Computational based on GUI MATLAB for back propagation method in detecting climate change: case study of mataram city

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Abstract. Climate change is a global phenomenon in which its impact can be perceived locally. In the face of this phenomenon, it is necessary to prepare and overcome this threat by developing various mitigation and adaptation strategies for climate change. To support this strategy, climate data such as temperature (maximum and minimum), rainfall, number of rainy days, as well as necessary information in the future need to be detected to prepare good and directional policies. The study aims to determine the climate parameters in Mataram city using forecasting by constructing the algorithm the Back Propagation method. In using the Matlab GUI application by analyzing climate change in Mataram city by using monthly data for the last 10 years. In the simulation stage, the data taken are the maximum temperature, minimum temperature, rainfall, and the number of rainy days in Mataram city. Based on the results of the training and testing process for climate data in the city of Mataram with a prediction of maximum temperature occurred in November at 32.58°C and maximum rainfall occurred in December as much as 399.2931 mm, while for the maximum number of rainy days occurred in January with a total of 21.99 days. These results can be used as an alternative policy in the handling and preparation of extreme climate change.

1. Introduction
The country of Indonesia is located in the equator area known as the maritime continent. Characteristics of meteorological elements, especially temperature and rainfall in the region of Indonesia is strongly influenced by the condition of monsoon climate namely with the difference of wet season and clear dry season [1]. Air temperature is the average kinetic energy measure of the molecular movement. The temperature of an object is a condition that determines the ability of the object, to remove heat from other objects or to receive heat from other objects. In the two-piece
system, objects that lose heat are said to be higher-temperature objects [2], [3]. The temperature can be defined microscopic in relation to the molecular movement in such a way that the greater the molecular velocity the higher the temperature. Temperature is a measure of the warmth or coldness of an object or substance with reference to some standard value. The temperature of two systems is the same when the systems are in thermal equilibrium [4].

While rainfall is defined as a liquid and solid water that falls on the surface of the Earth such as rain, drizzle, snow, and hail. Rainfall and temperature are an element of climate that is crucial to life on Earth [5]. The amount of rainfall is recorded in inches or millimetres (1 inch = 25.4 mm). The amount of rainfall is 1 mm, indicating the high rainwater covering the surface of 1 mm, if the water is not flowing, it does not sink into the ground or evaporates into the atmosphere [6].

Climate change, the periodic modification of Earth’s climate caused by changes in the atmosphere and interactions between the atmosphere and various other geologic, chemical, biological, and geographic factors. Learn how climate has changed since the last ice age and throughout longer stretches of geologic time [7]. Climate change refers to changes in the state of the climate that can be identified (e.g. by using statistical tests) the average change and variability of its properties over a long period, and usually longer. With this change in global temperature impacts climate change, such as changes in rain patterns that make the seasons erratic, as well as the rise and fall of rainfall in a region that has the potential to cause disasters (floods and droughts). For the study, it was generally analyzed by climate factors that are indicators of climate change such as temperature, rainfall, and rising sea levels. In Indonesia, the main factors used to identify climate change are temperature, rainfall, and rainy days, as measured by the pattern and intensity. Indications on climate change can be done with a time series analysis that can provide information on trend changes, cyclical analysis, or shifts around the flat in the long run [8].

Accurate weather forecasts are urgently needed to improve performance in areas such as marine and agriculture. So it is needed for forecasters to know the weather and changes in the future. Forecasting is an estimation activity to see what will happen in the future. Forecasting is indispensable due to the time lag between the awareness of the need for a new policy and the time of implementation of the policy [9]. If the time difference is long, then the role of forecasting is so important for modeling the mathematical timing and when something will happen, so that action can be prepared that needs to be taken. This method of forecasting will help in conducting an analytical approach to the behavior or patterns of past data, to provide a systematic way of thinking, workmanship, and solving, as well as provide a greater level of confidence than the accuracy of the forecast results made [10].

Today, the development of various methods of forecasting is presented with algorithms that can make it easier for users to operate them. However, not all methods are capable of being used in all situations, especially concerning time-series data [11], [12]. Some methods that are often used in the time series data forecasting process are Artificial Neural Network (ANN) type Back Propagation, so in anticipation of such mismatch, each process is shown with the accuracy level of each method such as Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE). The method with the least error rate or the highest level of accuracy is called the best method in the presented case [13]. So, one method that can be used in making weather forecasts is ANN because this method can provide a classification of weather. ANN is part of the artificial intelligence method, which represents how the human brain works to solve a classification problem. One of the algorithms of ANN that can be used in solving classification problems is the Back Propagation algorithm [14]. Back Propagation is an algorithm that uses a well-watched learning method that includes networks with multiple layers. In the Back Propagation network, there are three layers, namely the input layer, the hidden layer, and the output layer [15]. Each layer of tissue has one or more neurons. Each layer of tissue has one or more neurons. Research related to artificial neural networks with Back Propagation learning algorithms was conducted by researchers to predict maximum temperature, minimum temperature, rainfall, and rainy days in the last 10 years, namely 2010-2019 in Mataram city [16]. Back Propagation is an excellent method of classification considering its ability to adapt network conditions with data provided with the learning process [17].
ANN Back Propagation has advantages because its learners are done over and over again to realize a system that is damage resistant and consistently works well [18].

Currently, there are still many forecasting methods that display a minimal error rate known data input, however, it is still single, meaning it cannot simulate much data. Therefore, ANN Back Propagation has adopted a network with a lot of input so that the predictive results obtained are excellent because each data is treated through training and testing data by weighing each neuron (network) before the predicted output is generated [19]. So, the goal that is to be achieved in this study is to analyze the added momentum in the temperature and rainfall prediction process in Mataram city in the last 10 years, whether the changes to the weather per year are significant or insignificant using the Back Propagation method.

2. Method
This section focuses on two main discussions, namely data parameters, and accuracy. Data used for training and testing are (1) hydrological data (precipitation and rainy days), and (2) climate (temperature) data. Data taken from 2010-2019 is sourced from the Central Bureau of Statistics of West Nusa Tenggara Province. The accuracy parameters used in this forecasting include Mean Absolute Deviation (MAD), Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE), and Root Mean Squared Error (RMSE).

The steps performed to build the ANN Back Propagation computing system are as follows:

a. Identify problems. At this stage the authors collected references related to hydro climatology data and time series data prediction-simulation methods using artificial neural network Back Propagation.

b. Data Retrieval. At this stage the authors took hydrological data (rainfall and rainy days) and climatology data (maximum and minimum temperatures) from the Central Bureau of Statistics of West Nusa Tenggara Province.

c. Design and Prediction. At this stage the authors designed ANN back propagation algorithms and architecture numerically and implemented them using GUI Matlab to determine hydro climatology data in 2010-2018 as training data while 2019 data as data testing.

d. Simulation. At this stage, the authors simulated the data and discussed the predicted results by ANN Back Propagation.

3. Result and Discussion
The architectural parameters that researchers used in this study correspond to Table 1 below.

| Parameters          | Attribute               | Size/Type |
|---------------------|-------------------------|-----------|
| Number of Neurons   | Activation Function     | LOGSIG    |
|                     | Layer Input             | 111       |
|                     | Layer Hidden 1          | 20        |
|                     | Layer Hidden 2          | 5         |
|                     | Layer Output            | 1         |
| Algorithm Training  |                         | TRAINRP   |
| Parameter Settings  | Max. Epoch              | 1000      |
|                     | Goal                    | 0.0001    |
|                     | Learning Rate           | 0.9       |
|                     | Show Step               | 1         |

Based on the results of network construction in accordance with Table 1, forecasting is carried out for 2020. The results correspond to Figure 1 and Figure 2 below.
From the predicted results in Figure 1 it is known that Mataram City has a maximum temperature with a significant increase and the upward trend is accurate and evenly distributed because the MSE result is quite small with MSE = 0.121603 so the prediction for Mataram maximum temperature is quite good (red line). The predicted results known that Mataram City has the most accurate rise to minimum temperature because it has the least MSE value with MSE = 0.59456.

Figure 2 shows a less significant rainfall prediction result due to the result of a considerable MSE = 0.2358. Then the predicted result that Mataram City has a less good rainy day because of the predicted result of rainy day has a significant increase with the value of MSE = 7.48539. Based on the predicted results obtained the predicted results each month in 2020 according to the following Table 2.
Table 2. Hydro climatology predicted results of Mataram City in 2020

| Month    | Temperature (°C) | Rainfall (mm) | Rainy Day |
|----------|------------------|---------------|-----------|
|          | Maximum          | Minimum       |           |
| January  | 30.9578          | 24.3883       | 246.1705  | 21.9911   |
| February | 31.1644          | 24.0534       | 238.0144  | 20.445    |
| March    | 31.8316          | 23.5004       | 317.271   | 18.9837   |
| April    | 32.3445          | 23.5759       | 270.7408  | 19.6327   |
| May      | 32.0044          | 23.195        | 217.8103  | 9.7967    |
| June     | 31.1154          | 22.5001       | 201.3382  | 8.0797    |
| July     | 30.5937          | 21.5827       | 38.8705   | 4.8141    |
| August   | 30.8701          | 21.1615       | 130.2801  | 4.5516    |
| September| 31.7616          | 21.5947       | 77.7331   | 1.4932    |
| October  | 32.4496          | 22.6523       | 120.6818  | 5.3562    |
| November | 32.5776          | 23.692        | 332.2126  | 16.4992   |
| December | 31.4182          | 24.032        | 399.2931  | 20.8413   |
| Average  | 31.5907          | 22.994        | 215.8680  | 12.7069   |

Based on the data analysis of the predicted results in Table 2 above the average for maximum temperature is 31.5907 °C. While the average for the minimum temperature is 22.9940 °C. The maximum temperature occurred in November at 32.5776 °C, while for the minimum temperature data in July it was 30.5937 °C. This indicates that in 2020 the temperature in Mataram city is quite hot. The average rainfall prediction in Mataram city is 215.8680 mm. maximum rainfall occurred in December at 399.2931 mm, while the minimum rainfall occurred in July of 38.8705 mm. As for the average result of a rainy day is 12.7069 days. Many of the maximum rainy days occur in January as many as 21.9911 days, while for many days the minimum rainy day occurs in September as much as 1.4932 days.

On the other hand, the government's efforts to address climate change is one of the national climate change policy documents owned by Indonesia is the National Action Plan in the face of Climate Change (called RAN MAPI) published by the Ministry of State environment (called KNLH). At the regional level, one example of a policy to integrate elements of climate change adaptation has been implemented by West Nusa Tenggara Province (NTB). The policy effort made by the NTB government is to issue a decree of the Governor of West Nusa Tenggara No. 219 of 2007 on the Establishment of a Task Force for The Mainstreaming of Aspects of Climate Change in West Nusa Tenggara Province fiscal year 2007. Institutions established by the government should work more actively to make breakthroughs, one of which is to forecast climate change and convey it openly to the public so that the information can be used as a basis for decision-making in the wider community. This will certainly have an impact on improving people's economies.

4. Conclusion

The LOGSIG function and the TRAINRP method are the most accurate combinations in generating the smallest errors in MSE values. This is evident from the results of simulated hydro climatology data that the average accuracy rate is 85.55%. Good or not a forecast can be reviewed from two points of view, namely forecasts and users. With the results of predictions, we get benefits for the community so as not to rush to take action in work that is very influential on climate change such as farmers, fishermen, and aviation. This algorithm and architecture is very good and can be used in the next process of predicting weather and climate conditions in the future.

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