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To cite this article: Muhammad Chaerul *et al* 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1088** 012109


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# Potential impact of climate change on water resources availability in Bantaeng District, South Sulawesi Province

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**Abstract.** As a result of climate change, the condition of the rain pattern will be more extreme, where in the rainy season, the rainfall will be higher so that it can trigger more floods and landslides; while in the dry season, the rainfall will be less added by increasing evaporation due to increased temperatures which can trigger drought disasters. The objective of this research was to what extent the impact of climate change on water availability which will be used as the main raw material for Municipal Water in Bantaeng Regency. The research method was descriptive qualitative with cross sectional approach. The results of climate change projections showed that the potential monthly average surface water discharge in Bantaeng Regency, especially the watershed used by PDAM, changed fluctuatively. During the rainy season, the projected run-off discharge increased by around 15%; while during the dry season it decreased by around 13% in the Nipa-Nipa, Gusung, and Kaili Watershed. This indicated that the vulnerability of surface water resources during the peak of the dry season (August) to the watershed with Municipal Water intakes, however, in general, the availability of surface water resources in the three watersheds was relatively safe as indicated by the projection results of the run-off discharge average annual rate increased by 4%

## 1. Introduction

Climate change leads complex problems for government and development programs, among others, due to the variety of stakeholders involved, differences in conceptual definitions, large amounts of data and interpretation processes that must be carried out, and the wide spectrum of adaptation options available. Even though it is highly complex, it is extremely important to integrate climate change variables into planning and investment programs for government agencies and service providers (USAID, 2012).

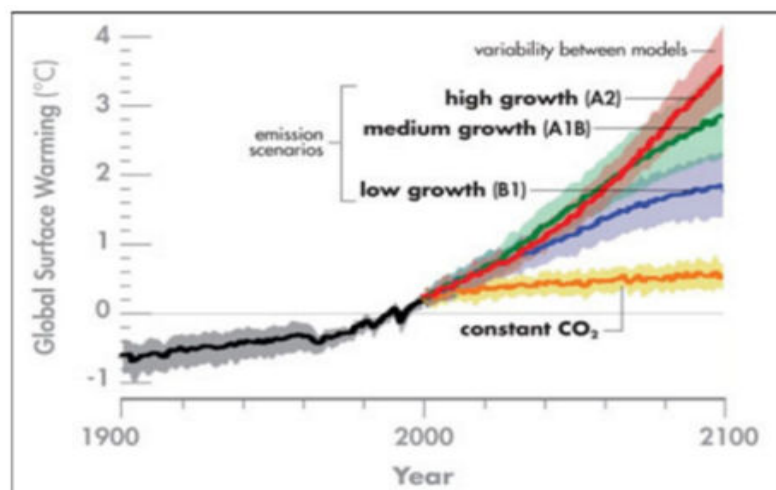
Climate change is caused by human (anthropogenic) activities related to increasing greenhouse gas (GHG) emissions such as CO<sub>2</sub>, methane (CH<sub>4</sub>), CO<sub>2</sub>, NO<sub>2</sub>, and CFCs (chlorofluoro-carbons) which drive global warming and have been going on since nearly 100 last years. This is what causes the conditions of several climatic elements that tend to change or deviate from the dynamics and average



conditions, either in the direction of increasing or decreasing (Popi, 2014). Based on the records and observations made by the IPCC on climate change and water vulnerability, it has been clear that freshwater resources are very vulnerable and also have great potential due to the effects of climate change that is happening at this time and will have a profound impact on human life.

For example, increasing the high intensity and variability of rainfall is expected to exacerbate existing conditions such as the high risk of flooding and drought in many areas, which in turn is projected to affect water quality and this could lead to high levels of water pollution (United Nations Framework Convention on Climate Change, 2011). The impact resulting from climate change is felt in all elements of life, especially on the availability of natural resources (SDA). Studies that have been conducted by the World Wide Fund show that in this 100-year period there has been an increase in the annual average temperature of up to 0.72-3.92 ° C, accompanied by a decrease in rainfall of up to 2-3% (Pujiraharjo A, Rachmansyah A, 2014).

Figure 1 provides a projected temperature up to year of 2100, based on various emission scenarios and global climate models. Several factors, such as population growth and adoption of new, cleaner technologies, will influence whether temperature increases follow the blue, green or red lines on the chart. Scenarios that assume the highest levels of greenhouse gas emissions provide estimates at the upper end of the temperature range. Orange line (constant CO<sub>2</sub>) projects mean global sea level rise (U.S. EPA, 2009).



**Figure 1.** Global Temperature Change Scenario

Scientists cannot predict with certainty what climate conditions will be like in the future. Historical records state that climate and hydrological conditions since the 19th century showed that the climate has changed significantly in the past and this happened without human intervention and absolutely, this will change significantly in a future where human life and life will always increase. The consequence of the great uncertainty in future climatic conditions is the presence of great uncertainty in future hydrological conditions and water availability (Intergovernmental Panel on Climate Change (IPCC), 2008).

## 2. Methodology

It used observational method with qualitative descriptive analysis technique with cross sectional approach (Sentosa, 2008). Primary data were in-depth interviews and field data collection in the form of field photos and existing conditions of water sources. Secondary data were in the form of rainfall data for the last 10 years, land shape, slope, soil type, land use and Region Layout Planning of Bantaeng Regency.

### 3. Result and Discussion

#### 3.1 Rain Catchment Area in the Research Location

Bantaeng Regency has nine watersheds where the largest watershed is the Nipa-Nipa watershed which is spread in the northern and eastern parts of Bantaeng Regency. The watershed has great potential to capture and drain rainwater, so it can be concluded that Bantaeng Regency has the potential for large surface water resources. Based on slope data, the watershed in Bantaeng Regency is on an average slope of 0 to 15%, but some watersheds are on a slope of more than 40% which indicates a steep area and is mountainous.

The Nipa-Nipa Watershed is an area dominated by a slope of more than 40% which can be seen in the Appendix of the Bantaeng District Watershed and Slope Map. The location of the intake plan of the Municipal Water in Bantaeng Regency is fairly evenly distributed throughout the Bantaeng Regency. However, based on the Watershed (DAS), we can group them into three different watersheds. The Kulepang intake and the Batu Massong Intake alternative are in the Nipa-Nipa watershed, the Mandaraki, Campaga, Eremerasa, and Biangloe intakes are in the Gusung watershed, while the Dammu Intake, an alternative to the Buttonoeja Intake, and Bissapu are in the Kaili Watershed.

The three watersheds stretch from North to South, with the upstream part at the foot of Mount Lompobatang and bounded by the Flores Sea at the downstream part. Generally, the slopes of the three watersheds are quite steep in the upstream part and sloping downstream. The rock conditions in the three watersheds have fairly uniform characteristics, namely young volcanic rocks. Compact rocks have a positive side in terms of land stability as an intake building location. However, the slope and the influence of rainfall and changes in land use need to be considered because it has the potential to cause landslides.

Even though the young volcanic rocks that compose the three watersheds have a fairly good level of water passing, the steep slope of the upstream slopes will also minimize the possibility of infiltration, especially if there is a significant reduction in forest area. As a result, runoff will increase and cause flooding in the downstream area. The Kulepang intake and the Batu Massong Intake alternative which are in the upstream part of the Nipa watershed have land conditions that are still forest. This is different from the Mandaraki, Campaga, and Eremerasa intakes which are in the Gusung watershed, all of which are located in areas that have been used as fields and are adjacent to irrigated rice fields. The Eremerasa and Biangloe intakes are located very close to residential areas, while the Dammu Intake, the Intake Buttonoeja alternative, and the Bissapu in the Kaili watershed are in areas used as fields with local bushes.

#### 3.2 Potential Impact of Climate Change on Water Resources

The results of climate change projection show that the potential monthly average surface water discharge in Bantaeng Regency, especially the watershed used by Municipal Waterworks, changes fluctuatively as can be seen in Figures 2 and 3. In the rainy season, the projected run-off discharge increases by around 15%; while during the dry season, it decreases around 13% in the Nipa-Nipa, Gusung, and Kaili watersheds. This indicates that the vulnerability of surface water resources at the peak of the dry season (August) to the watershed with Municipal Waterworks intakes, however, in general, the availability of surface water resources in the three watersheds is relatively safe as indicated by the projection results of run-off discharge on average increased by 4%.

It can be seen in Figure 4 the results of the analysis of climate change projections for groundwater in 2020-2030, which shows the potential for groundwater in the rainy months (November, December, February, and March) is higher than the existing condition; while in the dry months dry (June, July, and August) is lower. Groundwater potential is extremely low in September and October, as well as overall groundwater potential until 2030, Bantaeng Regency will decline where the annual average potential decreases to 0.020 m<sup>3</sup>/sec/km<sup>2</sup>, while overall, Bantaeng Regency has decreased to 2,04 million m<sup>3</sup>/year which is about 3%.

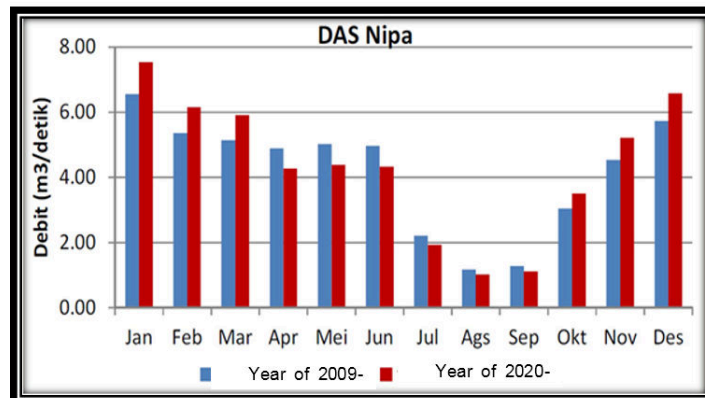


Figure 2. Changes in Monthly Average Run-off Discharge of Nipa-Nipa Watershed Due to Climate Change

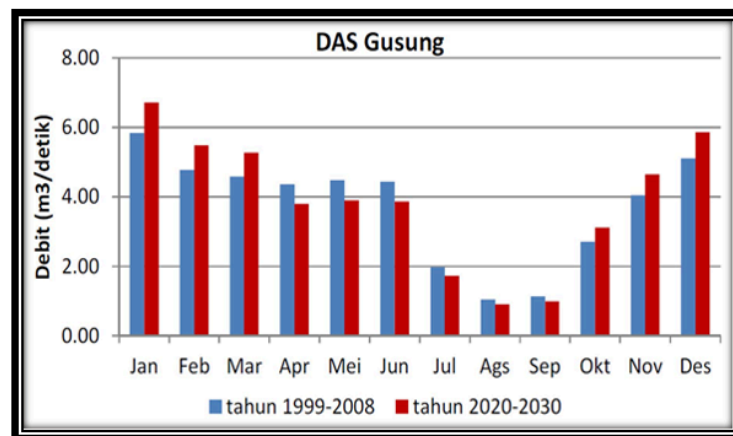


Figure 3. Changes in Monthly Average Run-off Discharge of Nipa-Nipa Watershed Due to Climate Change

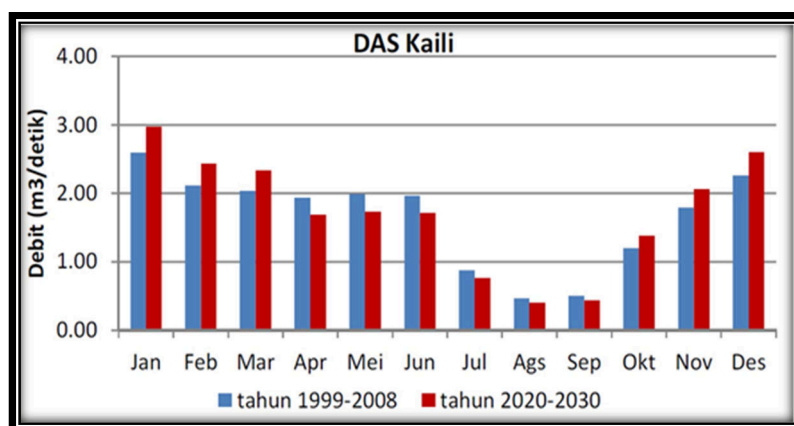


Figure 4. Changes in Monthly Average Run-off Discharge of Kaili Watershed Due to Climate Change

#### 4. Conclusion

Based on the discussion that has been done, it can be concluded that during the rainy season, the projected run-off discharge increases by around 15%; while during the dry season, it decreases by around 13% in the Nipa-Nipa, Gusung, and Kaili Watershed. This indicates that the vulnerability of surface water resources at the peak of the dry season (August) to the watershed with Municipal Waterworks intakes, however, in general, the availability of surface water resources in the three watersheds is relatively safe as indicated by the projection results of run-off discharge on average annual rate increased by 4%.

The results of this study identified three of the most commonly used and influential framework methods in the topic of attribute independence on the NB. They are Menzies et al. Framework, Lessmann et al. Framework, and Song et al. Framework. They are Langley et al [20], Friedman et al [2], and Wu et al [28].

#### 5. Recommendation

The needs for implementing policies related to reducing CO<sub>2</sub> emissions that the government can indirectly do by implementing policies on reducing the population through the Family Planning (KB) program, policies limiting the number of vehicles through the use of mass transportation and limiting the years vehicles are allowed to operate, saving fuel use, as well as increasing the number of Green Open Space (RTH).

#### Acknowledgment

We would like to express our gratitude to all those who have helped in this research so that it went well and smoothly. Especially to the Deputy for Strengthening Research and Development of the Ministry of Research and Technology/the National Research and Innovation Agency who has funded this research.

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