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Rice production model based on the concept of ecological footprint

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Abstract. Pursuant to what had been stated in Region Spatial Planning (RTRW) of Malang Regency for period 2010-2030, Malang Regency was considered as the center of agricultural development, including districts bordered with Malang City. To protect the region functioning as the provider of rice production, then the policy of sustainable food farming-land (LP2B) was made which its implementation aims to protect rice-land. In the existing condition, LP2B system was not maximally executed, and it caused a limited extend of rice-land to deliver rice production output. One cause related with the development of settlements and industries due to the effect of Malang City that converted land-function. Location of research focused on 30 villages with direct border with Malang City. Review was conducted to develop a model of relation between farming production output and ecological footprint variables. These variables include rice-land area (X_1), built land percentage (X_2), and number of farmers (X_3). Analysis technique was regression. Result of regression indicated that the model of rice production output Y=-207,983 + 10.246X_1. Rice-land area (X_1) was the most influential independent variable. It was concluded that of villages directly bordered with Malang City, there were 11 villages with higher production potential because their rice production yield was more than 1,000 tons/year, while 12 villages were threatened with low production output because its rice production yield only attained 500 tons/year. Based on the model and the spatial direction of RTRW, it can be said that the direction for the farming development policy must be redesigned to maintain rice-land area on the regions on which agricultural activity was still dominant. Because rice-land area was the most influential factor to farming production. Therefore, the wider the rice-land is, the higher rice production output is on each village.

1. Introduction

Malang Regency was the center of agricultural development in East Java. Through Region Spatial Planning (RTRW) of Malang Regency for Period 2010-2030, productive districts had been organized to maximize the supply of rice production, including districts bordered with Malang City. But rice-land area usually reduced due to the conversion of agricultural-land to other land-uses and district's development as the consequence of Malang City's growth. The conversion of agricultural-land into non-agricultural-land was evident by the use of farming fertile land for settlement, industry and other usage (Rustiadi, et al, 2011). Rice-land protection policy to reduce land convertion activity, including sustainable food farming-land (LP2B) in Malang Regency, was not maximally implemented. Conversion against farming-land was a factor behind the scarcity of food derived from farming

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production output (Rahmanto, 2002). As a result, agricultural-land stock for rice production output would be limited.

Ecological footprint concept was about resource supporting capacity. As noted in a theory proposed by Wackernagel and Rees (1996), ecological footprint was a calculation of biological capacity or resource supporting capacity. Resource support in this case, was shown by rice production output because, Ekins in Giljum, et al (2007), ecological footprint did not count all natural assets. Ecological footprint covered only natural environment parts but with irreplaceable important functions. Concerning with their regional characteristic, villages that bordered with Malang City must have huge potentials for supplying rice production.

2. Methods

Type of research was descriptive. Research attempted to investigate and to identify the patterns of development and phenomena that was still undergone or would be happening. This study focused on the villages in the Malang Regency, which bordering the city of Malang. There are 30 villages used as a location for this study and in accordance with the theory of the Roscoe in Sugiyono (2010) decent sample size in the study were between 30-500 samples and Hair et al (2006) which states that the linear regression can be effective with the amount of 20 data or samples. Selection of the 30 villages of the 8 district, also based on criteria such as policy direction, the conditions and characteristics of the village so that the data obtained varies.

Classic assumption test serves to determine and examine the variables that are used in accordance with the criteria variables. Its function is to determine the right variables and variables can generate a good regression model. Classic assumption test to be used are normality test, multicoloniarity test and heteroscedasticity test. Normality Test will be using the Kolmogorov-Smirnov method with significant value that must be larger than 0.05. Multicoloniarity test by looking at the value of tolerance that must be larger than the value of 0.10 and value of VIF (Variance Inflation Factor) should be less than 10. Meanwhile, Park method of heteroscedasticity test that takes into account the value of t-test that must be lower than the value of t-table.

Regression analysis is basically the study of the dependency the dependent variable with one or more of independent variables (Gujarati in Ghozali, 2005). The used variables are variable based on the concept of ecological footprint. This concept is also used in regression analysis with the use of regression model that function to calculate the supply or availability of resources indicated by the dependent variable of rice production. Multiple regression analysis was functioned to see the variables that affect the rice production and regression model can be used in the depiction of the value of agricultural land supply.

Variables for regression analysis were arranged based on ecological footprint. As noted by the concept, resource supply emanated from rice production output of each village. By virtue of ecological footprint concept, then theories were made to support the emergence of variables in rice production model.

Y : rice production (tons)
X1 : rice-land area (hectares)
X2 : built land percentage (percentage)
X3 : number of farmers (people)

The independent variables and the dependent variables will be analyzed on multiple regression using SPSS 16.0 software that simplify the implementation of multiple regression calculation. This calculation also includes the interpretation of model summary and coefficient values. So we get the regression model as follows:

$$Y_1 = a + b_1x_1 + b_2x_2 + b_3x_3 \qquad (1)$$

3. Data of The Variables

Datas used in this research was obtained from the secondary survey process. Datas are from government agencies such as BAPPEDA (planning and development agency), PU (infrastructure, settlements and spatial develpment agency), and BPS (statistic agency). Datas obtained in the form of districs in figures contains all data such as rice-land area, rice production, the number of farmers, and settlements area to compare with rice-land area and produce built land percentage.

Table 1. Data of the variables

No	Districts	Villages	Rice production (Tons)	Rice-land area (Hectares)	Bulit land percentage (%)	Number of farmers (people)
1	Dau	Karangwidoro	286,58	46,00	46,97	1.568
2		Kalisongo	118,37	19,00	83,07	1.408
3		Tegalweru	180,67	29,00	9,63	1.073
4		Landungsari	336,42	54,00	63,42	1.032
5		Mulyoagung	249,20	40,00	73,65	170
6	Karangploso	Tegalgondo	1.376,00	179,40	18,53	877
7		Kepuharjo	1.296,23	169,00	21,03	1.014
8		Ngijo	257,71	33,60	53,33	747
9		Ampeldento	880,52	114,80	24,97	454
10	Singosari	Banjararum	2.336,63	114,00	48,55	99
11		Tunjungtirto	3.013,03	147,00	37,95	613
12		Langlang	2.070,17	101,00	26,05	314
13	Pakis	Sekarpuro	556,93	72,00	48,79	94
14		Ampeldento	1.245,36	161,00	22,40	224
15		Sumberkradenan	1.059,72	137,00	10,72	425
16		Kedungrejo	510,52	66,00	20,13	414
17		Mangliawan	1.028,78	133,00	37,81	169
18		Tirtomoyo	154,70	20,00	32,56	202
19	Wagir	Sitirejo	363,09	91,00	22,30	108
20		Sidorehayu	446,88	112,00	14,34	212
21		Jedong	235,41	59,00	16,71	297
22		Pandanlandung	75,81	19,00	18,77	103
23	Tumpang	Ngingit	913,54	90,50	14,18	942
24		Kidal	625,85	62,00	32,40	1.617
25		Kambingan	575,38	57,00	15,02	416
26	Tajinan	Tambaksari	925,05	122,00	37,38	259
27		Tangkilsari	1.139,63	150,30	21,78	203
28		Sumbersuko	947,79	125,00	64,22	919
29	Pakisaji	Kebonagung	1.765,73	184,70	50,36	49
30		Kendalpayak	1.836,47	192,10	48,32	644
Total/Average			26.808,17	2.900,40	34,51	16.666

4. Results

4.1 Result of Classical Asumption Test

Classical assumption test in regression model, including normality test, multicolonearity test, and heterocedasticity test. Normality test on regression model generate significant value of 0,057 and had a value above 0.05. Multicoloniarity test generate all variables in regression model have a value of tolerance and VIF appropriate, so the correlation between variables is not proven. Tolerance and VIF value of rice-land area variable (X1) are 0,938 and 1,066. Built land percentage variabel (X2) had Tolerance and VIF value are 0,939 and 1,065. And the value of Tolerance and VIF of number of farmers variable (X3) are 0,924 and 1,083. All variabels had the value of tolerance are more than 0,10 and VIF value are less than 10.

The value of t-table of heteroscedasticity is 2,776 and all of the variables comply heteroscedastidsitas test because the t-test value is smaller than the value t-table. The t-test of of rice-land area variable (X1) is 2,501, Built land percentage variabel (X2) had the value of t-test is 0,814. And the value of t-test of number of farmers variable (X3) is 0,063. All variabels had the t-test value is less than 2,776. Based on the classic assumption test calculations on the model, all variables have been tested and can be used in the calculation of the regression model.

4.2 Results of Regression Model

The regression model had dependent variable is rice production (Y1) and independent variable are rice area (X1), built land precentage (X2), and the number of farmers (X3). Based on the calculation of regression model, the R-square value by 56,6%, which can be defined independent variables are used in the calculation of regression model can explain the relationship of influence by 56,6% against the dependent variable, and 43,4% are influenced by other variables not included in the independent variables of this study.

Table 2. Result of Model Summary and ANOVA

Model	R	R-square	Adj. R-square	F	Sig.
1	.752	.566	.516	11.302	.000a

The value of F-table on the first regression model was 2,59 and compared with the value F-test, the value of F-table is smaller and can be defined independent variables have a significant effect on the dependent variable.

Table 3. Result of Coefficient value

Model	B	Std. Error	t	Sig.
(Constant)	-207.983	300.865		
Rice-land area (X_1)	10.246	1.810	5.659	.000
Bullt land Perentage (X_2)	4.227	4.942	.855	.400
Number of farmers (X_3)	.063	.213	.295	.770

Based on the calculation of regression model, the variable of rice-land area (X1) is the most influential variable on rice production (Y1) and will form regression model as follows:

$$Y_1 = -207{,}983 + 10{,}246x_1 \quad (2)$$

Rice-land area (X1) had a coefficient of determination of 10,246 with positive effect (+). It means that each hectare of rice-land will have 10,246 tons of rice production. Every increment 1 hectare of rice-land may increase rice production into 10,246 tons. Which means the increasing of rice-land area, will make increasing of rice production.

The constant was -207,983 with negative load (-). The constant itself was a regression value reflecting a determination coefficient rate of independent variable. It means that if rice-land width is 0 or, in the case of a village without rice-land, there will be a deficiancy for rice production output by an average of 207,983 tons. and overall the negaative constant value in this regression model, indicating a shrinking of rice production and rice production is is very dependent on rice-land area.

4.3 Results of Regression Model

The simulation of regression model was aimed to attest the model and also to examine villages with potential for supplying rice production output. Because regression model was created with rice-land area (X1) as the influential variable, then rice production was measured from regression model. Simulation using regression model and existing data of rice-land area in each village. Based on the calculation model, will be obtained results of Rice Production (tons) The area constituted by rice-land in each village. The following findings regression calculation Simulation Model.

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Table 4. Simulation of Regression Model

No	Districts	Villages	Existing data		Result of Regression Model
			Rice-land Area (Ha)	Rice Production (Tons)	Rice Production (Tons)
1	Dau	Karangwidoro	46,00	286,58	263,33
2		Kalisongo	19,00	118,37	-13,31
3		Tegalweru	29,00	180,67	89,15
4		Landungsari	54,00	336,42	345,30
5		Mulyoagung	40,00	249,20	201,86
6	Karangploso	Tegalgondo	179,40	1.376,00	1.630,15
7		Kepuharjo	169,00	1.296,23	1.523,59
8		Ngijo	33,60	257,71	136,28
9		Ampeldento	114,80	880,52	968,26
10	Singosari	Banjararum	114,00	2.336,63	960,06
11		Tunjungtirto	147,00	3.013,03	1.298,18
12		Langlang	101,00	2.070,17	826,86
13	Pakis	Sekarpuro	72,00	556,93	529,73
14		Ampeldento	161,00	1.245,36	1.441,62
15		Sumberkradenan	137,00	1.059,72	1.195,72
16		Kedungrejo	66,00	510,52	468,25
17		Mangliawan	133,00	1.028,78	1.154,74
18		Tirtomoyo	20,00	154,70	-3,06
19	Wagir	Sitirejo	91,00	363,09	724,40
20		Sidorehayu	112,00	446,88	939,57
21		Jedong	59,00	235,41	396,53
22		Pandanlandung	19,00	75,81	-13,31
23	Tumpang	Ngingit	90,50	913,54	719,28
24		Kidal	62,00	625,85	427,27
25		Kambingan	57,00	575,38	376,04
26	Tajinan	Tambaksari	122,00	925,05	1.042,03
27		Tangkilsari	150,30	1.139,63	1.331,99
28		Sumbersuko	125,00	947,79	1.072,77
29	Pakisaji	Kebonagung	184,70	1.765,73	1.684,45
30		Kendalpayak	192,10	1.836,47	1.760,27
Total			2.900,40	26.808,17	23.478,01

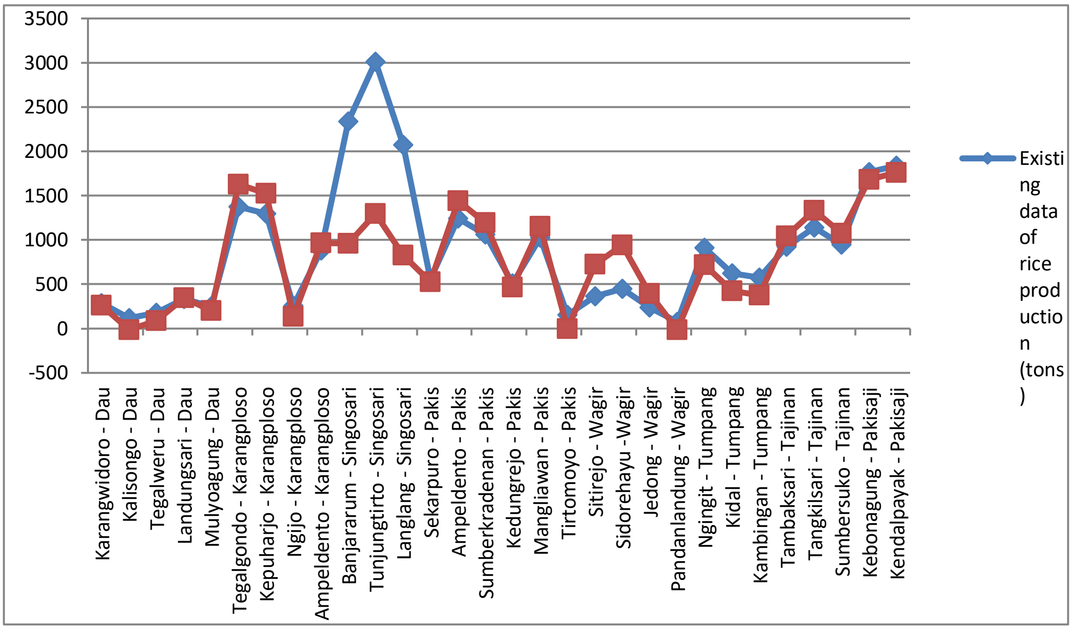

Figure 1. Comparison chart of rice production (tons) based on existing data and result of regression model

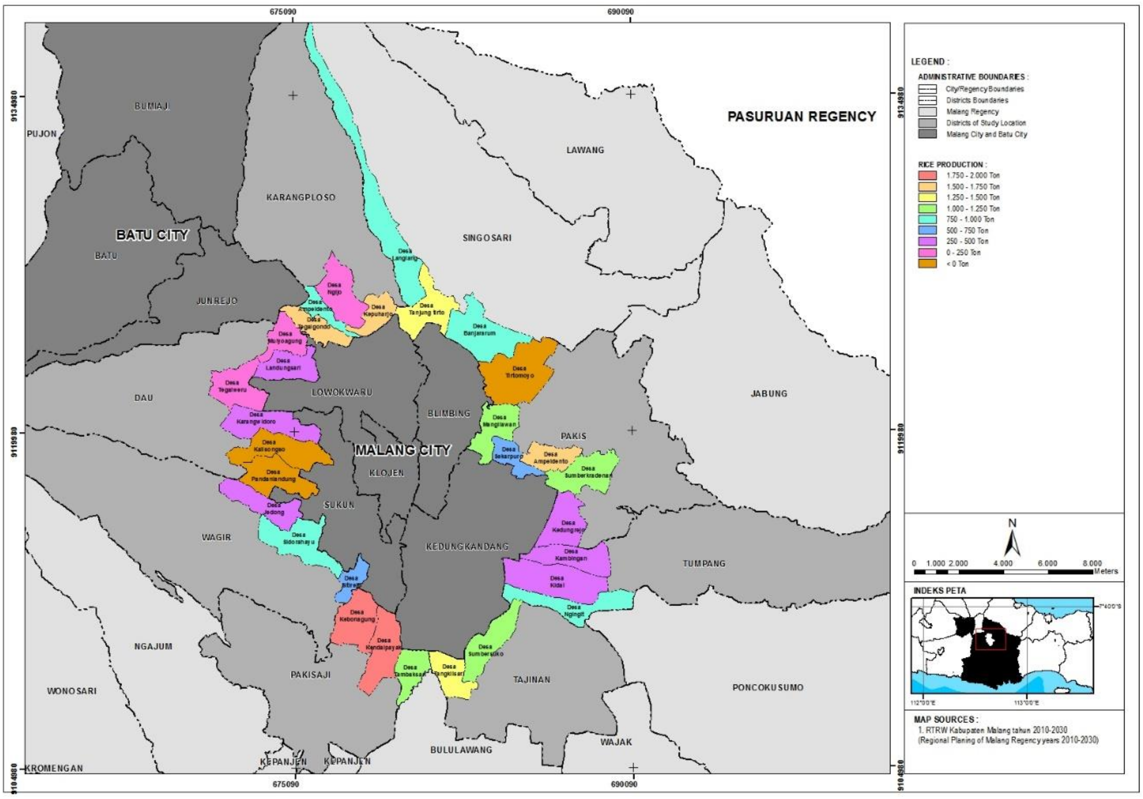

Figure 2. Map of rice production based on result of regression model

Result of regression model's simulation indicted that rice production output for all villages was 23,478.01 tons with rice-land area of 2,900.40 Ha. Based on existing data, rice-land productivity for all villages was 8,09 tons/hectares This productivity was quite high and potential if compared with other regions. Based on the result of regression model's simulation, there were 11 villages with rice production more than 1.000 tons/year. These villages in its existing condition would have quite extensive rice-land. But almost all vilages were influenced by urban effect when land conversion activity must be inescapable. The impact was evident on 12 other villages with rice production output less than 500 tons/year.

5. Conclusions

By taking account the result of regression model calculation, rice-land area was an influential variable for the supply of rice production output. In concern with their regional characteristic, villages that bordered with Malang City have rice-land are that was very potential. Rice-land to produce the rice had a quite higher productivity, precisely 8.09 tons/ha and the rice was a consumable food by few community members. Achieving this productivity, it would need very big and potential rice-land supply to produce the expected rice production output.

However, there were 12 villages with rice production output less than 500 tons/year. It is then recommended that the direction of policy must consider regional characteristic. Villages with extensive rice-land must be able to maintain its rice-land and to improve the quality and productivity of its land. Farming activity should be the dominant work in the village, and the supply of rice production output must be made available for fulfilling the rice demand of the community.

Recomendation on villages that have little rice products due to limited rice-land area, that villages can be used for the development of settlements and economic activity center. So between agriculture and settlements activity, both can able to develop well.

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