2017). The application of regional development policy itself must adjust to the conditions, potentials, and issues of problems in the region (Kementerian Pekerjaan Umum dan Perumahan Rakyat: BPSDM, 2017).

In this research, the Serang City area is one of Banten's strategic areas based on the potential, accessibility, and distribution of sector activities in the city and surrounding areas (hinterland) (Kementerian Pekerjaan Umum dan Perumahan Rakyat: BPSDM, 2017). One of the characteristics of developing a city characterized by infrastructure development supporting increasingly diverse community activities(Kementerian Pekerjaan Umum dan Perumahan Rakyat: BPSDM, 2017). The development of a city can also be seen from the increasing population, increasingly dense buildings and built areas that tend to be more spacious, and the completeness of city facilities that support the city's social and economic activities of the city (Branch, 1995).

Based on these conditions, Serang City has the potential to overgrow. New activities continue to emerge, such as the increasing number of business entities each year, requiring quite a lot of space/land used in the development (Kementerian Pekerjaan Umum dan Perumahan Rakyat: BPSDM, 2017). This study aims to find out the appropriate areas to be used as trade and service areas by using SMCE (Spatial Multi-Criteria Evaluation), where the variables used are the distance with roads, rivers, settlements, and marbles of the region.

2. Research Methodology

2.1. Research Area

Serang city is the capital of Banten Province, which, together with Serang Regency and Cilegon City are included in the Development Work Area (WKP) II in Banten Province (Bappeda, 2019). WKP II is an area geared towards developing government activities, education, forestry, agriculture, industry, tourism, services, trade, and mining. The Regional Spatial Plan (RTRW) of Serang City in 2010-2030 stated that the direction of development of Serang City is to realize Serang city as a central city of trade and service services, education, agriculture and religious tourism in Banten Province which is productive and sustainable and increases the investment potential in supporting Serang City as a National Activity Center (PKN).

This research, the study area that will be focused is related to trade and service areas in Serang City. This area based on RTRW Serang city is directed to the downtown and urban areas and along the main road corridor of Serang City and potentially developing roads. This research, Serang City area, is one of Banten's strategic areas based on the potential, accessibility, and distribution of sector activities in the city and surrounding areas (hinterland). One of the characteristics of the development of a city was infrastructure development supporting increasingly diverse community activities. The development of a city can also be seen from the increasing population, increasingly dense buildings and built areas that tend to be more spacious, and the completeness of city facilities that support the city's social and economic activities of the city (Branch, 1995).

Based on these conditions, Serang city has the potential to overgrow. New activities continue to emerge, such as the increasing number of business entities each year, requiring quite a lot of space/land to being used in the development. This study aims to find out the appropriate areas to be used as trade and service areas by using SMCE (Spatial Multi-Criteria Evaluation), where the variables used are the distance with roads, rivers, settlements, and marbles of the region.

2.2. Research Flow

The SMCE method of Trade and Service Area in Serang City will be processed using Arc GIS. The data used in this study adjusted to the four criteria mentioned in the above research variables, namely road, residential, marbles, and river network data, while for its evaluation will be compared with RTRW map of Serang City 2010-2030. The data then processed according to the thought flow in figure 1.

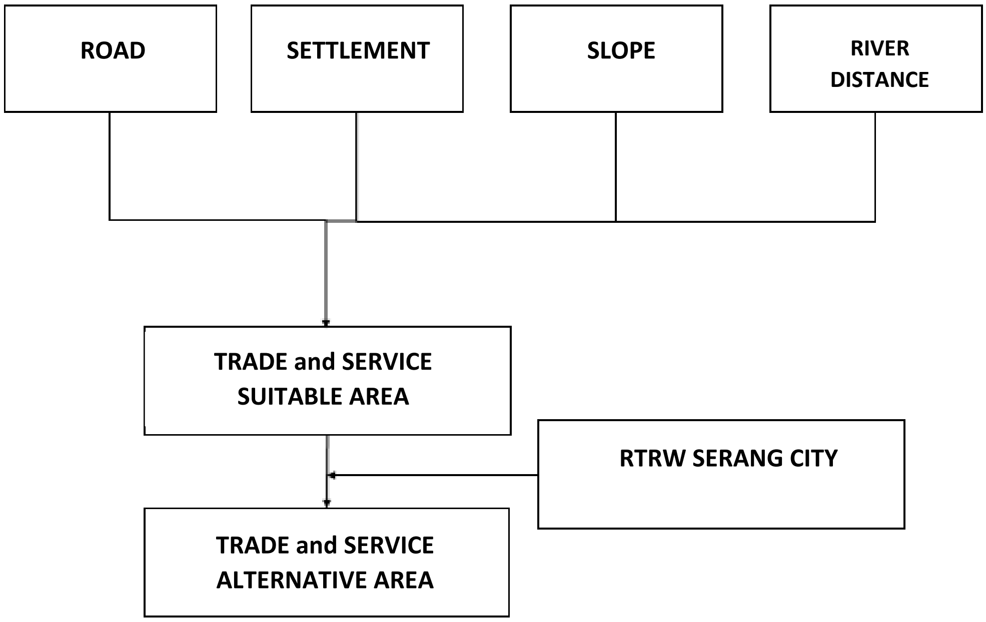

Figure 1. Research Flow

2.3. Data Collecting and Processing

The data used in this research is secondary data obtained from literature studies sources and institutions, namely the Geospatial Information Agency (BIG). Determining the spatial suitability of land is a complex process depending on various ecological and socio-economic criteria but can be done using the SMCE method. For example, in determining the suitability of protected areas in Tehran to be used as indoor recreation areas (Jozi et al., 2010). SMCE is a system of applications to assist in the spatial evaluation of several criteria, in which information from various criteria must combine to form a single evaluation index based on a particular procedure (Rahman et al., 2008). In Wibowo & Samedi research (2011), the SMCE method has successfully presented an overview of industrial estates' suitability in Serang city by considering the road network and river network variables, slopes, and altitude, and land-use. SMCE can be used to create a sustainable development area modeling area based on sustainability in Serang City (Januadi Putra et al., 2019). SMCE is also able to provide an overview of the vulnerability of a spatial area in Bantul Regency (Hizbaron et al., 2012). SMCE and stakeholder analysis can use the SMCE method with other methods for use in land suitability. For example, the SMCE combined with stakeholder analysis can assess the suitability of planning and management of the Pellice basin in Italy (Comino et al., 2016). In other research, SMCE can be combined with the Analytical Hierarchy Process (AHP) can be used to assess the suitability of agricultural land in Bogra, Bangladesh (Rahman et al., 2008). The main procedures for scoring SMCE methods are determining focus, identifying and grouping criteria, scoring for each criterion, standardizing scores for criteria, weighting criteria, creating conformity maps, and making decisions (Wibowo & Semedi, 2011).

2.3.1. Road Network

Trade and service areas or business centres are also called central business districts (CBD) according to the Spatial Dictionary is the place of the city's business activities centre which is located not always in the middle of the city, but has a big influence on the economic activities of the city. In general, infrastructure dramatically affects the development of a trade and services area. The impact of infrastructure on the economy in Indonesia can be in many ways, for example per capita income growth in a region, where it said that the condition of road and electricity infrastructure has a significant impact on per capita income growth, but not the port (Maryaningsih, 2014). Related to road infrastructure more specifically, theoretically, it is said that the condition of road and electricity infrastructure has a significant impact on per capita income growth, but not so with the port. Road infrastructure is a variable that plays an important role in improving economic growth (Warsilan et al., 2015). Higher access to road infrastructure will provide smoothness to community mobility, logistics, and ease of access for investors to come to the region to increase the economic growth (Irrfan, et, al, 2018). The use of road variables to evaluate trade and service areas in Serang city also refers to the Regulation of the Minister of Public Works No. 41/PRT/M/2007 where one of the characteristics of location and suitability of land for trade and service areas in Serang city is a strategic location and easily achieved from all corners of the city. The service became the initial basis of thinking that the higher the accessibility level of a trade and service area or the closer the trade area and services with road access, the fairer its use.

2.3.2. Settlement

Trade and services area is the place where economic activities carried out. Economic activities should be established in crowded locations and have trade activities in the vicinity. It was recommended to have easy access and close to residential areas because along with the increasing number of people in a region, there will also be a diversity of the population's activities and needs (Suryani, 2015). Wicaksono et al., (2018) in his research classified the distance to settlements in determining the suitability of land for shopping centres, including: < 100 meters, 100-200 meters, 200-1000 meters, > 1000 meters.

2.3.3. Slope

The next criterion is the fisiography group that is the slope, assuming that the flatter the more suitable it is for trade and services areas. Slopes are classified into different classes according to the percentage of slope. Determination of trade areas and services can develop, referring to SNI 03-1733-2004 (SNI 03-1733-2004, 2004) as shown on table 1.

Table 1. Suitability of land use based on the slope (SNI 03-1733-2004)

No	Land Use	Percentage of Slope Value Classification (%)							
		0-3	3-5	5-10	10-15	15-20	20-30	30-40	>40
1	Main Road	■							
2	Parking Area	■							
3	PlayGround	■							
4	Trade Area	■	■						
5	Drainage		■						
6	Settlement	■	■	■	■				
7	Pedestrian	■	■	■	■				
8	Recharge Septic Tank	■	■	■	■				
9	Garden	■	■	■	■	■	■	■	■
10	Recreation Area	■	■	■	■	■	■	■	■

From the slope reclassification results, Serang City's area is flat to sloping areas that fall into safe and suitable trade areas. Few in the southwest have a steep topography that is not suitable for the region. In previous research related to land suitability for trade and service locations, the selected topography should be relatively flat, because in addition to avoiding landslides also minimize land cutting or cut and fill work (Wicaksono et al., 2018). Determination of suitability for slopes based on research done in the previous Serang area is the flatter the more suitable for trade (Wibowo and Semedi, 2011).

2.3.4. River

Trade and service areas are not significantly affected by the distance to the river. Based on Pu Candy Number 63 the Year 1993, Article 7 for urban areas:

a. Rivers with a depth of no more than 3 (three) meters, the borderline is determined at least 10 (ten) meters calculated from the riverbank at the specified time.
b. Rivers that have a depth of more than 3 (three) meters to 20 (twenty) meters, the borderline is set at least 15 (fifteen) meters calculated from the riverbank at the specified time.
c. Rivers with a maximum depth of more than 20 (twenty) meters, the borderline is determined at least 30 (thirty) meters calculated from the riverbank at the specified time.

A distance to river form trade and service area assumed that this is more inappropriate when both trade and service areas are closer to the river. Furthermore, when both of trade and service area the further it is suitable.

2.4. Data Analysis

Reclassifying becomes the initial stage of data processing containing information related to variables to determine trade areas and services' suitability. Data of reclassified roads, settlements, marbles, and river networks then analyzed with overlays. This overlay analysis uses a weighted overlay method, a spatial analysis using an overlay technique from several variable maps related to land suitability assessment factors. One of these weighted overlay functions is to solve multicritical problems such as optimal location selection or conformity modelling by combining various grid maps with weighted factors from AHP expert (Adininggar et al., 2016). In each processed raster data can be scored and weighted from each pixel that has its value.
The determination of weights on each variable is determined based on the amount of variable influence on the formation of trade and service areas. The result of this weighted overlay is a raster map that has a new value on each pixel that describes the appropriate region and is not suitable for trading and service areas. Raster map of weighted overlay results depicting trade and service areas then overlayed with the map of The Spatial Plan of Serang City 2010-2030 to be evaluated for conformity.

3. Results and Discussion

The process to determine the conformity of Trade and Service Area in this study used four influential variables: road networks, settlements, slopes, and rivers.

3.1. Variable Classification

Road network variables are divided based on seven classifications provided that the distance closer to road access (white) is the most suitable distance for trade and service areas as shown on Figure 2. Furthermore, conformity classification displayed in Table 2.

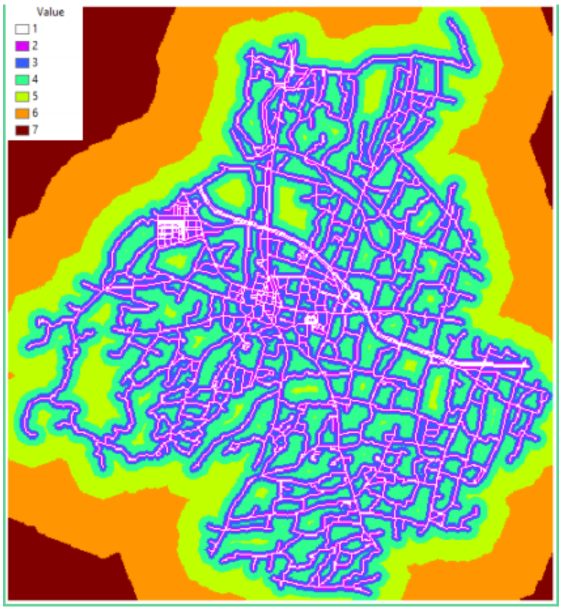

Figure 2. Road Network Classification

Table 2. Road Network Classification, Distance and Suitability

No.	Classification	Distance (meters)	Suitability
1	1	0-13	Suitable
2	2	13-50	Suitable
3	3	50-152	Moderate
4	4	152-434	Moderate
5	5	434-1217	Moderate
6	6	1217-3386	Not Suitable
7	7	> 3386	Not Suitable

(Pemerintah Daerah Kota Serang, 2010; Wibowo & Semedi, 2011)

This study shows that the distance of trade areas and services with road access with a value of 0 to 13 meters falls into the appropriate category. However, in the implementation of its development, it is necessary to note Article 1 of the Regional Regulation of Serang City Number 11 the Year 2010 concerning Buildings mentioned related to the Border Line. The building boundary line (GSB) is a line on the plot drawn parallel to the line of road, railway, high voltage network, riverbank, seafront or U.S. fence that is the boundary between the plot can build and that should not build. The residential buildings' criteria were the side free distance, and rear free distance is set at least 4 (four) meters on the ground floor. Moreover, each addition of floor or building level, the free distance on it plus 0.50 (zero points fifty) meters from the free distance of the floor below it until it reaches the furthest free distance of 12.5 (twelve points five) meters. The warehouse and industrial buildings, the side free distance and rear free distance, are set at least 3 (three) meters". Settlement variables divided into five distance classes in meters: 0, <100, 100-200, 200-1000 and> 1000, provided that the distance that is closer to the settlement (blue) is the most suitable distance for trade and service areas as shown on Figure 3. Furthermore, the suitability classification is shown in Table 3.

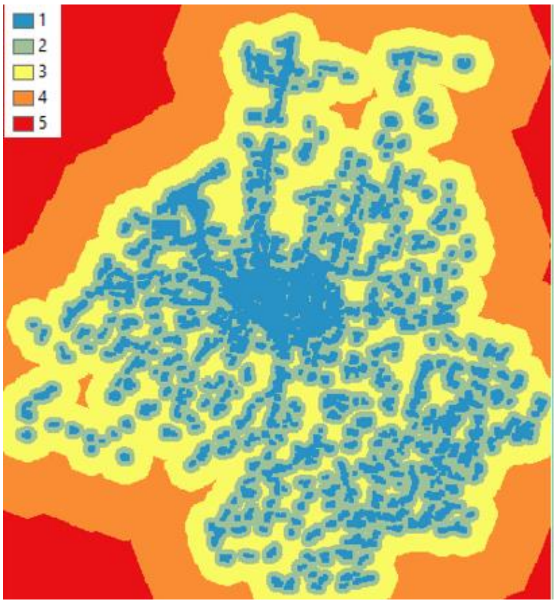

Figure 3. Settlement Classification

Table 3. Settlement Classification, Distance and Suitability

No	Classification	Distance (meters)	Suitability
1	1	0	Suitable
2	2	< 100	Suitable
3	3	100-200	Moderate
4	4	200-1.000	Not Suitable
5	5	> 1.000	Not Suitable

(Wicaksono et al., 2018)

Figure 4 results from slope reclassification, which shows three slope classes in the Kota Serang area. Furthermore, Table 4 is the suitability class of the slope classification, where the slope of class 2 is the most gentle, then slope 1 and then slope 3 is the steepest, so the weighting (scoring) of suitability for trade and service areas is made by giving the most appropriate weight, namely for class 2, followed by quite suitable for class 1 and class not suitable is class 3 which has the steepest slopes. Based on the provisions following SNI 03-1733-2004 concerning the Procedure for Built Environment Planning, the suitability of land use for built-in classes specifically for trade and services is 0-5% flat.

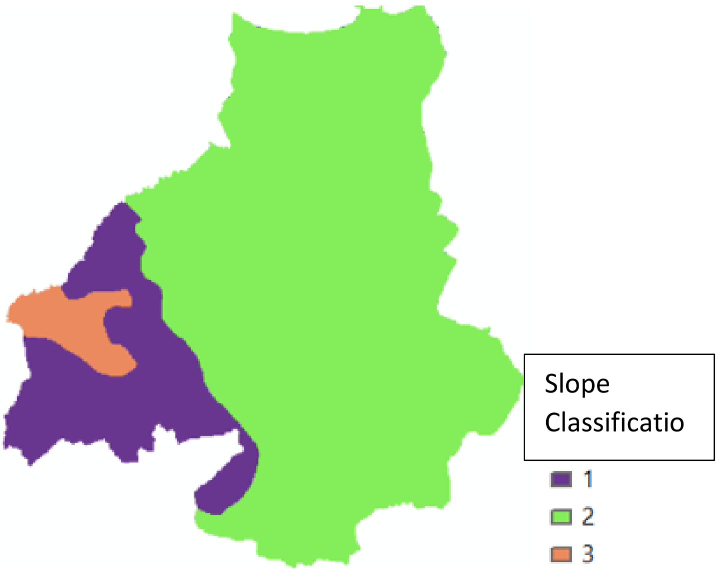

Figure 4. Slope Classification

Table 4. Slope Classification, Distance and Suitability

No	Classification	Suitability
1	1	Moderate
2	2	Suitable
3	3	Not Suitable

(Wibowo & Semedi, 2011; Wicaksono et al., 2018)

The variable classification of river distance divided into 5 with the distance in meters. The classifications are 0, <100, 100 - 400, 400 - 1000 and> 1000 that displayed in Table 5. This classification found that the closer the river is to the trade and service area, the more unsuitable it is. As shown in the figure (light blue), suitable areas or following trade and service areas and dark blue areas are not suitable for developing trade and service areas as shown on Figure 5. Even though the area near the river is not suitable, it needs to consider in the Minister of Public Works Regulation Number 63 of 1993 Article 7 which regulates the development of trade and service areas, which also considers the type of river.

Table 5. Distance From Rivers Classification and Suitability

No	Classification	Distance (meters)	Suitability
1	1	0	Not Suitable
2	2	< 100	Moderate
3	3	100-400	Suitable
4	4	400-1.000	Suitable
5	5	> 1.000	Most Suitable

(Kementerian Pekerjaan Umum, 1993; Wibowo & Semedi, 2011)

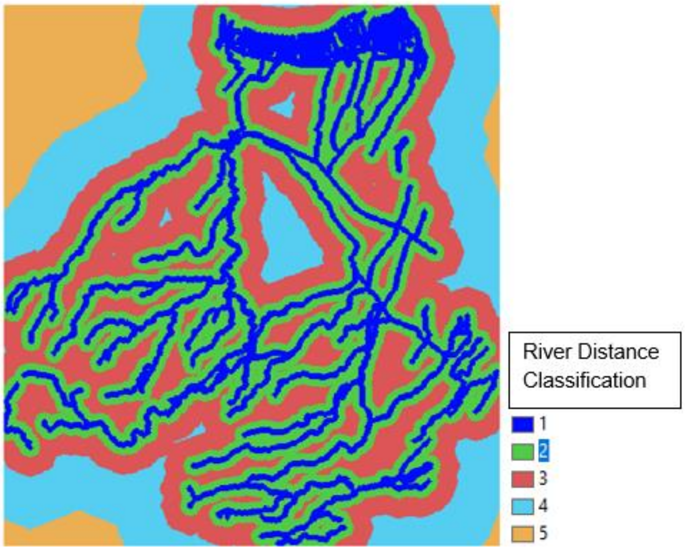

Figure 5. River Distance Classification

3.2. Weighted Simulation

To determine the appropriate trade and service areas used several simulations were carried out with different weight compositions using the Weight Overlay tool in the Arc GIS software, with a total overall weight of 100%. Weight Overlay works by overlaying several raster maps that are parameters of the land's physical condition given a score and weight based on their importance. (Adininggar et al., 2016).

A. Simulation Process Results from A

The simulation process A carried out by determining the road network, settlement, slope and river variables with the same weight, namely 25% as shown on the Table 6 (Wibowo & Semedi, 2011). The Simulation A results for equal weights for the Trade and Services Zone in Serang City shown in Figure 6, with the suitability classification: red is unsuitable, yellow is sufficiently appropriate and green is appropriate. There are two areas in the green area that form a block wider than the other areas (red box) as shown on the Figure 6 below.

Table 6. Variable Weights in Simulation A

No	Variable	Weight
1	Road	25%
2	Settlement	25%
3	Slope	25%
4	River Distance	25%

(Wibowo & Semedi, 2011)

Figure 6. Simulation Results from A with the same weight 25%

B. Simulation Process Results from B

Simulation process B carried out by giving a very high weight to only one variable (Wibowo & Semedi, 2011). In this Simulation, one variable gave the highest weight of 55% while the other variable is 15% as shown on the Table 7.

Table 7. Variable Weights in Simulation B

No	Variable	Weight 1	Weight 2	Weight 3	Weight 4
1	Road	55%	15%	15%	15%
2	Settlement	15%	55%	15%	15%
3	Slope	15%	15%	55%	15%
4	River Distance	15%	15%	15%	55%

(Wibowo & Semedi, 2011)

Simulation B's results compared to Simulation A show that Simulation A's red box area still appears in simulation B with an "appropriate" area based on the highest weight given. In criterion 1 shows that the suitable area saw in areas that have more road networks, criteria 2 shows that the appropriate area sees in areas that are close to settlements, criteria 3 shows that the appropriate area seen in the area has a flat slope and criterion 4 indicates that the appropriate area is visible in areas far from the river. Moreover, a result of simulation B from weight 1 to 4, presented in Figure 7.

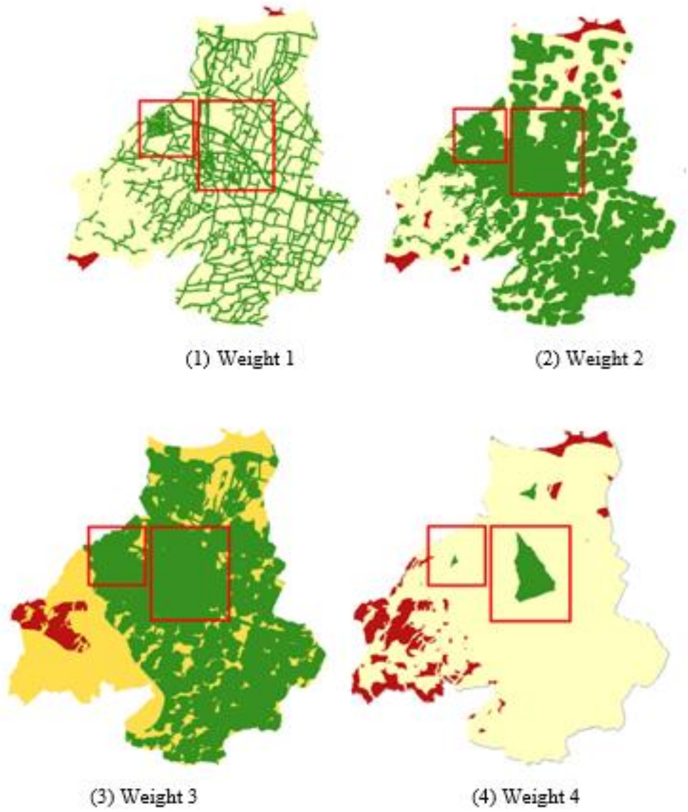

Figure 7. Simulation Results from B with one of the variables was weighing 55%

C. Simulation Process Results from C

The C simulation process is carried out by giving the highest weight to the most influential variables and giving the lowest weight to the less influential variables for the Trade and Service Area. In this simulation, the road network's weight is 30%, settlements 25%, slopes 25% and rivers 20% as shown on the Table 8.

Table 8. Variable Weights in Simulation C

No	Variable	Weight
1	Road	30%
2	Settlement	25%
3	Slope	25%
4	River Distance	20%

Source: Analysis Data

The results of simulation C are not much different from the results of simulation A that shown on Figure 8, with this it can conclude that the addition or reduction of the weight of 5% shows a not too significant change in the weighted overlay.

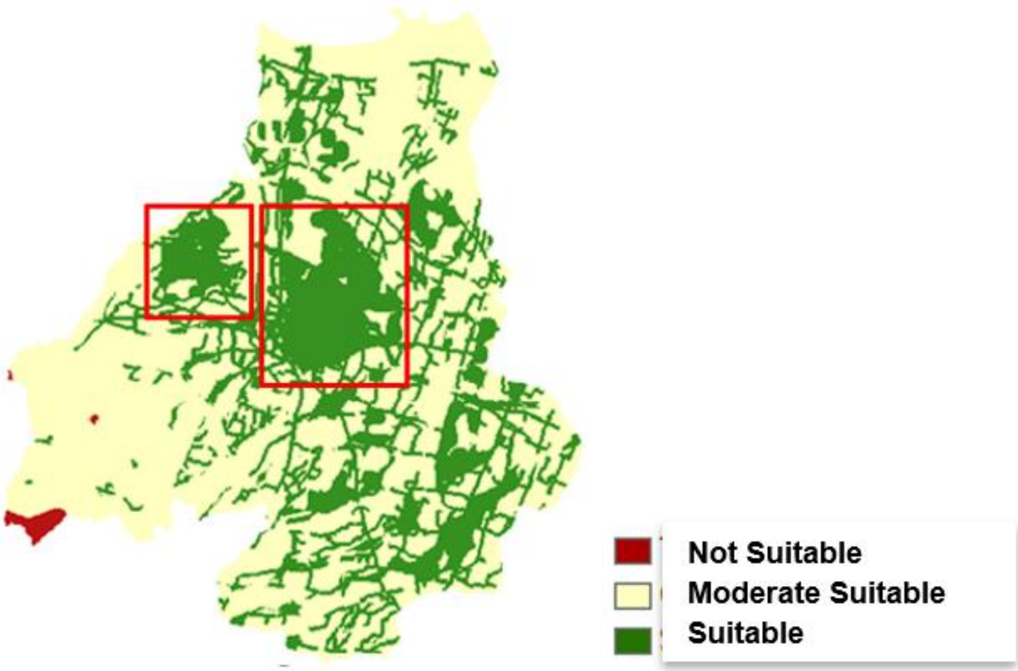

Figure 8. Simulation Results from C with a road network weight of 30%

D. Final Results of Commercial and Service Area Alternatives

The final result chosen in this study is Simulation C because based on the Regulation of the Minister of Public Works Number 41 / PRT / M / 2007 states that one of the characteristics of the location and suitability of land for the Cultivation Area is that it has a strategic location and is easily accessible from all parts of the city. . This simulation reflected in the easy accessibility of the road network. Apart from easy access, this area also recommended being located close to settlements and established on a relatively flat topography (Wicaksono et al., 2018). Thus the final result chosen is simulation C with a road network weight ratio of 30%, settlements 25%, slopes 25% and rivers 20%. The magnitude of each resulting area presented in Table 9.

Table 9. Suitable Area

No	Variable	Area (km2)	Percentage
1	Suitable	93.07	0.52
2	Moderate	168.59	64.10
3	Not Suitable	1.37	35.38

Source: Analysis Data

To form an area, then the part of the polygon that does not merge with the block area will be removed, so that there are two alternative areas for the Trade and Services Area in Serang City as shown in Figure 9. The area of the model results is 23.5 Km2 or about 8, 8% of the total area of Serang City. The two areas formed are in Taktakan District and Serang District.

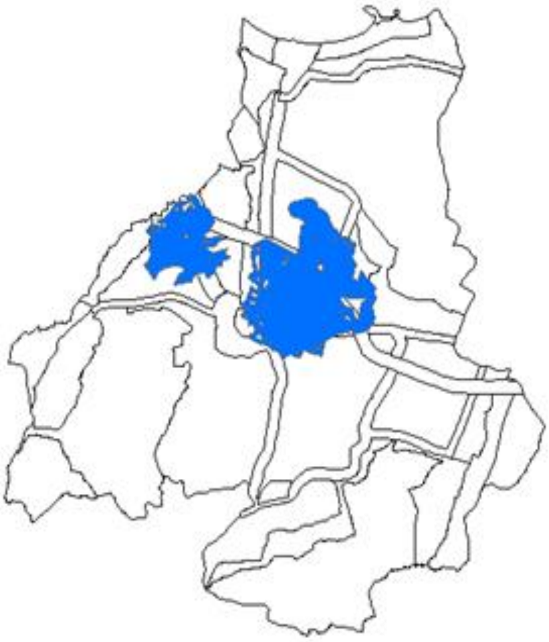

Figure 9. Alternative Areas for Trade and Services Areas

3.3. Comparison of Trade and Services Areas in RTRW and Model Results

In the Serang City Regional Regulation Number 6 of 2011 concerning the 2010-2030 Serang City Spatial Plan, the Serang City Spatial Pattern Plan is divided into several areas, as illustrated in Figure 10.

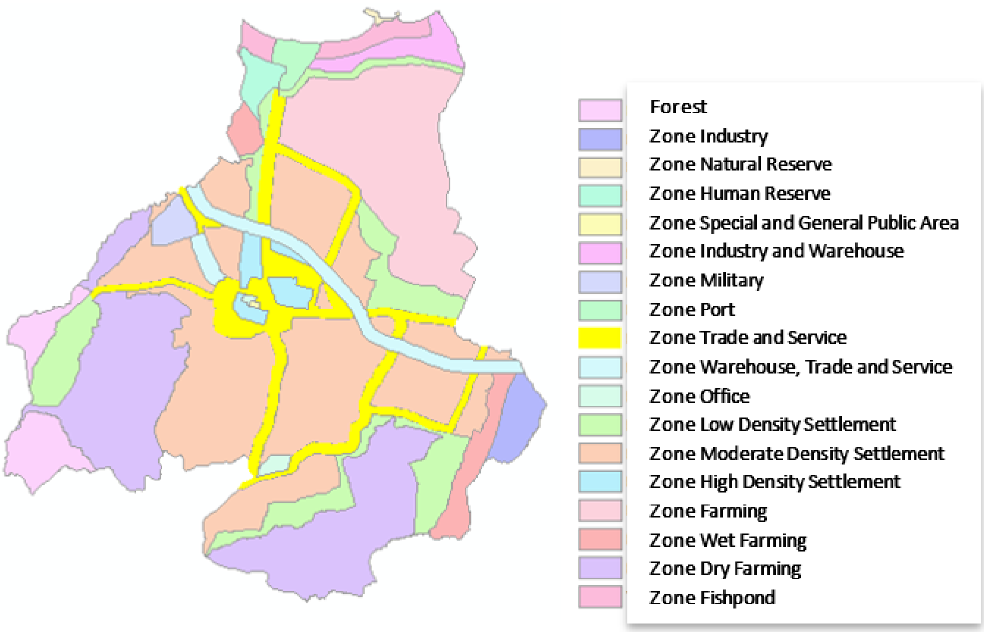

Figure 10. Serang City Spatial Plan Plan in RTRW 2010-2030

The Trade and Services Area in the RTRW has 23.2 km2 or around 8.7% of the total area of Serang City. The comparison between the Trade and Service Area in the RTRW and the model results are shown in Figure 11.

Figure 11. Comparison of Trade and Services Areas on RTRW and model results

The model obtained shows that the most suitable areas for trade and service areas were located in the city centre and its surroundings, as shown in Figure 12 in a green box. Current conditions indicate quite intensive physical development in the region.

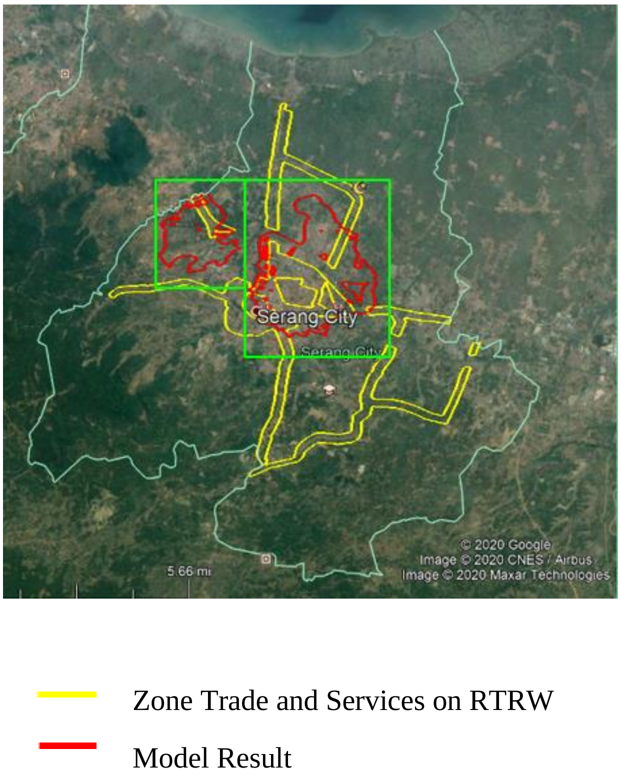

Figure 12. Monitoring on satellite imagery (Source: Google Earth Pro)

The Trade and Services Area in the RTRW and the model overlaid using the Arc GIS intersect tool. From the intersect results, the model result area's suitability is 6.58 km2 or about 28.3% of the Trade and Service Area in the RTRW. The results of the intersect process shown in Figure 13.

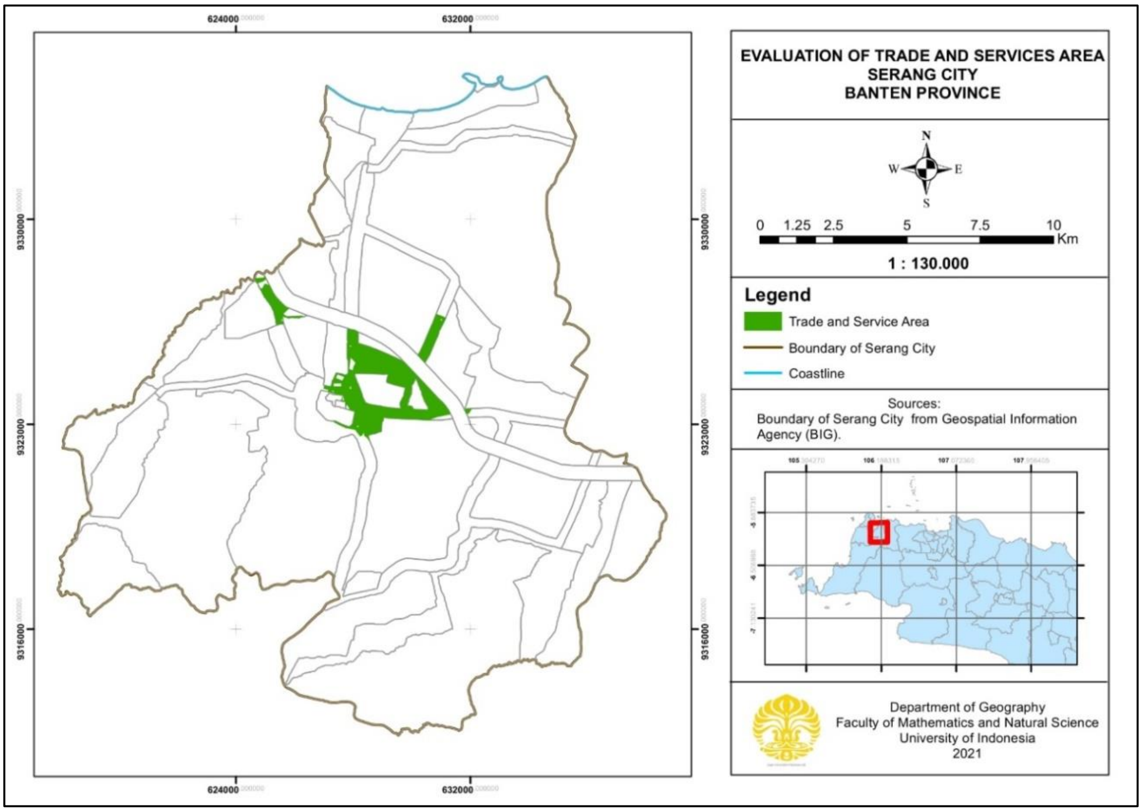

Figure 13. Results of the intersect process

4. Conclusion

The research concluded that the model obtained by the Weight Overlay technique shows that the trade and service areas in Serang City with the variables of roads (30%), settlements (25%), slopes (25%) and rivers (20%) form two areas. In groups, with a total area of 23.5 Km2 or about 8.8% of Serang City, and the resulting model area's suitability is 6.58 Km2 or about 28.3% of the Trade and Service Area in the RTRW. The model area located in the city centre with good accessibility, not far from residential areas, a safe distance from the river, and an area with a flat slope. From the monitoring results, cities' physical development in trade and service areas has been very intensive until now. This model can be an input for the Regional Government of Serang City, especially in the future physical development of trade and service areas.

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