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Characteristics of Weather and Rainfall Projection in 2021 around Jatigede Dam West Java for Fisheries Management

Titin Herawati[a*], Ayi Yustiati[b], Iskandar[c], Zahidah[d], Hafizan Juahir[e], Ruminta[f], [a]Doctoral Program in Agriculture Science, Faculty of Agriculture, Universitas Padjadjaran, Indonesia, [b,c,d]Faculty of Fisheries and Marine Science, Universitas Padjadjaran, Indonesia, [e]East Coast Environmental Research Institut, Sultan Zainal Abidin University, Malaysia, [f]Department of Agronomy, Faculty of Agriculture, Universitas Padjadjaran, Indonesia, Email: [a*]herawati.h19@gmail.com

The availability of water as a fish habitat in the Jatigede Dam is determined by the amount of rainfall and water supply from the headwater of the Cimanuk River. The purpose of this study is to determine the type of climate, weather parameter trends and opportunity for rainfall in the time period 2018-2021 as a basis for fisheries management. The method used for determining the climate was adapted from Schmidt and Ferguson (1952). Climatological parameters and projected trend of rainfall until April 2021 was made using the Autoregressive Integrated Moving Average model. The results show that the Jatigede Dam climate type is Monsoonal with moderate rainfall (Q 37.36%). The dry season occurs from May to October and the rainy season occurs at the end of October to April. The trend of rainfall, air humidity, and wind speed has decreased, while the air temperature and air pressure have increased. It can be concluded that based on rainfall patterns including the Monsoon climate type, and based on the Schmidt Ferguson type C climate (moderate rainfall): the peak of the dry season in July-August; the peak rainy season is in January-February; the transition season is in May-June and November and the projected rainfall in 2018-2021 in the Jatigede area, before the dam is flooded, follows a seasonal pattern and tends to decline, ranging from 210.70-288.16 on average 252.11 mm/month.

Key words: *Wet month, dry month, weather, rainfall, climate type, Jatigede Dam.*

Introduction

Meteorology or weather science is the study of weather events over a limited period of time and space (Rafi'i, 2010). Weather has a fairly high variability over time and from one place to another, but the weather in the long term can show a relatively fixed pattern called climate. Weather characteristics in a place are expressed by their own parameters and include rainfall, air temperature, air humidity, air pressure, evaporation, wind, and radiation.

The impact of climate change in Indonesia on average annual temperatures has increased around 0.3 °C, with annual rainfall increases up to 3%. In Indonesia, the Increased Rainfall is in the northern region. The rainy season and dry season have also changed. Rainfall in the rainy season in the southern region of Indonesia has increased while rainfall in the dry season in the northern region has decreased (Hulme and Sheard, 1999); (Boer and Faqih, 2004).

The impact of climate change on biodiversity and ecosystems in Asia is at risk of up to 50% of total biodiversity (Cruz et al., 2007). Significant decreases in fish larvae abundance and large-scale changes in fish habitat, such as skipjack, are projected to occur in the equatorial Pacific (Cruz et al., 2007); (Loukos et al., 2003). Rising sea levels reduce the flow of fresh water and salt water intrusion and added to this is the pressure caused by human activities that threaten mangrove forests in Indonesia (Tran et al., 2005). Changes have also occured in species distribution, reproductive time, and plant phenology

Rainfall in Java has tended to decrease compared to the beginning of the last century, especially in the longer dry season. Meanwhile, the rainy season varies spatially with some regions experiencing lower annual rainfall. The trend of changing seasonal rainfall shows a proportional reduction in monthly debit for large rivers in Java ranging from +0.8 and -8.3% in 2030 and between +1.3 and -13.8% in 2050 (Pawitan, 2010).

This study aims to detremine the type of climate and rainfall in the Jatigede Dam and its surroundings during the period 2018-2021 and the characteristics of rainfall, air humidity, air pressure, air temperature and wind speed. The results of the study are expected to provide information about the type of climate and constituent weather characteristics consisting of: rainfall, air humidity, air pressure, air temperature and wind speed, and projections of rainfall in 2018-2021 which can be used as basic ingredients in fisheries management in the Jatigede Dam.

Research Methods

Research Station

Jatigede Dam is located at coordinates 6°49'0" SL-7°04'0" SL and 107°60'0" EL-108°15'0" EL (Balai Besar Wilayah Sungai Cimanuk Cisanggarung (BBWS), 2016), such that the

Jatigede Dam is at latitude less than 23.5 °SL and the climate is tropical. Indonesia is located between two continents, Asia and Australia and as such Jatigede Dam is influenced by the winds of southwestern and the southeast monsoon. Southwest winds blow into Indonesia through the South China Sea and the Indian Ocean, between November and March and this wind brings water vapor which causes wet or rainy seasons. In April to October the wind blows from the Southeast and is dry, causing a dry season (Rafi'i, 2010).

Jatigede Dam is a newly constructed reservoir, the inundation process was inaugurated on August 31, 2015. Currently water from the Jatigede Dam has only been used for irrigation in Bendung Rentang (Herawati et al., 2017), and in 2020 water is planned to be used for hydroelectric power plants (PLTA), so that the water supply in the dry season is expected to be greater. The availability of water in the Jatigede Dam is determined by the amount of rainfall around the dam and the water supply from the Cimanuk River which is the main river that supplies water to the Jatigede Dam. Water sources in the Jatigede Dam come from three mountain slopes, they are Mount Papandayan 2,622 meters above sea level (masl), Mount Cikuray 2,821 masl, and Mount Mandalagiri 1,813 masl (Balai Besar Wilayah Sungai Cimanuk Cisanggarung (BBWS), 2016). Based on the altitude of the mountains, it is estimated that rainfall in the headwater of the Cimanuk River is higher.

The surface area of the dam is determined by the supply of incoming water and the released amount of water. This is in accordance with the function of the dam, which is to meet irrigation needs during the dry season, control floods in the rainy season and provide clean water for Cirebon, Indramayu and the surrounding area with a capacity of 3,500 L/sec, capable of producing 690 GWH of electricity per year 110 MW installed capacity for the purpose of tourism and capture fisheries (Islam, & Al Amin, 2016; Herawati et al., 2018). At a maximum elevation of 262 masl inundation area is 41.22 km^2, reservoir volume (gross) is 1,061.32 × 106 m^3. In normal water conditions the elevation is 260 masl, an area of 39.52 km^2, volume of 980.57 × 106 m^3. At minimum water level elevation is 230 masl, inundation area is 12.70 km^2, volume is 183.30 × 106 m^3 (Balai Besar Wilayah Sungai Cimanuk Cisanggarung (BBWS), 2016). The water volume and surface area of the dam, as well as other wetlands around Jatigede are predicted to affect the surrounding air humidity.

The use of the dam for fishing is as a means of capture fisheries. Fish species that currently live and breed in the Jatigede Dam are fish native to the Cimanuk River and are both introduced fish and restocked fish (Herawati et al., 2017). One of the original fish of the Cimanuk River that can adapt in the Jatigede Dam is one that is Hampala Macrolepidota (Kuhl & Van Hasselt, 1823), including the Red list IUCN (International Union for Conservation of Nature and Natural Resources) with the least concern status (LC). These fish spread widely in Jatigede, especially in the waters of the river that are flowing (Herawati et al., 2017) and are generally vulnerable to fluctuations in the water.

Currently, water volume fluctuates. In the dry season, the dam water recedes and especially in 2018, the surface of the dam receded drastically. In 2020, water will be used for hydropower and this ensures that the water in the dam will decrease in the upcoming dry season. Receding water in the dry season has an impact due to the loss of fish habitat such as spawning areas, upbringing areas and permanent enlargement areas, and it is estimated that the existing fish will continue to decline. Therefore, to anticipate the sustainability of fish native to the Cimanuk River in the Jatigede Dam, research is needed regarding rainfall and forecast rainfall after the hydropower plant begins operation in 2021.

Data Analysis

This study was conducted from March to October, 2018. The equipment used was hardware in the form of laptops and software: Excel, Minitab 18 and R. For modeling, Autoregressive Integrated Moving Average (ARIMA) modeling was used.

Climate monitoring follows Schmidt and Ferguson's (1952) rule, which states that in climate science it is determined that the data used is at least for a duration of 10 years (120 months) so that the data follows scientific method. In this study, the rainfall data used was from the climatology station in Darmaraja sub-district, Sumedang district at coordinates 6°55'32" SL-108°4'5"EL, at an elevation of 292 masl, for 11 years (132 months). The data was obtained from the Water Resources Research and Development Center of the Ministry of Public Works and Public Housing, Jalan Ir. H. Juanda No. 193 Bandung. The study area is the area affected by the inundation of the Jatigede Dam.

Climatological data was used to determine whether the relevant characteristics are rainfall, air humidity, air pressure, air temperature and wind speed for 30 months from December 1, 2015 to April 26, 2018. Data was obtained from the installation station climatology Jatigede Dam Specific Non-Vertical Work Unit Public Works Ministry of Public Works and Public Housing Jatigede Dam.

Climate Type Analysis

$$M_d = \frac{\sum f_d}{T} \qquad \textbf{(1)}$$

where M_d is mean of dry month, f_d is frequency of dry month and T is total time of the research (years).

$$M_w = \frac{\sum f_w}{T} \qquad \textbf{(2)}$$

where M_w is mean of wet month, f_d is frequency of wet month and T is total time of the research (years).

$$Q = \frac{M_d}{M_w} \times 100\% \quad (3)$$

Where

Q (%)	Climate type
$0.0 < Q < 14.3$	A
$14.5 < Q < 33.3$	B
$33.3 < Q < 60.0$	C
$60.0 < Q < 100.0$	D
$100.0 < Q < 167.0$	E
$167.0 < Q < 300.0$	F
$300.0 < Q < 700.0$	G
$Q > 700.0$	H

Climate determination refers to Schmidt and Ferguson (1952), which is based on dry months and wet months with the following criteria: dry months are defined when rainfall in one month is between 0 mm to 60 mm, humid months when rainfall is between 60 mm and 100 mm and wet months when rainfall in a month is more than 100 mm. The basic calculations used in this study are as follows:

Time Series Analysis

Forecasting climatology and rainfall parameters in May 2018 to April 2021 used Autoregressive Integrated Moving Average (ARIMA) modeling. Forecasting is a prediction of the values of a variable based on the known value of the variable or related variable (Makridakis, 1999). Forecasting techniques or methods vary widely, depending on the pattern or behavior of the data and the purpose of forecasting. There are two methods in forecasting, they are quantitative forecasting and qualitative forecasting. Quantitative forecasting consists of time series and causal methods while qualitative forecasting consists of exploratory and normative methods (Makridakis, 1999).

Autoregressive Integrated Moving Average (ARIMA) Modelling

The ARIMA method fully utilizes past data for accurate short-term forecasting. However, this method can only be used on univariate data. This means that this method only involves one

variable. Whereas in reality, a variable can be influenced by other variables outside that variable. ARIMA is often also called the Box-Jenkins method which is a method that has several assumptions that must be fulfilled, one of which is data stationary, both in average and in variance. If the data is not stationary in the average, it can be overcome by performing differencing, whereas if it is not stationary in variance it is overcome by transformation.
General equation Autoregressive (AR) order p or ARIMA(p,0,0):

$$X_t = \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + a_t. \qquad \textbf{(4)}$$

General equation Moving Average (MA) order q or ARIMA(0,0,q):

$$X_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q}.$$

General equation ARMA order (p,q) or ARIMA(p,0,q):

$$X_t = \phi_1 X_{t-1} + \cdots + \phi_p X_{t-p} + a_t - \theta_1 a_{t-1} - \cdots - \theta_q a_{t-q}$$
$$\phi_p(B) X_t = (1 - \theta_q(B)) a_t.$$

General equation ARIMA (p,d,q) (Wei, 2006):

$$\phi_p(B)(1-B)^d X_t = \theta_q(B) a_t$$

with

$$\phi_p(B) = 1 - \phi_1(B) - \phi_2(B)^2 - \cdots - \phi_p(B)^p$$
$$\theta_q(B) = 1 - \theta_1(B) - \theta_2(B)^2 - \cdots - \theta_q(B)^q$$

where p, d, q are order AR, differencing and MA non-seasonal; X_t is stasionery time series; ϕ_p is autoregressive model coefficient; $(1-B)^d$ is non-seasonal differencing order; θ_q is moving average model coefficient; and a_t is residual.

The autocorrelation coefficient (ACF) is a periodic correlation for the periodic series itself with a difference of time (lag) 0, 1, 2 or more, here is the equation:

$$\hat{\rho}_{kk} = \frac{\sum_{t=1}^{n-k} (x_t - \bar{x})(x_{t+k} - \bar{x})}{\sum_{t=1}^{n-k} (x_t - \bar{x})^2}. \qquad \textbf{(5)}$$

While the partial autocorrelation (PACF) is a function that shows the amount of partial correlation between observations on time to-t with observations at previous times ($t-1, t-2, \ldots, t-k$).

The partial autocorrelation formula is:

$$\hat{\phi}_{kk} = \frac{\hat{\rho}_k - \sum_{j=1}^{n-k} \hat{\phi}_{k-1,j}\hat{\rho}_{k-j}}{1 - \sum_{j=1}^{n-k} \hat{\phi}_{k-1,j}\hat{\rho}_{k-j}}. \quad \textbf{(6)}$$

To forecast rainfall in May 2018 until April 2021, the transformer function test was used, which is the approach method used in the time series that is connected to one or more other time series. The function of transformers is a method that mixes time series approaches with a causal approach (Makridakis, 1999). The transformer function model has the following general models:

$$Y_t = v(B)X_t + N_t \quad \textbf{(7)}$$

where Y_t is output series, X_t is input series, N_t is the effect of a combination of all factors that affect Y_t and $v(B) = v_0 + v_1 B + v_2 B^2 + \cdots + v_k B^k$ with k is orde transformer.

The method used to forecast rainfall in 2021 uses the Multi Input Transfer Method (Makridakis, 1999). Multi Input Transfer uses the influence of other variables to predict the value of a variable. In this case, rainfall can be predicted by looking at the effects of air temperature, air humidity, air pressure and wind speed.

Results and Discussion

Climate Type in the Darmaraja District Area Before the Jatigede Dam was dammed

Based on the results of monitoring for 11 years in Darmaraja, Sumedang; daily rainfall ranged from 0 mm to 150 mm as presented in Figure 1(a) below, monthly rainfall between 0 mm to 705 mm and in Figure 1(b), annual average rainfall between 1,372.5 mm up to 4,002.5 mm, the lowest rainfall occurred in 1999 and the highest occurred in 1998.

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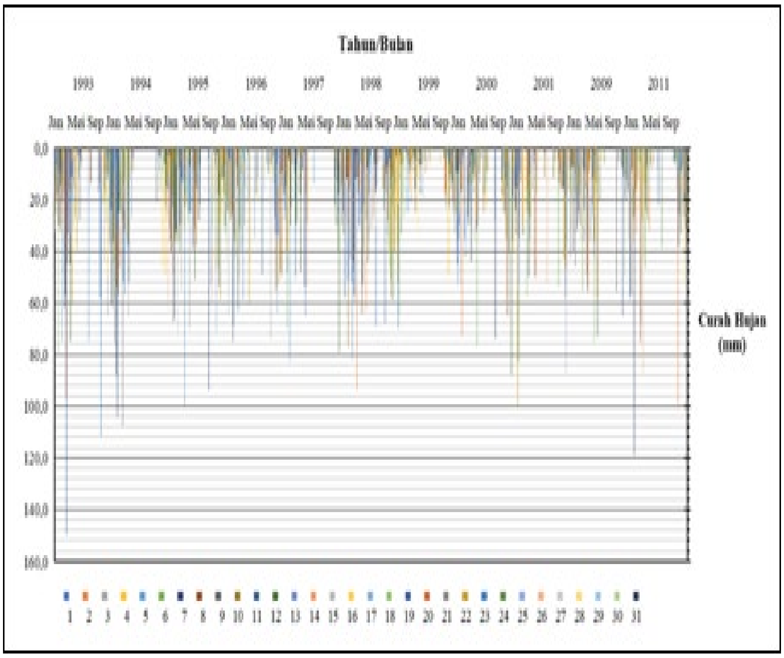
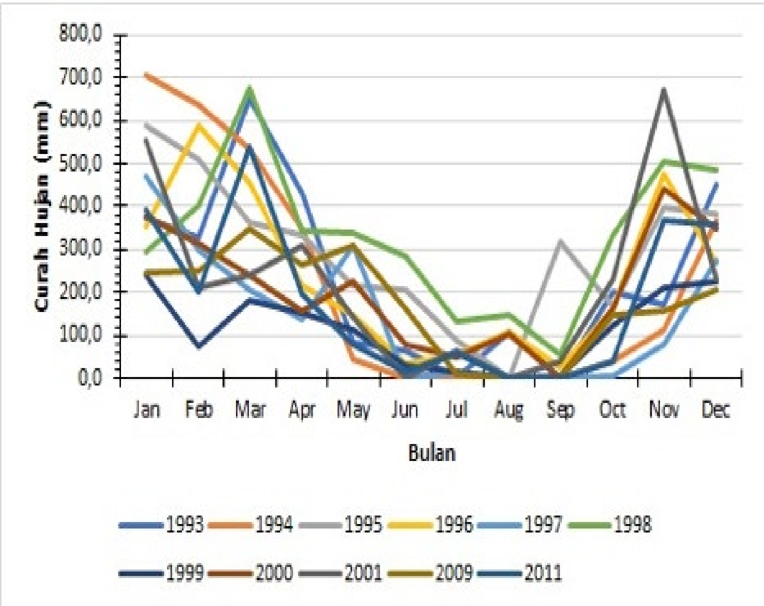
Figure 1. The rainfall in Darmaraja and its surroundings before the Jatigede Dam was dammed



(a) Daily Rainfall



(b) Monthly Rainfall

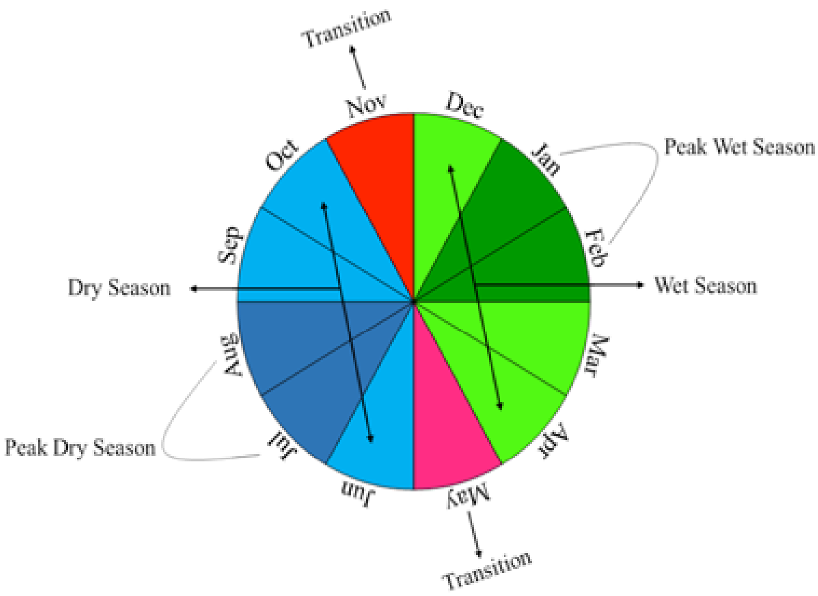
The results of the analysis of rainfall data for 11 years as presented in Figure 1(b) above show that rain patterns in the Darmaraja area before the dam is dammed are classified as type V pattern or monsoon (Ruminta, 2007). Rainfall patterns in Indonesia are known as type-V patterns or monsoon types, or rainfall with annual charts that form like the letter “V”. This means that the number of precipitates in Indonesia will increase during December-February and will decline during June-August. March-May and September-November are also known as the transition period. During this period, rainfall and wind conditions continue to change due to monsoons, which continues to shift due to the movement of heat sources (wind pressure). This is influenced by monsoons, which are winds blowing from the southwest of Asia and the wind blowing from the southeast of the Australian continent.

Table 1: Weather characteristics in Darmaraja before the Jatigede Dam is dammed

Season	**Rainfall (mm/month)**	**Time**	**Frequency (*f*)**	**Percentage (%)**	**Peak season**
Dry month/dry season	0-60	June-October	34	25.76	July, August
Humidity month/transition season	60-100	May-June, and November	7	5.30	-
Wet month/wet season	> 100	December-April	91	68.94	January, February
mean of dry month (M_d)	3.09				
mean of wet month (M_w)	8.27				
Ratio Q	37.36 %				

The result of the analysis using the Schmit and Ferguson method presented in Table 1 above show that dry months or dry seasons with rainfall between 0 mm to 60 mm occur between May and the end of October, the peak of the dry season occurs in July-August, the transition season from dry season to rainy season with rainfall between 60 mm to 100 mm occurs in November, wet month or rainy season with rainfall more than 100 mm occurs between December-April, the rainy-to-dry transition season with rainfall between 60 mm to 100 mm occurs in May-June. The results of this study indicate that the beginning of the dry month in Darmaraja has changed from April to May, as stated by Rafi'i, (2010). Southeast monsoon winds blow from April to October as depicted in Figure 2 below.

Figure 2. The Season Cycle in Jatigede before the dam is dammed



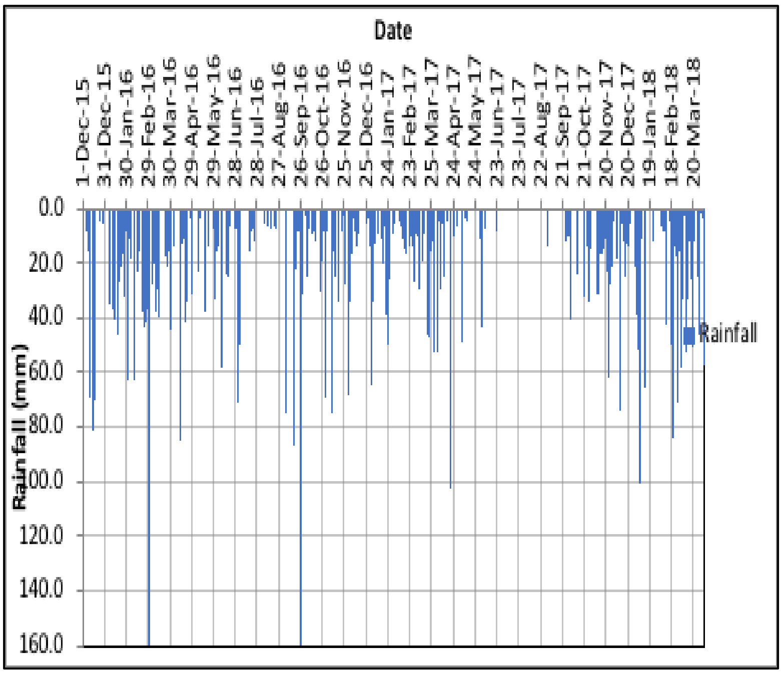
The result of the calculation of the average rainfall per year is 2.619.5 mm, the average dry month (M_d) 3.09, wet month (M_w) is 8.27, and the ratio between dry months and wet months (Q) is 37.36% (Table 1), it is the C Schmidt Ferguson climate type with moderate rainfall. The results of this study are similar to the results of Schmidt and Fergusons research in 1952 which conducted research at the same location for 20 years with the result climate type C (33.3% < Q < 60%). However, there are differences in annual rainfall, they are 3.175 mm, 3.5 mm of average dry month, 7.4 mm of wet month, Q value is 47.2% (Rafi'i, 2010). The results indicate that precipitation rainfall in Jatigede Dam decreases over time, and the number of wet months increases.

Climatological Parameter Characteristics After Jatigede Dam is dammed
Rainfall

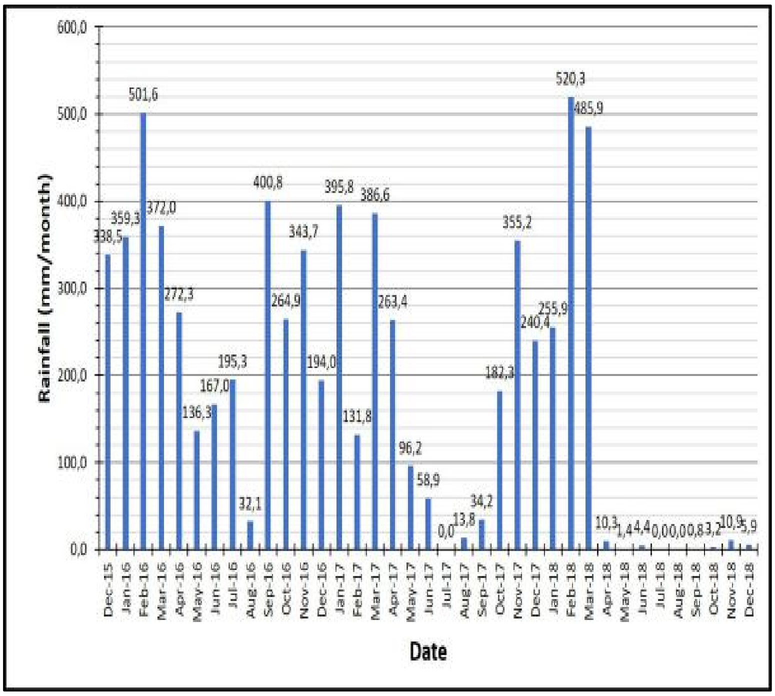
The result of weather monitoring at the Jatigede Reservoir climatology station, from December 1, 2015 to April 26, 2018 shows that daily rainfall fluctuates and shows a seasonal pattern.

The amount of rainfall per day fluctuates between 0-163 mm (Figure 3(a)). The highest rainfall occurred on September 26, 2016. The amount of monthly rainfall ranged from 0 mm to 520.3 mm (Figure 3(b)) with an average of 249.7 mm. The lowest rainfall occurs in July 2017, 0 rainfall means that in that month there is no rain. The highest rainfall occurred in February 2016 was 501.6 mm, rain fell by 19 days in one month. In January 2017 was 395.8 mm, rain fell by 19 days in one month. In February 2018 was 520.3 mm, it had rained for 22 days as presented in Figures 3(a) and 3(b) below.

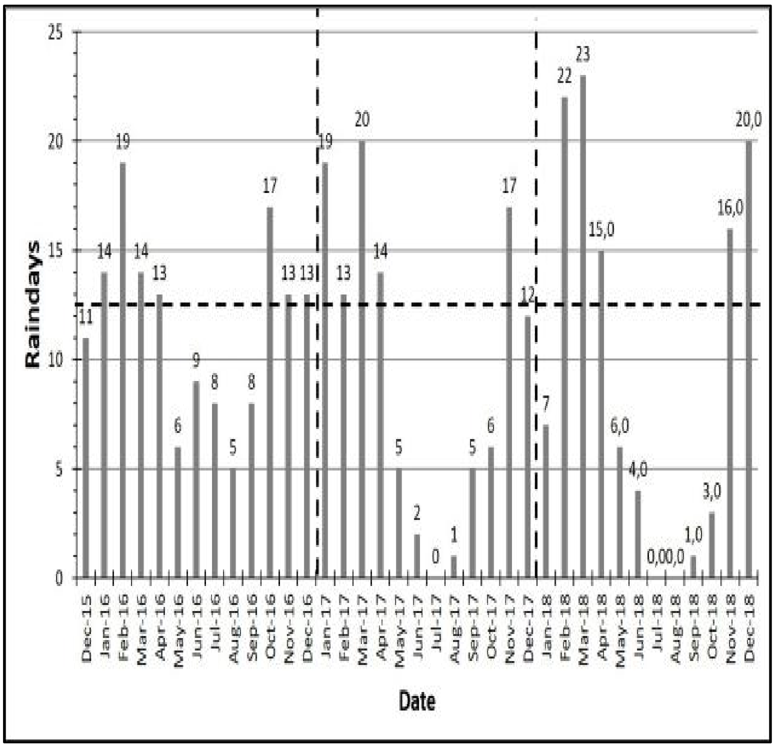
Figure 3. Rainfall in the Jatigede Dam after the Dam is dammed



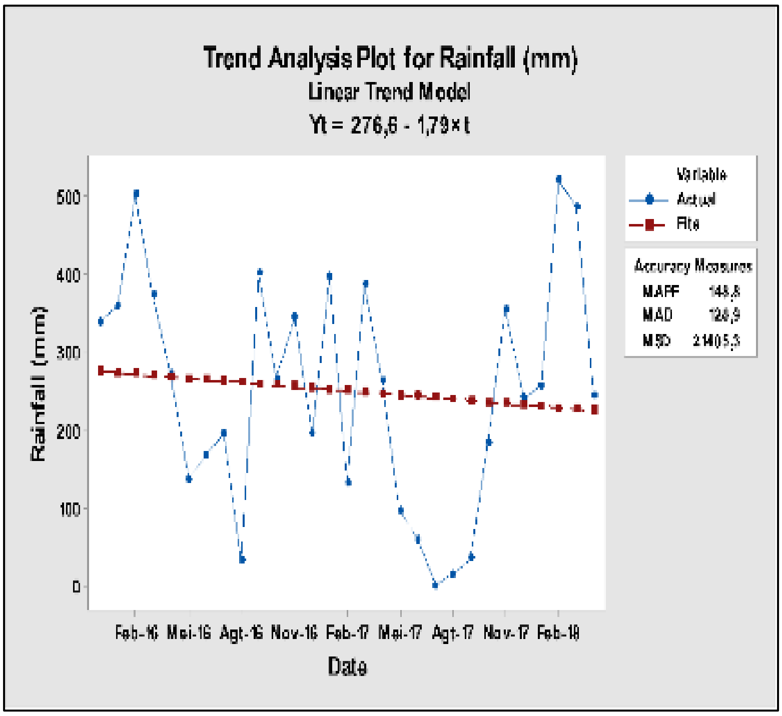
(a) Daily Rainfall



(b) Monthly Rainfall



(c) Sum of Monthly Raining Days



(d) Rainfall Trend

The high rainfall in February 2016, January 2017 and February 2018 was due to the timing, i.e. the peak season of the rainy season. Rafi'i states that the archipelago (Indonesia) is influenced by monsoons (Rafi'i, 2010). The wind that blows is the southwest wind that carries water vapor from the Indian Ocean. Season changes affect the direction of monsoons and rainfall. In January-February in Asia there is a winter with maximum air pressure. In that month the west monsoon blows which bring maximum rain in almost all of Indonesia. In July-September, Asia has minimum air pressure, while Australia is the center of maximum air pressure so that southeast monsoons blow from the continent of Australia to the continent of Asia, causing the dry season in Indonesia.

The highest number of rainy days in one month occurred in March 2018, it was 23 days with rainfall preservation was 485.9 mm. Meanwhile, in July 2017 there was no rain so that July was a dry month (Figure 3(b) and (c)).

In Figure 2(c), the number of rainy days in a month showed almost the same pattern between 2016 and 2017. In April to October there were fewer rainy days if compared to October to May. It proves that the climate in the Jatigede reservoir is influenced by the monsoon climate. Dry months with rainfall of 0-60 mm/month in 2016 occurred in August, while in 2017 occurred from June to September. Humid months with rainfall between 60-100 mm/month occurred in May and November 2017. Wet moons with rainfall more than 100 mm occurred in December to April. The number of wet months is relatively more compared to dry months. The results of the calculation of the amount of annual rainfall in 2016 were 3,239.3 mm, and in 2017 were 2,158.6 mm. This shows that rainfall precipitation has decreased by increasing time.

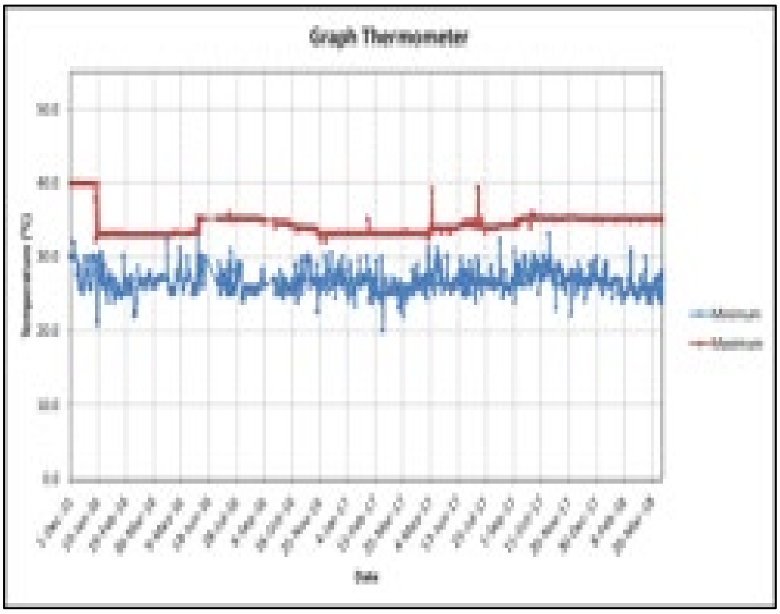
The trend between rainfall and time fluctuates, shows a seasonal pattern and tends to decrease. Rainfall in the rainy season between November and May precipitation is relatively high and the peak of the rainy season occurs in January and February. The dry season between April and October precipitation is low and the peak of the dry season occurs in July and August. The relationship between rainfall and time is formulated with the Linear Trend Model equation $Y_t = 276.6 - 1.79X_t$. Based on this equation, the average rainfall per month is 276.6 mm. Every time added rainfall in one month decreased by 1.79 mm (Figure 3(d)).

Air Temperature

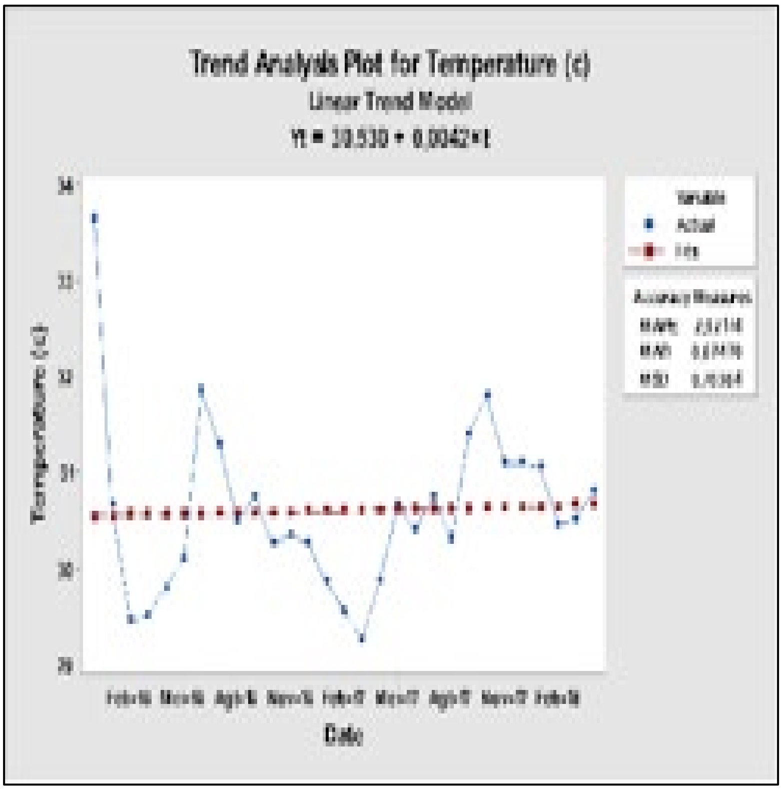
Daily air temperature in the Jatigede Dam fluctuates. The lowest temperature was 20 °C which occurred on January 10, 2016, the highest temperature was 40 °C which occurred on December 12, 2015 as presented in Figure 4(a) below. Everyday minimum and maximum temperatures are different. As happened on January 10, 2016, the minimum temperature was 20 °C and the maximum temperature was 39.8 °C. There was 19.8 °C temperature difference. The minimum temperature on December 12, 2015 was 29 °C and the maximum temperature was 40.0 °C and there was a temperature difference of 11 °C. There is a difference in air temperature during the day and night that can affect water temperature, activity of fish and other organisms.

Monitoring of results in Jatigede Dam found that the fish activity is low when the air and water temperature are low. This can be proven by the fact that there are fewer catches by fishermen, and usually fishermen are not successful when the water and air temperature are low and when the wind blows hard.

Figure 4. Air temperature in the Jatigede Dam after the dam is dammed



(a) Daily Air Temperature



(b) Air Temperature Trend

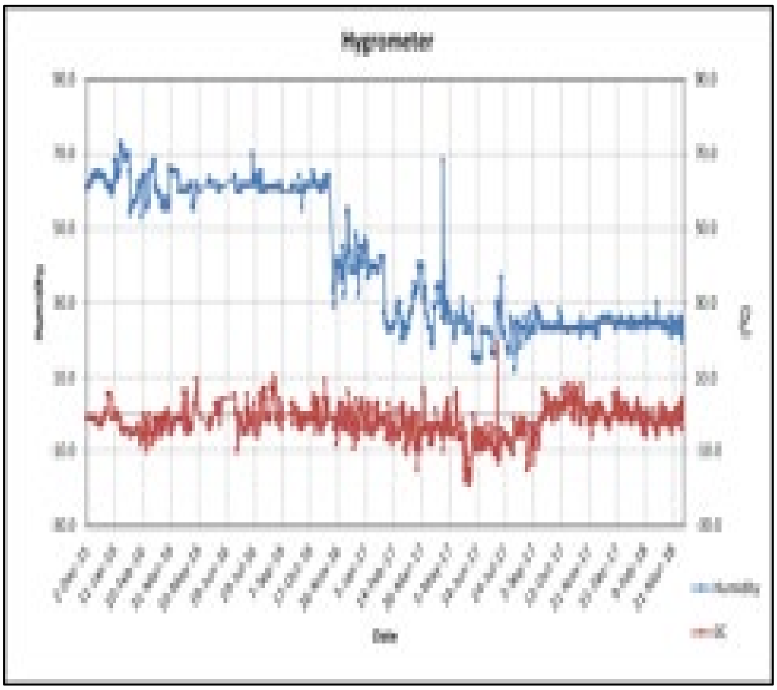
The relationship trend between air temperature and time fluctuates, and seasonal patterns occur and show an increasing but not significant trend, which is formulated with the Linear Trend Model equation $Y_t = 30.53 + 0.0042X_t$. Based on this equation, the average air temperature is 30.53 °C and every additional month, temperature rises by 0.0042 °C as shown in Figure 4(b) above. The increasing of air temperature around the dam is caused by the nature of water which is able to absorb heat from sunlight and is relatively more difficult to remove heat. The greater the volume of water contained in the reservoir, the more the temperature increases. The results of monitoring the maximum water volume in the Jatigede Dam from 2015 to 2018 at a maximum elevation of 250.68 masl are (gross) 649.905 × 106 m^3 with a water surface area of 3,176,241 hm^2.

Air Humidity

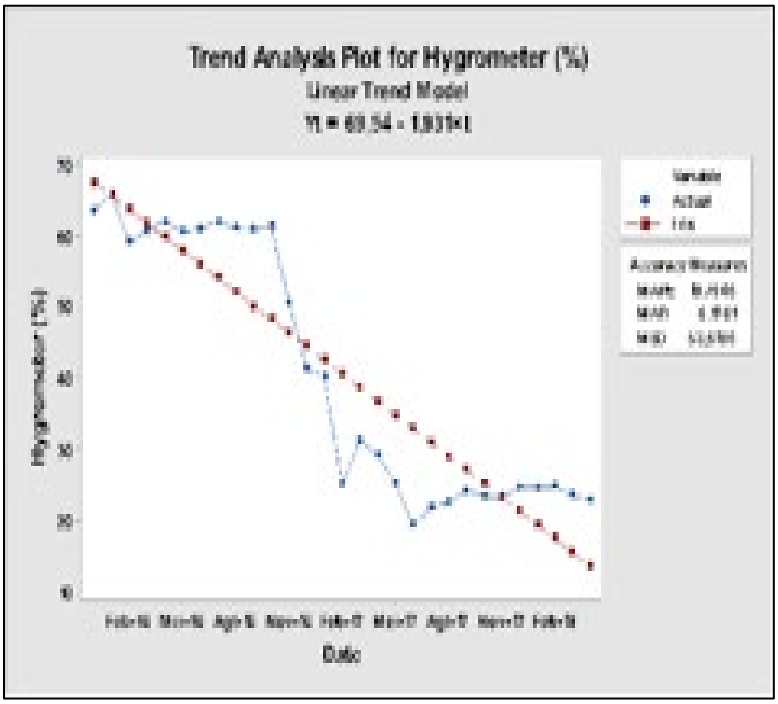
The air humidity in the Jatigede Dam has decreased. Daily air humidity ranges from 12.0%-73.0%. The lowest air humidity occurred on August 16, 2017 and the highest occurred on January 19, 2016. Figure 5(a) below shows that the air humidity at the initiation of dam functionality was stable with relatively high humidity between 59.2%-66.1%, and subsequently decreased in middle October 2016.

The decrease in humidity in the Jatigede Dam may be caused by evaporation of water vapor originating from the Jatigede Dam with a maximum surface area of 3,176,241 hm^2 and other mainland waters such as rivers, ponds, rice fields that cannot add air humidity to the troposphere layer. It is presumed that water vapor moves to another location due to the absence of media that hold evaporation water vapor such as trees and mountains around the dam. The environmental conditions around the dam are in the form of hills with land use in the form of mixed gardens. According to the Central Office of Cimanuk Cisanggarung River Region, forest areas and plantations that change function into Jatigede Dam have an area of 1,381 hectares consisting of 1,200 m^2 of dam area and 181 hectares of land are used as supporting facilities. The location is located in three sub-districts, they are Jatigede District which includes Cijeungjing Village, Jemah Village, Sukakersa Village and Ciranggem Village; Darmaraja Sub-District which includes Paku Alam Village; and Cisitu District, which includes Pajagan Village. The decrease in air humidity is evidenced by the increase in air temperature around the dam as presented in Figure 5(b) below.

Figure 5. Air humidity in Jatigede and its surroundings after the dam is dammed



(a) Daily Air Humidity



(b) Monthly Air Humidity Trend

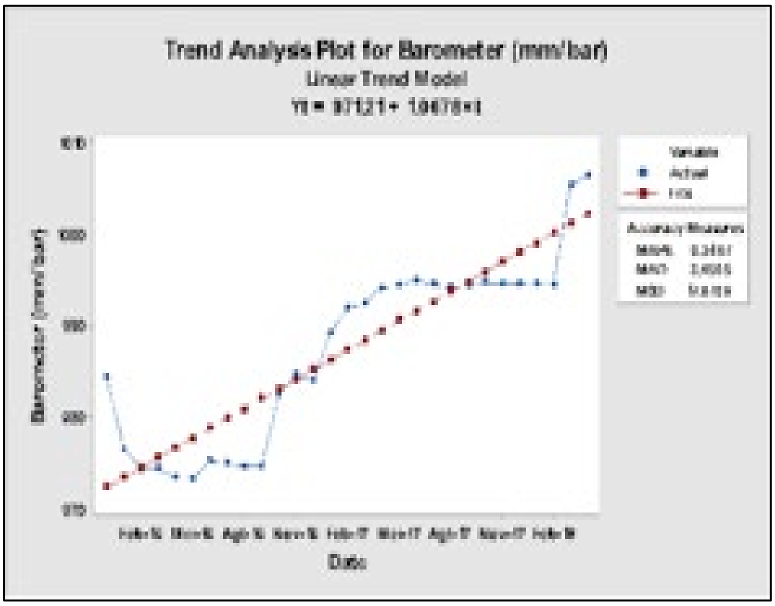
The trend of air humidity against time has a marked decrease formulated by the Linear Trend Model equation $Y_t = 69.54 - 1.93X_t$. Based on this equation, the average humidity of the air is 69.54% and for each addition of one month, air humidity is reduced by 1.93%.

Air Pressure

Trends between the air pressure and time increased when formulated with Linear Trend Model equation $Y_t = 971.21 + 1.0678X_t$ as presented in Figure 6(a) below. Based on this equation, the average air pressure is 971.21 mm/bar, every additional one month time the air pressure increases by 1.0678 mm/bar. Increased air pressure in the Jatigede Dam is not caused by increasing water vapor rather there is another factor as shown in the results of measurements of air humidity that have decreased with increasing time presented in Figure 6(b) below.

Figure 6. Air pressure in Jatigede and its surroundings after the dam is dammed

(a) Daily Air Pressure

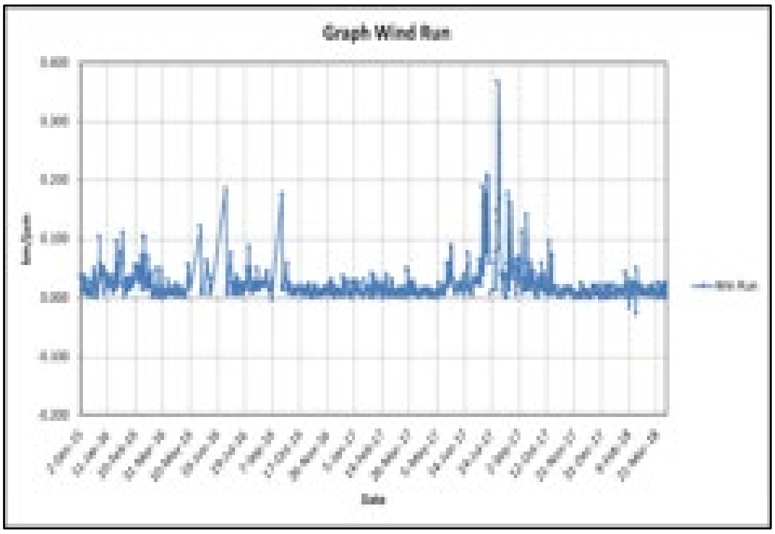


(b) Air Pressure Trend

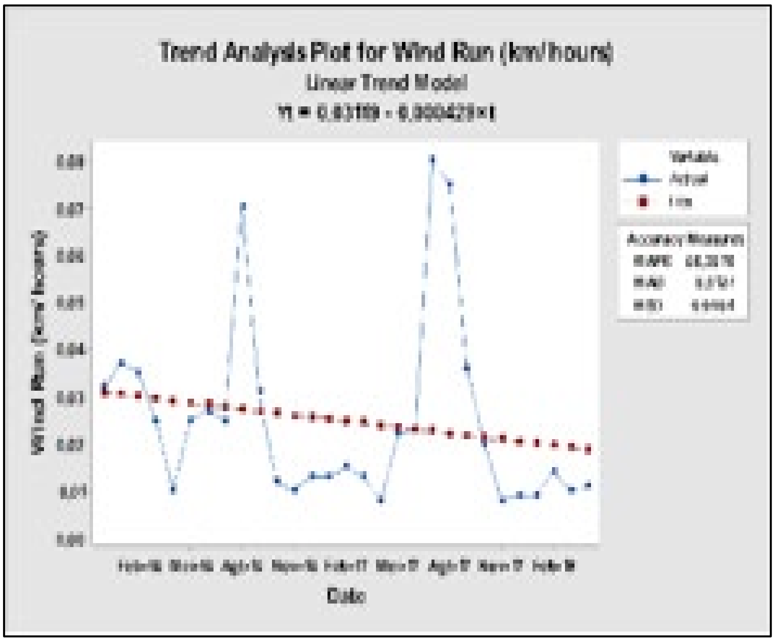
Wind Velocity

Daily wind velocity in the Jatigede Dam was between 0.0-0.4 km/hr, the biggest wind speed occured on August 2, 2017. In 2016 the wind blew from March to mid-October, and in 2017 from March to October. This shows that the wind blows in the dry season until the beginning of the rainy season as presented in Figure 7(a) below.

Figure 7. Wind velocity graph in Jatigede after the dam is dammed



(a) Daily Wind Velocity



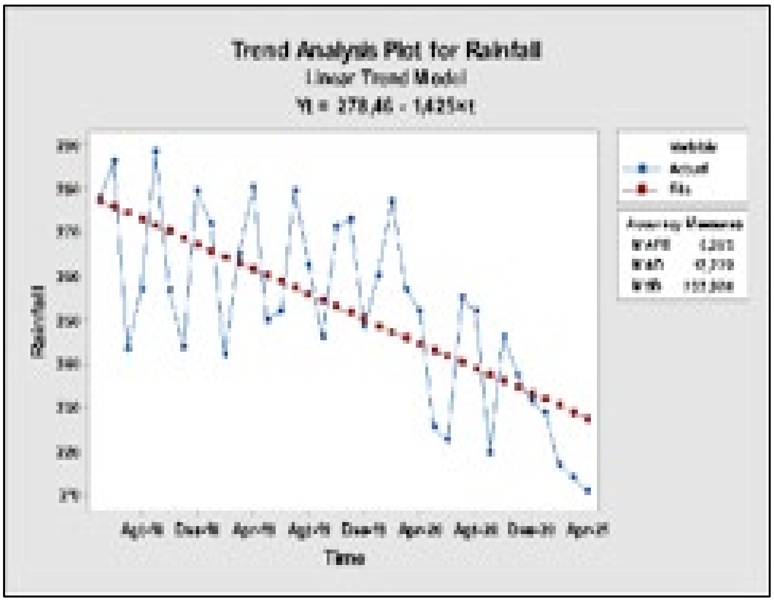
(b) Wind Velocity Trend

The velocity-to-time trend decreases which is formulated by the Linear Trend Model equation $Y_t = 0.03119 - 0.000429X_t$ presented in Figure 7(b) above. Based on this equation, the average wind velocity per month is 0.03119 km/hr. Every additional one month, the wind velocity decreases by 0,000429, the wind velocity becomes 0.03076 km/hr.

Rainfall Projections on May 2018 to April 2021

Using the Multi Input Transfer method (Makridakis, 1999), rainfall forecasts in the Jatigede Dam and its surroundings take into account the influence of climatological parameters such as air temperature, air humidity, air pressure and wind speed, May 2018 to April 2021, bulk minimum rainfall of 210.70 mm, maximum rainfall of 288.16 and an average of 252.11 mm/month and this is reflected in Figure 8 below.

Figure 8. Rainfall Projection in Jatigede Dam and its surroundings in May 2018 to April 2021



Based on Figure 8 above, the trend of rainfall decreases with increasing time. In May 2018 it was 277.64 mm to 210.70 mm in April 2021. This is in accordance with (Pawitan, 2010), Java, which has been decreasing compared to earlier last century, especially when it was lengthening, while the seasons varied spatially with some showing lower annual rainfall. Trends in seasonal rainfall changes implied proportional reduction in monthly rates for rivers in Java at rates between +0.8 and -8.3% by 2030 and between +1.3 and -13.8% by 2050. (Precipitation in parts of Indonesia, and in other areas of Indonesia will increase and may occur less during the critical times of the year (i.e., during the dry season) and more intense events which could lead to flooding). The decrease in rainfall in the Jatigede Dam is not only due to global climate change but also due to the decrease in air humidity, rising temperatures, suspected increase in air pressure due to the loss of 1.831 m2 of trees. The trigger for rain is trees.

The results of monitoring in the field in the context of the long dry season in June 2018 until the end of October 2018 were that there was a drastic decline in the water level in the Jatigede Reservoir which effected whether buildings and rice fields in the village of Cihideung, Darmaraja Sub-District were submerged in water. The decrease in water level causes loss of fish habitat and fishermen lose their livelihoods due to the absence of fishing grounds. In accordance with Wang et al., (2006) decreased rainfall during critical times of the year may translate into high drought risk, uncertain water availability, and consequently, uncertain ability to produce agricultural goods, economic instability, and drastically more undernourished people, hindering progress against poverty and food insecurity.

Conclusion

Based on the results of the study, it can be concluded that:

a) The climate in the Jatigede Dam and its surroundings is based on rainfall patterns including the monsoon climate type, and based on Schmidth Ferguson including climate type C (moderate rainfall), Q = 37.38%. The dry season occurs in June to October with the peak of the dry season in July and August. The rainy season occurs from December to April, the peak of the rainy season in January and February. The transition season occurs in November and May, the average annual rainfall is 2,619.5 mm.
b) The characteristics of weather parameters in the Jatigede Dam are different. Rainfall fluctuates according to seasonal patterns and tends to decrease. The average rainfall per month is 276.6 mm. Air humidity has decreased significantly, the average air humidity per month is 69.54%. The air temperature fluctuates according to the seasonal pattern and tends to increase, on average the air temperature per month is 30.53 °C. Air pressure has increased significantly, the average air pressure per month is 971.21 mm/bar. Fluctuating wind speed follows a seasonal pattern and tends to decrease, the average monthly wind speed is 0.03119 km/hr.
c) Monthly rainfall projection from May 2018 to April 2021 has decreased, with minimum rainfall 210.70 mm, maximum 288.16 and average 252.11 mm.

Recommendation

Rainfall in the Jatigede Dam and its surroundings continues to decline which is predicted to have an impact on the volume and surface area of the dam, therefore the following recommendations are made as a result of this research:

a) Reforestation at the edge of the dam and its surroundings must consider climate type.
b) In determining the zoning of the use of waters for fisheries, it is necessary to consider the peak of the dry season in July and August and fishing regulations so that the propogation of fish native to the Cimanuk River is sustainable.

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