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MORALITY BEFORE KNOWLEDGE

The correlation of human activities to climate change effect on hydrological cycle and water resource

JANNIE[1]*, YUNITA ISMAIL MASJUD[1]
[1] *Environmental Engineering, Faculty of Engineering, President University, Bekasi, Jawa Barat, 17530, Indonesia*
*Correspondence jannie.wind.04@gmail.com

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ABSTRACT
Background: The most fundamental natural resource is water. The hydrological cycle, which produces water, connects interactions between the Earth's four major domains and is influenced significantly by human activities and socioeconomic development. This research objective is to determine the correlation of Human Activities due to hydrological cycle and water resource which related on climate change. **Methods:** This research using the literature method. There are 2 concept approaches used in this journal, the conceptual framework and socio-hydrological model framework. **Findings:** show when the system is unstable, the water supply system encounter water deficit, meanwhile society still can fulfil their demand of water through SAL (capital investment). Hence, there are several external factors in relation of the water supply system. **Conclusion:** The scarcity of water resources is affecting many major. The involvement of climate change on present and future is importantly need to consider. The target of sustainable groundwater resource is possible to achieve after understand how to control some factors related such as physiography, geology, and hydrological cycle. Beside of it, the management will return to community to form the oriented strategies on sustainable water resource on protection and coherent utilization.

KEYWORDS: climate change; human activities; hydrological cycle; water resource.

1. Introduction

The most fundamental natural resource is water. Because of its cyclical nature, water resources are renewable. The hydrological cycle, which produces water, connects interactions between the Earth's four major domains and is influenced significantly by human activities and socioeconomic development (Yang et al., 2021).

Since the early 20th century, there are several terms of climate and the interconnected concept of the climate system (Koutsoyiannis, 2021):

a. The USA National Weather Service; The average of a region's composite or generally prevailing weather conditions over a period of years.
b. The American Meteorological Society; The climate system is the system that governs the earth's climate as a result of mutual interactions and responses to external forces (forcing). The interactions among the components of the climate system, namely the Earth's atmosphere, oceans, land masses, and biosphere, entail physical, chemical, and biological processes.
c. The World Meteorological Organizational (WMO): The climate of the Earth is determined by the varying states of the atmosphere and other parts of the climate

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system. The hydrosphere is the liquid water distributed on and beneath the Earth's surface, as well as the cryosphere, i.e., the snow and ice under the surface.

d. The Intergovernmental Panel on Climate Change (IPCC); Climate is typically defined as the average weather, or more strictly, as the statistical description of important values in terms of the mean and variability over time spans ranging from months to thousands or millions of years.

Climate provides the environment for all living things on Earth, and its variability has huge implications for all aspects of human society (Aini et al., 2023). Scientists and the general public have long recognized the consequences of significant changes in the long-term mean climate and its variability (Ma, et al., 2020). With recent rapid changes in climate and land use, the global water cycle is experiencing high levels of spatial and temporal variability, which has resulted in numerous water-related issues that pose challenges to human water security. Therefore, obtaining a better understanding of environmental and natural resources research.

Surface characterization will have an impact on the hydrological condition to water potential (Farhaini et al., 2022). The IPCC report, which predicts that climate change/variability, as measured by temperature increases, will have a direct impact on the hydrological cycle and water availability, provided the theoretical framework for this research. Each change would have a different level of impact, ranging from increased air temperature to national security concerns. The most pressing issue on the watershed is "authority," which refers to the watershed's authority in prioritizing long-term water resource management efforts and anticipating climate change consequences (Irwandi et al., 2021; Pujiono et al., 2021).

2. Methods

There are 2 concept approaches, the conceptual framework and socio-hydrological model framework. The model is aimed to indicate the interaction of sector related between climate change, water demand and human activities (Viola et al., 2021).

2.1 Conceptual Framework

The IPCC study provided the theoretical framework for this research, the correlation of variability of climate change is connected by temperature, which will have an impact on the hydrological cycle. The change of circulation of hydrological cycle will damage on water availability or on another impact would result on higher-level shown on the figure below (Fig. 1).

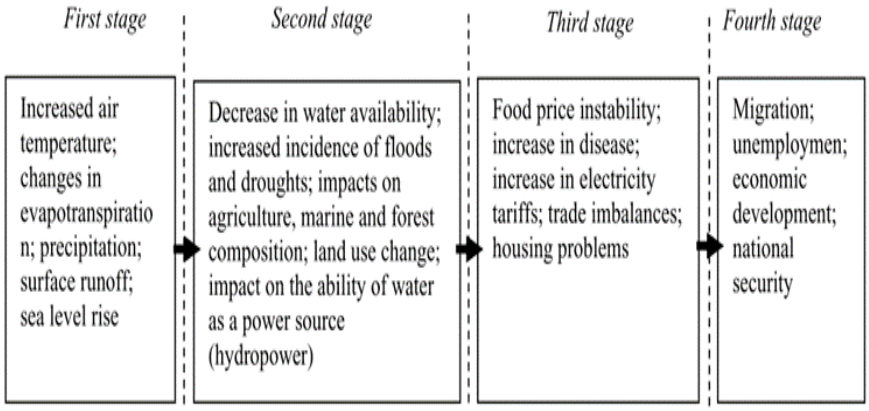

Fig 1. Stage of impact

2.2 Socio-hydrological Model Framework

Three pillars of sustainable will be related each other, and it also connect on this framework. Due to increased population or population growth, so human also need the development on their economic and it demand on good environment for good development, the effects of human activities on the natural water cycle have become increasingly severe. Streamflow changes are influenced by both climate change and human activities (Kazemi et al., 2021). As a result, it's critical to assess the effects of various human activities which need of water use. On the other hand, human activities are considered as the main factor but the total change may be not impacted fully by that factor (Liu et al., 2019).

The correlation of environment, social and economic on water demand is shown in Fig. 2. The correlation starts with the environment which is interrelation of the water bodies and rainfall on hydrological cycle. Regarding the water need treatment or any management procedures before consumed by society, hence it is needed CAP or capital as the investment in water infrastructures. On the below of concept, the clean water as need will distribute to society or population and the investment capital will return to the management company.

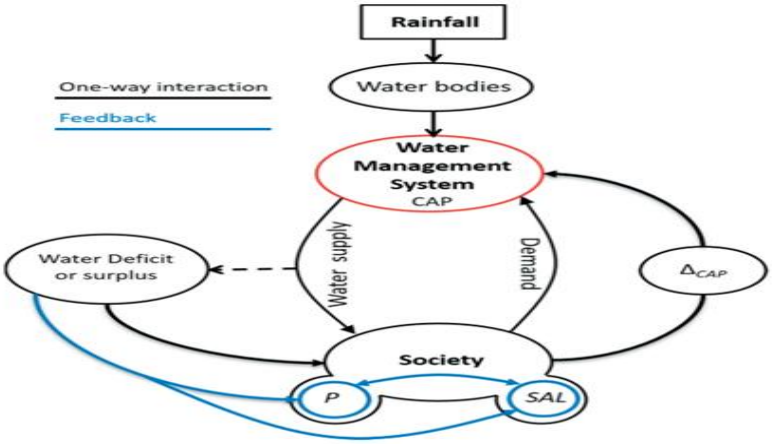

Fig 2. The correlation of environment, social and economic on water demand

The water demand and supply define the two-way interactions between society and the water management system. The concept figures the correlation between the society and water demand which P and SAL (salary), when the relation does not balance, the P and SAL will be effected, e.g. the water supply system encounter water deficit, meanwhile society still can fulfil their demand of water through SAL (capital investment). Hence, there are several external factors in relation of the water supply system.

3. Results and Discussion

Climate change will have an impact on natural resource management efforts. In terms of both space and time, precipitation is the most important variable in the water balance. Changes in precipitation have a significant impact on hydrology and water resources. Climate conditions were directly linked to the change in rainfall-runoff. Climate models predict that precipitation in the semi-arid zone will decrease by 0.34 percent per year on a regional scale (Nait et al., 2021). Human survival depends on natural water storage. Human activity causes climate change, it will undoubtedly always follow the climate, which means that, like a living creature, the climate is constantly changing (Ningrum et al., 2023). It's being rethought as a way to avoid the climate's misleading concept.

According on climate change causes several vulnerabilities, the IPCC build up the assessment on vulnerability concept. this concept is widely used in vulnerability assessments. The vulnerability concept is related on exposure and sensitivity without adaptive capacity (Yang et al., 2021).

$$\text{Vulnerability} = \text{f}(\text{Exposure} + \text{Sensitivity} - \text{Adaptive Capacity})$$

The water is continuously flow through Earth's effect such as atmosphere, surface and subsurface. This cycle also transient but life-sustaining stores in water bodies and ecosystem (Fig. 3A). On precipitation, the ocean is contributed as provider of water vapor, while the river is used as return flow or primary conduit on precipitation (Fig. 3B).

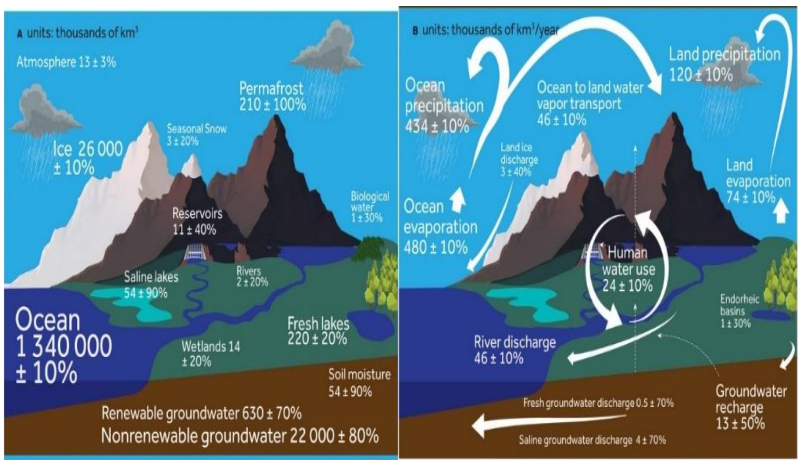

Fig 3. The global water cycle: (A) stores (in thousands of km3) and (b) fluxes (thousands of km3 per year)

Several natural phenomena in sun and volcano eruptions influence the water cycle, as well as internal fluctuations on climate system (Putra et al., 2021). The comprehensive evidence of significant past changes from the paleoclimate record. Human activities are increasingly dominating the water cycle through climatic responses to greenhouse gas and aerosol particle emissions and directly through interference with land aspect, groundwater and water bodies systems for human industry (Fig. 3B). While the energy balance of the Earth determines global mean precipitation changes, it shown the water vapor transport and dynamical process dominated on regional (Allan et al., 2020).

3.1 Major Effects of Climate Change

Climate change has hampered aquatic ecosystems' ability to adapt. Human actions that reduce other types of ecosystem stress and improve adaptive capacity will be critical in reducing the risk of major system impacts (Sa'adawisna & Putra, 2022). Seasonal changes in stream discharge, which are linked to the hydrologic cycle, will harm many aquatic ecosystems severely (Prakasah, 2021).

3.1.1 Precipitation Pattern

Precipitation is essential for the survival of various life forms on Earth. The increasing of Green House Gasses (GHG) on atmosphere is an issue between on the reliance of rainfall and population. As the temperature of the air rises, so does the rate of evaporation, increasing the atmosphere's water-holding capacity. As water-holding capacity rises, so does the amount of moisture in the atmosphere; in other words, as temperature rises, relative humidity decreases, intensifying the global hydrological cycle. Extremely dry and

wet years result from the intensification of the hydrological cycle (Madakumbura et al., 2019).

Several disasters are considered hydrological extreme events such as drought and flood (Wahidah et al., 2023). The less precipitation and high temperatures on surface cause the decreasing of water resource which is caused widespread and need long duration over months or years to drought, meanwhile extremely precipitation on current period of time will cause floods (Chaturvedi et al., 2021).

3.1.2 Water Quality

Through various biochemical processes, the water quality can be affected directly or indirectly by climate change. Furthermore, the specific effects will differ depending on the scale of place and type of water body (Sa'adawisna & Putra, 2023). Understanding the both various of hydrological and biochemical that occur in various water bodies are realizing the relationship between climate change and water quality in various water bodies. Increased contaminant discharge due to water events and an aspect of temperatures build the further effects on the aquatic ecology (Chaturvedi et al., 2021).

3.1.3 Eutrophication

Climate change-related on natural phenomena and other factors increase diffuse nutrient loading (Sharma et al., 2021). Climate change could increase the residence time of water on lowland water bodies. The increasing of residence times will reduce turbidity so it will Improve light penetration to the growth potential of algae, and reduce concentration of sediment (Chaturvedi et al., 2021).

The leaching into water bodies and the risk of eutrophication and loss of biodiversity is caused by fertilizer use on land-use and time growing. Furthermore, the increase of temperature will build the long period of thermal stratification and raise the thermocline water which is increase the possible of pollutants to release from sediments by hypoxia in the bottom water. The further effect is microorganism's growth such as phytoplankton whom intense the eutrophication. Several effects on water resources from climate change are mentioned in Fig. 4.

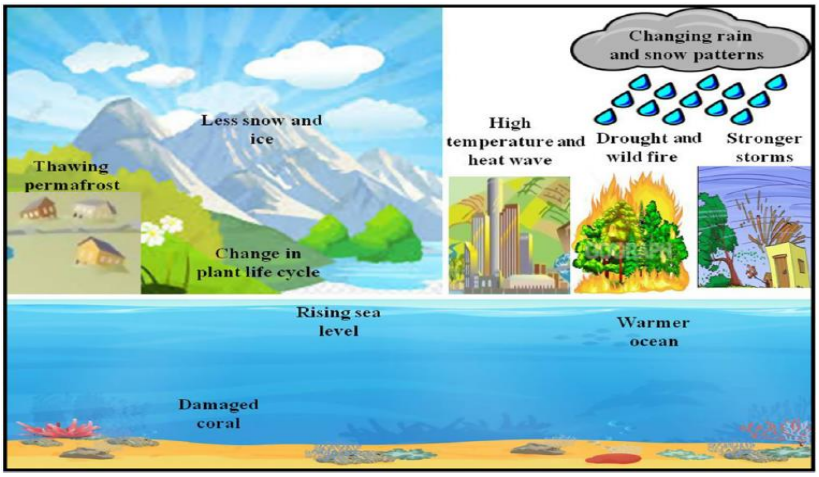

Fig 4. Some major impacts of climate change on water resources

3.2 Groundwater Extractions and Climate Change

Not only this hydrological cycle, but the aspect of major impacts of climate change has a strong bond with the groundwater resources must be understood as the important component on water aquifers system such as recharge and runoff.

The extraction of groundwater is strongly related on hydrological cycle which is infiltration and precipitation. The climate change may reduce the infiltration from natural precipitation that occur in vegetative area and reduce groundwater recharge and reciprocal groundwater extraction (Sharma et al., 2021).

3.3 Management of Groundwater Sources

The involvement of climate change on present and future is importantly need to consider. The target of sustainable groundwater resource is possible to achieve after understand how to control some factors related such as physiography, geology, and hydrological cycle. Thus, database is required to be integrated with geographic information system (GIS) in purpose to build up the system itself (Lee et al., 2020). Based on demand, there must be a consistent use of groundwater and surface water. While on research, researcher must build the strategy to improve the sustainable water resource.

Develop the technology such as mapping, artificial recharges and the regulation to suitability the condition of groundwater is important. Beside of it, the scientific data is needed from community to form the oriented strategies and innovation in the purpose how to make the groundwater resource on protection and coherent utilization (Sharma et al., 2021).

4. Conclusions

From the discussion above, it can be concluded human activities as the one of main major of climate change affect the circumstances of hydrological cycle which related on water resources. Therefore, the major challenge is how to maintain the sustainability of hydrological-cycle or extraction-climate equilibrium with development method.

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Biographies of Author(s)

JANNIE, Environmental Engineering, Faculty of Engineering, President University.
- Email: jannie.wind.04@gmail.com
- ORCID:
- Web of Science ResearcherID:
- Scopus Author ID:
- Homepage:

YUNITA ISMAIL MASJUD, Environmental Engineering, Faculty of Engineering, President University.
- Email:
- ORCID: https://orcid.org/0000-0002-3297-8850
- Web of Science ResearcherID:
- Scopus Author ID: 57205019607
- Homepage: