2024 ENGINEERING INSTITUTION OF ZAMBIA SYMPOSIUM

Universal Access To Clean Water: A 21st Century Engineering Grand Challenge.

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INTRODUCTION

Climate change been the fluctuations in the weather patterns that are indirectly or directly caused by human activities.

- Climate change has put immense strain on water sources, resulting in the inadequacies which lead to lack access to clean water.
- The increase climate change cause environmental disasters such as flood and droughts caused by greenhouse effect.
- This is because due to climate change the evaporation and precipitation processes that combine to replenish the freshwater sources become (disordered) uneven distributed (Melissa & Rachel, 2023)
- Due to Climate change, the disordered snow packs that regenerate rivers tend to melt earlier than expected in a particular year leading to excess saltwater intrusions and shifted precipitation patterns on the other hand increase the risk of flooding and droughts, making the available water not conducive for drinking.

CON'T…

- A drift towards preservative measure is expected as the demand of freshwater seems to have exceeded the available supply and other sources such as, groundwater harvesting are to be implemented so as to meet the required demand.
- The United Nation Climate Change stressed the urgency of action through their represented countries as the effects of flooding, droughts and saltwater intrusions were more pressing than before and evident due to human activities making the universal access to clean water very difficult (GUTERRES, 2021).

Figure 1: Drought *(Shirley, 2021)*

Figure 2:Floods *(Shirley, 2021)*

PROBLEM STATEMENT

Digging of wells has become a new trend for sustainability.

- Cone of depression is formed due to the localized drop in the water table.
- If formed on unconfined aquifer, causes the change of direction of water flow hence polluting the well water.
- Also, Increase of these wells, drops the regional water table significantly, hence groundwater mining which leads to saline water and if the water aquifer is near the ocean coastlines causes saltwater to penetrate into fresh water.
- Not only that, wells are associated with sinkholes and subsidence problems.
- Hence, the water source that seem to be more reliable isn't safe for the population.

AIM/OBJECTIVES

AIM

Access universal ways of acquiring clean, health and safe drinking water because due to climate change, precipitation patterns and sown packs shift lead to floods, droughts and intrusion of salts into the clean water sources causing water shortages of quality and reliable water for human usage hence, digging of wells.

OBJECTIVES

- To evaluate how climate change affects the quality and quantity of the water.
- To investigate and discuss the different measures that can be used to acquire clean water
- To investigate how the measures can mitigate the water challenges.

METHODOLOGY

In order to achieve the research objectives, the following shall be considered;

- Through literature, will discover the effects of climate change on the quality of water and then suggest essential measures that are to be employed for clean water harvesting.
- The measures that will be suggested, will have the authors perceptive on how best the measures can be implemented for access to clean water.

Essential Measures to Address Water Challenges

Water is very important for all socio-economic development and for sustaining the ecosystems otherwise the lack of quality and reliable drinking water may lead to desertification, forced migration, hunger, diseases.

The measures to address water challenges for universal access to clean water are discussed.

Centralized Governance

A Centralized governance is a water authority system that holds the responsibility of licensing the drilling of wells, desalinating water, treating domestic and industrial wastewater, designing and constructing water infrastructure and setting water prices (Rapheal, *et al*., 2023).

- In cases of sea, ocean and saline well water due to groundwater mining, a centralized governance should advice which desalination process should be adopted.
- Water infrastructure help reduce water-related climate changes in that, they are used to store and access water in drought and flooding seasons (Dena, *et al*., 2018).
- One of the duties of a centralized governance is to set the water prices, this should be done while considering the per capita income of a specific country.

Irrigation and Agriculture Practices

The agricultural industry has been recognized as a major consumer of water resources, accounting for 70% of the world's freshwater to irrigate a world's cropland (Shemer, 2023).

- For this percentage to be maintained, the available water should be strategically managed amidst little rainfall so as to still maintain the yield to sustain the country.
- Two smart irrigation systems have been suggested in order to avoid over or under irrigation.

Figure 3: Drip Irrigation *(Bernard, 2021)*

Figure4: Subsurface Irrigation *(Naan, 2019)*

CONTINUED

figure 3 shows a drip irrigation type that admits the water on the surface of the crops with an advantage that fertilizers are injected directly into the water stream.

- One of the drawbacks of this system caused by excessive irrigation is soil salinization when saline water is used and this may affect the yield.
- Desalinating of irrigation may be used to prevent soli salinization.
- Subsurface irrigation may also be a viable alternative in cases where salinity free water is not available but has considerate percentage such as well water.
- Not only that, the water system is passed underground hence, reducing evaporation and weed growth as the water is administered directly.

Pollution Control

- Carbon dioxide been a principal gas has a higher percentage that contributes to the greenhouse emissions compared to nitrous oxide, methane and other fluorinated gases.
- Any increase in the temperatures could cause severe droughts, floods and that the carbon dioxide emissions must be reduced by 45% (Shirley, 2021).

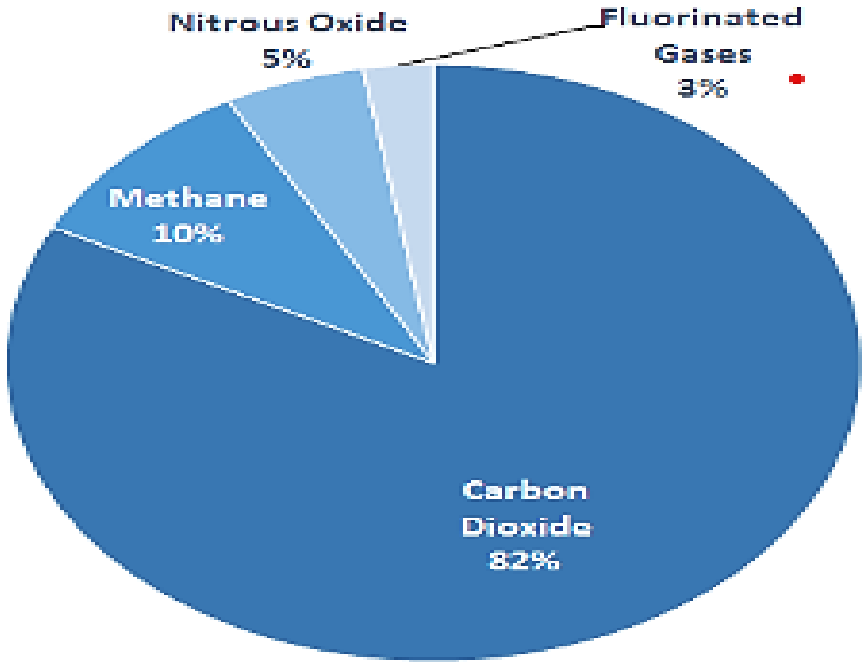

Figure 5: Greenhouse Gases *(Flederbach, 2023)*

Continued

- Methane and nitrous oxide have much stronger heat-trapping effects that is; methane is 21 times and nitrous is 310 more potent a greenhouse gas than carbon dioxide (James, 2021).
- Pollution destroys the hydrological cycle in the sense that as the greenhouse gases increase in the atmosphere the global temperature rise thus more evaporation which may lead to increased precipitation (Noboko, 2016).
- Thus more rainfall for that particular season and this would lead to flooding.
- Therefore, any small increase in methane and nitrous oxide gases have very huge impacts.
- Therefore, the anyhow release of carbon dioxide, methane and nitrous oxide should be banded so as to have universal access to clean.
- The real problem though is how rapidly the greenhouse gases are increasing in the global atmosphere and affecting the quality and quantity of water.

Education

It is imperatively important to raise awareness about the water management issues and encourage the individuals and organizations to start taking preventive measures.

- Typically, groundwater is clean and safe to drink because soil on the top acts as a filter (Kiekebusch, 2020), this statement might not always be true.
- Therefore, educating the domestic wells users of the possibility of pumping saline polluted water in cases of a cone of depression and groundwater mining is essential.
- And in such cases, domestic water filters can be employed to purify their drinking water.
- The filter is shown on the next slide that we use in case of polluted and saline grounwater.

Continued

Figure 6:Domestic Water Filter

Water Catchment and Harvesting Technologies

These are rainwater harvesting technologies which augments the water supply and help reduce storm water runoff.

- Technologies that can be implemented are rainwater harvesting aquifer recharge, floodwater harvesting systems, and dams (McGuire, 2022).
- These technologies do not just increase the groundwater levels but distributes the groundwater water more evenly and this reduces the risks associated with hydro meteorological events such as drought and flooding, promote soil moisture, and regulate water tables that support vegetation and biodiversity (Zaidi, 2010).
- Hence, reducing the possibility of saline water in wells. Therefore, water catchment and harvesting technologies must be implemented to greater heights to increase the quality and quantity of clean water sources.

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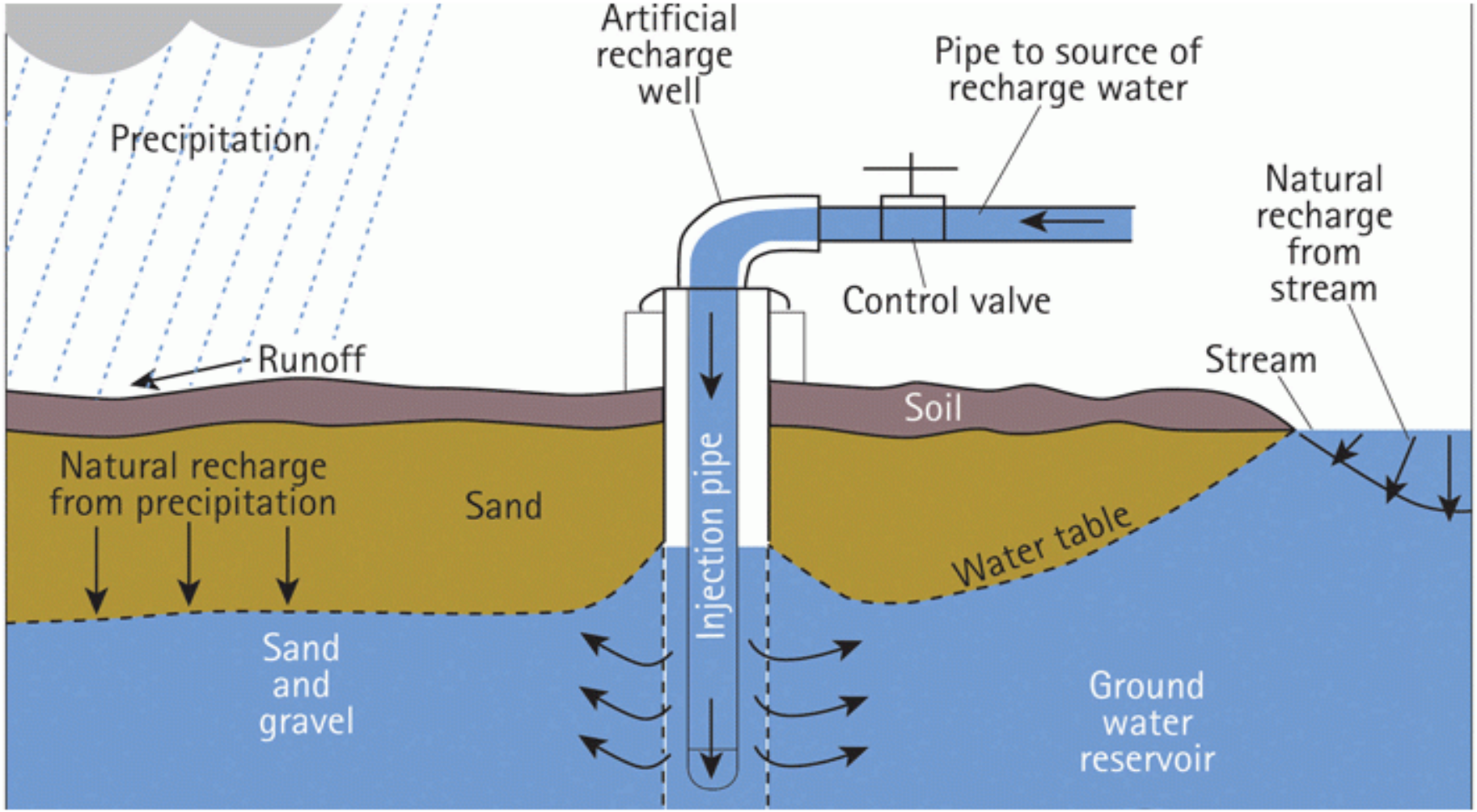

Figure 7: Rainwater harvesting aquifer recharge and floodwater harvesting systems

Source: *(Ahmedabad, 2020)*

Avoid disturbances of wetlands

Wetland's act as sinks for rain water into the underground (Xiaodong, 2023).

- If these wetlands are disturbed may lead to flooding because the wetland has been blocked and as discussed earlier floods reduced the quality and quantity of clean water.
- This will eventually lead to reduced groundwater hence, groundwater mining due to water scarcity leading to pollution of this water because of the reversed groundwater flow.
- Therefore, sensitizing the society on avoiding the wetland will help the country have drinkable water.

Conclusion

- This paper has evaluated the effects of climate change (i.e., droughts and floods) on the quality of water and has investigated measures that can mitigated to overcome water scarcity challenges.
- And through these measures, ways of acquiring clean amidst floods and droughts and water management tactics have been explored.
- And if employed, positive changes shall be seen amidst droughts and floods.

Recommendations

Water governance should involve entities such as government agencies, non-governmental organizations, community groups and private sector to work together to manage the available water in drought and flooding seasons order to have continued water supply of safe water from water and sanitation companies.

- A solar powered electrodialysis water treatment process for well saline and polluted water should be used to purify water so as to reduce effects of climate change while utilizing the solar energy..
- Instead of the thermal desalination that uses heat energy from oil/coal which contributes to the climate change effects.
- Or, membrane distillation processes that utilizes electricity energies hence making the process very costly which may increase the price of water.

THANKS FOR YOUR ATTENTION !!

ANY QUESTIONS PLEASE.