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| **EFFECT OF CLIMATE CHANGE ON THE AVAILABILITY OF RIVER WATER IN THE VILLAGE KRANJI DISTRICT PEKALONGAN** **Naelatul Karimah🖂, Ian Yulianti, and Fianti**

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## **INTRODUCTION**

Several springs which are now the source of water for PDAM Pekalongan Regency, one of which is river water in Kranji Village, Kedungwuni Timur District, Pekalongan Regency, has decreased in quantity and quality. Preliminary observation data from BMKG indicate that the flow rate of water in river water has decreased by up to 60% compared to the initial state. The problem of water availability vulnerability in Kranji Village is indicated by a significant decrease in river water flow. This reduced discharge has the potential to make it difficult to meet the needs of clean water or drinking water for community consumption in Kranji village. If there is no effort to protect and repair water sources, it is certain that this decrease in discharge will continue until it reaches a critical condition, where there is no longer water source that can be taken.

Based on the 2007 IPCC Report, it is stated that climate change is characterized by changes in several climate parameters or events, including: (a) Changes in the earth's surface temperature, (b) Changes in rainfall, (c) Changes in extreme weather events, (d) Changes in cover ice/snow, and (e) Changes in sea level (Rejekiningrum, 2014). Analysis of climate change (*climate change*) is carried out because it sees the magnitude of the impact resulting from climate change on the availability of natural resources (SDA). As an example for Indonesia as a whole, a study conducted by WWF ((Hansen et al., 2012) shows that in this 100 year period there has been an increase in the average annual temperature of up to 0.72-3.92°C accompanied by a decrease in rain precipitation of up to 2-3%. The study also showed that in the southern part of Indonesia has been a shift in the rainy season more than one month later with the increase of rainfall intensity up to 10% in the rainy season and a 75% decrease in the intensity of rainfall in the dry season.

The problem of vulnerability river water in Kranji Village can be affected by climate change. In order to understand this problem, a preliminary study on the condition of water sources is needed. A preliminary study is carried out by collecting adequate information on the condition of existing water sources and infrastructure for the provision of clean water / water drinking water by PDAM. The information was obtained from secondary data, namely collect all information and data from BMKG Pekalongan Regency. In the concept of hydrological analysis, it is explained that rain data analysis is carried out to obtain more accurate and clear data regarding rainwater intensity, duration, net rainfall, flood probability and design flood discharge with statistical tests. (Asdak, 2018). In the concept of regional average rain, it is explained that by measuring or recording rain, only rainfall is obtained at a certain (*pointpoint rainfall*). If in an area there are several measuring devices or rainfall recording devices, then to get the price of regional rainfall (*rainfall area*) is to take the average price (Spear et al., 2018).

In the design rainfall concept, it is explained that the quantity used as the design load is the annual maximum daily rain, which is the largest rainfall in a year that falls within 24 hours (Pryor, 2013). In the science of probability introduced the concept of probability of being exceeded, namely the probability of an event equal to or exceeding a set value and analysis of the *return period.* In the design flood concept, it is explained that frequency analysis can be carried out with data series obtained from recorded data, both rain data and discharge data. This analysis is often considered the best method of analysis, because it is carried out on directly measured data that does not go through the transfer first (Ferijal et al., 2016).

## **METHOD**

This research was conducted to collect data and information regarding the condition of existing water sources and infrastructure for the provision of clean water/drinking water by PDAM. The information was obtained from secondary data, namely data from BMKG. In conducting this research, several steps such as Figure 1. The sequencing of the stages, namely: literature and preliminary studies, analysis of climate change consisting of the analysis of rainfall data andanalysis, surface flow *supply*

**Figure 1.** Flow chart

Literature review and preliminary study

Weather change analysis

Rain data analysis

Surface flow analysis

Existing supply (water availability)

Supply (ater availability) due to weather changes

Discussion

**RESULTS AND DISCUSSION**

1. **Rain Data Analysis**

Rain data analysis is to analyze daily rainfall data to estimate the maximum daily rainfall with a certain return period (McCarthy et al., 2001). The maximum daily rainfall data with a certain return period is then used to estimate the magnitude of the planned flood. The magnitude of the design flood is used to estimate the amount of flood discharge in the river.

In Table 1, we get data on the area of ​​the watershed in the Kedungwuni Timur District, Pekalongan Regency by taking one data for each village. From several areas of river flow in the Kedungwuni Timur District, Pekalongan Regency, one of which is the area of ​​the river flow in Kranji village which has an area of 33.85 km2.

**Table 1.** The area of ​​the watershed in the East Kedungwuni District, East Pekalongan Regency.

|  |  |  |
| --- | --- | --- |
| **No** | **Nama Watershed Area** | **L (km2)** |
| 1 | Kranji  | 33.85 |
| 2 | Prawasan | 18.78 |
| 3 | Sidodadi | 28.24 |
| 4 | Rogobayan | 17.39 |
| 5 | Capgawen | 23.73 |
| 6 | Gembong | 34.54 |
| 7 | Amboekembang | 21.63 |
| 8 | Paesan | 25.80 |
| 9 | Surobayan | 24.21 |
| 10 | Tangkil | 13.54 |

**2. Maximum Daily Rain**

The rain data used is the data for recording daily rain height for the last 10 years from several rain recording stations located in the study area. The data is then analyzed to obtain the maximum daily rainfall that represents the area of ​​each watershed. To obtain the amount of regional rainfall, the Thiessen Polygon Method is used, where the location is plotted on a scale map.

**3. Design Rain**

Design rain is the maximum daily rainfall that is expected to occur only once in a certain period of time, for example 5 years or 10 years. Design rain was obtained based on statistical analysis of the maximum daily rainfall data representing the area of ​​each watershed (Soewarno, 1991). Rain data analysis is usually used Gumbell probability distribution or Log-Pearson Type III probability distribution. In this study only the Log-Pearson Type III probability distribution will be used, because from various applications this method usually gives good results. In Table 2, the maximum daily rainfall data is generated and Table 3 is the design rainfall calculation.

**Table 2.** Maximum daily rainfall data for Kranji Village, Kedungwuni District, Pekalongan Regency

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Daily Weather (mm)** | **Thiesen Koef.** | **Reinfall Region (mm)** |
| 2011 |  115 | 0.2000 | 82.7 |
| 2012 |  175 | 0.2000 | 89.7 |
| 2013 |  133 | 0.2000 | 80.6 |
| 2014 |  69 | 0.2000 | 85.3 |
| 2015 |  117 | 0.2000 | 122.2 |
| 2016 |  108 | 0.2000 | 125.2 |
| 2017 |  77 | 0.2000 | 96.9 |
| 2018 |  88 | 0.2000 | 95.6 |
| 2019 |  113 | 0.2000 | 78.8 |
| 2020 |  115 | 0.2000 | 91.8 |

The maximum daily rainfall data in Table 2 in the Kranji Village area, Kedungwuni District, Pekalongan Regency produces rainfall data, thiesen coefficient, and regional rainfall from 2011 to 2020. The rainfall experienced from 2011-2020 experiences changes up and down in rainfall rates. rain. The value of the Thiesen coefficient is 0.2000. Rainfall in the Kranji Village area, Kedungwuni Timur District, Pekalongan Regency from 2011-2016 experienced fluctuations in regional rainfall figures. However, in 2017-2020 the rainfall rate in the region decreased to 91.8 mm. From the maximum rainfall data for 2011-2020, it can be seen that the availability of river water in Kranji Village, Kedungwuni District, Pekalongan Regency has decreased, resulting in reduced water availability in the village.

**Table 3.** Design rainfall data in the Kranji Village area, Kedungwuni District, Pekalongan Regency

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **No** | **ear** | **Xi (mm/day)** | **Log Xi** | **(Log Xi – Log X)2** | **(Log Xi – Log X)2** |
| 1 | 2011 | 82.7 | 1.9175 | 0.0029 | -0.0002 |
| 2 | 2012 | 89.7 | 1.9526 | 0.0004 | 0.0000 |
| 3 | 2013 | 80.6 | 1.9061 | 0.0043 | -0.0003 |
| 4 | 2014 | 85.3 | 1.9309 | 0.0017 | -0.0001 |
| 5 | 2015 | 122.2 | 2.0869 | 0.0133 | 0.0015 |
| 6 | 2016 | 125.2 | 2.0974 | 0.0158 | 0.0020 |
| 7 | 2017 | 96.9 | 1.9863 | 0.0002 | 0.0000 |
| 8 | 2018 | 95.6 | 1.9805 | 0.0001 | 0.0000 |
| 9 | 2019 | 78.8 | 1.8963 | 0.0057 | -0.0004 |
| 10 | 2020 | 91.8 | 1.9626 | 0.0001 | 0.0000 |
| Total | 948.5 | 19.717 | 0.04442 | 0.00257 |
| Average Log Xi = Log X | 1.972 |  |  |
| Coefficent of Asymmetry Log, Cs = | 1.031 |  |  |
| Standart Deviation Log, s log X = | 0.070 |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Repeat Period (T) (year)** | **P (%)** | **K** | **S kog x** | **K\*( S kog x)** | **Log X rerata** | **Log X*ϒ*** | **X*ϒ* (mm/day)** |
| **[1]** | **[2]** | **[3]** | **[4]** | **[5]** | **[6]** | **[7]** | **[8]** | **[9]** |
| 1 | 1.01 | 99.0 | -1.5666 | 0.070 | 0.1101 | 1.972 | 1.8617 | 72.72 |
| 2 | 2 | 50 | -0.1689 | 0.070 | -0.0119 | 1.972 | 1.9598 | 91.17 |
| 3 | 5 | 20 | 0.7540 | 0.070 | 0.0530 | 1.972 | 2.0247 | 105.85 |
| 4 | 10 | 10 | 1.3403 | 0.070 | 0.0942 | 1.972 | 2.0659 | 116.38 |
| 5 | 25 | 4 | 2.0317 | 0.070 | 0.1427 | 1.972 | 2.1144 | 130.15 |
| 6 | 50 | 2 | 2.5552 | 0.070 | 0.1795 | 1.972 | 2.1512 | 141.65 |
| 7 | 100 | 1 | 3.0419 | 0.070 | 0.2137 | 1.972 | 2.1854 | 153.25 |
| 8 | 200 | 0.5 | 3.5153 | 0.070 | 0.2470 | 1.972 | 2.2187 | 165.45 |
| 9 | 1000 | 0.1 | 4.5829 | 0.070 | 0.3219 | 1.972 | 2.2937 | 196.63 |
| Description: |
| [2] = repeat peiode (year) [6] = [4] \* [5] |
| [3] = probability (%) [7] = logarithmic mean value |
| [4] = frequencyfactor K (Log-person III table ) [8] = [6] + [7] |
| [5] = logarithmic standard deviation [9] = Antilog [8] |

From Table 4 the design rainfall data in thearea, Kranji VillageKedungwuni District, Pekalongan Regency from 2011-2020 has an average Log X of 1,972. The asymmetry coefficient of Log, Cs is 1.031 and the standard deviation of Log, s log X is 0.070. The design rain data gets repeated words. Probability, K frequency factor generated from the Person III log table, and the logarithmic mean value.

**4. Potential Surface Flow Surface**

Runoff in question is rainwater that falls and flows on the surface and enters the river into a river flow. So the flow of the river comes from surface runoff *(surfacerun* off) coupled with the flow *(interflow)* that flow of river water seepage from the ground. The combination of *surface run off* and *interflow is* referred to as*direct run off*. In rivers, the *direct run off* mixes with the base flow from the spring *(base flow*), so that the river discharge will be calculated as the total amount between *direct run off* and *base flow*. What will be analyzed in this study is surface runoff which is the largest flow caused by design rain with a certain return period, resulting in a design flood discharge. This design flood discharge can later be used as a basis for designing river protection buildings or other buildings around the river that are affected by river flow.

**5. Potential of River Water for Clean Water in Kranji Village**

To estimate the availability of surface water as a water source, it can be done by estimating the magnitude of the river's mainstay discharge (Rahmawati & Noerhayati, 2015). The river mainstay discharge is the minimum discharge that is estimated to always exist (flow) in the river with a certain level of confidence which is basically obtained from statistical analysis of daily rain data and the condition of the relevant watershed (Muhammed et al., 2004).

The mainstay river discharge can be analyzed using the NRECA method or the method developed by FJ Mock based on the condition of rivers in Indonesia. In this study, the FJ Mock method was used. The data used to analyze the mainstay discharge with the FJ Mock method are daily rainfall data, the number of rainy days per month, evapotranspiration data which is usually analyzed by the Penmann method, data on watershed area and land cover conditions.

The amount of evapotranspiration was analyzed by the Penmann method. The data needed for evapotranspiration analysis required for evapotranspiration analysis using the method Penmannare data on daily average temperature, air humidity, average hours of sunshine, and other data so that the daily evapotranspiration is obtained. The evapotranspiration data is then used for mainstay discharge analysis as well as the amount of infiltration that will become groundwater reserves. Other watersheds and subsequent years were analyzed to obtain the magnitude of the mainstay discharge and the volume of incoming water as groundwater reserves each year from 2011 to 2020. In Table 3, data are produced on the mainstay discharge and the volume of river surface water in Kranji village in 2001-2021.

## **CONCLUSION**

The five-tier diagnostic test is a five-level multiple-choice test consisting of the first tier, which is a multiple choice conceptual question with five answer choices, the second tier is the level of confidence in the answer to the selected answer on the first tier, third tier, namely four choices of answer reasons with one open reason, fourth tier is the level of confidence in the correctness of the reasons for answers, tier five in the form of belief in the existence of a cause-and-effect relationship (correlation) between answers and reasons for answers. Expert validity test and instrument feasibility level obtained that the assessment developed was valid and met the eligibility requirements. The profile of students' conceptual understanding in maritime-based schools was 23.9% of students understood concepts, 33.5% of students did not understand concepts, and 38.8% of students had misconceptions. The most dominant misconception is that the deeper a point in the fluid is, the greater the buoyancy experienced.This student misconception is influenced by the conceptual appreciation and intuition in daily life.

|  |  |  |
| --- | --- | --- |
| **Year** | Mainstay discharge (m3/detik) | Water surface volume(x 109 m3) |
| **2011** | 136.30 | 145. 64 |
| **2012****2013****2014****2015****2016****2017****2018****2019****2020** | 4.30133.71137.07149.45145.82146.05246.12174.405.50 | 4.594.224.324.714.604.617.76155.584.91 |

In 2011 the mainstay discharge was 136.30 m3/second and the surface water volume was 4.30×109 m3, in 2012 the reliable discharge was 145.64 m3/second and the surface water volume was 4.59×109 m3, in 2013 the reliable discharge was 133.71 m3/second and the surface water volume was 4.22×109 m3, in 2014 the reliable discharge was 137.07 m3/second and the surface water volume is 4.32×109 m3, in 2015 the reliable discharge was 149.45 m3/second and thewater volume was surface4.71×109 m3, in 2016 the reliable discharge was 145.82 m3/second and the surface water volume 4.60×109 m3, 2017 produced a reliable discharge of 146.05 m3/second and a surface water volume of 4. 61×109 m3, in 2018 the reliable discharge was 246.12 m3/second and the surface water volume was 7.76×109 m3, in 2019 the reliable discharge was 174.40 m3/second and the surface water volume was 5.50×109 m3, 2020 produced a reliable discharge of 155.58 m3/second and a surface water volume of 4.91×109 m3.

Based on the analysis of changes in surface water volume from 2011 to 2020, it can be predicted that the volume of river water in Kranji village for the next 20 years. the amount of surface water has increased to 19% in the 10th year, reached 28.5% in the 15th year and reached 39% in the 20th year.

**CONCLUSION**

After conducting research on the effect of climate change on the availability of river water in Kranji Village, Kedungwuni Timur District, Pekalongan Regency, the following conclusions can be drawn:

1. The current condition of water availability in Kranji Village, Kedungwuni Timur District, Pekalongan Regency is indicated to be able to meet existing needs. Nevertheless, it is seen that there is a decrease in discharge which could potentially lead to insufficient raw water needs in the future.

2. With climate change on the water crisis, it can lead to potential floods and droughts in Kranji Village, Kedungwuni Timur District, Pekalongan Regency. With a topography of mountainous and hilly areas, the area in Kranji Village, Kedungwuni Timur District, Pekalongan Regency does not have problems with potential seawater intrusion and sea level rise caused by climate change, however in some areas there are indications of potential landslides that can be caused by a long rainy season.

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