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Utilization of Air Humidity and Surface Air Temperature Data in Regression Equations for Rainfall Forecast Simulation in the Gamping Area, Sleman, Yogyakarta (Yogyakarta Class 1 Geophysical Station)

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ABSTRACT

Rainfall prediction simulations for January 2010 using predictors of air humidity (RH) and air temperature (T) have been carried out at Yogyakarta Geophysics Station. Rainfall prediction in January 2010 using average weather parameter data and real time data in the Gamping Sleman Yogyakarta area has been carried out using two regression methods, namely simple linear regression equation method and multiple linear regression. The evaluation is done by comparing and calculating the amount of deviation from the prediction of total monthly rainfall to the observation of total monthly rainfall. The results of data processing carried out to predict rainfall in January 2010 show. In the study area, rainfall was very strong with RMSE = 0.68 mm using predictors of air temperature and humidity at the same time.

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1. INTRODUCTION

Indonesia is known as part of a maritime continent characterized by land surrounded by sea, where convection activity is part of the global circulation. Indonesia is located between 6°N-11°S and 95°BT-141°BT and is a tropical region with 2 (two) seasons, namely: dry season and rainy season. In the tropics, rainfall is one of the most diverse climate elements [1].

The characteristics of rainfall in various regions are certainly not the same. This condition is caused by several factors [2], namely: geographic, topographic, and orographic. Not to mention the structure and orientation of the islands [3] As a result, the pattern of rainfall distribution tends to be uneven between one region and another within a wide scope. Given that rain in the tropical region has a lot of influence on human life in all its aspects [4].

Based on the above background, the author collected and processed the rainfall data in question in this research. In addition, it is also accompanied by data processing of air temperature and humidity at the Meteorology, Climatology, and Geophysics Station of Yogyakarta. Meanwhile, data for simulating the January total precipitation prediction used a simple and multiple linear regression methods. Associated with the types of monthly rainfall totals, the precision of predicting monthly rainfall totals will vary from one place to another. For this reason, evaluation of the prediction of monthly rainfall totals is needed so that the results of the study can be used as input in preparing predictions of monthly rainfall totals in the following months.

2. METHODS

The data used in this research are rainfall data, air humidity data, and air temperature data that have been recorded and documented by the Yogyakarta Geophysical Station. Data processing uses Microsoft Excel software to get the final result in the form of predictor data. In this study, used a variety of data to predict January rainfall using average data and real time data at Geophysical Station Yogyakarta. The prediction methods used in this research are Simple Linear Regression and Multiple Linear Regression. Evaluation methods used in this research are root mean square error (RMSE) and correlation coefficient.

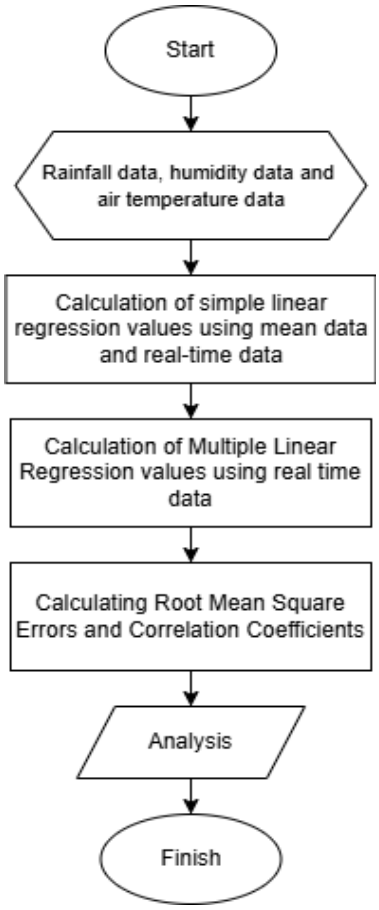

Figure 1. Flow Chart of Research

3. RESULTS AND DISCUSSION

3.1 Forecast for Rainfall using average data

Based on the rainfall observation data obtained using a simple linear regression equation the mean data are as follows:

1. Utilization of the Air Humidity Predictor from January average data for samples

   A simple linear regression equation using the Air Humidity predictor (RH) obtains the following simple linear regression values:

$$Y = -56.74285714 + 0.292857143X \quad (1)$$

   The regression equation explains that the regression coefficient for the humidity variable is 0.293 which means that if the humidity increases by 1°C then the precipitation will increase by 0.293. A positive coefficient means that there is a positive relationship between humidity and precipitation, the more humidity the precipitation rate increases. Similarly, if the humidity decreases, the rainfall will decrease.

The results of the calculation showed that in 2010 the correlation coefficient values between January total precipitation prediction simulations using air humidity predictors were r = 0.74 and r^2 = 0.544 indicating that 54.4% of the effect of air humidity on precipitation, was greater than 0.74%. This means that the effect of humidity on precipitation is strong and the remaining 45.6% is affected by other factors. Using the air humidity predictor, a total value of rainfall in January was estimated at 53.1 mm. Deviations to observation data were obtained 1.74 mm.

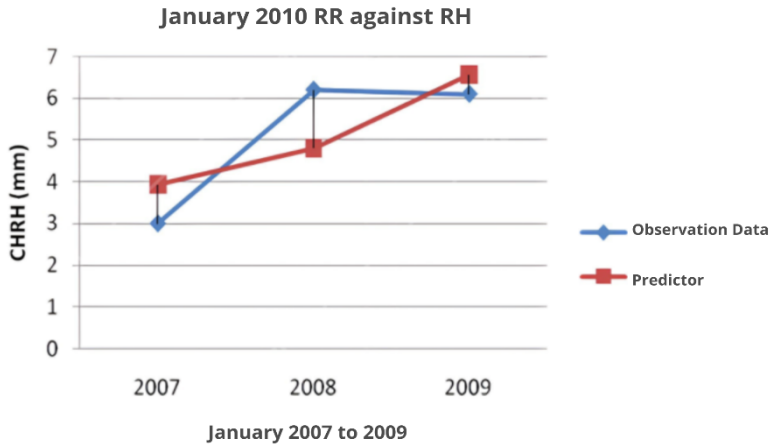

Figure 2. Comparison Chart for January 2010 against Humidity

2. Utilization of the Air Temperature Predictor from the January average data for the samples

A simple linear regression equation using the Air Temperature predictor (T) obtains a simple linear regression value as follows:

$$Y = 86.47633669 - 0.914157933X \quad (2)$$

The regression equation explains that the regression coefficient of the variable air temperature is -0.91 which means that if the air temperature increases by 1°C then the precipitation will decrease by -0.91. Negative coefficient means that there is a negative relationship between air temperature and precipitation, the more temperature the precipitation decreases. Similarly, if the air temperature decreases, the precipitation increases.

Calculations showed that in 2010 the correlation coefficient value between the January total precipitation prediction simulations using the air temperature predictors was r = -0.50 and r^2. = 0.252 showed that 25.2% of the effect of humidity on precipitation, meaning that the effect of humidity on precipitation was strong enough and the remaining 74.8% was affected by other factors outside. Using the air temperature predictor, the January total rainfall prediction value was -42.35 mm. Deviations to total observation rainfall were 1.28 mm.

The January total precipitation prediction chart using air humidity predictors has a fairly good forecast result, while using air temperature predictors with observed total precipitation charts in general, the pattern is likely to be regular, and the total precipitation prediction tends to follow the total actual precipitation.

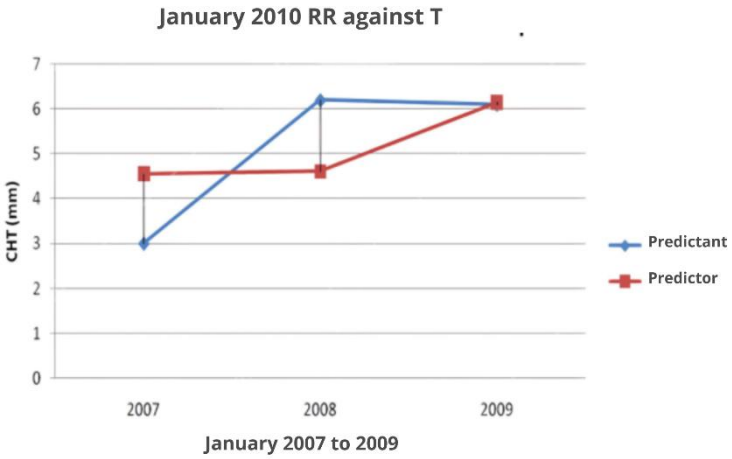

Figure 3. Comparison Chart for January 2010 against Air Temperature

3.2 Forecast of Rainfall using real time data

Meanwhile, based on the rainfall observation data obtained using a simple linear regression equation, real time data are as follows:

1. Utilization of Air Humidity Predictors from January real time data

   A simple linear regression equation using the Air Humidity predictor (RH) obtains the following simple linear regression values:

$$Y = 1.6815502 - 0.016208X \quad (3)$$

The regression equation explains that the regression coefficient for the humidity variable is -0.016 which means that if the humidity increases by 1°C then the precipitation will decrease by -0.016. Coefficient is positive. The higher the air pressure, the higher the precipitation rate, and vice versa. The results of the calculation showed that in January 2010 the value of the Correlation Coefficient between the January total precipitation prediction simulations using air humidity predictors was r = - 0.078 and r^2 = 0.006 showed that 0.6% of the effect of air humidity on precipitation, with respect to precipitation. This means that the effect of humidity on precipitation is strong and 99.4% is affected by other factors. Using the air humidity predictor, a January total rainfall value of -39.1 mm was obtained. Deviations to observation data were obtained by 0.87 mm.

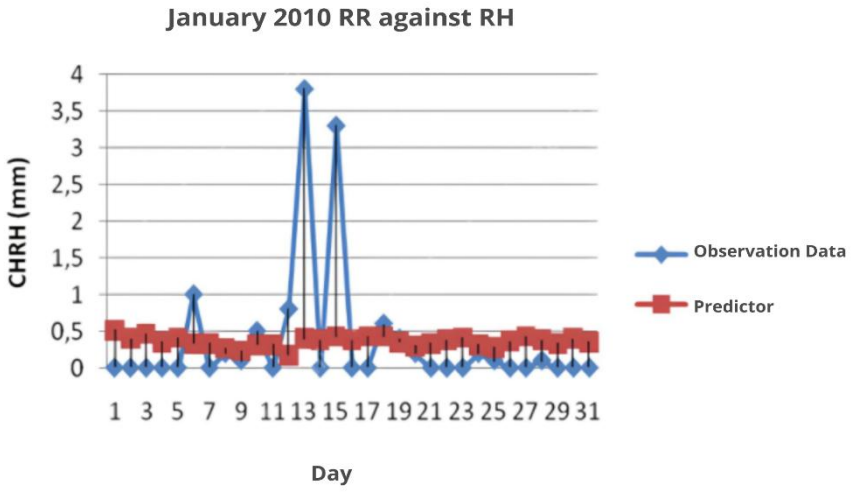

Figure 4. Comparison Chart for January 2010 against Humidity

2. Utilization of the Air Temperature Prediction from January real time data

A simple linear regression equation using the Air Temperature predictor (T) obtains the following simple linear regression value as follows:

$$Y = 0.566037736 - 0.007673713X \quad (4)$$

The regression equation explains that the regression coefficient for the humadity variable is -0.008 which means that if the temperature increases by 1°C then the precipitation will decrease by -0.008. Negative coefficient means that there is a negative relationship between air temperature and precipitation, the more temperature the precipitation decreases. Similarly, if the air temperature decreases, the precipitation increases. The results of the calculation showed that in January 2010 the value of the Correlation Coefficient between simulated total precipitation prediction using air temperature predictors was r = -0.009 and r^2 = 0.0087. This indicates that 0.0087 is 0.87% the effect of humidity on precipitation, meaning that the effect of humidity on precipitation is strong and 98.13% is affected by other factors. Using an air temperature predictor, the monthly total precipitation prediction value is -5.68 mm. Deviations to total observation rainfall were 0.94 mm.

The prediction graph of the total rainfall in January using the predictor of air humidity and using the predictor of air temperature with the total rainfall graph of the observations in general appears that the pattern that occurs is irregular, and it appears that the prediction of the total rainfall tends to follow the actual total rainfall.

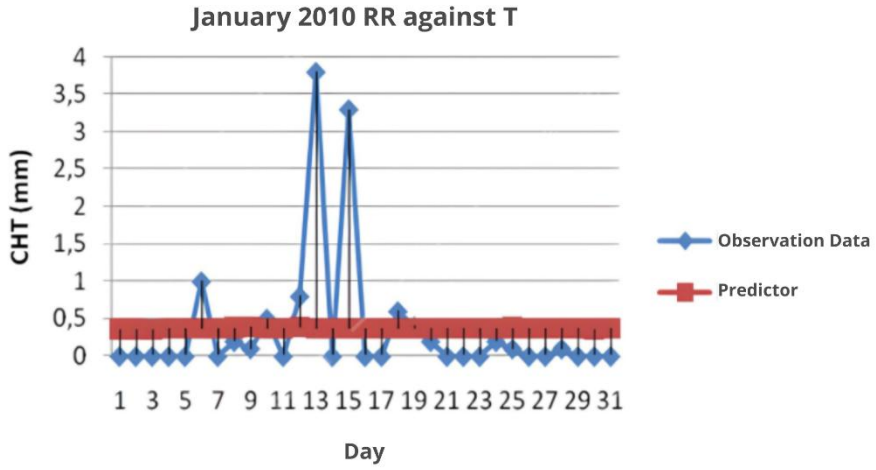

Figure 5. Comparison Chart for January 2010 against Air Temperture

3.3 Comparison of air humidity and air temperature predictors from average data and real time data

The results of the comparison between rainfall predictors using average data and real time data are as follows:

1. Prediction of total rainfall in January 2010 using air humidity predictors and using air temperature predictors in January using average data is quite good. While using air humidity predictors and using air temperature predictors in January using real time data is very weak.
2. The regression value obtained using average data obtained for air humidity predictors is positive, while for air temperature predictors it is negative. Compared to using real time data, the results of the air humidity predictor and air temperature predictor are both negative.
3. The correlation coefficient value obtained using the average data is obtained for the air humidity predictor, the influence on rainfall is strong, while using the air temperature predictor, rainfall is more influenced by the x (other) factor. Meanwhile, the correlation coefficient value using real time data from air humidity predictors and air temperature predictors of rainfall is more influenced by the x (other) factor.
4. The prediction graph of the total rainfall in January 2010 using the average data of air humidity predictor and air temperature predictor with the total rainfall graph of the observation results in general appears that the pattern that occurs is likely to be regular, and the predicted total rainfall tends to follow the actual total rainfall. While the prediction graph of the total rainfall in January 2010 using real time air

humidity predictors with the total rainfall graph of observations in general appears that the pattern that occurs is irregular, and it appears that the prediction of the total rainfall does not follow the actual total rainfall

3.4 Precipitation of precipitation using predictors of Air Humidity and Air Temperature

A simple linear regression equation using the predictors Air humidity and air temperature is obtained by simple linear regression values as follows:

$$Y = 16.490348995 - 0.078545231X1 - 0.371017505X2 \quad (5)$$

with X1 = Moisture, and X2 = Air Temperature. Coefficient is negative. The higher the humidity and temperature the lower the precipitation rate, and vice versa. Using the predictors of air humidity and air temperature, the total value of January precipitation was estimated at -483.4 mm. Deviations to observation data were obtained 4.2 mm.

The graph above describes the comparison of the monthly precipitation amount from the results of observation data to the prediction data carried out using the multiple linear regression method in the January 2010 test data. The chart formed showed larger prediction results on January 13 and 15, 2010.

The results of RSME calculations using the predicted humidity and air temperature were obtained by an RSME value of 0.86. Multiple linear regression correlation coefficient values using air humidity and air temperature predictors are derived person correlation values of r = -0.87, while determinant correlation values of $r^2 = 0.76$. The resulting correlation between humidity and air temperature to precipitation rate is 76% with a strong relationship. The remaining 24% is affected by other variables.

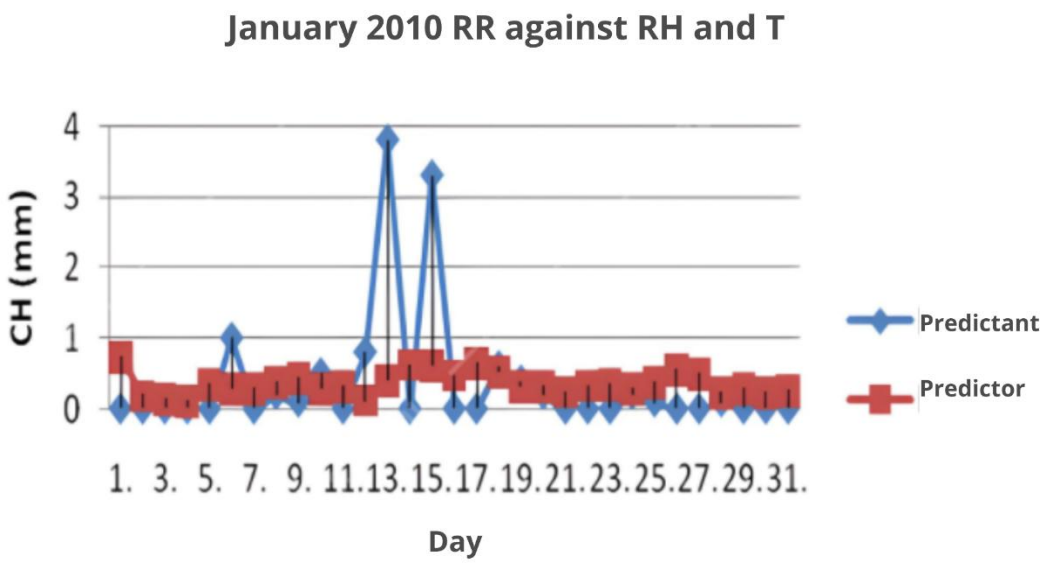

Figure 6. January 2010 Rainfall Comparison Chart using RH and T predictors with observation results

From these three predictors it appears that the monthly total precipitation prediction using the temperature and humidity predictors has a relatively greater deviation value than using the temperature or humidity predictors. The prediction output deviation value indicates a considerable deviation value. Meanwhile, the monthly total precipitation prediction using the air humidity predictor has a relatively lower deviation value than others. The above shows that the January 2010 total precipitation prediction using the temperature and humidity predictors was quite good compared to the forecast using the temperature and humidity predictors. Although the RMSE value is calculated to be more than moisture, the correlation value is the highest among the three regression models.

The monthly total precipitation prediction chart using the air temperature predictor with the observed total precipitation chart in general, appears to be the pattern that occurs to tend to be regular, and the total precipitation prediction tends to follow the total actual precipitation. However, there is a difference in precipitation of prediction results with inconsistent observation data. In regression models with predictors of

air temperature or humidity, the precipitation prediction result is lower than the observation data. Meanwhile, using the temperature and humidity predictors simultaneously, the results of the 13th prediction have higher values than the observation data.

In this study, precipitation only applies in normal weather not to extreme weather. Where the precipitation value is between 85%-115% of the average value.

4. CONCLUSION

Based on the results of the analysis of the rainfall forecasts that have been carried out, it can be concluded that:

1. The January rainfall prediction in the Gamping Sleman area of Yogyakarta uses humidity predictors and air temperature predictors from average data is quite good, while using very weak real time data.
2. The January rainfall prediction in the Gamping Sleman area of Yogyakarta showed the best prediction value on the 13th and 15th. Monthly precipitation total prediction values with humidity and temperature predictors show over-estimate results (greater than actual values) than their observation values.
3. The correlation coefficient values of precipitation prediction obtained from both the humidity predictor and the temperature predictor using the average data are accurate, while the correlation coefficient values of precipitation prediction using the average data are inaccurate. The precipitation prediction coefficient values obtained from the predictors of air humidity and air temperature are accurate.

DECLARATION

Author Contribution

Conceptualization, Wawan Joko Suwondo.; methodology, Wawan Joko Suwondo. and Karita Ramadina.; software, Karita Ramadina.; validation, Wawan Joko Suwondo. and Karita Ramadina.; formal analysis, Karita Ramadina.; investigation, Wawan Joko Suwondo.; resources, Karita Ramadina.; data curation, Wawan Joko Suwondo.; writing—original draft preparation, Karita Ramadina.; writing—review and editing, Wawan Joko Suwondo. and Karita Ramadina.; supervision, Wawan Joko Suwondo.; project administration, E.F Karita Ramadina. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

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