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Changes in rainfall and discharge in Saddang Watershed, South Sulawesi, Indonesia

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Abstract. Climate change occurred in Indonesia has a great impact. It can be indicated by the changes of seasons, rainfall patterns, and temperature. Changes in rainfall patterns may result in seasonal shifts. The purpose of this study is to identify changes in rainfall and discharge on Saddang Watershed, including Buntu Batu River, Mata Allo River, and Pekkabata River. The method used is to collect rainfall data and debit to analyzed by regression analysis. As the result of the study, it is found that rainfall on the River Buntu Batu has decreased during the last 6 years. Beside that, rainfall on Mata Allo River also has decreased over the last 10 years and has experienced a decrease over the past 10 years. Rainfall on Pekkabata River also has decreased over the last 10 years and has experienced a decrease in discharge over the past 10 years. Overall, the rainfall on Saddang River has decreased over the past 10 years and has experienced a decrease in discharge over the past 10 years.

1. Introduction

Climate change is a global issue that has begun to become the topic of world-wide conversation since the Earth Summit in Rio de Janeiro, Brazil in 1992. Increasing concentrations of carbon dioxide and other Greenhouse Gases in the atmosphere are the main causes of climate changes. [1] state that the potential impacts of climate change are rising temperatures, rising sea levels and changing rainfall patterns. Intergovernmental Panel on Climate Change (IPCC) reviews that conditions of global and regional change periodically [2, 3, 4], as well as the forecasting of climate change in the future.

Climate change in Indonesia is generally characterized by daily temperature changes, rainfall patterns, sea level and climate variability. The change has caused air temperature enhancement and global rainfall characteristics. Climate change also cause the change of rainfall patterns that affect the season beginning. Dry season will last longer which leads to drought disaster, lowering the productivity. Meanwhile the rainy season will occur in a short time with a tendency of rainfall intensity higher than normal rainfall, which causes floods and landslides [5]. The rainfall changes are different in each place generally, even changes in a location experience different patterns. Ratag [6] analyzed the rain patterns change of 1900 – 2000 for the rainy season in September – October – November. It turns out that the intensity of the rain turned higher due to the amount of rain getting shorter in a year, and it's predicted to continue in the future.



Indonesia's climate variability is closely related to ENSO (El Niño Southern Oscillation) in Pacific Ocean [7, 8] and IOD (Indian Ocean Dipole) in Hindia Ocean [9, 10, 11, 12]. El Nino is indicated by rainfall decrease and the increase of air temperature, meanwhile La Nina stimulates the increase of rainfall over normal rainfall. [1] states that the rain pattern is one of the indicators of global climate change, it can be concluded that global climate change has occurred in Indonesia today. The change of rainfall pattern and the change of rainfall intensity that occurred become the basis of the research by collecting the rainfall data for 10 years and the discharge data for 10 years.

2. Methodology of Study

The location of the research is in Saddang River. Saddang River is one of the largest river in Saddang Watershed. Saddang Watershed area is 6.848,20 Km², the average length of the river is 189,5 Km, averages width of the river is 80 m and has 294 tributaries. There are 3 research locations that have been implemented, the first is Buntu Batu River, the second is Mata Allo River and the third is Pekkabata River. Can be seen in figure 1.

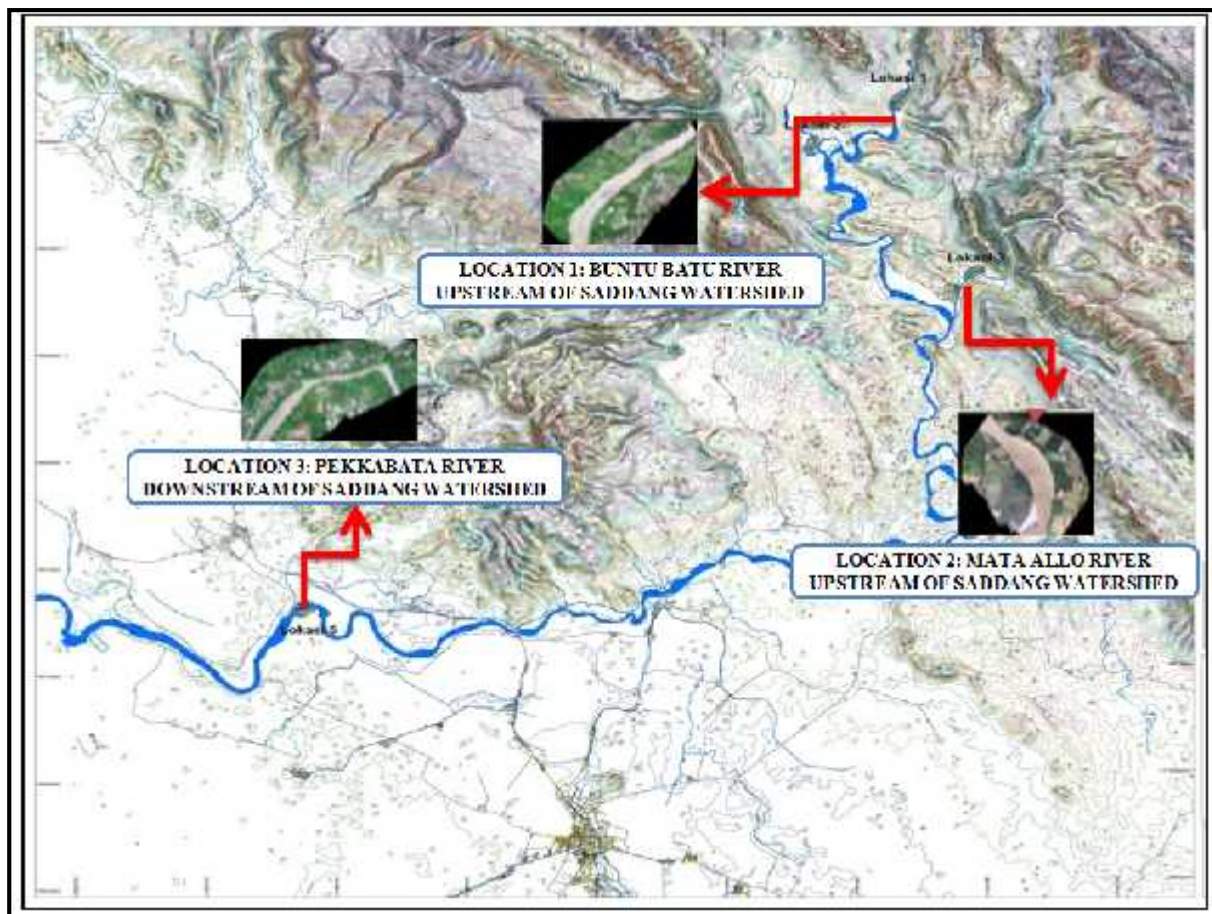


Figure 1. Saddang River research location.

Research activities conducted by the flow diagram as in figure 2.

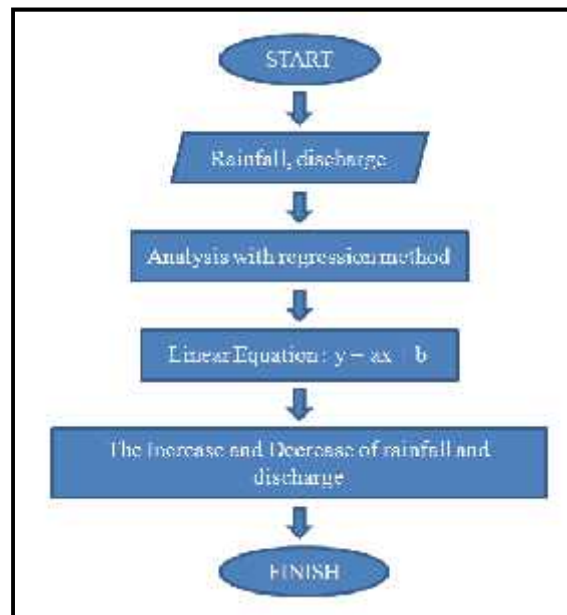


Figure 2. Research flow diagram.

3. Result of Study and Discussion

The location of the research is at 3 points on Saddang River. 1). Buntu Batu River, 2). Mata Allo River and 3). Pekkabata River.

3.1. Buntu Batu River

The Buntu Batu River is the upstream part of the Saddang Watershed. By using rainfall data from 2011-2016. The graph was made by processing data from the results of the average recapitulation per month. By using regression analysis obtained regression and rainfall graph in figure 3.

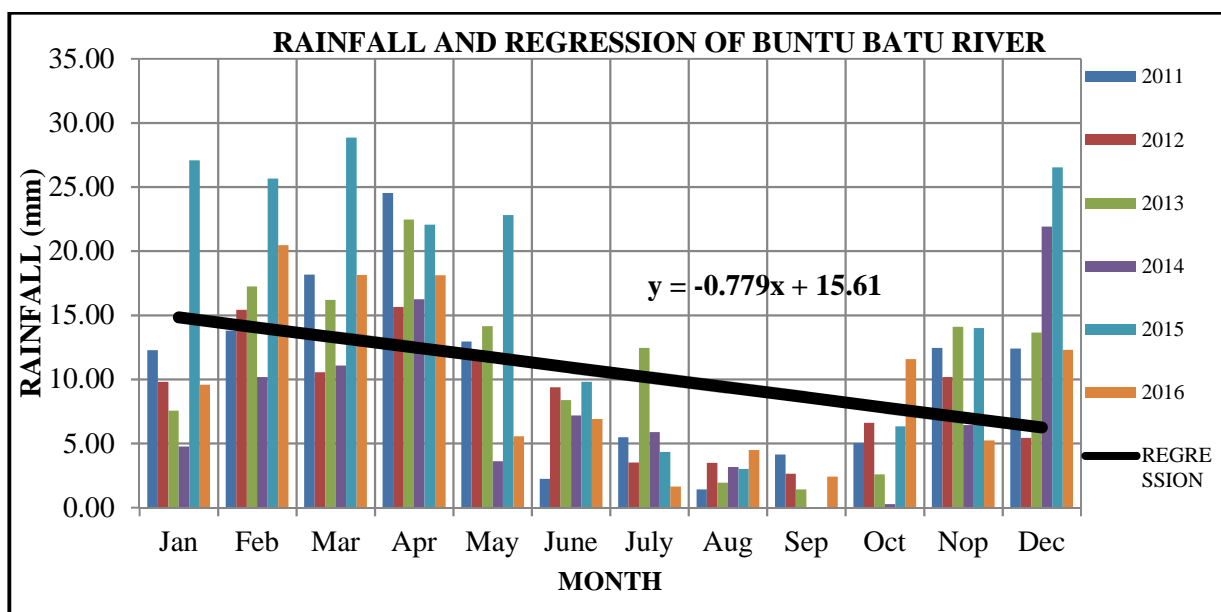


Figure 3. Graph of rainfall and regression of Buntu Batu River.

Based on the graph above, we can see that rainfall from 2011 – 2016 has decreased. With a gradient of -0,779 was obtained that during 6 years the rainfall that occurred in the Buntu Batu River experienced a decrease by 77,9 %.

3.2. Mata Allo River

The Mata Allo River is the upstream part of the Saddang Watershed. By using rainfall data during 10 years from 2008 – 2017 and discharge data during 10 years from 2003 – 2015 because the data obtained in 2007, 2008 and 2013 was empty. For the results of research it is necessary analyze by using regression analysis. Can be seen in figure 4 and figure 5.

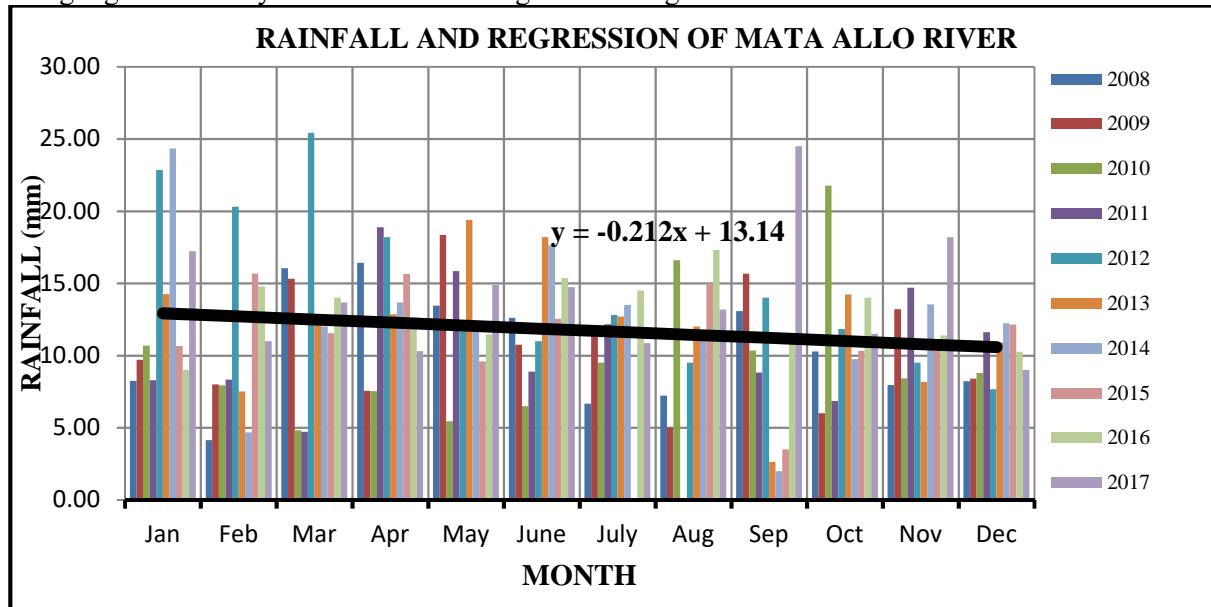


Figure 4. Graph of rainfall and regression of Mata Allo River.

Based on the graph above, the rainfall during 10 years in Mata Allo River, from 2008 – 2017 has decreased. From the regression results was obtained a gradient of -0.212 which means that during the rainfall data over 10 years above has decreased by 21.2%.

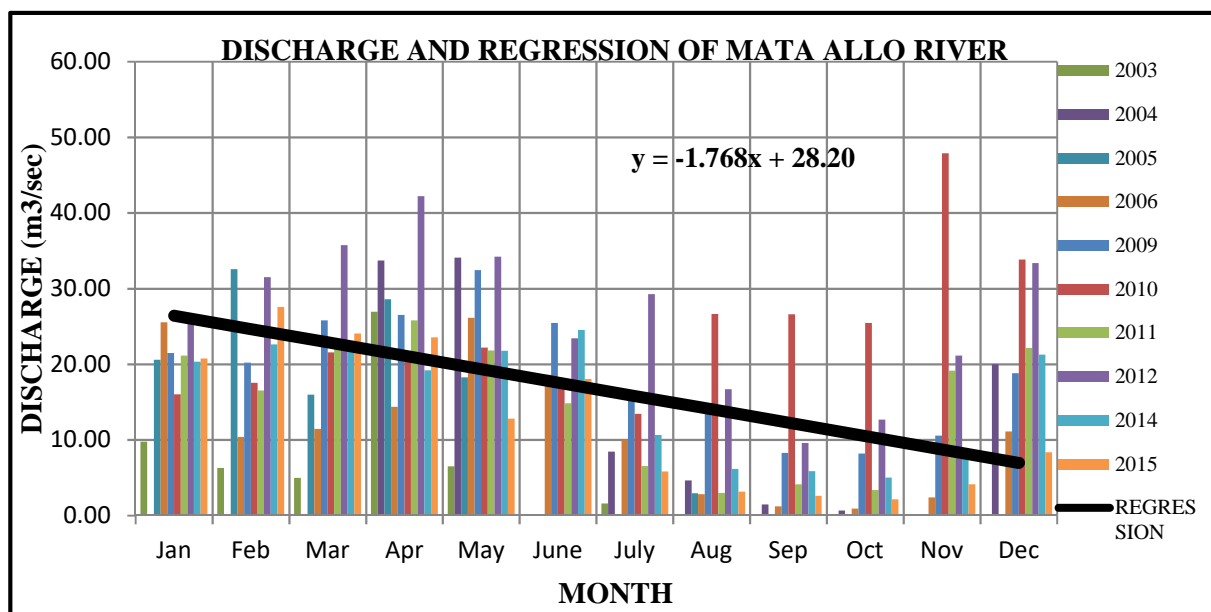


Figure 5. Graph of discharge and regression of Mata Allo River.

Based on the result of the graph above, the discharge of Mata Allo River decreased during 10 years, from 2003 – 2015. This is directly proportional to the result of rainfall in the same river that also decreased. With the gradient of -1.768 then it is obtained a discharge decrease of 176.8% in 10 years on Mata Allo River.

3.3. Pekkabata River

The Pekkabata River is a downstream part of the Saddang Watershed. By using rainfall data during 10 years from 2007 - 2017 because rainfall data on 2015 is empty and the discharge data during 10 years from 2005 - 2015 because in 2013 the data is empty. For the results of research it is necessary analyze by using regression analysis. Can be seen in figure 6 and figure 7.

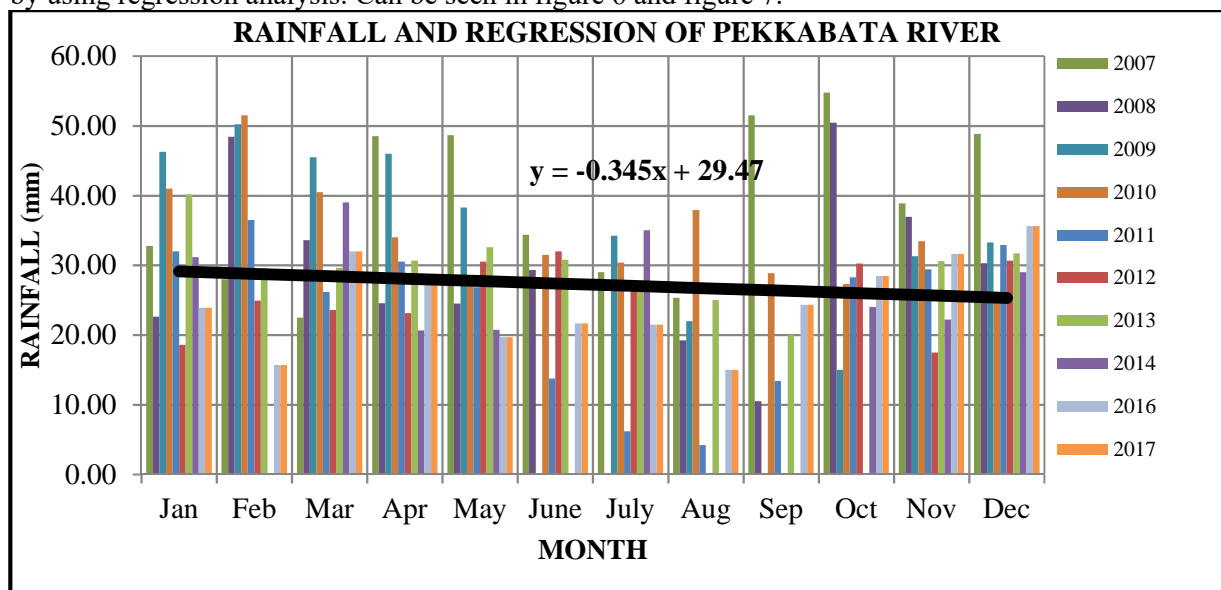


Figure 6. Graph of rainfall and regression of Pekkabata River.

Based on the results of rainfall charts and regression above, it was found that there was a decrease in rainfall within 10 years, from 2007 - 2014 and 2016 - 2017 in the Pekkabata River. With gradient result of -0,345 therefore was obtained the rainfall decrease in 10 years at Pekkabata River equal to 34,5%.

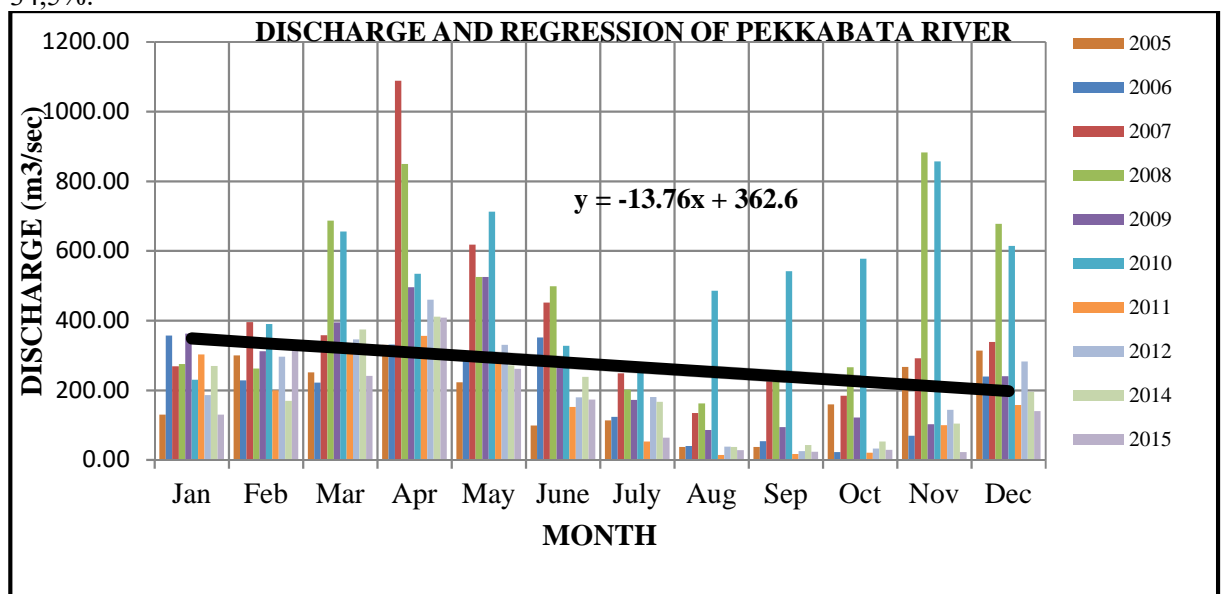


Figure 7. Graph of discharge and regression of Pekkabata River.

From the results of discharge and regression graph above, it was found that in 2005 - 2015 there was a decrease of discharge at Pekkabata River. This is directly proportional to the results of rainfall data which also decrease on the Pekkabata River. From the gradient -13.76 it was found that there was a decrease of discharge on Pekkabata River by 1376%.

4. Conclusions and Recommendations

4.1. Conclusions

The results of this study found that from the three rivers that have been researched, all of them have rainfall decrease. They are Buntu Batu River, Mata Allo River and Pekkabata River. The discharge of the three rivers also decreased proportionally to the results of rainfall regression analysis. The decrease of rainfall and the discharge from the three rivers can be indicated as the impact of the occurrence of El Nino climate anomaly that occurred in Indonesia, it caused the decrease of rainfall in various parts of Indonesia.

4.2. Recommendations

Further research is needed to determine the causes of decreasing rainfall and discharge influenced by climate change or changes in land usage patterns in the area of Saddang Watershed.

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