

# Spatial Analysis of Sustainable Land Use Development Coastal Areas in Batang Regency

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## Abstract

Batang Regency as the northern coastal area of Java island experiences a problem of land use management that has not been optimal so that there is a need for analysis of land use development in the coastal area of Batang Regency. The purpose of this study is to examine the direction of land use development in coastal areas of Batang Regency with spatial analysis. This research method implements quantitative approach while the analytical technique is spatial analysis. Spatial analysis is performed to identify land use of the coastal area in Batang Regency. The study scope of coastal areas is based on administrative sub-districts located along the coast of Batang Regency. This research utilizes Spot satellite image year 2015 with the map of regional spatial pattern plan of Batang Regency in 2011-2031. The spatial analysis result of land use development in Batang Regency's coastal area includes the suitable category of 18.130,65 (56,32%) while the unsuitable category is 14.059,44 (43,68%). Batang Sub-district's suitable category is 1.214,03 ha, while the unsuitable category is 2.220,51 ha. Kandeman Sub-district's suitable category is 1.565,02 ha, while the unsuitable category is 2.610,65 ha. Tulis Sub-district's suitable category is 2.452,98 ha, while the unsuitable category is 2.055,80 ha. Subah Sub-district's suitable category is 5.381,89 ha, while the unsuitable category is 2.970,28 ha. Banyuputih Sub-district's suitable category is 2.314,61 ha, while the unsuitable category is 2.127,89 ha. Gringsing Sub-district's suitable category is 5.202,12 ha, while the unsuitable category is 2.074,31 ha. The conclusion of land use planning development for Batang and Kandeman Sub-districts is that there are still a lot of lands designated for residential development. Subah Sub-district is for fisheries development while Tulis, Banyuputih, and Gringsing Sub-districts are for industrial development.

**Keywords:** Land use, Batang Regency, Coastal area, Spatial pattern

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# **Spatial Analysis Of Sustainable Land Use Development Coastal Areas In Batang Regency**

Ahmad Ibnu Riza dan Athoillah Islamy

## **I. Introduction**

Coastal areas and small islands are ideal areas in carrying out development planning in Indonesia. According to Bramati (2014), coastal areas attract a variety of interests and activities in limited space and for some unique and more complex reasons than inland areas. The coastal areas and small islands are not only exploited for their natural resources but also become the development areas for several development activities such as transportation and ports, industries, fisheries, tourism and settlements (Bengen, 2010). The law of the Republic of Indonesia No. 1 of 2014 states that the Management of Coastal Zone and Small Islands is a coordination of planning, utilization, supervision and control of coastal resources and small islands conducted by the Government and Local Government, between sectors, between ecosystems land and sea, and between science and management to improve people's welfare.

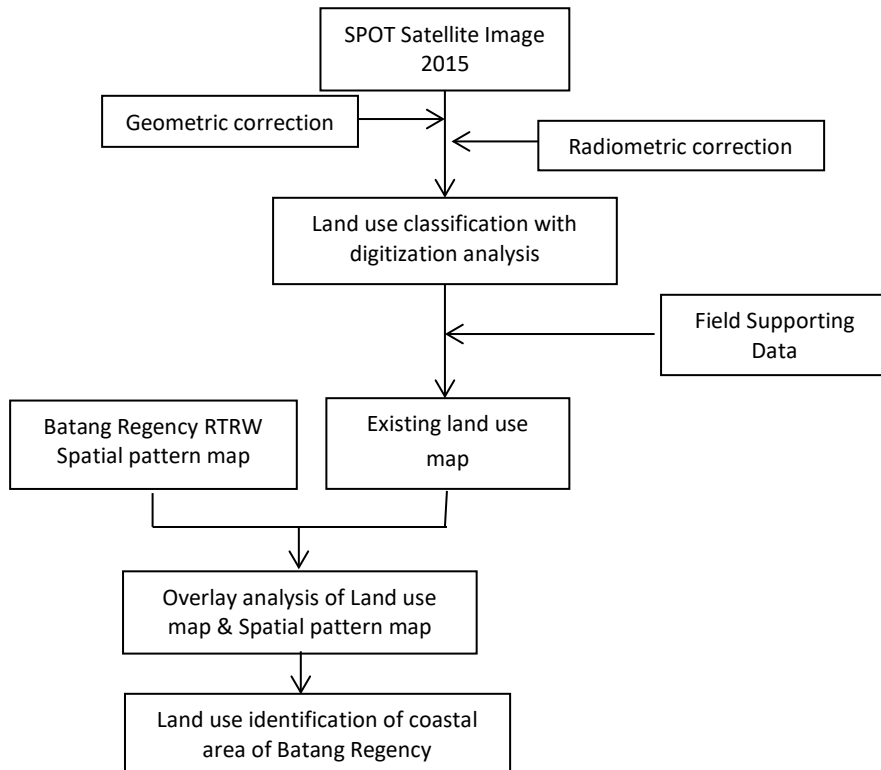
According to Dahuri (2003), an estimated 60% of the total population in Indonesia live in coastal areas. It is not surprising that coastal areas are the most populous areas inhabited by humans with a variety of development activities. Batang Regency is one of the regencies in the northern coastal area of Java Island that has a tendency to be developed as an integrated and sustainable coastal management area. With a coastline length of about 38.75 Km stretches from east to west, there are many natural resources with the varying geographical conditions of Batang Regency such as coastal areas, lowland and highlands. The future development of Batang Regency needs the optimization of coastal area management. The direction of development in Batang Regency utilizes the coastal space that has been issued in the Regional Regulation no. 07 of 2011 on Spatial Plan of Batang Regency Year 2011-2031. For the direction of coastal area management planning, Regulation of Regent No. 16 of 2011 has been issued on the strategic plan of Coastal Area of Batang Regency in 2011-2030. Management of land use in the coastal areas can be performed by utilizing spatial data both raster data and vector data. According to Burrough (1986), Geographic Information System (GIS) is an integrated information system because the managed data is spatial data.

The nonoptimal management of coastal areas in Batang Regency has disrupted the continuous management. This situation may arise due to various problems such as (1) Spatial use conflicts and (2) Unorganized coastal areas planning. According to Riza (2016), the development of coastal areas in Batang Regency is still not optimal due to the lack of support regarding good policies and activities in the management of coastal areas. In addition to environmental factors, the reduction of mangrove plants along the coastal areas in Batang Regency sparks an impact that is the incidence of a very high abrasion increase. Approximately, 4.2 ha of the land is susceptible to sea level rise in Batang Sub-district, Kandeman Sub-district, and Subah Sub-district (Kusumawardani, 2013). This study aims to examine the direction of land use development in coastal areas of Batang Regency by utilizing spatial analysis.

## **II. Research Methodology**

Research on sustainable coastal resource management in Batang Regency is a research utilizing quantitative descriptive approach. This approach is carried out by collecting data obtained from population samples analyzed by statistical methods which then

the result gets interpreted. According to Sugiyono (2015), quantitative method is referred to as a positivistic method with scientific method because it has fulfilled the rules of science that is concrete / empirical, objective, measurable, rational, and systematic. The analysis is implemented with the support of theories, hypotheses and phenomena that develop at this time. In addition, this study is also based on parameters that are prepared by using secondary data and primary data.



**Figure 1.** Process Flow of Land Use Identification of Coastal Area in Batang Regency  
 Source: Author's Analysis, 2017

Land use identification is implemented to determine the nonoptimal spatial condition of land in Batang Regency for the current development. This analysis is conducted with SPOT satellite image data of 2015, spatial pattern data of Batang Regency, field observation photograph, and other supporting data. The tools include Er- Mapper software, Arc GIS 10.3 software, SPSS software, camera, GPS, stationery, and laptop. The analysis performed in land use identification is Overlay analysis. Overlay analysis is often referred to as overlapping analysis. This analysis utilizes satellite imagery with digitized on-screen processing to obtain the latest land use of coastal areas of Batang Regency. The preliminary analysis includes geometric and radiometric correction. This process includes observation and validation between the processing with the real condition of the field related to land use. The purpose of observation and validation in the field is to ensure the land use that is either optimal or not optimal. It is also supported by the photo of existing conditions and coordinates list. After that, the overlay analysis is conducted between spatial land use and spatial plan map of Batang Regency. From this analysis, the land use that is either optimal or nonoptimal will show. This study will focus on the land use that has not been optimally

utilized in accordance with the spatial planning of Batang Regency. Therefore, it will discover how much land that either has been utilized or has not been utilized.

### III. General Description

Batang Regency is one of the regencies that have a mixture of geographical situations between the coastal areas, lowland and the mountains. The coastal area of Batang Regency possesses strategic value in the development of the region and the city. This situation is due to its location in the coastal line, and almost half of its sub-districts are in coastal areas. The coastal area of Batang Regency consists of 6 sub-districts which are Batang Sub-district, Kandeman Sub-district, Tulis Sub-district, Subah Sub-district, Banyuputih Sub-district, and Gringsing Sub-district. It is in figure 2 as follows:

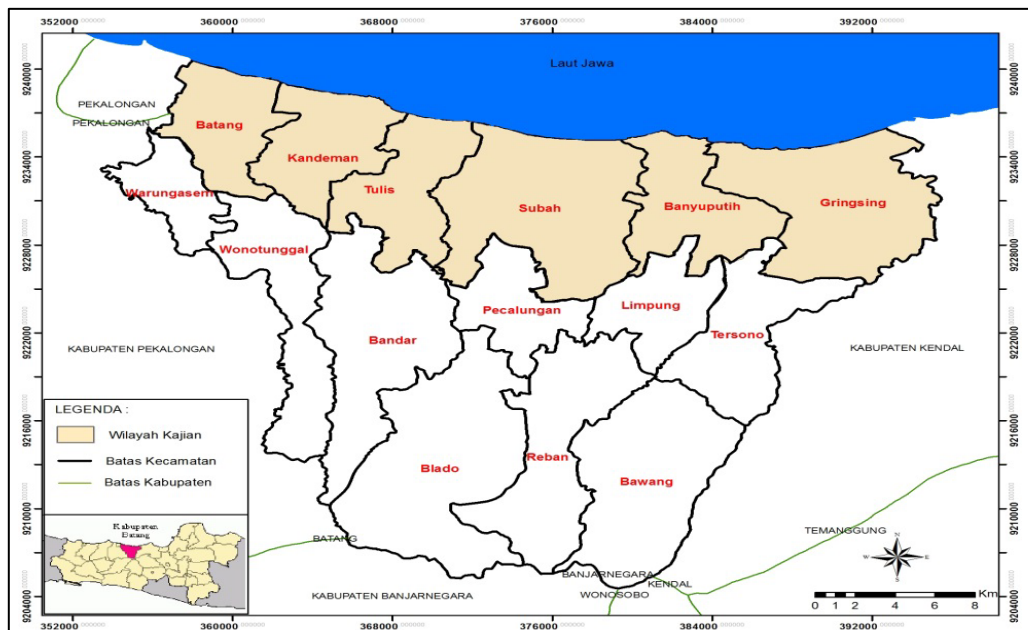


Figure 2. Study Area MAP

Source: Author's Analysis, 2017

### IV. Literature Review

Coastal area is a unique region with various complex characteristics. According to Kristiyanti (2016), in the latest international agreement, the coastal areas are defined as the transition region between the sea and the land, towards land covering areas that are still affected by sea splash or tidal and towards the sea covering the continental exposure area. The landward boundary includes the administrative boundaries of all coastal villages belonging to the coastal areas. In administrative aspect, coastal area is an area that is administratively governed by the upper boundary of the upstream district or city, and towards the sea twelve miles from the coastline for the province or one-third of the twelve miles for the district/city. In planning aspect, coastal area is the area of management planning and focused on issues handling responsibly (Hidayati, 2013). According to Lasabuda (2013), several potentials and advantages of Indonesia's coastal and marine resources are area potential, biological resource potential, mineral and energy resources potential, maritime industry and services potential, marine transportation potential and environmental services, and cultural potential.

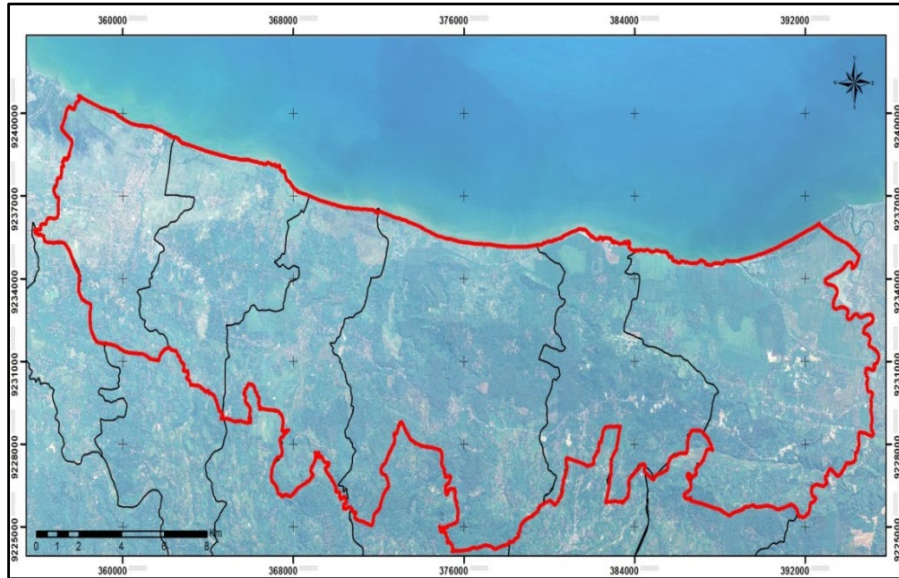
Sustainable development owns a vital role to play in its implementation because there are many principles to implement in proper and orderly manner. This situation concerns the interests of all stakeholders with the common goal of creating community welfare. Management of sustainable coastal area is critical. According to Arifin (2004) in Witarso (2015), co-management combines elements of user community (fishermen group, fishery entrepreneur, etc.) and the government that avoids the overriding dominant role of one party in the management of coastal and marine resources so that aspiration habits in one party can be eliminated. Sustainable development transforms short-term perspectives into long-term perspectives, enriches natural resources that will have economic, social and environmental impacts, and simultaneously removes natural resource degradation and depletion (Salim, 2010). Science and technology can increase the added value of natural resources that can last for a long time.

Local and regional government policies must actively support more effective coastal management through preparing guidelines for coastal resource management, greater community participation and stakeholder engagement in coastal development projects, design and implementation of new monitoring programs (Buono, 2015). Additionally, according to Sale (2014), policies adapted to local and interim social-ecological contexts should consider external inputs and processes from cultures, businesses, laws, public opinions, and other considerations. Policies for coastal zone management and planning should be able to promote effective and balanced conservation and sustainable development, within the sphere of integrated coastal management (Cicin-Sain and Knecht, 1996). Land use policy using spatial analysis becomes an alternative in supporting integrated coastal area management. According to Munroe and Muller (2007), land use change is a complex phenomenon which reflects the interaction between humans and their environment. In this case, the human is as subject to carry out management and environment is a material object for planning and development. In addition, coastal land use planning considers land capability for specific purposes to maintain sustainable living environments (Panem, 2006).

## **V. Results And Discussion**

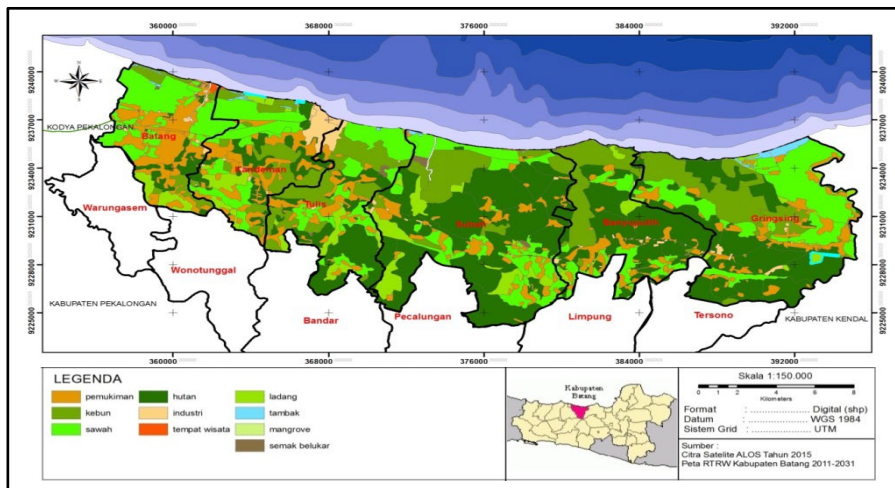
### **5.1. Satellite Management of Satellite Coastal Region of Batang Regency**

Land use evaluation of coastal areas in Batang Regency utilizes spatial analysis by the assistance of Geographic Information System (GIS). The image processing is the first to perform by radiometric correction and geometric correction, then the digitization of land use in coastal area follows suit. The corrected SPOT satellite image will be visibly better than the satellite image which is yet to receive those two corrections. The superiority of geometrically corrected image is that the satellite image can match the image of world coordinates, while radiometric correction provides a more precise visual image quality so that the use of satellite imagery itself can be more optimal. After correcting the satellite images, the next step is a digitization process to observe land use in the coastal area of Batang Regency. The results of image processing analysis show clear images of the existing land use in coastal areas such as settlements, forests, rice fields, and others. The second result of the correction to the SPOT satellite image is as shown in Figure 3.



**Figure 3.** Improved Satellite Image Result  
 Source: Author's Analysis, 2017

## 5.2. Image Classification



**Figure 4.** Classification Map of Land Use of Coastal Area of Batang Regency  
 Source: Author's Analysis, 2017

Image classification is carried out by using a corrected image which is either by radiometric correction or geometric correction. It aims to reduce errors of interpretation that often occur in the stages of the classification process. Classification stages implement on-screen digitization technique. This technique shows directly on the screen by classifying existing land use on the map or satellite. Satellite image analysis result by using land use digitization technique is organized into ten types that represent all kinds of land use in the coastal area of Batang Regency. Those ten types of land use classification are settlements, rice fields, forests, gardens, fields, tourist sites, industries, ponds, mangroves and shrubs.

### 5.3. Accuracy Test of Classification Results

Accuracy test is one way to test classification result that has been performed in determining eligibility to proceed to the next analysis. This accuracy test involves location surveys supported by photos. Some of the existing land use sample points will be compared with the classification result. There are 500 coordinate points of land use location sampling spread throughout the coastal area of Batang Regency. This accuracy test will utilize descriptive statistical method through Cohen's Kappa coefficient test which aims to discover the consistency level of land use classification with thereal condition in the field. Determination of location sample points based on geographical area is taken at random so that it covers the entire study area. The process includes overlay between land use classification map with sample point in the whole coastal area of Batang Regency

The overlay result between the whole survey sample points with the classification of land use generates some correction of land use recorded in thereal condition in the field. After that, acoefficienttest of Cohen's Kappa is performed to find out the valuein consistency of existing land use process with survey point of coastal area in Batang Regency. The results of the coefficient test of Cohen's Kappa show the coefficient of land use classification value of 0.903 with a significance value of 0,000, way below 0.05. According to Anderson (1976) in Farda & Khoiriah (2012), the value of Cohen's Kappa coefficient above 0.85 (85%) for the classification of land use is still acceptable to the actual condition of current land use. Therefore, the classification result can be the base for analysis and interpretation process ofexisting land use in the coastal area of Batang Regency. Based on the tabulation test of land use classification, there are some partial errors occur between objects as forest, rice fields, fields, gardens and constructed lands such as industry, settlement, and others. Differences of two years affect the classification of land use in the coastal area of Batang Regency, but most of the classification of land use is still relevant after the test of Cohen's Kappacoeficiency.

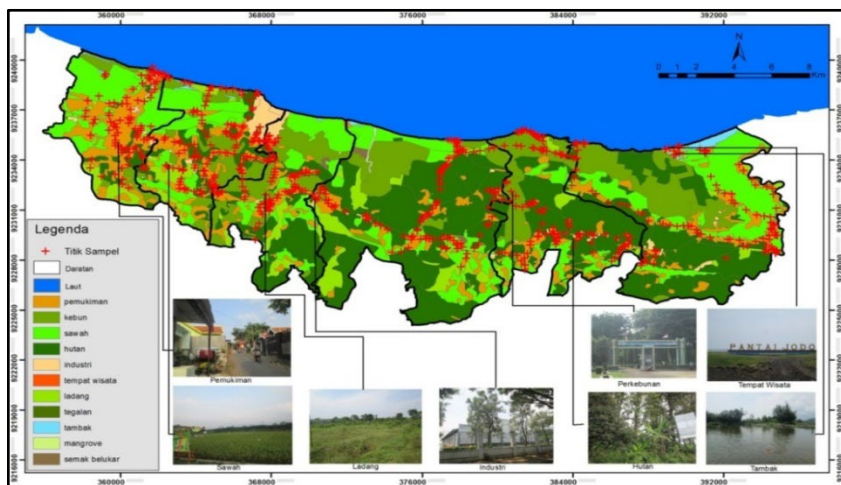


Figure 5. Map Of Sample Points Of Land Use Of Coastal Area Of Batang Regency

Source: Author analysis, 2017

### 5.4. Analysis of land use in coastal area of Batang Regency

Analysis of land use in the coastal area of Batang Regency is conducted to determine areas that have the potential for coastal resources development that has been and has not been utilized. Optimal land use will have an impact on future coastal developments and sustainability of the coastal area.

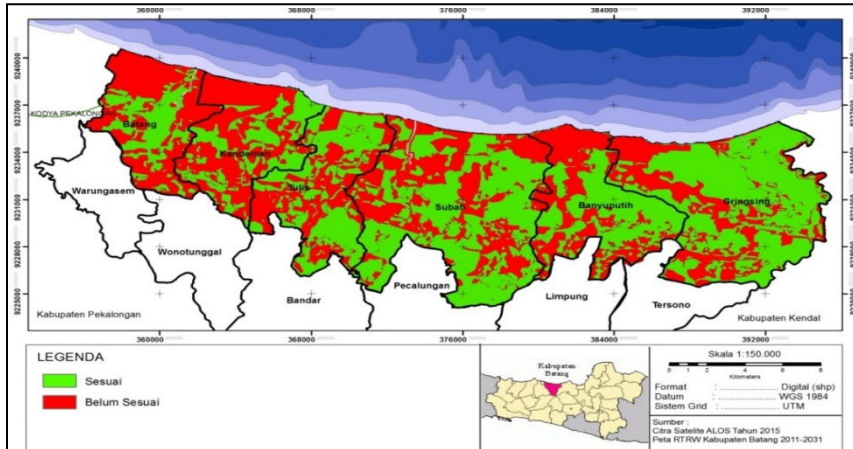
**Table 1.** Comparison of Existing Land Use Area With Spatial Plan of 2011-2031 Batang Regency

EXISTING LAND USE			SPATIAL PLAN 2011-2031		
Land Use	Area (ha)	Percentage	LandUse	Area (ha)	Percentage
Settlements	4.959,946	15,381	Settlements	8.745,730	27,067
Rice fields	7.087,174	21,977	Rice fields	5.543,820	17,158
Forest	11.253,600	34,898	Forest	4.437,220	13,733
Garden	5.945,321	18,437	Garden	8.293,730	25,668
Field	2.032,352	6,302	Field	1.515,720	4,691
Tourist sites	47,039	0,146	Tourist sites	136,778	0,423
Industry	587,567	1,822	Industry	1.199,310	3,712
Pond	209,849	0,651	Pond	636,126	1,969
Mangrove	1,108	0,003	Border	1.007,100	3,117
Shrubs	123,471	0,383	Others	795,411	2,462

Source: Author's analysis, 2017

The result of overall evaluation of existing land use with pattern allotment of coastal area in Batang Regency which is suitable category equals to 56,32% and not yet suitable equals to 43,68%. Based on the evaluation results, there are two concluded possibilities. First, there is still land use that has not been appropriately utilized according to allotment of coastal area pattern of Batang Regency. The use of the land in question should be the spatial pattern for either residential area which is still in the form of rice field or industrial area allotment which is still in the form of bushes and gardens. Therefore, there is still enormous potential of the coastal area to be developed. The second is the land use that is not suitable with the designation of the existing spatial pattern in the coastal area or not yet to be maximally supervised by the government in enforcing the regulation of Batang Regency Spatial Plan such as the existing land use for settlement which should have been reserved for the coastal border. This concern should be a joint evaluation of the community, government, and the private sector to be able to comply with existing Spatial Plan regulations in land use allocation in the coastal area of Batang Regency. The land use evaluation map is in Figure 6 as follows.





**Figure 6.** Land Use Evaluation Map

Source: Author's analysis, 2017

Batang Sub-district possesses land in accordance with Spatial Plan year 2011-2031 of the coastal area of 1.214,03 ha and the unsuitable land of 2.220,51 ha. The area that does not suit the Spatial Plan is greater than the corresponding one. This situation is because, in most of the sub-districts, the existing land use in the form of rice fields is actually designated for spatial patterns of settlements so that residential areas in Batang Sub-district can still be developed. Most of the spatial pattern designation for Batang Sub-district is for urban residential areas which makes development potential for settlement quite high. In addition, accessibility in Batang Sub-district is quite convenient to create it as Center for Local Activities/ *Pusat Kegiatan Lokal* (PKL). Aside of Batang Sub-district, settlement designation is also located in Kandeman Sub-district. Tulis Sub-district owns proper use of land compared to Batang and Kandeman Sub-districts. Tulis Sub-district's suitable area is 2.452,98 ha while the unsuitable area is 2.055,80 ha. Areas that have not been suitable for most of the designation for border areas are currently utilized for fields and rice fields. Other than that, in the existing situation, the designated land for industry is still in the form of forest and garden. The evaluation is in Table 2.

**Table 2.** Evaluation Result of Existing Land Use With Spatial Plan

Sub-district	Suitable	Unsuitable
Batang	1.214,03	2.220,51
Kandeman	1.565,02	2.610,65
Tulis	2.452,98	2.055,80
Subah	5.381,89	2.970,28
Banyuputih	2.314,61	2.127,89
Gringsing	5.202,12	2.074,31
Total	18.130,65	14.059,44

Source: Author's analysis, 2017

Most of Banyuputih Sub-district area is designated for plantation area, industrial estate, and residential area. From the evaluation result of land use, appropriate area in accordance with the spatial pattern is 2.314,61 ha, and unsuitable area equals to 2.127,89 ha. It can be seen in Figure 4.7 that the unsuitable land use is located in the north of Banyuputih Sub-district because the allocation for the industrial estate is still in the form of rice field, garden and settlement. Gringsing Sub-district has more suitable existing land use than unsuitable area because the suitable area is 5.202,12 ha while unsuitable area is 2.074,31 ha. Almost all of the land use in Gringsing district is in accordance with the designation of existing spatial patterns in coastal areas of Batang Regency. There are some unsuitable areas in the northern part of Gringsing Sub-district because it should be intended for industrial areas while the existing land use is still as gardens, forests, fields, and fields so that there are still areas that have not been optimally utilized.

**Table 3.** Result of Evaluation of Land Use Which Not Yet Suitable in Coastal of Batang Regency Based on Space Pattern

No	Land Use	SUB-DISTRICT					
		Batang	Kandeman	Tulis	Subah	Banyuputih	Gringsing
1	Settlements	1870.67	1697.28	443.77	486.73	482.68	439.44
2	Rice fields	272.76	350.71	436.14	442.29	386.27	374.01
3	Forest	0.00	0.00	106.22	559.10	198.99	81.61
4	Garden	23.54	253.64	420.95	687.90	398.09	528.15
5	Field	1.39	92.86	226.40	284.19	56.81	173.38
6	Industry	0.00	19.26	153.26	278.27	327.73	292.63
7	Pond	0.00	0.00	0.00	0.00	194.24	0.00
8	Tourist sites	0.00	134.64	0.00	0.00	0.00	0.00
9	Border	46.53	44.31	219.31	216.05	83.07	185.08
10	Shrubs	5.61	17.95	49.74	15.76	62.58	160.67

Source: Author's analysis, 2017

The evaluation result of land use that is not suitable based on the spatial pattern according to each sub-district resulted in the conclusion that most of the sub-districts in the coastal area of Batang Regency still tend to be developed for the designation of settlement. Batang and Kandeman Sub-districts have the most extensive area compared with other districts, namely 1870,67 ha and 1697,28 ha respectively. The existing land use for paddy fields is also mostly not suitable ranging from 270 ha to 450 ha in each sub-district. The unsuitable existing land use for forest is mainly in Subah Sub-district including the land use of garden and fields. While the designation of industry that is not suitable are concentrated in three Sub-districts which are Subah Sub-district, Banyuputih Sub-district, and Gringsing Sub-district. Unsuitable land use as pond is mostly in Banyuputih Sub-district which equals to 194,4 ha. The land use for tourist attractions can still be developed in Kandeman Sub-district with an area of 134,64 ha. The land use for irrelevant border exists in all sub-districts with the highest area in Tulis Sub-district of 219,31 ha. The highest unsuitable land use for shrubs is in Gringsing district with an area of 160,67 ha. From the results of the evaluation of land use, there is still the need for the development of designation of settlements, industries, ponds, and tourist attractions in several sub-districts. In addition, there is a need for sustainable use of wetland, forests, fields, gardens, and border areas.

## VI. Conclusion

Evaluation analysis of existing land use with the coastal area pattern of Batang Regency possesses two categories which are suitable category and unsuitable category. Based on spatial analysis from the land use evaluation as a whole, Batang Regency is discovered to possess suitable category equals to 18.139,65 ha with the percentage of 56,32% and unsuitable category equals to 14.059,44 ha with the percentage of 43,68%. Batang Sub-district's suitable category is 1.214,03 ha, while the unsuitable category equals to 2.220,51 ha. Kandeman Sub-district's suitable category is 1.565,02 ha, while the unsuitable category equals to 2.610,65 ha. Tulis Sub-district's suitable category is 2.452,98 ha, while the unsuitable category equals to 2.055,80 ha. Subah Sub-district's suitable category is 5.381,89 ha, while the unsuitable category equals to 2.970,28 ha. Banyuputih Sub-district's suitable category is 2.314,61 ha, while the unsuitable category equals to 2.127,89 ha. Gringsing Sub-district's suitable category is 5.202,12 ha, while the unsuitable category equals to 2.074,31 ha. The conclusion of land use planning development for Batang and Kandeman Sub-districts is that there is still a lot of land for residential development. Designation for Subah Sub-district is fisheries development while Banyuputih Sub-district and Gringsing Sub-district are for industrial development.

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