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Integration of logistic regression and multicriteria land evaluation to simulation establishment of sustainable paddy field zone in Indramayu Regency, West Java Province, Indonesia

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Abstract. Ministry of Agriculture have targeted production of 1.718 million tons of dry grain harvest during period of 2016-2021 to achieve food self-sufficiency, through optimization of special commodities including paddy, soybean and corn. This research was conducted to develop a sustainable paddy field zone delineation model using logistic regression and multicriteria land evaluation in Indramayu Regency. A model was built on the characteristics of local function conversion by considering the concept of sustainable development. Spatial data overlay was constructed using available data, and then this model was built upon the occurrence of paddy field between 1998 and 2015. Equation for the model of paddy field changes obtained was: logit (paddy field conversion) = $-2.3048 + 0.0032*X_1 - 0.0027*X_2 + 0.0081*X_3 + 0.0025*X_4 + 0.0026*X_5 + 0.0128*X_6 - 0.0093*X_7 + 0.0032*X_8 + 0.0071*X_9 - 0.0046*X_{10}$ where X_1 to X_{10} were variables that determine the occurrence of changes in paddy fields, with a result value of Relative Operating Characteristics (ROC) of 0.8262. The weakest variable in influencing the change of paddy field function was X_7 (paddy field price), while the most influential factor was X_1 (distance from river). Result of the logistic regression was used as a weight for multicriteria land evaluation, which recommended three scenarios of paddy fields protection policy: standard, protective, and permissive. The result of this modelling, the priority paddy fields for protected scenario were obtained, as well as the buffer zones for the surrounding paddy fields.

1. Introduction

The most dominant land use change in Indonesia occurs in forest, settlement and paddy field. This happens because the development of existing cities and paddy field are in the region. Paddy field function is common in many suburban areas, especially along the north coast of Java Island. Directorate General of Land and Water Management showed that in Java conversion of wetland into housing was 58.7%, while into industry, offices and shops was 21.8% [1]. National Land Agency reported that during 1994-2004 there had been a change of paddy field function in Java and Bali by 36,000 ha or about 3,600 ha/year [2]. Comparison of land use maps produced in 1990 and 2011 yielded that paddy field in Indramayu Regency in 1990 was 54,961 ha (20% from all area in the regency), while in 2011 it decreased to 13,006 ha.

In the period of twenty-one years there was a decrease of wetland area by 34,557 ha or decreased by 72.65%. The rate of depreciation of paddy fields in Indramayu Regency was 1,645 ha/year. As the impact of increasing public demand for various purposes of land use, the existence of land resources became increasingly scarce. Thus, space as the basis of economic activity must be well laid out in order to accommodate various interests.

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Land use that does not consider the land suitability aspect will lead to environmental degradation so that it is against the principle of sustainable development which requires the realization of a sustainable environment so as not to harm the interests of future generations to come. For the agricultural sector land use that is not in accordance with the characteristics of the land in addition to environmental damage will also cause the decline in productivity of the plant [3].

Indramayu Regency is one of the main agricultural regions, which accounts for 43% of the total Gross Regional Domestic Product (GRDP) of Indramayu Regency. In 2011, rice production was 1,704,956.71 tons produced from 239,465 ha harvested area with paddy productivity of 7.12 tons/ha. Ministry of Agriculture have targeted food self-sufficiency by production of 1.718 million tons of dry grain harvesting during the period of 2016-2021. In order to accelerate the achievement of food self-sufficiency, it was pursued through the optimization of special commodities, including rice, soybean and corn.

Land use changes could be predicted quantitatively by incorporating physical, social, economic, and policy factors [4]. Predicted land use changes could be analyzed through a spatial-based model approach, one of which was based on Cellular Automata (CA). CA is a spatial-based model that is able to predict future conditions of local interactions between cells on a regular grid [5], in which cells represent land use. Rules were made as a consideration of the neighboring cell that became the basis of land use change. CA consists of several components: cell (pixel), state, neighborhood (neighborhood) and transition ruler/transition function.

The land use model using CA had been applied as a tool to support land use planning and policy analysis as well as exploring scenarios for future development [3]. Changes in land use, at a given location and within a certain time, could be studied as phenomena or dichotomous events. Land use change, as a binary phenomenon, consisted of only two categories: change or unchanged. Factors affecting land use change were generally a combination of continuous and categorical variables [6]. The analysis of factors influencing land use change was approached by logistic binistic regression equation (logit model). Logistic regression is a mathematical model to analyze the relationship of independent variables in the form of data continue, discrete, dichotomous, or a combination that affects one dependent variable [7]. This analysis technique has been carried out on forest conversion [8, 9], urban growth [7] and changes in wetland [10].

The purpose of this research was to know the change of land use in Indramayu Regency in period 1998-2015, and to build spatial model of change of paddy field in Indramayu Regency. The spatial model was designed by considering sustainable development aspects and characteristics of local land use conversions, which were analyzed using logistic regression. Results of this analysis were then used as values in determining the establishment of sustainable paddy fields using multicriteria evaluation.

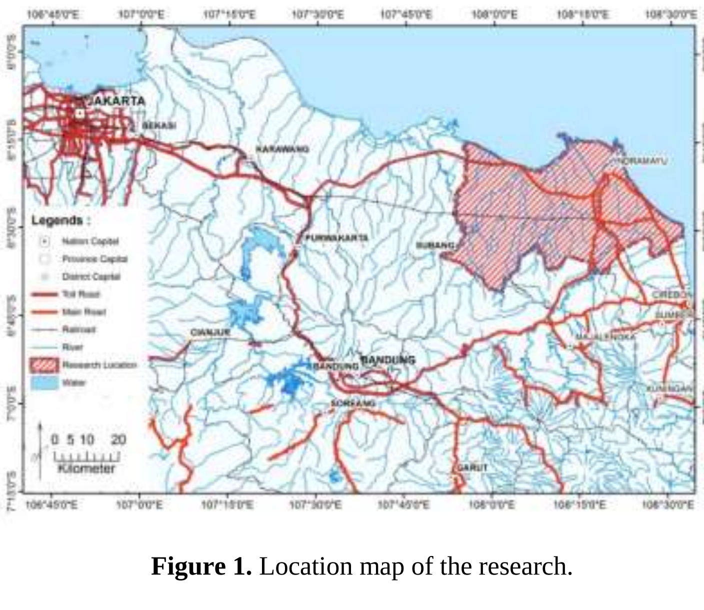


Figure 1. Location map of the research.

2. Methods

This research used ArcGIS Software, Idrisi TerrSet Software and MS Excel Software. Location map of the research can be seen in Figure 1.

2.1 Materials and tools

Data used in this study were (a) Digital Map RBI scale 1:25,000 Indramayu District year 1994 (layers: road network, river network, cities); (b) IKONOS Imagery year 2008, GeoEye Imagery year 2008, SPOT 6 Imagery year 2014 and 2015; (c) Land use and land cover map scale 1:25,000 scale year 1998, 2008 and 2015, (d) Map of the administrative area of Indramayu Regency scale 1:50,000, Development Planning Agency of Indramayu Regency year 2014, (e) Land suitability maps for paddy rice crops year 2016, (f) Map of population density of Indramayu Regency, scale 1: 50,000 year 2008. and (g) Demographic and land data from Statistics Agency year 2016. The research activity stage was presented in Figure 2

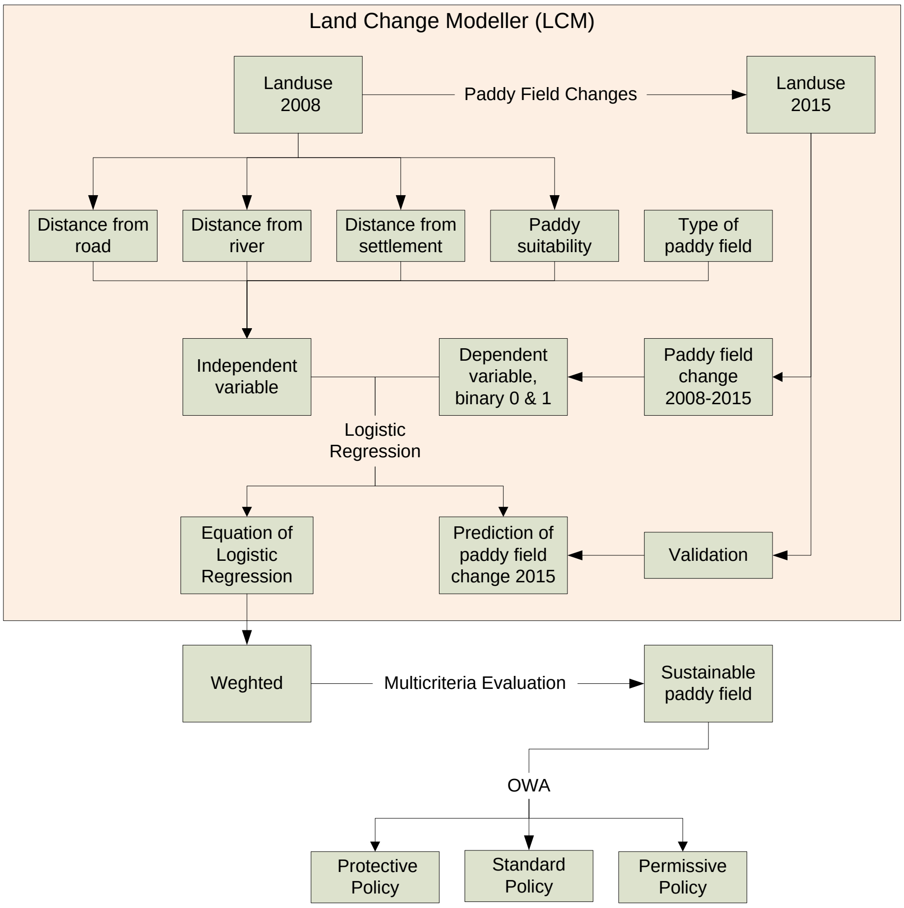


Figure 2. Research flow diagram. [11]

2.2 Analysis of land cover changes

Analysis of changes in land cover was performed by comparing the land cover maps produced by Regional Development Agency of Indramayu Regency. Determination of land cover area used spatial analysis which was done by Land Change Modeler in Indrisi TerrSet process of the maps of Indramayu Regency in 1998, 2008 and 2015. Spatial analysis of multi layer could be integrated when the data had the same format. The spatial data format used was presented in Table 1.

2.3 The Logistic Regression Model

In the modeling process land use and land cover maps for 1998, 2008 and 2015 were reclassified. The existing land cover consisted of 7 classes, namely: water bodies, forests, gardens, plantations, Irrigation paddy fields, Rain fed paddy fields and others. It then was reclassified into 3 classes, namely irrigated paddy fields, rain-fed paddy fields, and non-paddy fields. Vector-format maps were converted to raster format with cell size 20. Furthermore, using the land use map of 1998 as baseline and land use map of 2008 as the final data, analysis of land changes using TerrSet Idrisi software was performed. Analysis of land use d change was done with the Land Change Modeller (LCM) module in TerrSet Software as shown in Figure 2.

Table 1. Standard of spatial data format of Indramayu Regency.

No	Parameter	Information
1	Data type	Real
2	File type	Binary
3	Column	4,102
4	Line	2,697
5	Coordinate system	UTM Zone 49 S
6	Coordinate unit	Meter
7	Distance units	1.00
8	Minimum x	148,692.2088
9	Maximum x	230,732.2088
10	Minimum y	9,259,649.7982
11	Maximum y	9,313,589.7982
12	Resolution X	20.00
13	Resolution Y	20.00

The probability of paddy fields change was considered as a function of the explanatory variables. It was a monotonic curves linear response bounded between 0 and 1 [11] and defined by the logistic function. Changes (Y) were 0 or 1, where 0 meant no change and 1 meant there was a change. The logistic regression equation could be formulated by the form of equation 1 and equation 2 as follows:

$$p = E(Y)\frac{e^{\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4}}{1+e^{\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4}} \quad (1)$$

$$p' = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \quad (2)$$

Where:

p = the probability of paddy fields change,
E(Y) = the expected value of the dependent variable Y,
β_0 = a constant to be estimated,
β_i = the coefficient to be estimated for each variable (X_i)

As mentioned earlier, land use change analysis was done using LCM module in TerrSet sotware. LCM is one of many tools which concern for enviromental spatial analyst. Future land cover could be predicted based on actual and previous land cover, and the module also considered some driver variables. We conducted the study in the area by cross tabulating the derived land cover map of 2008 as the land cover early input image and the 2015 land cover map as the later input image. Potential transition modelling was used to group land use transitions into a set of sub-models and then utilized to explore the potential power of the chosen explanatory variables. In the current study, the change analysis showed that there were two sets of transitions, from irrigated paddy field to non-paddy field and from rain-fed paddy field to non-paddy. Meanwhile, some independent variables used in this research were: distance from road (X_1), distance from settlement (X_2), distance from river (X_3), distance from district capital (X_4), type of paddy field (X_5), productivity of paddy fields (X_6), price of paddy field (X_7), intensity of harvesting of paddy fields (X_8), population density (X_9) and land suitability of paddy fields (X_{10})

In order to predict change, the transition was empirically modelled using Multi-Layer Perception (MLP) neural network and Logistic Regression Model (LRM). LRM was used to model and analyze the land cover change in Idrisi TerrSet. The binary presence or absence was the dependent variable for the periods 2008–2015. The predicted land cover of 2015 was validated using ROC/AUC (Relative Operating Characteristic/ Area Under Curve) module of Idrisi TerrSet. The ROC module compared suitability image by depicting the likelihood of that class occurance (the input image) and a boolean image showing where that class actually existed (the reference image) [12, 13]. The ROC curve was the true vs false positive fraction and the AUC was a measurement of overall performance.

Logistic regression was a special form of regression that was formulated to predict and explain a binary category variable [14]. Meanwhile logistic regression model required that all variables be calibrated so as to align with the change of paddy fields [8, 9]. Thus, all variables needed to be normalized between 0.1 and 0.9. Based on the land use change from paddy fields to non-paddy fields, after validating the estimation model by comparing the value with the actual changes, then the trend of land use changes during a certain period could be predicted.

2.4 Multicriteria evaluation

Multicriteria evaluation was carried out using Idrisi TerrSet. The objective was to establish sustainable paddy field area to the whole region of Indramayu. Weighting in this analysis used the results of the logistic regression equation. Multi Criteria Evaluation (MCE) with a weighted spatial analysis approach was used to establish the sustainable paddy fields. MCE consisted of two things: goals setting and criteria setting. These criteria were divided into factors and constraints. Factors consisted of sub factors which were the criteria to achieve goal. Weighted Linear Combination (WLC) equation is shown in equation 3.

$$WLC = \left(\sum_{i=1}^{n} X_{ij} \times W_{ij}\right) \times C_j \qquad (3)$$

Where:
X_{ij} = the suitability degree of j-th factor in i-th location,
W_{ij} = the weight of j-th factors/sub factors in factor location,
C_j = the constraint on the j-th factors/sub factors.

The WLC method was based on the assumption that each factor was weighted differently. The process of determining the weight was done by using the result of logistic regression analysis, which obtained the value of the variables on the change of paddy field function in Indramayu. While for variables that were categorical, namely: types of paddy field, production of paddy, paddy field price, intensity of harvest, population density and land suitability, the value of regression analysis was not used and therefore replaced with a value of one. The values were then used as weighted values in multicriteria evaluation. Furthermore the weight values were normalized by dividing the value for each variable with the sum of variable values. Weighting results and normalization were presented in Table 2.

Table 2. Weighting of independent variables in establishment of sustainable paddy field zone.

Land suitability for paddy	LR Value	Weight	Normalized
Distance from road	-0.0032	0.32	0.0418
Distance from settlement	-0.0027	0.27	0.0353
Distance from the river	+0.0081	0.81	0.1059
Distance from district	0.0025	0.25	0.0327
Types of paddy field	+0.0026	1.00	0.1307
Production of paddy	0.0128	1.00	0.1307
Paddy Field Price	-0.0093	1.00	0.1307
Intensity of harvest	0.0032	1.00	0.1307
Population density	0.0071	1.00	0.1307
Land suitability	-0.0046	1.00	0.1307
		7.65	

Where LR = logistic regression

The results of multicriteria evaluation were then tested by Ordered Weighted Average analysis (OWA), which was characterised by two sets of weights: criterion importance weights and order weights. An interactive way of choosing, modifying, and fine-tuning the decision strategy defined by the order weights was proposed [15]. Meanwhile, OWA method was a technique used to rank the criteria and manage the uncertainty interactions [16]. OWA method would produce continuous scale scenario between slices (risk adverse) with the union (risk-taking). OWA method could provide many options between two extreme sides, such as only focusing on protecting the best paddy fields and protecting almost all existing paddy fields.

Establishment of paddy field conservation using OWA method had flexibility in accomodating other land use needs for regional development. The conservation could be limited to areas having high priority or expanded to medium priority. The priority of paddy field conservation was determined by combining characteristics of the paddy field function change and its internal potential [17]. In this research OWA was performed using MCE module in TessSet software, which could give an outlook on the risks of policy scenarios taken, whether it was standard, protective or permissive, and thus could adjust trade-off and compensation between criteria. Standard policy was the result of multicritera evaluation without OWA, which could be used directly with a standard protection level. Standard policy was basically a safeguard which was equal to threat magnitude. Protective scenario was to be chosen to protect almost all existing paddy fields, whereas permissive scenario would provide government flexibility to converse in order to encourage the region development [17].

Other advantages of OWA were its ability to integrate heterogeneous datasets, such as qualitative and quantitative criteria using expert knowledge, its flexibility to choose certain criteria for different study areas or different problems, its flexibility to alter criteria priorities, and its freedom to develop various scenario models on risk level [16]. Based on result of Analytic Hierarchy Process (AHP), evaluation criteria were obtained. Weighting results and normalization were as presented in Table 3.

Table 3. Ordered weight of OWA for three different scenarios.

Ordered Weight	Policy		
	Standard	Protective	Permissive
Weight 1	0.1000	0.2000	0.0015
Weight 2	0.1000	0.1500	0.0015
Weight 3	0.1000	0.1500	0.0900
Weight 3	0.1000	0.1250	0.0900
Weight 5	0.1000	0.1000	0.0900
Weight 6	0.1000	0.0900	0.1000
Weight 7	0.1000	0.0900	0.1250
Weight 8	0.1000	0.0900	0.1500
Weight 9	0.1000	0.0015	0.1500
Weight 10	0.1000	0.0015	0.2000

Parameters used to support sustainable development included (a) physical factor; (b) economic factor and (c) social factor. The factors of multicriteria evaluation design were as shown in Figure 3.

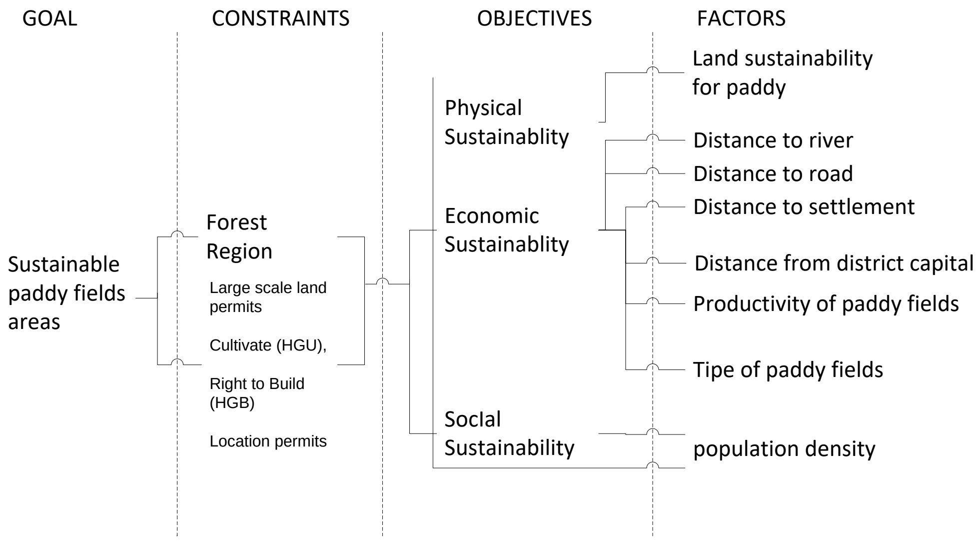


Figure 3. The design of multicriteria evaluation on sustainable paddy field establishment. [11]

In practice, logistic regression test was carried out on various combinations of independent variables in both quantity and type. The combinations of variables were implemented from 2 to 10 combinations of variables.

Results of OWA for all the three scenarios (standard, protective, and permissive) would result a value ranging from 0 to 255. The values would then be grouped into 5 classes with the same intervals. The highest value represented the paddy field that was prioritized to be protected the most due to its change function characteristics and internal potential (land suitability and productivity).

3. Results and Discussion

3.1 Determinants of Rice Function

After passing logistic regression test of various combinations on number and type of variables, then the best equation was obtained. The results in Table 4 showed that the best equation was the equation in the Set 2 combination column which was indicated by the highest pseudo R-square value of 0.1950, which was closest to the minimum standard value of 0.2.

Table 4. Results of logistic regression analysis with various variables.

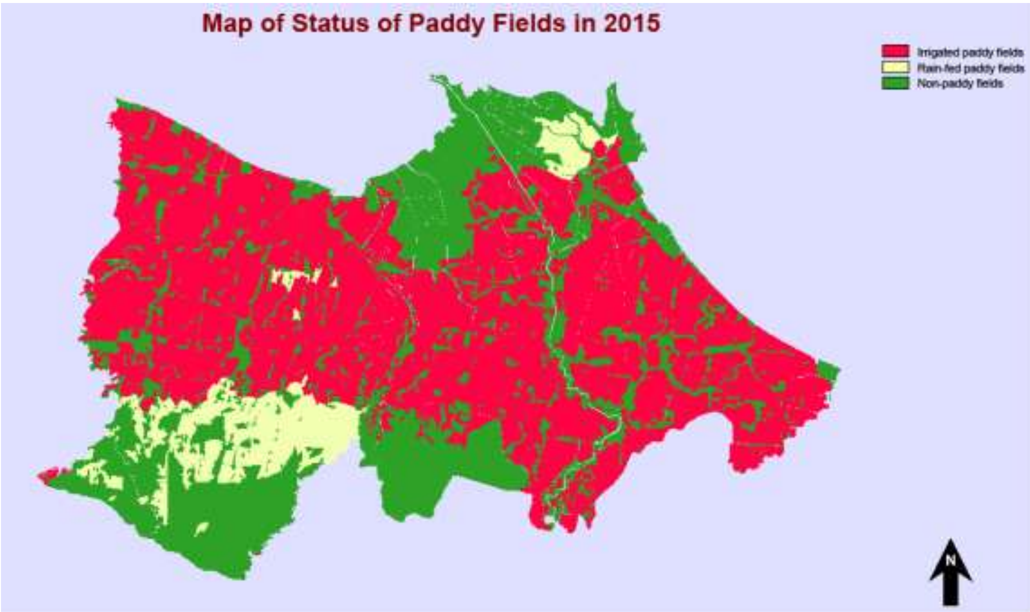
No	Variabel / parameter	Set 1	Set 2	Set 3	Set 4
	Intercept	-5.2958	-2.3048	-2.1582	-4.6195
X_1	Distance from road	0.000751	+0.0032	+0.0032	
X_2	Distance from settlement	0.000753	-0.0027	-0.0027	
X_3	Distance from the river	-0.000512	+0.0081	+0.0079	0.0054
X_4	Distance from district	-0.0000112	0.0025	0.0024	
X_5	Types of paddy field	-0.34423	+0.0026	+0.0028	0.0026
X_6	Production of paddy	1.0220	0.0128	0.0127	0.0115
X_7	Paddy Field Price	0.8301	-0.0093	-0.0096	-0.0104
X_8	Intensity of harvest	0.4525	0.0032	-0.0030	0.000167
X_9	Population density		0.0071	0.0076	
X_{10}	Land suitability		-0.0046	-0.0046	
	-2logL0	72,252.8935	72,158.1203	72,514.4209	72,535.7134
	-2log(likelihood)	62,055.2679	59,963.5606	60,223.0069	61,815.0977
	Goodness of fit	386,838.6960	406,342.7648	412,298.1619	367,547.6517
	Pseudo R^2	0.1411	0.1950	0.1690	0.1478

ROC	0.7990	0.8262	0.8158	0.8032

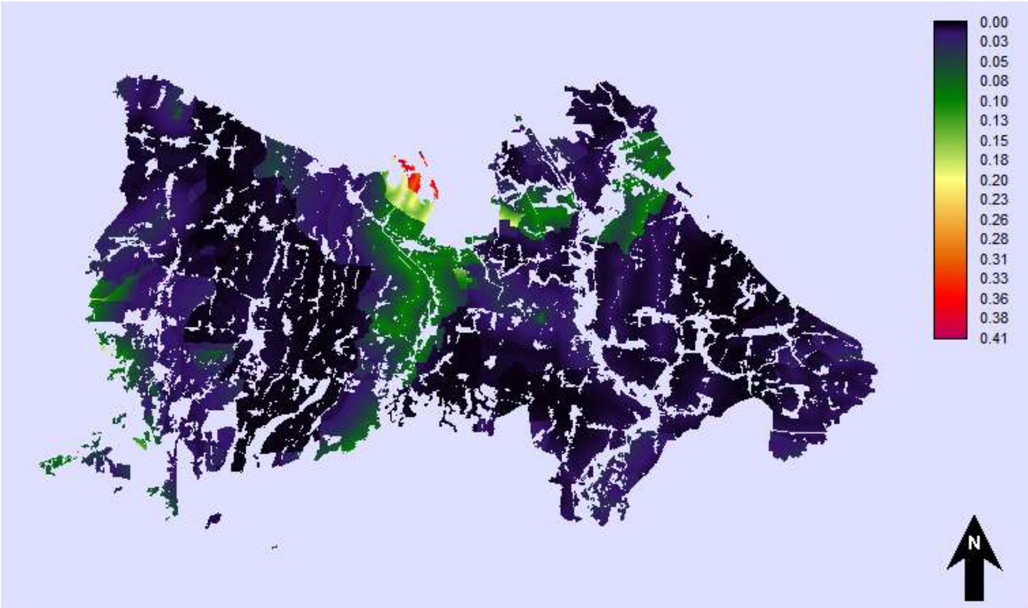
By using ROC method, the result of validation of prediction result was 0.8262. The ROC result gave the optimum predicted model value. The results of the 2015 paddy field prediction is presented in Figure 4a, where it was clear that the threat of wetland function was based on the largest logistic regression equation along the main roads in Indramayu. This region is a path of economic growth, tourism, industrial areas, and settlement growth. The column of Set 2 in Table 4 could be arranged in the form of the equation as follow:

$$\text{Logit (paddy field conversion)} = -2.3048 + 0.0032{*}X_1 - 0.0027{*}X_2 + 0.0081{*}X_3 + 0.0025{*}X_4 + 0.0026{*}X_5 + 0.0128{*}X_6 - 0.0093{*}X_7 + 0.0032{*}X_8 + 0.0071{*}X_9 - 0.0046{*}X_{10} \quad (4)$$

Equation 5 showed that variables to the conversion of land influenced both positively and negatively. The weakest variable in influencing the change of paddy field function was the paddy field price, while the most influential factor in the change of paddy field function was distance from river and from road. The large change of paddy fields adjacent to the main road showed that economic growth was still focused around the main road lane. This relationship was useful for selection of the explanatory variables for paddy fields change in the study area. Figure 4 showed projected land cover in 2015 and the potential of paddy field conversion. This was due to the relationship between dependent variables and the explanatory variables done in this research.



(a) Projected Land Cover 2015



(b) Potential for Paddy Field Conversion
Figure 4. Prediction of Paddy Field in 2015.

Table 5. The paddy fields conversion data from 1998 to 2015.

No	Classes	Year			Changes	
		1998	2008	2015	1998-2008	2008-2015
1	Irrigated paddy fields	122,054.04	119,448.44	118,913.84	-2,605.60	-534.60
2	Rain-fed paddy fields	15,495.52	15,313.08	15,352.20	-182.44	39.12
3	Non-paddy fields	68,708.52	71,496.56	71,992.04	2,788.04	495.48
	Total irrigated and rain-fed rice fields conversion				-2,788.040	-495.48

From Table 5 above, irrigated paddy fields continued to decline within 1998-2015, whereas about 3,140 Ha had been converted to other uses. In periode 1998-2008, about 2.605.60 ha (260 ha per year) and periode 2008-2015 about 534.60 ha (76 ha per year) had been converted to other uses. Meanwhile, rain-fed paddy fields were not significantly decreased, which was only about 143 Ha (8 ha per year). The case of paddy field conversion was also discovered by Asmarani that showed that rice production in Indramayu district from year 2011-2015 tended to decrease with an average of 4.16% per year, probably caused by paddy field conversion [18].

The majority of paddy fields in Indramayu district were technically irrigated ones. These paddy fields were generally located in the lowlands area, in which the industrial development, settlement, and other facilities/infrastructure were more easily developed. The strategic geographical location and accessibility to the business areas such as Bandung, Bogor, and Bekasi, could be other reasons for conversion. Agricultural land usually had a lower rent price compared to residential and industrial land [19]. The calculation from Kamilah (2016) research indicated that the ratio of land rent for agricultural land to residential was 13.89 and 329.26 to industrials. No wonder, majority of land conversion in Indramayu occurred because of settlements and industrial developments.

Meanwhile other research, Changes in land use in Indramayu Regency mostly occur in paddy fields that turn into settlements. This change occurred mainly in the sub-districts of Indramayu, Patrol, Sukra, Losarang, and territories crossed by the main route of Java's northern coast. The rate of land use change between the period of 1994 - 2008 was 101.5 ha / year, whereas 2008-2015 was only 14 ha / year. Conversion of agricultural land to nonagriculture if it continues can be one of the causes of the food crisis. Conversion of this land will remove the function of rice fields as land intended to produce rice [20]

3.2 Establishment of Sustainable Paddy fields

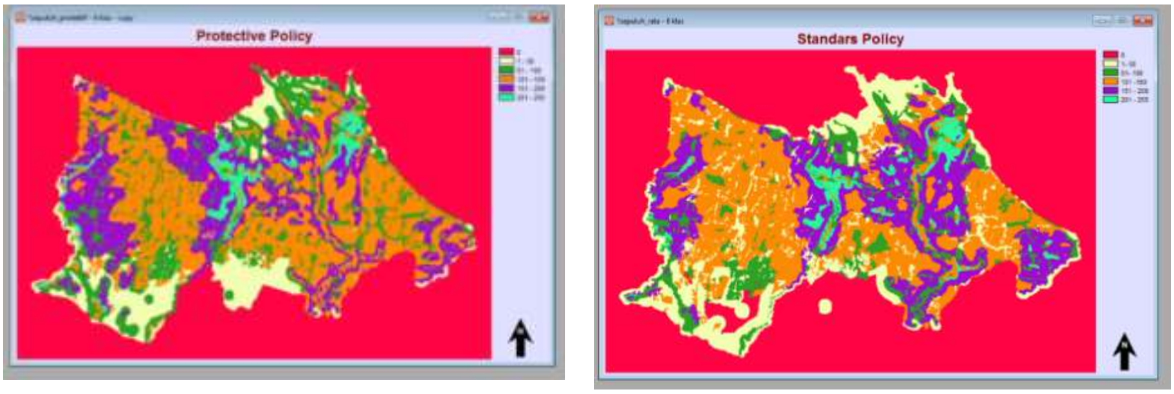
Three policy scenarios could be arranged from sustainable paddy field protection model, namely: standard policy, protective policy and permissive policy. Standard policy was the result of multicriteria evaluation without OWA, which could be used directly with a standard protection level. Standard policy basically is a safeguard which is equal to threat magnitude. Protective scenario was chosen to protect almost all existing paddy fields, whereas permissive scenario provided government flexibility to convert in order to encourage regional development [17].

Paddy field protection priority was obtained using sustainable paddy field protection model that was demonstrated earlier. The paddy fields were mostly located on land suitability class S1, which had the most suitable land physical characteristics. The values of the results from the standard, protective and permissive scenarios were classified with range of 0-255 to 5 paddy field protection classes. The classification result and its calculation of each class can be seen in Figure 5 and Table 6. By using the three scenarios, the model had high flexibility to accommodate other land use interests of development. Paddy field protection was limited to areas with high to medium protection weight. Likewise, the regional development, should aim the paddy fields with low protection weight.

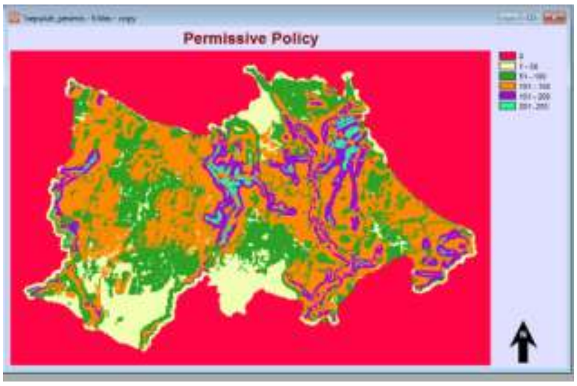
Based on the results of classification and calculation in Table 2 shown the results there were 5 categories. Category 1 meant the land area was more important to be protected than 2 to 5, and on the contrary category 5 meant that the land would change more quickly. Thus, the most priority land area to be protected for protective policy was 4.28%, for standard policy was 4.35% and for permissive policy was 2.12% as shown in Table 6.

Table 6. The area of each protection class in three different scenarios.

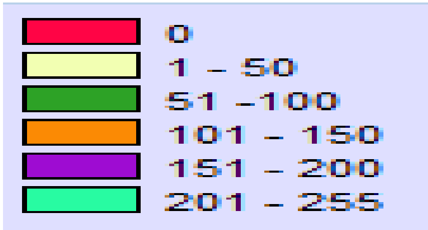
Category	Protective		Standart		Permissive	
	Hectare	percent	Hectare	percent	Hectare	percent
1 (200 – 255)	9,017.28	4.28	8,927.80	4.35	4,575.24	2.12
2 (151 – 200)	50,308.84	23.85	48,498.92	23.62	24,717.28	11.47
3 (101 – 150)	82,662.64	39.19	76,774.64	37.40	89,754.96	41.64
4 (51 – 100)	41,919.96	19.88	29,059.88	14.16	60,921.44	28.27
5 (0 – 50)	26,994.64	12.80	42,027.84	20.47	35,560.08	16.50
Total	210,903.36	100.00	205,289.08	100.00	215,529.00	100.00



(a) Protective Policy (b) Standard Policy



Legend



(c) Permissive Policy

Figure 5. Different policy scenarios to preserve paddy fields.

In order to accelerate the food self-sufficiency as targeted by the Ministry of Agriculture to produce 1.718 million tons of dry grain harvest within 2016-2021, optimization of special commodities such as paddy, soybean and corn should be performed. As a sample application of Table 6 above, suppose Indramayu was required to provide only 100,000 to 120,000 ha paddy fields with best to medium suitability (category 1 to 3), then permissive policy could be applied, because the sum of the areas in those category would be 119,047 ha and it would be sufficient. However, should Indramayu be required to provide 140,000 to 150,000 ha, then protective policy should be applied (sum of the areas would be 141,989 ha).

4. Conclusion

This research presented a sustainable paddy field setting model developed using logistic regression and multicriteria evaluation with respect to the characteristics of local paddy field transfers and the concept of sustainable development. Logistic regression was able to reveal the key variables in the transfer of wetland functions in a region quickly. Variable determinants of the transfer of paddy fields in Indramayu included distance from roads, settlements, and industries.

This model was built upon the occurrence of paddy field between 1998 and 2015. Equation of the paddy field changes models obtained were: logit (paddy field conversion) = $-2.3048 + 0.0032*X_1 - 0.0027*X_2 + 0.0081*X_3 + 0.0025*X_4 + 0.0026*X_5 + 0.0128*X_6 - 0.0093*X_7 + 0.0032*X_8 + 0.0071*X_9 - 0.0046*X_{10}$ with a value of Relative Operating Characteristics (ROC) of 0.8262.

Through multicriteria evaluation priority fields that must be protected and also a buffer for the fields behind it could be obtained. Sustainable paddy field protection policy could then be applied through three policy scenarios, namely standard, protective, and permissive. This would make it easier for the government to provide subsidies appropriately and efficiently while still opening investment opportunities for regional development.

The model built in this study involved spatial and temporal data that could be applied for other regions. With more complete and accurate data support, the results could be more optimal. The model was composed by clear stages so it is possible to be tested on other areas with different characteristics.

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