

Sustainable agricultural land use determination modelling in Banyuwangi

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Abstract. Population growth in Banyuwangi Regency resulted in increasing food and land needs. This is very influential in the protection of agricultural land through Sustainable Food Agricultural-Land (LP2B) program. Spatial modeling for potential of sustainable agriculture land in Banyuwangi Regency based on land-use change is achieved through 4 stages : (1) identifying trend of land-use change, (2) identifying factors that affected agricultural land conversion, (3) modelling potential land for sustainable food agriculture, and (4) establishing sustainable food agriculture. The result of the analysis shows that the land-use change in Banyuwangi regency has developed into settlements area, industrial warehousing and trade service which is quite fast for the periods 2010-2016. Accessibility factors covering the road network, location factors of agricultural field covering the proximity to water source / water supply and the dynamics factors of urban growth covering the developing settlement area, has a very big influence in the occurrence of agricultural land conversion in Banyuwangi Regency.

Keywords : *LP2B, Modelling, Landuse Change*

1. Introduction

Sustainable Food Agricultural-Land (LP2B) is a field of agricultural land established to be consistently protected and developed to produce essential food for national food self-sufficiency, resilience and sovereignty [1]. Land priorities that include of LP2B are land with high productivity, cropping index reaches three times in one growing season, integrated and has technical irrigation system and good actual land suitability level. Furthermore, it is mentioned in the regulation from the Minister of Agriculture No. 07/PERMENTAN/OT.140/2/2012 that broad expanse of Sustainable Agriculture and/or Sustainable Food Farms in an area that meets the needs and consumption of basic staple food is at least 5 Ha.

The problems faced are increasing population while the land area is relatively fixed, productivity of cultivated agricultural land (levelling-off), and the competition of land use for development. Under these circumstances, if the stakeholder paradigm in spatial planning only focuses on the economic value and lease of land, there is no balance between the development of the agricultural sector and development in other sectors [2].

In an effort to realize Sustainable Food Agricultural-Land (LP2B) in the region, the Government of Banyuwangi Regency has issued Local Regulation of Banyuwangi Regency No. 08 of 2012 concerning



Spatial Planning (RTRW) of Banyuwangi Regency 2012-2032. In the third paragraph of article 55 paragraph 1a mentioned that sustainable food cultivation land with an area of approximately 61.841 hectares of food crops in Banyuwangi Regency amounted to 65.992 hectares. Subsequently confirmed in article 55 paragraph 3 that the area of sustainable food agriculture in each sub-district set in the Local Regulation with a map accuracy of 1 : 25.000 scale.

Based on this phenomenon, it is important to conduct a study on the existence of agricultural land based on the model of land-use change, which through this study is expected to be used as input in the determination of Sustainable Food Agricultural-Land in Banyuwangi Regency.

2. Identifying Trend of Land-Use Change

Analysis of land-use change in Banyuwangi Regency during the period of 2011-2016, conducted using raster data overlay method with the help of ArcGIS software.

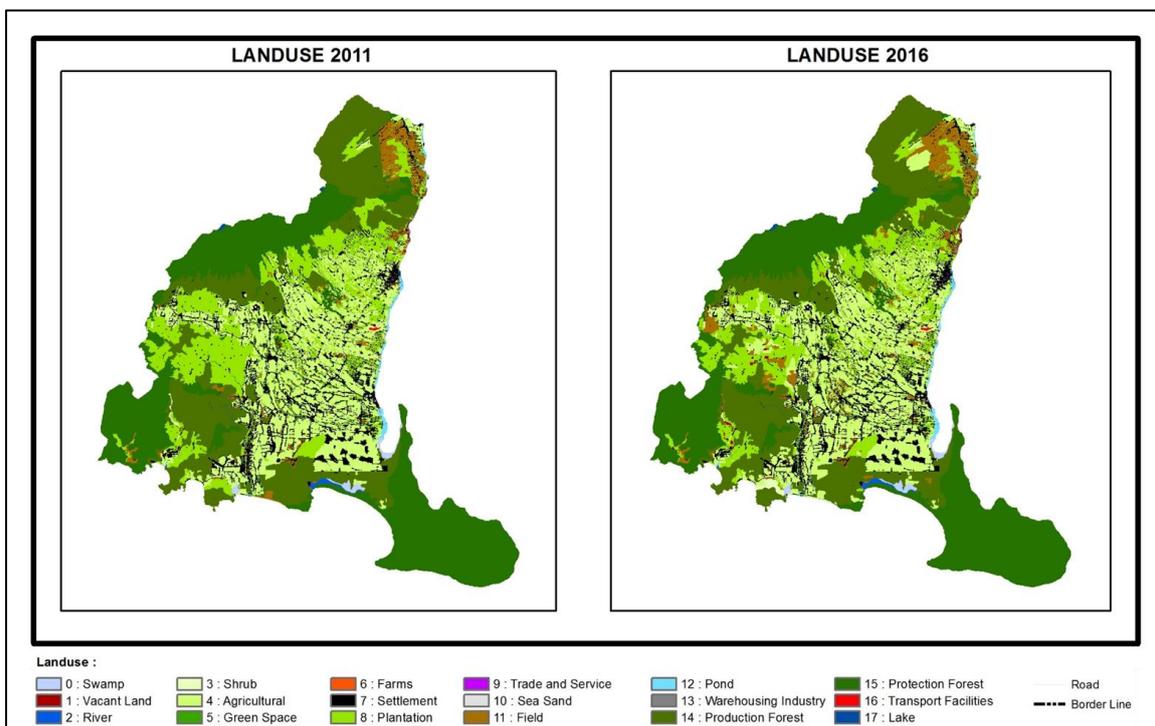


Figure 1. Land Use of Banyuwangi Regency in 2011 and 2016

From the overlay analysis, the proportion of land use in Banyuwangi Regency between 2011 and 2016 has similarities in terms of dominant land use. The dominant land use in Banyuwangi Regency is protection forest, production forest, agricultural, plantation, then settlement. In 2011, the proportion of protection forest in Banyuwangi Regency was 27 % of total land use, while production forest was 22%, agricultural 20%, plantation 17%, and settlement 9%. In 2016 the proportion of land use in Banyuwangi Regency did not experience significant development, as can be seen from the change in the proportion of land use in the year by 27% for protection forest, 21% for production forest, 21% for agricultural, 15% for plantation and 9% for settlement.

Based on land use comparisons In 2011 and 2016 there are several land uses that have expanded in area, this occurs in the use of vacant land, shrub, agricultural, settlement, trade and service, field, and warehousing industry. If we look further at the changes of each class of land in table 2, it can be explained that the growth of wetland in Banyuwangi Regency is caused by the conversion of plantation land and production forest into agricultural, besides changing the agricultural cropping pattern in Banyuwangi causing frequent land use change which was originally a field to agricultural fields.

The development of the city seen from the growth of built-up form of settlement land in Banyuwangi Regency for 5 years experienced considerable growth, where the average growth per year of 1.194 pixel settlements (107,46 hectares) with the tendency of growth of settlement land to convert non-constructed land in the form of vacant land, agricultural, and plantation. The growth of warehousing industry in Banyuwangi Regency is also experiencing rapid growth, which from the data can be explained that the average growth per year is 126 pixels (11,34 hectares), with the pattern of industrial land developments that tend to convert non-constructed land in the form vacant land, agricultural, plantation and fields.

3. Identifying Factors that Affected Agricultural Land Conversion

The analysis of factors that affected agricultural land conversion is done through Analytical Hierarchy Process (AHP). Based on the formulation of factors used in the determination of land conversion there are 3 factors that influence the Accessibility Factor, Dynamics Factor of City Growth, and Location of Agricultural Field Factor. Stakeholders in the local government of Banyuwangi Regency are the Regional Development Planning Board (Bappeda), the Public Works Agency (PU), the Agricultural Agency, and the Academics expert in Regional Planning. From the results of AHP analysis, it can be concluded that the weight of the influence of each factor can be explained in the following table:

Table 1. Weight Scores of the Effects of Agricultural Land Conversion Factors

Factors	Weight Scores
Transportation Facilities	0,063
Existing Settlements	0,282
Existing Industry	0,05
Existing Trade and Services	0,087
Public facilities	0,105
Irrigation Network	0,027
Supply / Water Resources	0,058

From the table it can be explained that the existing road network and settlement factors are the most dominant factor in influencing the conversion of wetland in the Study Area. This indicates that the more dean location of agricultural field with road network and residential area, the higher possibility for the happening of land conversion.

4. Modelling Potential Land for Sustainable Food Agriculture

This stage use to predict land-use change in Banyuwangi Regency, where the result of this analysis can be used as a basis to determine potential LP2B in Banyuwangi Regency. The first step in this land-use change model is prepare the rules or the path of the simulation. Basically, there are 2 (two) important things in preparing modeling rules, namely the allocation of land growth from each growing land class, and preparing the path of the land development in the simulation process.

Table 2. Land Growth Allocation Trends and Land Change Patterns

Land Use	Growth per year (Pixel)	Growth in 20 year (Pixel)	Conversion Land Trend	Uncorverted Land Trend (Constrain)
(7) Settlements	1.193,6	23.872	1, 3, 4, 6, 7, 11, 12, 14	0, 2, 5, 9, 10, 13, 15, 16, 17
(9) Trade and Services	28,4	568	1, 4, 7, 8, 11, 14	0, 2, 3, 5, 6, 9, 10, 11, 12, 13, 15, 16, 17
(13) Warehousing Industrial	125,6	2.512	1, 4, 8, 11	0, 2, 3, 5, 6, 7, 9, 10, 12, 13, 14, 15, 16, 17

Table 3. The Effect of Land Conversion Factors on Land Development Patterns

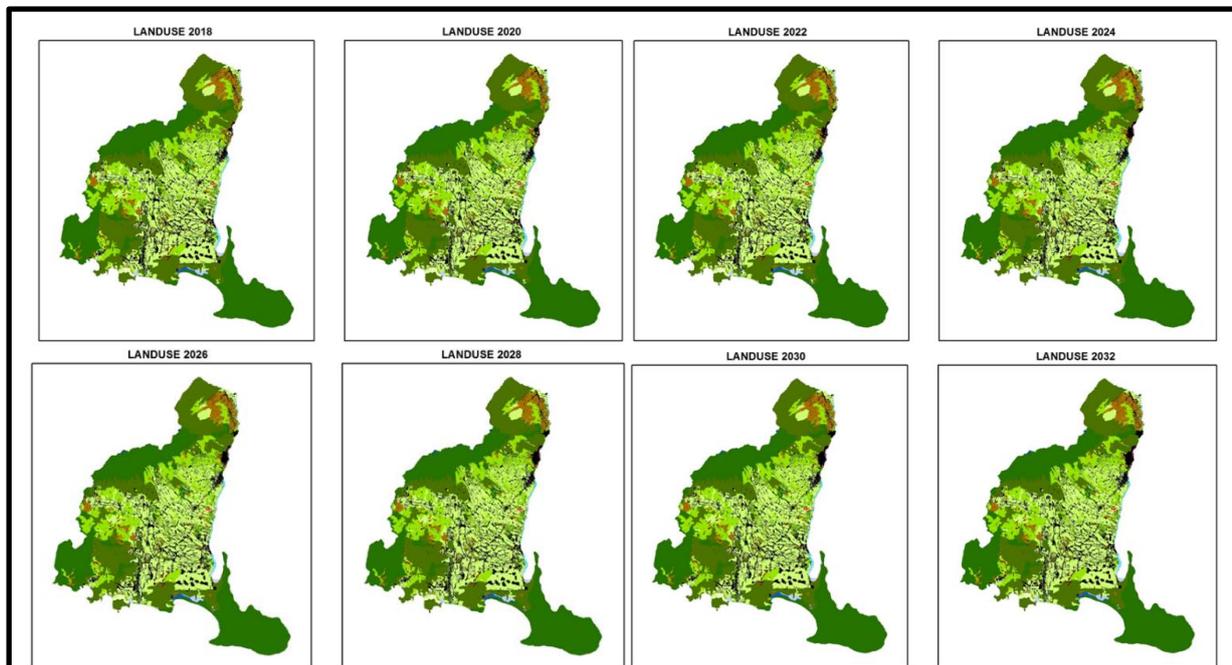
Factors	Weight Scores	Land Use		
		Settlements	Trade and Services	Warehousing Industrial
Road Network	0,328	Dec	Dec	Dec
Transportation / Public Facilities	0,168	Dec	Dec	Dec
Existing Settlements	0,282	Dec	Dec	Inc
Existing Industry	0,05	Inc	Dec	Dec
Existing Trade and Services	0,087	Dec	Dec	Dec
Irrigation Network	0,027	Inc	Inc	Inc
Supply / Water Resources	0,058	Inc	Inc	Inc

***Description :**

Increasing (Inc) The farther along with the factors that influence the higher growth opportunities in the land convert other land

Decreasing (Dec) The closer to the factors that influence the higher the growth opportunities of the land in converting other land

From the modeling rules can be explained that land modeling did not model the growth of agricultural and fields, this is based on the urgency of this study which aims to find LP2B potential land in Banyuwangi Regency, so that agricultural and fields are assumed not to grow. Based on several spatial factors and modeling rules that have been formulated, the result of modeling of land change in Banyuwangi Regency is as follows.



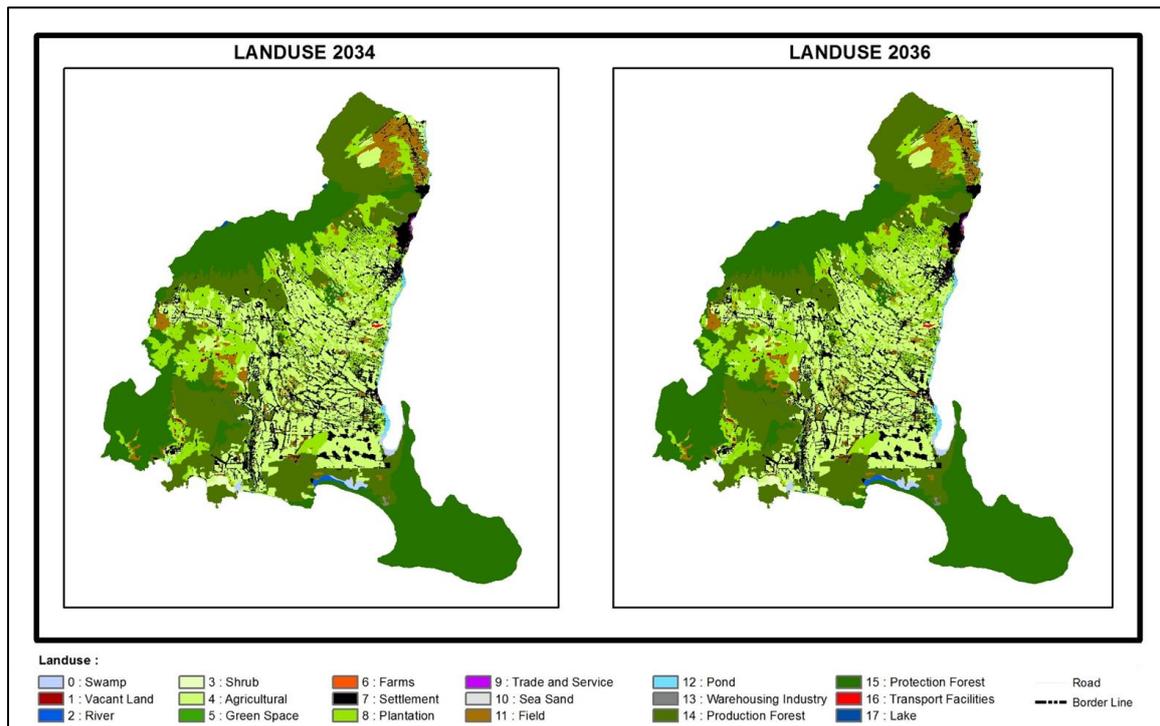


Figure 2. Results of Modeling of Land-Use Changes of Banyuwangi Regency 2016-2036

Based on the simulation results and table 4 of land use comparison 2016 and 2036 it can be explained that the development of settled land (settlements, trade and services, and warehousing industry) in Banyuwangi tends to lead to urban areas. When viewed from the results of land use comparability, it can be explained also that within 20 years the development of built-up land in Banyuwangi regency for settlement land tends to convert the land that serves as a field of 10.268 pixels (924,12 Ha), the land that serves as a plantation of 8.724 pixels (785,16 Ha), the land that serves as a agricultural of 2.817 pixels (253,53 Ha), the land that serves as a production forest of 2.270 pixels (204,3 Ha), land that serves as pond as much as 95 pixels (8,55 Ha), and land that serves as a bush of 19 pixels (1,71 Ha).

For land use as trade and services, the results of simulation and comparison of land use label explains that in its development this land tends to convert agricultural by 33 pixel (2,97 Ha), settlement of 273 pixels (24,57 Ha), plantation of 84 pixels (7,56 Ha), 182 pixel (16,38 Ha) field, and 4 pixels production forest (0,36 ha). As for the warehousing industry in Banyuwangi Regency, it can be explained that this land is likely to convert agricultural by 1545 pixels (139,05 Ha), settlement of 857 pixels (77,13 Ha), and 70 pixels (6,3 Ha) field.

Table 4 Land Use Comparison Year 2016 and 2036

	Land Use 2036 ^a							
	(0) Swamp	(1) Vacant Land	(2) River	(3) Shurb	(4) Agricultural	(5) Green Space	(6) Farms	(7) Settlement
(0) Swamp	17006							
(1) Vacant Land		4774						
(2) River			13420					
(3) Shurb				14032				19
(4) Agricultural					844842			2817
(5) Green Space						2335		
(6) Farms							58	
(7) Settlement								350136

(8) Plantation										8724
(9) Trade and Service										
(10) Sea Sand										
(11) Field										10268
(12) Pond										95
(13) Ware-housing Industry										
(14) Produc-tion Forest										2270
(15) Protection Forest										
(16) Transport Facilities										
(17) Lake										
Sum	17006	4774	13420	14032	844842	2335	58	374329		

^a1 pixel = 30 x 30 m = 900 m²

Table 4 (Continued)

	Land Use 2036 ^a									
	(8) Plan- tation	(9) Trade and Service	(10) Sea Sand	(11) Field	(12) Pond	(13) Ware- housing Industry	(14) Production Forest	(15) Pro- tection Forest	(16) Tran- sport Facilities	(17) Lake
(0) Swamp										
(1) Vacant Land										
(2) River										
(3) Shurb										
(4) Agricultural		33				1545				
(5) Green Space										
(6) Farms										
(7) Settlement		273								
(8) Plantation	601573	84				857				
(9) Trade and Service		1599								
(10) Sea Sand			3858							
(11) Field		182		172868		70				
(12) Pond					17309					
(13) Ware- housing Industry						5586				
(14) Produc-tion Forest							826665			
(15) Protection Forest		4						1099742		
(16) Transport Facilities									1348	
(17) Lake										1922
Sum	601573	2175	3858	172868	17309	8058	826665	1099742	1348	1922

^a1 pixel = 30 x 30 m = 900 m²

Based on these results, it can be explained that the area of agricultural that has the potential to serve as sustainable food farming (LP2B) in Banyuwangi Regency is 844.842 pixels or 76.035,78 Ha. Based on the determination of LP2B land potential based on the simulation of the development of this land, the determination of LP2B land in Banyuwangi Regency needs to be reviewed again with technical provisions set by the Government in determining LP2B land in Indonesia.

5. Establishing Sustainable Food Agriculture

Based on the Regulation of the Minister of Agriculture No. 07/PERMENTAN/OT.140/2/2012 about the Technical Guidelines on Criteria and Requirements for Sustainable Land, Reserves and Land of Food Reserves that the technical requirements for LP2B land acquisition are as follows:

- Width of agricultural fields > 5 Ha
- The determination of a agricultural field can be limited by physical boundaries such as road network, river network, and technical irrigation network.

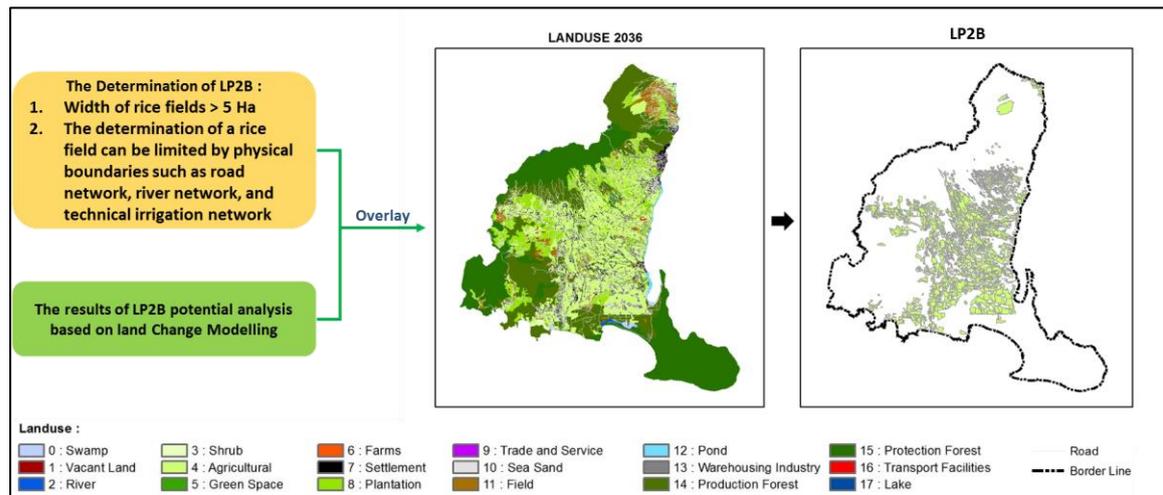


Figure . 3. Result of Determination of LP2B in Banyuwangi Regency

Based on the results of the analysis it is found that the area of agricultural fields that can be used as LP2B land in Banyuwangi regency of 73.955,41 Ha of total 76.035,78 Ha of agricultural fields in Banyuwangi.

6. Conclusion

Based on the prediction analysis of land use change based on land use trends and factors affecting agricultural fields area conversion, development of land use built in 2016 to 2036 experienced growth toward urban area. Settlement land converts fields, plantations, agricultural, production forests and some ponds and shrubs. While trade and services land convert settlements, fields, and some plantations, agricultural, and production forests. Warehousing industrial tends to convert agricultural, plantations, and some fields. The end result is the area of agricultural field which has potential as LP2B is 76.035,78 Ha from the simulation result 2036. Based on the technical criteria of LP2B determination, the result of LP2B potential land prediction in overlay with the technical stipulation of LP2B is obtained the width of field that can be used as LP2B amounting to 73.955,41 Ha of total LP2B prediction 76.035,78 Ha. The total area of LP2B can be made in 1.549 agricultural fields of Banyuwangi.

7. References

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