



Climate Change: Effect of Climate change on Water Resources and Adaptation

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ABSTRACT

Introduction: Climate change has an impact on all sectors of water resources. As a real example, there are many droughts in Indonesia. Changes in the water cycle have caused two extreme conditions, namely an increase in drought conditions which will reduce the natural availability of groundwater. Rainwater Harvesting can be an alternative for adaptation to the current water crisis. The water obtained from rainwater harvesting can be used for many things such as watering plants, washing, bathing, and can even be used for cooking if the quality of the water meets health standards. **Methods:** The author uses the literature review method. The author searches for literature that is in accordance with the topic of the paper, then makes an analysis, then writes a review of the literature. **Findings:** In addition to droughts and erratic rains, climate change is making it harder and harder to find clean water. However, the Indonesian water issue can be solved by using rainwater harvesting. This method is appropriate for harvesting since it takes into account Indonesia's comparatively heavy rainfall. **Conclusion:** This study concludes that the community can employ rainwater gathering as a water-saving technique to supply clean water needs. Rainwater harvesting will be able to support the survival of both the current and future generations by helping to maintain environmental and water sustainability

KEYWORDS: climate change; harvesting; Indonesia; rainwater; water.

1. Introduction

The dry season and the rainy season are the two seasons that frequently occur in Indonesia. Many people are experiencing a water supply crisis as a result of the dry season's drought. Currently, Indonesia and the rest of the globe are discussing climate change frequently. A considerable change in climate, air temperature, and rainfall that can last for a few decades to millions of years is known as climate change. The greenhouse gas effect, which is brought on by an increase in the atmospheric concentration of carbon dioxide and other gases, causes climate change (Direktorat Jendral Pengendalian Pencemaran dan Kerusakan Lingkungan). Weather is the condition of the atmosphere at a specific time, and climate is the average weather. The average and variability of pertinent quantities of a given variable are measured as the climate (such as temperature, precipitation or wind, over a specified period of time ranging from months to years or millions of years) (Direktorat Jendral Pengendalian Pencemaran dan Kerusakan Lingkungan Direktorat Jendral Pengendalian Pencemaran dan Kerusakan Lingkungan).

Basically, both the wet and dry seasons are subject to change due to climate. The impact of climate change, which results from global warming, is that the air conditioning is becoming hotter (Global Warming). The process of raising the average temperature of the atmosphere, ocean, and land on Earth is known as global warming. Over the past century,

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Earth's average temperature has risen by 0.74°C (Panel & Change, 1990). Global warming is one of the effects of increasing concentrations of greenhouse gases. Basically, the greenhouse gas effect serves to keep geothermal heat stable. However, increasing greenhouse gases will make the atmosphere layer thicker which causes the amount of geothermal trapped in the atmosphere to increase the concentration of trapped gases causing an increase in the earth's temperature rise. The largest greenhouse gas is methane gas, which comes from the agricultural and livestock sectors.

Water is affected by climate change as well; specifically, warming speeds up the hydrological cycle. The likelihood of precipitation in the form of heavy rain increases as a result of an increase in air temperature because it increases water storage. The process of evaporation may be sped up by a rise in temperature. This may result in more clean water, both in quantity and quality. The proliferation of malaria mosquitoes and other diseases is impacted by changes in the global environment. Unrestrained groundwater consumption decreases groundwater outflow, which can hasten the infiltration of seawater onto land. Events related to climate change may exacerbate the water problem, which is brought on by the length of the dry season in regions with minimal water availability. The unpredictably changing seasons are what brought to this water catastrophe. The forecasted drought caused by water constraints of up to 10–30% poses another threat to dry subtropical and tropical areas. Climate change has an impact on the water sector.

Water is the most important element for life after air. Due to the fact that water makes up around three-fourths of our bodies, no one can go more than four to five days without drinking any. Water is required for cleaning up messes around the house, cooking, washing, and bathing. A material with the chemical formula H₂O and only one oxygen atom is called water. Normal conditions result in tastelessness, odorlessness, and colorlessness of water. Water resources are said to be abundant geophysically, but only a small portion can be utilised right away. The importance of water availability increases as the population expands, the escalation rises, and the demand increases (Astuti, 2015).

The clean water crisis becomes more evident as a result of climate change. Changes in the water cycle have resulted in two severe situations, including an increase in drought conditions that may reduce the natural supply of groundwater. Because of the more severe droughts and floods brought on by climate change, people's access to water is already being disrupted. Climate change affects the water cycle because it changes when, where, and how much precipitation happens. Additionally, it causes more extreme weather over time (National Geographic Society, 2022). Another effect of climate change is the rise in sea level, which increases sea water incursion and degrades the quality of fresh water in the mainland region. In fact, the quantity and quality of clean water have gradually changed as a result of climate change. The second concern is whether or not the multiple initiatives made can truly reduce the risks they confront and assure their survival in the long run. If these alterations have already undergone some tweaks. To ensure the safety of human life, it is predicted that the best environmental adaptations or alterations will be implemented (Nugroho, 2014).

Climate change has an effect on aquatic ecosystems as well because they are dependent on water availability, quantity, quality, and timing as well as temperature. In reservoir and lake systems, this influence will be more apparent since changes in the dynamics of water availability might have an impact on changes in nutrient exchange in water. Changes in water outflow, agricultural practices, domestic and industrial pollution, as well as changes in how well water can absorb pollutants owing to temperature changes, are all effects of climate change that have an impact on water quality. Due to the fact that heat expands into the ocean and melts ice at the poles, global climate change may cause sea levels to increase (Universitas Gadjah Mada, 2007).

Indonesia has a catchment area of 1.9 million square miles, making it a large nation. However, of the 21.12 mm/year of rain that falls as rain, only 25% of the airborne water is collected in reservoirs, rivers, lakes, or groundwater basins. However, the ocean absorbs 72% of it. The final 3% are engaged in domestic and agricultural activities. Because of population growth and development, the ability of the land to store rainfall as a long-term water reserve is declining. In order for groundwater to fill gaps in the soil and rocks, water

must first enter the pores of the soil, which concrete and asphalt hinder from happening. This hinders the water from properly soaking into the soil (infiltration) (Prasetyawan, 2015).

2. Methods

In writing this paper, the author uses the literature review method. The author searches for literature that is in accordance with the topic of the paper, then makes an analysis, then writes a review of the literature. Sources of literature reviews come from articles and journals.

3. Results and Discussion

Tourism development not only affects the social aspects of society, but also has a significant impact on local cultural life. In the context of the Selo Hiking Trail tourist attraction, this development not only creates changes in social terms, but also affects the sustainability and dynamics of the surrounding community's culture. According to Faizun (2009), tourism development has both positive and negative impacts on society. However, the use of positive and negative labels in the impact of tourism on social change is very subjective and needs a deeper sociological study. Therefore, in this study, it is necessary to conduct an analysis that includes social and cultural impacts, taking into account relevant indicators. In addition to the lack of clean water, other issues include the lack of a drainage system on the mainland and degradation of the environment where people reside as well as the water supply (Vanesa et al, 2020). Through its effects on precipitation's amount, unpredictability, timing, form, and intensity, climate change will have an impact on water supplies. Higher evaporation rates, a higher proportion of precipitation received as rain instead of snow, earlier and shorter runoff seasons, higher water temperatures, and decreased water quality are further effects of global climate change that have significant influence on water resources. Water resources are anticipated to be reduced in several regions due to increased evaporation rates. For those who use water resources, more frequent and severe droughts brought on by climate change will have substantial management repercussions. Users of water will gradually learn to cope with more severe and frequent droughts, in part by repurposing their limited water resources for other valuable use.

Increasing temperatures, changing rainfall patterns, and perhaps increasing frequency of floods and droughts are the main effects of climate change on water resources (European Environment Agencies, 2020). Because there are more greenhouse gas molecules present, the surface emits more infrared energy, which is subsequently absorbed by the atmosphere, leading to the current rise in temperature. Earth's surface temperature increases as part of the extra energy from the warmer atmosphere radiates back to the surface (Earth Observatory, 2010).

In Precipitation intensity and frequency can be impacted by climate change. Oceans that are warmer cause more water to evaporate into the atmosphere. More severe rainfall, such as torrential rains and floods, can arise when more moisture-laden air travels over the earth or gathers into a storm system. Crop damage, soil erosion, and a higher danger of flooding are some potential effects of heavy precipitation. High rainfall does not always mean that the total amount of rainfall in a location has increased, only that the rain occurs in more intense events. However, changes in precipitation intensity, when combined with changes in the interval between precipitation events, can also cause total precipitation as a whole (United States Environmental Protection Agencies, 2023). Rising temperatures will accelerate the water cycle on Earth, increasing evaporation, according to current climate models. More frequent and severe storms will result from the increased evaporation, although some portions of the earth may experience drought. Because of this, communities affected by hurricanes typically see less rainfall and a higher risk of dryness (Global

Precipitation Measurement). So far any impacts that climate change may have on regional rainfall are indistinguishable from natural variations (The Met Office et al, 2011).

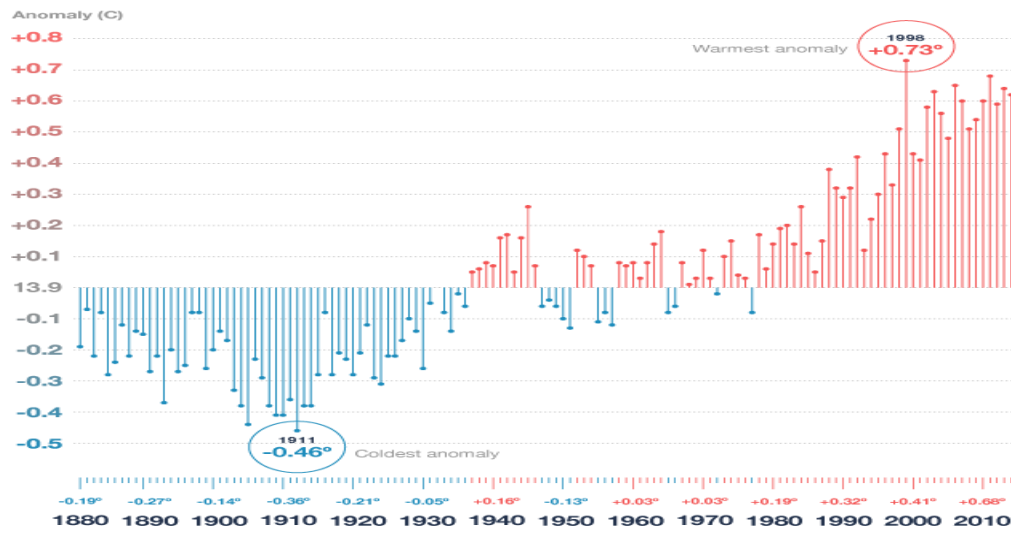


Figure 1. Data on gradual increase in temperature over the last 30 years. (Public health, 2022)

According to scientists from the IPCC, climate change is interfering with rainfall and the water cycle, and it's possible that anthropogenic effects have changed the global water cycle since 1960 (Diffenbaugh et al, 2015). could possibly have an effect on the likelihood of more frequent droughts and heavier rainfall. A pattern of prolonged dry spells interspersed with brief but heavy rains and potential flooding may develop due to higher average temperatures and warmer air that can contain more water (Water Footprint Calculator, 2018). Natural disasters like droughts, torrential downpours, and floods are caused by a variety of variables, including topography, but climate change can make them worse. For instance, a rise in temperature leads to higher rates of plant evaporation and transpiration, which causes water to evaporate from soil and plants (Hatchett, 2018).

River floods may get smaller or less frequent in certain regions due to climate change, but bigger or more frequent in others. Changes in the size and frequency of floods result from increased evaporation of water due to warming temperatures from the sea and land (US EPA, 2022). A larger chance of precipitation results from the warmer atmosphere's ability to retain and then lose more water. Although flooding is not necessarily caused by heavy rain, it does raise the likelihood that it will [21]. For each degree Celsius that climate change raises the temperature, the air can store 7% extra water vapor. This air swiftly cools, converting the water vapor into droplets that eventually create heavy rain (Denchak, 2023).

Water and sanitation infrastructure, such as water points, wells, toilets, and wastewater treatment facilities, can be damaged by floods and increasing sea levels, which can also contaminate land and water resources with salt water or sewage (UN Water) Climate change's effects on poor water quality have a wide range of effects on people, communities, animals, industry, and the economy. Our weather and oceans are changing as a result of climate change, which can lower the quality of our water supplies (AdaptNSW), among others:

1. Sea level rise, which is increasing the amount of saline water in coastal waters and contaminating freshwater
2. More intense storms and rainfalls that wash away soil in waterways and erode it, lowering the quality of the water
3. Warmer water can raise the risk of bacteria or algae growth in storage facilities like dams.
4. Drought conditions, which make natural salts more concentrated in waterways through evaporation and decrease the frequency of high flow events that flush out salt

Such effects can harm freshwater ecosystems and render water resources unfit for use as a source of drinking water for people and agriculture. To guarantee that people have access to water, the current water issue must be resolved quickly. However, long-term strategies must also be created (European Environment Agency, 2021).



Figure 2. Curah hujan harian di Indonesia bulan Mei 2021 (BMKG, 2021)

According to the image above, Indonesia receives a lot of rain, so by using rainwater harvesting, Indonesia can resolve its clean water crisis. An alternative for coping with the current water problem is rainwater harvesting. If the water quality satisfies health regulations, it can even be used for cooking. Some common uses for the water acquired through rainwater collection include washing, bathing, and watering plants. A technology known as rainwater harvesting is used to collect and store rainwater for human consumption (Ogale, 2022). The main advantage of rainwater gathering is sustainable water management, which can be outlined by anyone at any level. The following are some advantages of collecting rainwater: reduce spending on water, rainwater harvesting tanks can save expenses; avorable to the environment. Rainwater is a free resource, thus using it lowers both water expenses and carbon footprints (Tyagi, 2020); lowering the likelihood of floods due to the fact that any falling rain will be collected.

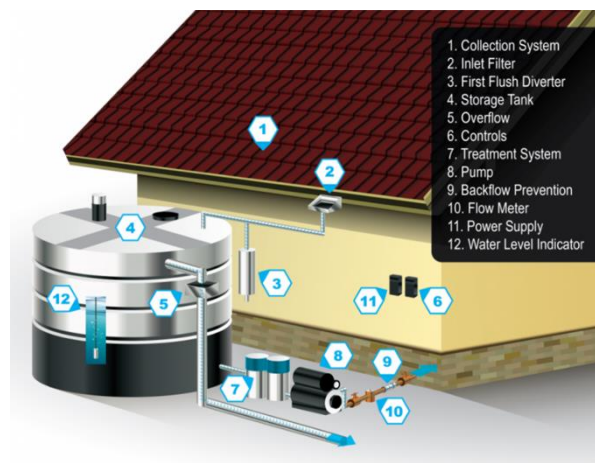


Figure 3. Component of Rainwater Harvesting system (Federal Energy Management)

From the picture above there are several components to support rainwater harvesting system technology, namely:

1. Collection systems, roofs, and gutters that transport rainwater to storage systems
2. Inlet filter, screen filter to catch large debris.
3. First Flush Diverter, to purge contaminants from the initial stream of rainwater that were not caught by the inlet filter.
4. Storage tank. A food-grade polyester resin substance, which is green in color and inhibits bacterial development, makes up the storage tank.
5. Overflow, Drainage spout that allows overflow if tank is full.

6. Control, control system that monitors the water level and filtration system
7. Treatment System, a system of filtration and sanitation that purifies water to a potable or non-potable level.
8. Pump, pump to facilitate water through the system to where it will be used.
9. Backflow Prevention, in order to prevent water from entering the make-up water system under negative pressure.
10. Flow meter, to measure water production.
11. Power Supply, The system has the option of using conventional power sources or utilizing off-grid resources, such as standalone or grid-tied solar systems, or off-grid capabilities.
12. Water level Indicator, to monitor the water level in the storage tank

The quantity and frequency of rain are inconsistent, and the quality of the rain does not adhere to WHO clean water standard requirements. Insect vectors and bacteriological water quality are the two issues that are connected to the issue of rainwater quality. The first is the problem with the bacterial composition of the water. It is recommended to keep the roof clean because dirt in the catchment region has the potential to pollute rainwater. In order to keep out dirt, rainwater reservoirs must also have a lid. Insect vectors are the second problem. In order to reproduce, insects place their eggs in water. Therefore, it is preferable if the water

4. Conclusions

Water in particular is impacted by the current climate change, which affects many facets of human existence. Clean water availability is significantly impacted by climate change. Climate change has reduced the availability of clean water. Different types of contaminants contaminate clean water. In addition to droughts and erratic rains, climate change is making it harder and harder to find clean water. However, the Indonesian water issue can be solved by using rainwater harvesting. This method is appropriate for harvesting since it takes into account Indonesia's comparatively heavy rainfall. The community can employ rainwater gathering as a water-saving technique to supply clean water needs. Rainwater harvesting will be able to support the survival of both the current and future generations by helping to maintain environmental and water sustainability

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The author declare no conflict of interest

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