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Effect Analysis of Irrigation Infrastructure on Submission of Land Use Change (Case Study In West Lombok District)

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Abstract: Development has resulted in land use change, especially agricultural land which is economically profitable and has been converted into land for housing, roads and other infrastructure. Several assessment criteria conducted by the Agency of Regional Spatial Planning Coordinating (BKPRD) in filing land use allocation permits require weighting so that the feasibility land use change of agricultural land can be measured and technically accountable.

The purpose of this study is to give a score and weighting index value on several criteria and sub-criteria for BKPRD assessment in submitting land use change, especially from the Technical Side of Irrigation and to build a decision support system for land use change of irrigation land in West Lombok Regency.

Analytical Hierarchy Procces (AHP) (Saaty, 2000) is a decision-making approach designed to help find solutions to complex multicriteria problems in a number of application domains. This method has been found as a practical and effective approach that can consider decisions that are not structured and complicated (Partovi, 1994). AHP final result is a ranking or priority weighting of each alternative decision or called element. The results of the analysis using AHP indicate the weighting priority criteria in making decisions on land use change of irrigated land in terms of irrigation and agriculture. Based on the irrigation sector, obtained that a weight of 33.70% for irrigation water sources, 25.80% for technical irrigation management, 21.00% for irrigation management authority and 19.50% for irrigation channel types. While a review of the agricultural sector found a weight of 41.20% for land area, 39.70% for cropping patterns and 19.10% for farmer institutions.

Keywords: land use change, irrigation, priority criteria, AHP

1. Introduction

Development is running very fast, as well as West Lombok Regency, especially in the infrastructure sector, has reduced agricultural land and resulted in land use change. especially agricultural land that is economically profitable has changed its function into land for housing, roads and other infrastructure.

Based on data from BAPPEDA of West Lombok Regency, the area of agricultural land in West Lombok Regency until the end of 2017 was 17,326.22 Ha consisting of 10,861.27 hectares of irrigated rice fields, 2,261.94 hectares of non-technical irrigated rice fields and 4,203.01 Ha rainfed rice fields, because of the land use change of agricultural land, it is estimated that the agricultural area will be reduced by 25 ha / year, even though the availability of agricultural land is absolutely necessary in an effort to maintain the national food security program.

Several assessment criteria conducted by the Agency of Regional Spatial Planning Coordinating (BKPRD) in filing land use allocation permits require weighting so that the feasibility of land use change on agricultural land functions can be measured and can be technically accounted. Some of the criteria are (a) irrigation section which includes technical management of irrigation water, irrigation water sources, types of irrigation channels, management authority (b) agricultural sector which consists of land area, farm institution and cropping pattern. Based on the description above, Analytical Hierarchy Procces (AHP) are used in determining the feasibility of an irrigation and agricultural land use change in West Lombok Regency.

By utilizing the AHP, it is expected to be able to give a score and weighting index value on several criteria and sub-criteria for BKPRD assessment in the submission of land use functions, especially from the Technical Section of Irrigation and to build a decision support system of land use chnage in irrigated land in West Lombok Regency. In this study the weighting was only carried out on the criteria of irrigation fields which included technical management of irrigation networks, irrigation water sources, types of irrigation channels and the authority of irrigation management. The assessment criteria used were based on the assessment criteria used by BKPRD West Lombok Regency.

2. Methodology

Analytical Hierarchy Procces (AHP) (Saaty, 2000) is a decision-making approach designed to help find solutions to complex multicriteria problems in a number of application domains. This method has been found as a practical and effective approach that can consider decisions that are not structured and complicated (Partovi, 1994). AHP final result is a ranking or priority weighting of each alternative decision orcalled element. Basically, there are three steps in decision making with AHP, namely: building hierarchy, valuation; and priority synthesis.

Calculation of element weights in the AHP method uses pairwise comparison matrices, Pairwise comparisons are carried out from the highest hierarchy, where the criteria are used as the basis for making comparisons. The basic mathematical formulation in the AHP model is carried out with the matrix shown in Figure 1.

	A_1	A_2	...	A_n
A_1	a_{11}	a_{12}	...	a_{1n}
A_2	a_{21}	a_{22}	...	a_{2n}
...	...	...	...	...
A_n	a_{n1}	a_{n2}	...	a_{nn}

Figure 1. Comparative matrix between elements in pairs

Source: Permadi (1992) in Rostianti (2003)

The A_{nn} matrix is a reciprocal matrix and it is assumed that there are n elements, namely W_1, W_2, ..., W_n which will be assessed by pairwise comparisons.

$$\frac{W_i}{W_j} = a_{(i,j)}; i, j = 1, 2, \dots\dots, n \quad \text{...} \quad (1)$$

In this case the comparison matrix is a matrix with the elements a_{ij} with ij = 1, 2, ..., n. The matrix elements are obtained by comparing one operating element against another operating element for the same hierarchy level. For example element a_{11} is a comparison of the importance of operation A_1 with the A_1 operation itself so that by itself the element value of a_{11} is equal to 1.

Steps to get the criteria weights as follows:

a. Multiply elements in a row and root the rank n as in the equation below:

$$W_i = \sqrt[n]{a_{11}\ x\ a_{12}\ x\ \dots .a_{1n}} \quad \text{................................} \quad (2)$$

b. Calculate priority vector or eigenvector (eigenvector)

$$X_i = \frac{W_i}{\sum W_i} \quad \text{..} \quad (3)$$

The results obtained are Eigenvectors as element weights

c. Calculates the maximum Eigen value (λmaks), by multiplying the reciprocal matrix with the weight obtained, the result of the sum of the matrix operations is the maximum eigenvalue (λmaks). Eigenvectors and maximum Eigenvalues are calculated for each matrix at each level of the hierarchy.

$$\gamma_{maks} = \sum a_{ij}\ x\ X_i \quad \text{..} \quad (4)$$

with,

λ_{maks} = maximum eigenvalue

a_{ij} = value of paired comparison matrix

Xi = vector Eigen (weight)

d. Furthermore, the consistency index is calculated, this calculation is intended to determine the consistency of the answers that will affect the validity of the results. Consistency index for each matrix at each level of the hierarchy using the equation:

$$CI = (\lambda_{maks} - n) / (n - 1) \quad \text{..} \quad (5)$$

with,

CI = *Consistency Index*

λ_{max} = maximum value of eigenvalue

n = matrix variable

e. Calculated the Consistency Ratio

Consistency Ratio valeu (CR) calculated by equation:

$$CR = CI/RI \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. \quad (6)$$

with,

CR = *Consistency Ratio*
CI = *Consistency Index*
RI = *Random Consistency Index*

Classification of Irrigation Networks Based on the method of measuring and regulating irrigation water is divided into three levels, namely: simple irrigation networks, semi-technical irrigation networks and technical irrigation networks.

Classification of irrigation networks based on water sources are of two types, namely surface water irrigation networks, irrigation networks whose water comes from water flowing on the surface of the ground and groundwater irrigation networks, irrigation networks whose water sources are below ground level or pumped. In West Lombok Regency, because there is no groundwater irrigation network, the parameters used are surface water irrigation networks only.

Surface water irrigation network when viewed from the source of water, there are 3 water sources available, namely irrigation sources from irrigation networks owned by the district, provincial or central government, water sources from village managed irrigation networks (village irrigation) and rainfed irrigation. In an irrigation network there are irrigation channels, there are various types of irrigation channels including primary channels, secondary channels, tertiary channels, quarter channels and drainage channels.

Data collection techniques in this study used 2 methods, first by collecting primary and secondary data directly related to the purpose of the research to be achieved. Primary data is processed by tabulation and coding of data to be more effective for further analysis. Then tabulation result matrix simulated with the AHP Expert Choice Decision Analyst application tool.

Processing data in this study uses the AHP calc 2017 version to determine the weight of each criterion.

The method used in this study is to use quantitative methods. Quantitative methods are carried out using survey methods based on questionnaires filled out by respondents as well as competent and experienced parties (experts). Quantitative methods are used to carry out hierarchical ranking and calculate the weighting of each criterion.

The sampling technique of this study used purposive sampling. Sugiyono (2008) argues that purposive sampling is sampling based on certain considerations. In order to carry out a weighting and scoring analysis based on the priorities of various assessment criteria in filing land use allocation permits, the opinion of policy makers and users as a basis for analysis to produce an effective and efficient policy is very necessary.

Data indicator weights obtained from AHP are used in making a decision support system for irrigating land use in West Lombok Regency by using the Microsoft Excel application, so that it can assist Local Governments in determining permits for conversion of agricultural land. Primary data to be used in this study are questionnaire data or interviews with competent stakeholders in handling the agricultural sector and irrigation system in West Lombok Regency and with the private sector, Distribution of questionnaires with direct interviews with respondents who have assignments and experiences in the fields of Agriculture and Irrigation and the private sector as many as 20 respondents.

Secondary data used include data on the area of irrigated agricultural land, data on irrigation infrastructure conditions, West Lombok Regency Spatial Planning (RTRW) Map, Government Regulation Number 11 of 2011 concerning Determination and Transfer of Sustainable Food Agriculture Land Functions, Permen PU 14 / PRT / M / 2015 concerning Criteria and Determination of Irrigation Area Status, Standard Operating Procedure of BKPRD Team in West Lombok Regency.

The AHP modeling structure in this study is presented in the form of a hierarchical structure as shown in Table 1 and Table 2 below.

Table 1. Criteria modeling and AHP sub-criteria for irrigation fields

No.	Criteria	Weight	Sub-Criteria					
			1		2		3	
			Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)
1	Technical Irrigation Management		Technic		Semi-technic		Simple	
2	Source of Irrigation Water		Technical irrigation		Village irrigation		Rainfed fields	
3	Types of Irrigation Channels		Primary/secondary channel		Tertiary/quartiery channel		Banishment channel	
4	Authority for Irrigation Management		Government		Province		Regency	

Tabel 2.Criteria modeling and AHP sub-criteria for agricultural fields

No.	Criteria	Weight	Sub-Criteria					
			1		2		3	
			Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)
1	Land area		Area< 1 Ha		Area 1 – 5 Ha		Area> 5 Ha	
2	Farming Institution		Exist, Integrated and registered		Exist, Integrated and not registered		Not registered	
3	Crop Pattern		Rice-rice-rice		Rice-rice-secondary crop		Another crop pattern	

Inter-Criteria Assessment

As explained earlier, the research criteria that will be used as material for consideration in determining the weight assessment of the feasibility of land use permits are irrigation which includes: technical management of irrigation, irrigation water sources, types of irrigation channels, management authority, while agriculture includes: production of land area, institutional farming and cropping pattern ...

Each of these criteria will be compared the level of significance with each other then made in the order matrix as an assessment material. Because it consists of 2 fields, where in the irrigation field there are 4 criteria, while the agricultural field has 3 criteria, the order matrix used is a matrix of orders 4 x 4 and 3 x 3

3. Results and Discussion

With the help of AHP K. D. Goepel Vesion 11.10.2017, the following is shown the results of the answers of all respondents to each matrix-shaped criteria as shown in Table 3,

Table 3. Pairwise Comparison Results Matrix between Irrigation Field Criteria

Matrix	Technical Irrigation Management	Source of Irrigation Water	Types of Irrigation Channels	Authority for Irrigation Management
Technical Irrigation Management	1.00	0.50	2.18	1.14
Source of Irrigation Water	1.99	1.00	1.67	1.08
Types of Irrigation Channels	0.46	0.60	1.00	1.48
Authority for Irrigation Management	0.88	0.92	0.67	1.00

By using equations 2,3,4,5 and 6, the value is obtained,
W_i Total = 4.093
λmax = 4.201
CI = 0.067
CR = 0.075

The provisions of the above comparison matrix can be accepted if the CR value <0.08 from the above calculation shows the value of the ratio ratio (CR) of 0.075 0.075 <0.08, so it can be concluded that the results of the above assessment can be accepted or consistent.
The same method is used to determine the consistency of the ratio in the comparison matrix for the technical criteria for irrigation management, irrigation water sources, irrigation canal types and irrigation management authority.

Results of the Assessment

Based on the calculation of the pairwise comparison matrix between criteria and between sub-criteria, we obtain the weights for each component of the assessment for all criteria and sub-criteria in the irrigation sector as presented in Table 4 below:

Table 4. Summary of Results of Comparative Assessment Analysis between criteria and Sub-criteria in the Irrigation Sector

No.	Criteria	Weight	Sub-Criteria					
			1		2		3	
			Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)
1	Technical Irrigation Management	25.80	Technic	59.60	Semi-technic	25.20	Simple	15.20
2	Source of Irrigation Water	33.70	Technical irrigation	58.00	Village irrigation	22.40	Rainfed fields	19.60
3	Types of Irrigation Channels	19.50	Primary/secondary channel	41.20	Tertiary/quartiery channel	33.90	Banishment channel	24.90

4	Authority for Irrigation Management	21.00	Government	36.40	Province	32.30	Regency	31.30

From the results of the Assessment Analysis Comparison between the criteria in the Irrigation Field, the most influential criteria were the Irrigation Water Source Criteria with a weight of 33.70%, then the Irrigation Management Technical criteria of 25.80%, then the irrigation management authority criteria were 21.00% and finally the criteria for irrigation channel types are 19.50%. This was obtained because respondents argued that to increase agricultural productivity and ease in managing agricultural land, the most important were irrigation water source factors, then technical factors for irrigation management, authority factor irrigation management and the last factor was the type of irrigation channel.

In the Criteria for Irrigation Water Resources, the most important sub-criteria with the highest weight values were PU Irrigation sub-criteria weighing 57.90%, then village irrigation sub-criteria weighing 22.50%, and finally the rainfed rice sub-criteria with 19.60% weight. This was obtained because the respondents argued that agricultural production was very dependent on the availability of available water, while the land that had good water availability was the PU irrigation area, followed by the village irrigation area and finally the rainfed rice field.

In the Irrigation Management Technical Criteria, the most important sub-criteria with the highest weight values were the Technical Irrigation sub-criteria weighing 59.60%, then Semi-technical irrigation sub-criteria weighing 25.30%, and finally the simple irrigation sub-criteria with weighs 15.10%. This was obtained because the respondents stated that the location of the land that had strategic value and influence on agricultural production was land that was passed by the Technical irrigation network, then the land passed by semi-technical irrigation networks and finally the land passed by simple irrigation networks.

In the sub criteria for irrigation management authority, the most important sub-criteria assessment with the highest weighting value was the Central Management Authority sub-criteria weighing 36.40%, then the Provincial Management Authority Sub-criteria weighing 32.30% and finally the sub-criteria of District / City authority with weight 31 , 30%. This was obtained because the respondents argued that the better the area of agricultural land that is not converted, therefore certainly the wider land in the irrigation area of the management authority of the Center is better than the land in the provincial irrigation area, and the wider land those in the irrigation area of the provincial authority are better than the land in the irrigation area of the Regency / City authority.

In the sub criteria for the type of irrigation channel, the most important sub-criteria with the highest weight value were the Primary Channels sub-criteria with a weight of 41.10%, then the tertiary / Quaternary sub-criteria weighing 34.00%, and finally the sub-criteria for the drainage channel with 24.90 %. This is obtained because respondents argue that the most important and decisive in the use of irrigation networks and management of agricultural land in an effort to increase agricultural production are primary and secondary channels on irrigation networks, then followed by tertiary channels and new quarters then the drainage channels.

Table 5. Summary of Results of Comparative Assessment Analysis between criteria and Sub-criteria in the Agriculture Sector

No.	Criteria	Weight	Sub-Criteria					
			1		2		3	
			Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)	Sub-Criteria	Weight (%)
1	Land area	41.20	Area< 1 Ha	9.00	Area 1 – 5 Ha	20.10	Area> 5 Ha	70.90
2	Farming Institution	19.10	Exist, Integrated and registered	53.90	Exist, Integrated and not registered	31.90	Not registered	14.20
3	Crop Pattern	39.70	Rice-rice-rice	27.20	Rice-rice-secondary crop	52.50	Another crop pattern	20.30

In the Criteria for Agriculture, the most important criteria with the highest value of weighting are the criteria for land area of 41.20%, then the criteria for cropping patterns are 39.70%, and finally the criteria for farmer institutions are 19.10%. This was obtained because the respondents considered that in order to prevent land conversion from occurring, the land area was the main factor, because the more extensive agricultural land in an area to be maintained, the wider the area of agricultural land that was not converted. from the criteria of farmer institutions, because cropping patterns have more influence on the level of agricultural production and the welfare of the community than existing farmer institutions.

In the criteria for land area, the most important sub-criteria for assessment with the highest weight value are sub-criteria. Land area above 50 ha weighs 70.90%. Then sub-criteria Land area 1-5 ha with a weight of 20.10% and finally sub-criteria. 1 Ha with a weight of 9.00%. This was obtained because the respondents considered that the wider the area of agricultural land available, the better the land should be converted.

In the Cropping Pattern Criteria, the most important sub-criteria with the highest weight values were sub-criteria for Rice-Cropping Crops Patterns with a weight of 52.50%, then sub-criteria for Rice-Rice Cropping Patterns with a weight of 27.20% and finally sub-criteria Other Cropping Patterns weighing 20.30%. This was obtained because respondents rated the best cropping pattern in increasing food productivity in an effort to support the government's food security program, namely paddy-rice cropping patterns, then rice-paddy-rice cropping patterns and last is another cropping pattern.

In the Institutional Criteria of Farmers, the most important sub-criteria assessment with the highest weighting value is the sub-criteria There are institutions, integrated and registered with a weight of 53.90%. Then the sub criteria There are institutions, integrated and not registered with a weight of 31.90% Unregistered Farmers weighs 14.20%. This was obtained because according to respondents with the existence of integrated and registered agricultural institutions, agricultural production increased because the methods and patterns of management of agricultural land were more advanced than without the existence of institutional farming.

Land Use Change Permit Support System

From the results of the calculation of the weight of each criterion and subcriteria in the field of irrigation and agriculture which has been described previously, a decision support system for land use can be built using Microsoft Excel applications, in each system the fields of irrigation and agriculture will have the weight of the calculation of the feasibility value of the land function, which is obtained from the accumulation of multiplication between each criterion weight and subcriteria in each field, as shown as follows:

Value of Feasibility Calculation of Land Use Change in Irrigation and Agriculture

Value of Irrigation Field Feasibility (NKBI)

NKBI = (Weight of Technical Criteria for Irrigation Water Management x Weight of Irrigation Water Management Technical Sub-Criteria) + (Weight of Irrigation Water Source Criteria x Weight of Irrigation Water Source Subcriteria) + (Weight of Criteria Types of Irrigation Channels x Weight of Types of Irrigation Channel) + (Weight of Authority Criteria Irrigation Management x Weight of Sub-criteria for Irrigation Management Authority)

Value of Feasibility in Agriculture (NKBP)

NKBP = (Weight of Technical Criteria for Land Area x Weight of Technical Land Area Sub-Criteria) + (Weight of Farmer Institutional Criteria x Weight of Farmer Institution Sub-Criteria) + (Weight Criteria Planting Pattern x Sub-criteria Weight Planting Pattern)

In a land use change decision support system, the requesting can find out quickly, precisely, transparently and objectively to the proposed land whether or not permits for land conversion will be granted, only by choosing the type of subcriteria that is in accordance with the conditions of the land proposed. The following is the appearance of the decision support system function land conversion application as shown in figure 2.

In this decision support system for land conversion, permits for conversion of agricultural land will be given if the proposed land passes in two assessments, namely technical assessment of the irrigation field and technical assessment of agriculture, with a threshold or passing grade given is the median or middle value of the maximum and minimum values of the Technical Assessment of each field. The Irrigation and Agriculture Field Technical Assessment will be said to pass if it has a value below the passing grade.

ASSESSMENT SYSTEM FOR LAND USE CHANGE OF AGRICULTURAL LAND WEST LOMBOK REGENCY

Name of applicant	:	_____
address of the applicant	:	_____
Area location	:	_____
Backwoods	:	_____
village	:	_____
sub-district	:	_____
Land area (Ha)	:	_____
Date of submission	:	_____
Applicant signature	:	_____

No.	Assestment Section	Criteria	Weight (%)	Sub-criteria	Weight (%)	Value
1	**IRRIGATION**	Technical Irrigation Management	26	Technic	59,6	15,38
		Source of Irrigation Water	34	Technical irrigation	58	19,55
		Types of Irrigation Channels	20	Primary/secondary channel	41,2	8,03
		Authority for Irrigation Management	21	Government	36,4	7,64
TOTAL VALUE						50,6
PASSING GRADE						36
NOT PASS BY IRRIGATION SECTION ASSESSMENT						
2	**AGRICULTURAL**	Land area	41	Area > 5 Ha	70,9	29,21
		Farming Institution	19	Exist, Integrated and registered	53,6	10,29
		Crop Pattern	40	Rice-rice-secondary crop	52,5	10,8
TOTAL VALUE						50,3
PASSING GRADE						36
NOT PASS BY AGRICULTURAL SECTION ASSESSMENT						
To the permit for requesting land use change, then the submission:						
NOT ALLOWED						

Figure 2. Decision Support System for land use change of Agricultural Land

4. Conclusion and Suggestion

Conclusion

Based on the results of the analysis, the conclusions obtained from this study are as follows:

1. In the irrigation field the weighting and scoring index of each criterion and sub-criteria in the Assessment of Submission of Function of Agricultural Land are as follows:

a. Criteria for irrigation water sources 33.70%
- PU Irrigation Criteria Sub : 58.00%
- Village Irrigation Criteria Sub : 25.40%
- Rainfed Irrigation Criteria Sub : 19.60%

b. Irrigation Management Technical Criteria 25.80%
- Sub Criteria for Technical Irrigation : 59.60%
- Sub k Semi-Technical criteria : 25.20%
- Sub Criteria for Simple Irrigation : 15.20%

c. Irrigation Management Authority Criteria 21.00%
- Sub Criteria for Central Authority : 36.40%
- Sub Province Authority Criteria : 32.30%
- Sub District / City Authority Criteria : 31.30%

d. Criteria for type of irrigation channel 19.50%
- Primary / Secondary Channels Criteria : 41.20%
- Tertiary / Quarter Channels Criteria : 33.90%
- Waster Channel Criteria : 24.90%

As for Agriculture, the weighting and scoring index of each criterion and sub-criteria in the Assessment of Submission of Function of Agricultural Land are as follows:

a. Criteria for land area 41.20%
- Land Sub Criteria> 5 Ha : 70.90%
- Land Sub Criteria 1-5 Ha : 20.10%
- Land Sub Criteria <1 Ha : 9.00%

b. Cropping Pattern Criteria 39.70%
- Sub-criteria for rice crops : 52.50%
- Rice-paddy-rice sub-criteria : 27.20%
- Sub Criteria for other planting patterns : 20.30%

c. Farmer Institutional Criteria 39.70%
- Sub Criteria exist, integrated and registered : 53.90%
- Sub Criteria Existing, integrated and not yet registered : 31.90%
- Criteria Sub Unregistered : 14.20%

2. The establishment of a support system for evaluating the submission of functions of agricultural land by using Microsoft Excel Software, using index data data and weighting the results of research. The system will assess objectively, transparently, quickly and accurately about the feasibility of the permit application submitted.

Suggestion

1. To control land use change of agricultural land to existing development permits, the West Lombok District Government can use the results of the weight of the calculation of this study, so that it is expected that there will be no violation of the use of spatial planning.
2. To create a management system for permitting clean, transparent and objective land use change, then the weight for calculating the land use function evaluation criteria is included in the Standard Operating Procedure (SOP) for submitting land use functions at the Agency of Regional Spatial Planning Coordinating (BKPRD)
3. Criteria and Sub-Criteria for Transfer Evaluation Support Systems Function of land should be reviewed every 10 years to harmonize with the Development and Development of West Lombok Regency.
4. The Passing Grade value is determined by the Regional Head in accordance with the West Lombok Regency Development Policy.

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