

# Prediction Analysis of Rice Field Conversion in Badung Regency Using Big Data Method

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## ABSTRACT

Badung Regency is situated in Bali Province and encompasses an area of 418.52 km<sup>2</sup>. With the development of time and the dynamics of development and population growth, the existence of land has begun to be disturbed. One of the problems closely related to the existence of rice plants is the increasing conversion of agricultural land. This study aims to determine the extent of rice field conversion using Big Data. The data used in this study includes rice field area (ha), population (people), per capita GDP (IDR), and the share of agriculture in GDP (%) from 2018 to 2024, sourced from BPS and the Agriculture and Food Security Department of Bali Province. The results of the study indicate that the forecasting method using the Backpropagation algorithm can be used to provide an approach for the years 2025 and 2026. The Backpropagation design uses MAPE of 0.00012, categorized as good forecasting. Therefore, it is recommended to conduct further research focused on each regency, as each regency has distinct characteristics in food data collection methods, particularly for rice. Future research should develop this forecasting method by incorporating machine learning techniques to achieve more accurate forecasting results

**Keywords:** Forecasting, Land use change, Rice fields, Badung, Artificial neural networks

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## 1. INTRODUCTION

One of the regencies in Bali Province is Badung Regency. This regency extends from Bali Island's center to its southernmost point. With the passage of time and the dynamics of development and population growth, the existence of land has begun to be disrupted. The growing conversion of agricultural land is one of the problems that are directly linked to the existence of rice crops. Land conversion, defined as the alteration of land's intended use (Patel & Goyena, 2013) is driven by considerations that generally encompass the necessity to accommodate the increasing demands of the population. Land conversion refers to

the transformation of undeveloped land into developed land to satisfy the demands of the population in a certain region. Land conversion, also known as land use change, entails the modification of a land area's function from its original designated use to an alternative use that adversely affects the environment and the land's potential. Land use change, defined as an alteration in land utilization, is driven by factors that encompass the necessity to accommodate a burgeoning population and escalating aspirations for enhanced quality of life. The phenomenon of land use change, particularly with productive property that continues to yield income or output, albeit

at a diminished level relative to its state post-conversion from an economic standpoint. If a location undergoes agricultural land conversion, the land surrounding it will also be converted, and this tendency is progressive.

In line with changes in the economic structure, which is a characteristic of the development of a country or region, the need for land for non-agricultural activities is increasing from year to year. This trend makes land conversion difficult to avoid; in other words, land conversion occurs every year. The area of land converted each year will continue to increase because agricultural land conversion is generally contagious. In other words, once land conversion occurs in a location, the area of land to be converted in that location will increase due to secondary land conversion in the surrounding areas. In addition, human labor (farmers) is rarely available to cultivate the land professionally because the land is relatively small (smallholder farmers), so that the costs incurred are higher than the income they earn from agriculture, and many young people no longer work in the agricultural sector.

Alterations in land utilization during the execution of development are unavoidable. These changes arise from two factors: firstly, the necessity to accommodate a burgeoning population, and secondly, the escalating desire for an enhanced quality of life. Furthermore, the alteration in community welfare has resulted in the establishment of new residences/settlements, necessitating land for development. Economic growth, fluctuations in income, and consumption patterns are variables influencing alterations in land usage.

The growing need for residential space, transportation, and recreational facilities

will prompt alterations in land utilization. According to Siswanto (2006), there are three ways in which technology influences land use patterns. First, technological changes have brought about changes in agriculture through increased agricultural land productivity and labor productivity. Second, changes in transportation technology have increased labor efficiency, providing opportunities for increased urbanization in urban areas. Third, transportation technology can improve accessibility to an area. Experts argue that changes in land use are primarily driven by human needs and desires.

## 2. METHODS

### 2.1 *Research design*

This research is a descriptive study employing a quantitative methodology (Apriyaty, 2020). The analysis utilizes secondary data (Nasehat *et al.*, 2023) comprising annual figures for a five-year period from 2018 to 2024, sourced from the Central Statistics Agency (BPS) and land use conversion data from the Bali Provincial Agriculture Office. Data analysis techniques are conducted in several stages, namely: 1) Collecting data on Rice Field Area (Y), Population (X1), and Per Capita GDP (X2) from 2018 to 2024. 2) Determining the effectiveness of the forecasting method using the Mean Absolute Percentage Error (MAPE) technique; 3) Determining the projected data for the years 2024 and 2025; 4) Calculating the forecast for each period using the Backpropagation algorithm.

### 2.2 *Research Location and Time*

This research was performed in the Province of Bali. The selection of the location was done purposively, meaning it was intentionally chosen based on specific

considerations. The research period began in January 2024. The basis for selecting the location and time required for the study was the need for a sufficient and comprehensive amount of secondary data for analysis, which could only be provided by the Bali Provincial Central Statistics Agency and the Bali Provincial Agriculture Department.

### 2.3 Research Location and Time

a. Qualitative Data, which is data represented in the form of descriptions or explanations that cannot be counted, not in the form of numbers. Qualitative data in this study consists of opinions and answers from interviews with key informants regarding land use change that has an impact in Bali Province.

b. Quantitative Data, which is data expressed in numerical form. The

quantitative data in this study includes Rice Field Area (hectares), Population (people), and Per Capita Regional Domestic Product (Rupiah).

### 2.4 Research Location and Time

This study was conducted to predict land use change in Bali Province. The variables and indicators used in this study are presented in Table I.

a. Rice fields are a type of land use that has undergone significant conversion, particularly around urban development centers and settlements. In general, the conversion of rice fields is irreversible.

b. Population size influences development in Bali Province, which requires infrastructure. In addition, population growth in Bali also greatly influences land use change and population growth in Bali.

Tabel I  
Research variables

Konsep	Variabel	Parameter	Pengukuran
Land use change	1. Rice fields	1. Rice field area (ha)	Quantitative
	2. Population	2. Population (people)	Quantitative
	3. GRDP per capita	3. GRDP per capita (rupiah)	Quantitative

c. Regional Domestic Product (RDP) is the gross value added of all goods and services produced within the domestic territory of a country resulting from various economic activities during a specific period, regardless of whether the factors of production are owned by residents or non-residents, expressed in Rupiah.

### 2.5 Research Location and Time

This study was conducted using two types of data collected through qualitative interviews with key informants regarding land use classification by the Agriculture

Office in Bali Province and quantitative data collected from BPS.

The quantitative data collected from BPS will be processed according to data mining system procedures.

a. Data cleaning

Data cleaning involves eliminating noise, inconsistent or irrelevant data, and standardizing units of measurement for variables.

b. Data integration

Data integration refers to the merging of data from numerous databases into a single database (Pradnyana & Agustini, 2018).

c. Data transformation

Data is converted or combined into a format suitable for processing in data mining within the KNIME program system.

d. Mining process

This is the primary process in which approaches are used to extract important and hidden knowledge from data using the Backpropagation algorithm in the MATLAB programming system.

e. Pattern evaluation

To find intriguing patterns in the information base that has been found. At this point, the findings of data mining methods, which include unique patterns and prediction models, are looked at to see if the original hypotheses have been met.

f. Knowledge presentation

This involves the visualization and presentation of knowledge regarding the methods used to obtain the knowledge gained by users. The results of this land use change forecasting study in Bali Province will then be tested for accuracy using land area recapitulation data from the previous year (Purwanto & Afiah, 2020).

## 2.6 Research Procedure

Backpropagation can train networks (Asthana S. *et al.*, 2017; Asthana S. *et al.*, 2017) to achieve There needs to be a balance between the network's capacity to recognize a pattern that will be used during training and its ability to respond correctly to an input pattern that is similar to the one utilized. Here is an explanation of the steps in Backpropagation training:

### 1. Backpropagation Algorithm

1. Set the initial weights (choose random numbers that are modest enough)
2. As long as the condition is still false, then the value is false

### 2. Forward propagation stage (Feed forward)

1. At each input unit ( $x_i, i = 1, 2, 3, \dots, n$ ) will receive a signal  $x_i$  and then forward the signal to all units in the hidden layer

2. Each hidden unit ( $x_i, i = 1, 2, 3, \dots, n$ ) will sum the input signal weights using the equation 1.

(1)

$$z_{in_j} = v_{0j} + \sum_{i=1}^n x_i v_{ij}$$

3. Then use equation 2 to find the output signal by applying the activation function.

(2)

$$z_i = f(z_{in_j})$$

4. The sigmoid function is the most popular activation function. After that, the signal goes to all output units.

5. Each input unit ( $y_{ki}, k = 1, 2, 3, \dots, m$ ) will sum the input signal weights using the equation 3.

(3)

$$y_{in_k} = W_{0k} + \sum_{i=1}^n z_{iw} \quad jk$$

6. Next, use equation 4 to find the output signal by applying the activation function.

(4)

$$z_k = f(y_{in_k})$$

### 3. Backward propagation stage (feed backward)

1. At each output unit ( $y_k, k = 1, 2, 3, \dots, m$ ), the corresponding target pattern will be received according to the training input pattern, then the error will be calculated using the equation 5.

(5)

$$\delta_k = (t_k - y_k) f'(y_{in_k})$$

2. F' is the derivative of the activation, then calculate the weight correction using the equation 6.

(6)

$$\Delta w_{jk} = a \delta_j z_j$$

3. Next, calculate the bias correction using the equation 7.

(7)

$$\Delta w_{0j} = a\delta_k$$

4. Next, it will send to the units in the hidden layer ( $y_i, = 1, 2, 3, \dots, p$ ) after that, it will sum the input data (from the units in the layer to its right) using the equation 8.

(8)

$$\delta_{in_j} = \sum_{k=1}^m \delta_k w_{jk}$$

5. Next, calculate the error information by multiplying it by the activation function using the equation 9.

(9)

$$\delta_j = \delta_{in_j} f'(z - in_j)$$

6. The next step is to calculate the weight correction using the equation 10.

(10)

$$\Delta v_{jk} = a\delta_j x_i$$

7. Then calculate the bias correction using the equation 11.

(11)

$$\Delta v_{jk} = a\delta_j$$

### 2.7 Research Location and Time

A good prediction method is one that provides predictions with a low level of error. The validation of prediction methods cannot be separated from indicators for measuring prediction results, including: Mean Absolute Percentage Error (MAPE).

MAPE is a way to measure how wrong something is. MAPE shows how many of the predictions were wrong compared to the real numbers (Nupuku *et al.*, 2021; Afiyah S. *et al.*, 2021) This method calculates the difference between the original data and the predicted data. The difference is then normalized and expressed as a percentage of the original data. The mean of these percentages is then calculated. This is

systematically formulated using an equation 12.

(12)

$$MAPE = \frac{\sum_{t=1}^n \left| \frac{X_t - F_t}{n} \right|}{n} \times 100$$

Explanation:

$X_t$  = actual data in period t

$F_t$  = predicted value in period t

n = number of data

### 3. RESULT AND DISCUSSION

Badung Regency is one of the regencies situated in Bali Province. Badung Regency is located between 8°14' and 8°50' South Latitude and 115°5' and 115°14' East Longitude. The total area of Badung Regency is 418.52 km<sup>2</sup>. Based on the results of the forecasting calculation of the per capita Regional Domestic Product (PDRB) in Badung Regency using the backpropagation method with data from 2025 to 2026, the findings are as follows.

#### 3.1 Rice Field Forecasting in Badung Regency.

The estimated rice fields in Badung Regency in 2025 and 2026 are derived from the results of forecasting calculations conducted using the Backpropagation method. Table II illustrates the rice fields in Badung Regency (Lestari & Trihadiningrum, 2019)

The rice field forecasting calculation in Badung Regency using the Backpropagation method resulted in an MAPE accuracy of 6.4%. A visual representation of the relationship between the original data from BPS and the forecasting results, showing the differences or similarities in graph form, is presented in the figure I.

Tabel II

Table of Rice Fields in Badung Regency

	2018	2019	2020	2021	2022	2023	2024	2025	2026
Aktua 1	9631. 3	9592. 5	9566. 7	9495. 3	9228. 8	9099.3	8674.7	-	-
JST	-	-	-	-	-	9099.2 5	8674.7 2	8674.7 3	8674.7 2

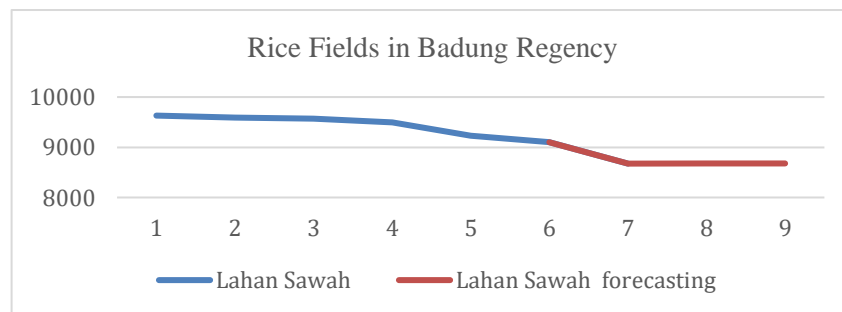


Fig. 1 Rice Fields in Badung Regency

### 3.2 Forecasting the Population of Badung Regency

Based on the results of the forecasting calculations using the Backpropagation method, the population of Badung Regency in 2025 and 2026 is estimated to be. Table III of Population in Badung Regency (Sabarella *et al.*, 2021)

The forecasting calculation of the population in Badung Regency using the Backpropagation method resulted in an MAPE accuracy of 0.00012%. A visual representation of the relationship between the original data from BPS and the forecasting results, showing the differences or similarities in graph form, is presented in the figure 2.

Tabel III

Table of Rice Fields in Badung Regency

	2018	2019	2020	2021	2022	2023	2024	2025	2026
Aktual	662.9	678.9	548.19	552.8	558.1	563.3	568.55	573.7	-
JST	-	-	-	-	-	-	563.30	568.54	563.32

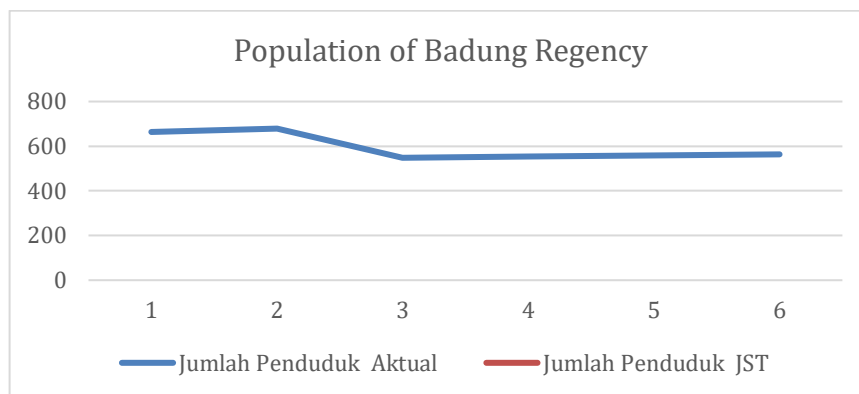


Fig. 2 Population of Badung Regency

### 3.3 Forecasting Per Capita GRDP in Badung Regency

Based on the results of the forecasting calculations using the Backpropagation method, the Per Capita GRDP in Badung Regency in 2025 and 2026 is estimated to be. Table IV of Per Capita GRDP in Badung Regency.

The calculation of per capita GRDP forecasting in Badung Regency using the Backpropagation method resulted in a MAPE accuracy of 0.00038%. A visual representation of the relationship between the original data from BPS and the forecasting results, showing the differences or similarities in graph form, is presented in the figure 3.

Tabel IV

Table of Rice Fields in Badung Regency

	2018	2019	2020	2021	2022	2023	2024	2025	2026
Aktual	57791	62836	49026	44882	55290	68399	75098	-	-
JST	-	-	-	-	-	68399.1128	75094.67624	63747.96392	63747.96392

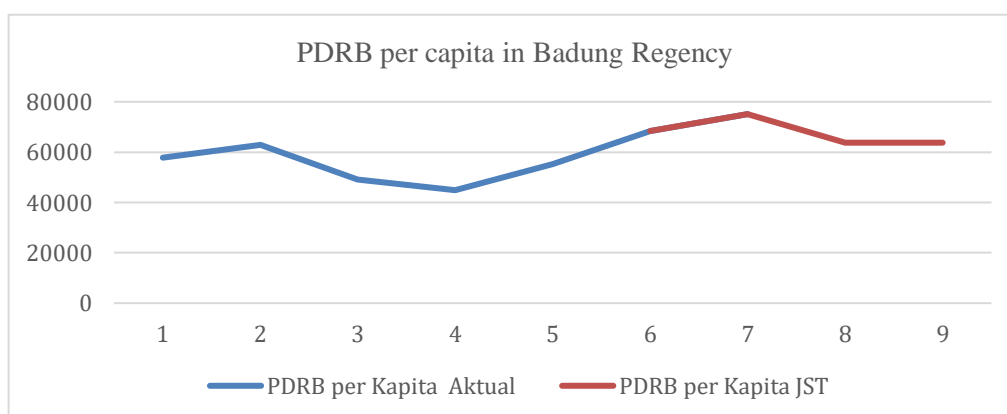


Fig. 3 PDRB per capita in Badung Regency

#### 4. CONCLUSIONS

The results of testing the Backpropagation algorithm to predict rice production and consumption levels yielded an average MAPE of 0.000064 for rice fields, 0.00038 for population, and 0.00012 for per capita GDP, placing it in the very good category. Based on the testing results using MAPE and interviews with key informants, the forecasts generated using the Backpropagation algorithm can be used for future predictions. To maintain and reduce land conversion in Bali Province, it is hoped that the government will focus more on agricultural development, particularly efforts to preserve productive agricultural land.

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