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Ginni Rani
Assistant Professor, Department of Chemistry, DPG Degree College, Gurugram, Haryana, India

Prachi Kaushik
M.Sc., Chemistry, DPG Degree College, Gurugram, Haryana, India

Bhumi Shekhawat
M.Sc., Chemistry, DPG Degree College, Gurugram, Haryana, India

Corresponding Author:
Ginni Rani
Assistant Professor, Department of Chemistry, DPG Degree College, Gurugram, Haryana, India

Influence of the hydrological cycle on climate variability and change

Ginni Rani, Prachi Kaushik and Bhumi Shekhawat

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Abstract
The importance of water on earth cannot be underestimated. Water is transported throughout the whole Earth's climate system and affects every constituent along the way. The climate and hydrological systems on earth are delicately interconnected forming a complex feedback loop. Amendments in any one system unavoidably trigger changes in the other. Witnessed climate changes, along with anticipation from climate models, indicate strengthening of these shifts in future. Global warming has capability to modify the hydrological cycle in multifaceted manner accommodating increased latent heat flux and enhanced formation of cloud which lead to intense and frequent precipitation events like storms, floods and droughts. These incidents have increased focus in recent years due to their appreciable socio-economic impacts. Are all natural calamities be solely attributed to atmospheric alteration effects? This question usually arises in the perspective of reviewing literature on climate change and its impact. This article reviews the components of hydrological cycle and effect of climate change on hydrological cycle.

Keywords: Hydrological cycle; climate change; global warming; climate models

1. Introduction
Global hydrologic cycle is produced by water exchanging between the land and the oceans. Water is stored in the oceans, the transfer of water between all these constituents plays an important role in Earth's climate [1]. Knowing that water is fundamental segment of Earth's life- support system, as a result recognizing the impacts of present and predicted climate change on aquatic assets is critically significant. Demographic growth has amplified pressure on nature as well as water resources. These strains have led to considerable effects on terrestrial climate change. Concurrently, these factors have affected water circulation process, with observable hydrological changes evident as a result of ecological misbalance. At this moment this situation point significant concerns related to the forthcoming of the society and eventually the planet because Earth has witnessed frequent and intense issues with water cycle over several decades. Hence, we aim to grab attention on complexity of this concept and requirement to justify various aspects of environmental shift. In this paper we are going to delve into the concept of atmospheric alteration and its hydrological impacts [2-3].

2. Components of hydrological cycle
The hydrological cycle may be divided into three major sources: the first one is the ocean, which is a major reservoir and source of water; the second is the atmosphere, which functions as a carrier and delivers the water; and the last one is land, which uses the water. The water that is available at a particular place may change with time because of changes in supply and delivery. Water movement can be the hydrological cycle may be divided into three major sources. The first one is the ocean, which is a two-system system: a closed system on the global basis and an open system on the local basis [4-5].
The evaporation of water from the oceans and land is mainly due to solar energy. Moisture moves through the atmosphere in the form of water vapour, which precipitates on land or ocean surfaces in the form of rain, snow, hail, sleet, etc. Some of this precipitation is captured by vegetation or buildings [6]. The amount that reaches the surface of the earth, a part infiltrates into the soil, and the remaining water flows from the surface of the earth into waterways. These currents eventually empty into the ocean. Some of the infiltrated water seeps deep and joins the groundwater and some returns to streams or appears on the surface as springs [7-8].

The movement of water is due to the solar energy that excesses the entering radiation over the leaving radiation. Therefore, the sun is the main driver of the hydrological cycle. The energy to evaporate water from streams, ponds, and oceans comes from the sun. Living things also add water vapour to the atmosphere through perspiration. Gravity plays an important role in the movement of water on the earth's surface. An interesting point of hydrological cycle is that in each phase, there generally occur (a) transport of water [9], (b) temporary storage of water [10] and (c) change in the state of water [11].

2.1 Stages of the hydrological cycle

- Evaporation
- Transpiration
- Condensation
- Precipitation
- Interception
- Surface run off, as mentioned in Fig 1.

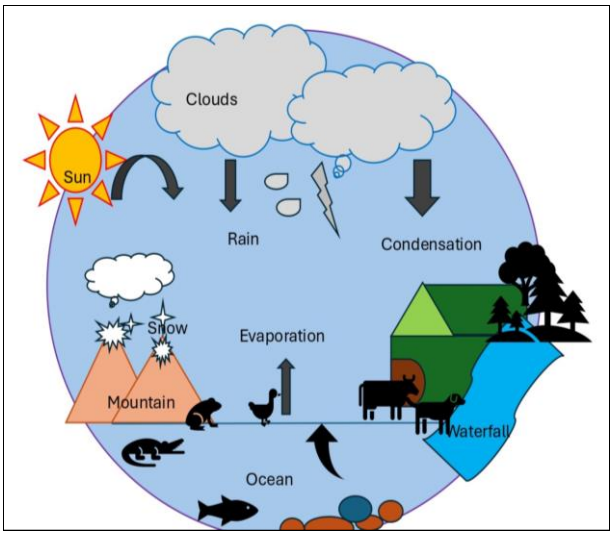

Fig 1: Hydrological Cycle

3. Global climate change and the hydrological cycle

The release of high amount of carbon dioxide (CO_2) into the atmosphere and the changes occurring during this are the reason of getting research attention. Greenhouse gases present in the atmosphere reflect and re-emit the long wave radiations to the Earth's surface, raising the temperature [12]. CO_2 is the major gas, while others are like methane, nitrous oxide and so on. There is a relation between the concentration of the CO_2 and the earth's temperature. For example, in the last glacial period the concentration of CO_2 was approx. 20 parts per million by volume, and the earth was 5-8ºC cooler than pre-industrial condition of 280ppmv. Now a day, the Concentration of CO_2 is approx. 370ppmv [13-15].

In the upcoming period, if the amount of long wave radiation reflected back to the Earth's surface is raised, then the potential evaporation from the oceans and the land surface may also increase. Also, the precipitation rates should change, if the increase in water vapors storage in the atmosphere does not balance the increased evaporation [16-18]. It is difficult to understand the impact of climate change on all the view of hydrologic cycle, translating these results into their effects on human activities is even more of a challenge. Humans are most sensitive to hydrological variations and certain sequences of events [19].

The atmosphere is not the factor that affected by the climate change, but the ocean and cryosphere may also be affected. Change in climate also predicted that the highest warming in atmosphere occur at high latitudes. Also, when the surface temperature warms enough, then freezing melts and thermal expansion of the oceans also may cause sea level changes over the 100 years. This is also a big task because 1% decrease in glacial water content can increase sea level by 30cm.

The expected factors of climate changes on surface runoff are still remain unknown, in part because of the fine spatial scale considered and unknown changes in rainfall seasonality and timing [20]. However, the possible consequences of these changes should not be underestimated. In regions where water resources are fully occupied, a decrease in supply can lead to regional disputes and international conflicts [21].

4. Improvement of hydrological cycle

The release of a high amount of carbon dioxide (CO_2) into the atmosphere and the changes occurring during this are the reasons for getting research attention. Greenhouse gases present in the atmosphere reflect and re-emit the long wave radiations to the Earth's surface, raising the temperature [12]. CO_2 is the major gas, while others are like methane, nitrous oxide, and so on. There is a relation between the concentration of CO_2 and the earth's temperature. For example, in the last glacial period the concentration of CO_2 was approx. 20 parts per million by volume, and the earth was 5-8ºC cooler than the pre-industrial condition of n of 280 ppm. Now a day, the concentration of CO_2 is approx. 370 ppm [13–15].

The economic and social effects are among most vulnerable concerns for organizations. Usually, ecological imbalance mitigation and transformation tactics are developed with a pioneering concern on ecological and environmental levels. This blueprint establishes a unique hierarchy within the impacts of atmospheric alteration as portrayed by figure 2. Analogously, variations in the effect of climate misbalance can embrace both spatial and temporal dimensions. The impacts fluctuate significantly depending on the time scale (e.g. centennial, decadal, and seasonal) and the spatial scale (e.g. local, global, and regional).

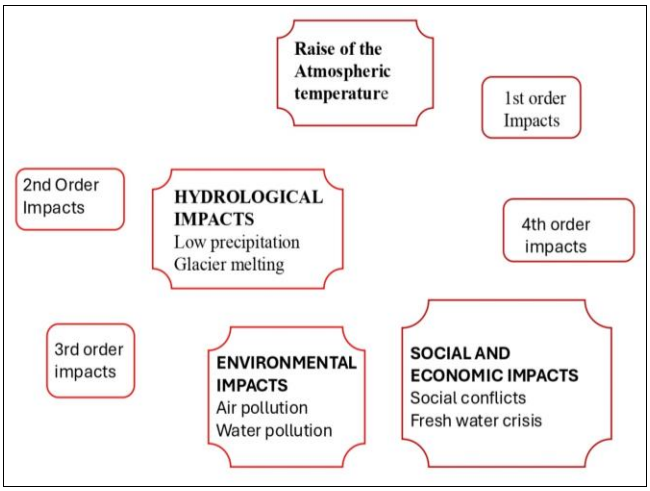

Fig 2: Hierarchy of effects atmospheric misbalance aiming on hydrological framework.

In the upcoming period, if the amount of long-wave radiation reflected back to the Earth's surface is raised, then the potential evaporation from the oceans and the land surface may also increase. Also, the precipitation rates should change if the increase in water vapour storage in the atmosphere does not balance the increased evaporation [16–18]. It is difficult to understand the impact of climate change on the entire hydrologic cycle; translating these results into their effects on human activities is even more of a challenge. Humans are most sensitive to hydrological variations and certain sequences of events [19].

The atmosphere is not the only factor affected by climate change, but the ocean and cryosphere may also be affected. Change in climate also predicted that the highest warming in the atmosphere occurs at high latitudes. Also, when the surface temperature warms enough, then freezing melts and thermal expansion of the oceans also may cause sea level changes over the next 100 years. This is also a big task because a 1% decrease in glacial water content can increase sea level by 30 cm.

The expected factors of climate change on surface runoff still remain unknown, in part because of the fine spatial scale considered and unknown changes in rainfall seasonality and timing [20]. However, the possible consequences of these changes should not be underestimated. In regions where water resources are fully occupied, a decrease in supply can lead to regional disputes and international conflicts [21].

5. Conclusion

The climate system is governed by the global water and energy cycle, which consists of many interdependent and complex processes, interactions, and mutual feedbacks in the atmosphere, hydrosphere, cryosphere, and biosphere. Only a thorough understanding of these processes will enable quantitative and accurate determination of hydrological variables from satellites. In turn, the new abundance of data relevant to studies of land surface hydrological processes that come from remote sensing sources allows us to abandon conceptual model approaches and further develop hydrological models that are based on first-order principles in the representation of land surface hydrological processes in the physical and physiological field.

Understanding Earth's complex hydrology and its connection to the carbon cycle and atmosphere will support our ability to design the local, regional, and global water cycle with high predictive power; thereby, it can reduce uncertainties in climate and Earth system models.

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