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The Change in Climate and Its Impact on the Water Resources

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Abstract:

The change in climate is a major concern for the society because it gives an adverse effects on the environment as well on living beings. The climate change is defined as the change in the factors of the climate like change in the temperature. Now these days, the temperature of environment is increasing rapidly. The main cause of increasing temperature is human activities. According to the report, the temperature of the climate will be increased up to 4°C by 2100. It will be a huge adverse effect in the climate. Because of the increased temperature, the rainfall, streamflow and drought which are opposite to each other occur. High temperature have many effects: it melts the ice rocks due to which the level of the ocean and sea has been increased that cause flood, the evapotranspiration is also increased cause the drought because the decreasing the surface and groundwater level. In this paper, the effects of climate change on the water resources has been discussed and also their observation by the modeling system.

Keywords: *Climate, Rainfall, Streamflow, Drought, Evapotranspiration, Modeling System*

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Introduction

In twenty-first century, Climate change is identified as a major globally predominant scientific, economic, political and moral issue that affects both natural and human systems. Intergovernmental Panel explain the climate change means the temperature will increase up to 4°C by 2100 that will affect the water resources and the demand of water all over the world. The effects of both supply and demand of water is considering as the gap between supply and demand will increase that would be a current challenge of water management. The change in the statistical distribution of weather patterns over periods of time is known as climate change. It may vary from the change in the average weather conditions to change in the distribution of weather events with respect to an average values.

The climate change in the term of increased temperature has a pervasive influence on the hydrological cycle and water resources that are recognized as part of complex, dynamic and interdependent. The change in the climate affect the ground and surface water resources on both quality and quantity because of the precipitation and evapotranspiration of the water. High rates of surface runoff is seen due to the increased intensities of precipitation that cause the increment in the risk of flood and decrement in the rate of groundwater recharge resulting in the drought condition. Growing population, rapid urbanization, changing agriculture and livelihoods, growing industries and power need privatization are the factors that generate multiple challenges for Indian water sectors. Inter-state issues are also the cause of over extraction and degradation of the existing resources.

By the southwest monsoon, freshwater resources of India are generated that fulfill the water requirements for many purposes such as agriculture, industries, domestic purposes, energy sectors and ecosystem that depends upon the monsoonal system. In India, more than 80% rainfall happens at the time of monsoon between 'June to September'. A significant impact on agricultural production is due to the change in the climate at the time of Indian southwest monsoon. Already agricultural field is under stress because of the high population and other problems like water resources management **(Kumar *et al*, 2017; Madhusoodhanan, Shreej and Eldho, 2016; Qatarneh *et al* 2018).**

Water Resources

In recent time, resources of water is coming under increasing pressure due to the changing climate. The demand of water is affected with the supply and quality by the climate change. The loss in water supply as well as climate change enhance the competition for the use of water for the economic, social and environmental applications in arid and semi-arid areas of India. In future, water would be at high demand due to the large population who need irrigation and industrialization at the expense of drinking water. After 2025AD, worse condition can be generate if the amount of rainfall decrease in the major food producing regions and increase in the rate of evaporation **(Mall, Bhatle and Pandey, 2007).**

Surface Water Resources

In India, river systems have a large and intricate network in which most of the rivers are the part of Himalayan. Other than these, there are numerous water bodies present in the subcontinent by which it makes wettest place in the world after South America. Snowfall is the main source of water in the India recorded as 4000 km^3. Ganga-Brahmaputra-Meghna system is the major provider of total water resources potential of the country. It shares about 60% of total water resources potential of the various rivers **(Mall, Bhatle and Pandey, 2007).**

Groundwater Resources

A diversified geological climatological and topographic set-up is found in India that gives divergent groundwater situations in different parts of the country. The formation of rock from Archaean to Recent control the occurrence and movement of groundwater vary in composition and structure. In the same way, not too insignificant are the variations of landforms, from the rugged mountainous terrains of the Himalayas, Eastern and Western Ghats to the flat alluvial plains of the river valleys and coastal tracts, and the aeolian deserts of Rajasthan. The water runoff and groundwater recharge are controlled by the topography and rainfall **(Mall, Bhatle and Pandey, 2007).**

Detection of Climate Changes

There are many atmospheric variable such as temperature, rainfall and evapotranspiration that are analyzed for the determination of climate change. According to the study, the condition like droughts, floods and cyclone are the indicators of changing climates. The increasing of greenhouse emission is also one of the evidence. There are following section that are undertaken for the climate change.

Temperature

The increase in the temperature is the main cause of changes in the hydrological cycle due to which increase in the evaporation and rainfall. The pattern of

rainfall is changed due to the changes in the temperature, and temporal distribution of runoff, soil moisture, and groundwater reserves as well as the frequency of occurrence of droughts and floods are also change because of the temperature. Remote sensing devices are used to derive and observe the rainfall as a factor of climate changes.

Modeling for Observing the Impacts of Climate Change

For understanding the climate dynamics, General Circulation Models (GCMs) are used and project about the future climate change. They also give the input data for the impact studies of climate change on coarse horizontal scales.

A hydrological modeling is required to understand the climate changes and their impact on the water balance components. One of the hydrological modeling is Soil and Water Assessment Tool (SWAT) that is used in this study. The basic principle of SWAT modeling is the division of watershed into many sub-units. This model follow two steps:

1. Topographic discretization is performed by dividing the watershed into a number of sub-catchments based on DEM.

2. The information for sub-units is grouped and organized into give classes: climate, hydrological response units (HRUs), ponds/wetlands, groundwater and the main channel or reach draining the sub-basin.

Now, SWAT have achieved a high level of recognition all over the world. It has multi-objective applications like analysis of impacts of climate change. This model is a versatile model that is flexible for integrating the environmental processes and handle the watershed management practices.

Protection of Water Quality

Due to change in the precipitation, flow and temperature create the water quality problems. Instream summer base flows is reduced by the longer dry seasons and loss of snowpack that results in the increased concentration of pollutants. The capacity of sewer systems and wastewater treatment will be overloaded by the increased frequency and intensity of rainfall events that results in the more combined sewer overflows and stormwater runoff. This stormwater runoff and sewer overflow increase the pollution from sediments, nutrients, pathogens, pesticides, and other pollutants. These given following steps would be helpful in protecting the water quality and water supplies, and provide the additional wildlife and flood protection benefits.

- The protection and restoration of the streamside vegetation buffers, wetlands and headwaters are helpful in filtration of pollutants and it reduce the inflow of urban and agriculture runoff.

- Clean Water Restoration Act should be passed that would restore pollution protections under this act to many of these same resources.

- Environmental and public health monitoring and surveillance systems should be restored and improved for the evaluation of climate-health baseline relationships.

- Adoption of minimum stream flow water quality standards for the protection aquatic ecosystems.

- For the preparation of more frequent and heavier rainfall events, Stormwater and combined stormwater and sewage systems should be upgraded and investigation should be done for the opportunities that give beneficial reuse of stormwater and wastewater (www.nrdc.org/policy).

Review of Literature

According to Mall, Bhatla and Pandey (2007) The problem of water quality deterioration/pollution are caused by the unplanned development of surface and groundwater, haphazard disposal of municipal and industrial wastes and application of agricultural inputs. Due to these problems new challenges are developed for water management and conservation front. They gave a review that the hydrological cycle has been modified quantitatively and qualitatively in most agro-climatic regions and river basins by the human activities such as changes in cropping pattern, land use pattern, overexploitation of water storage, irrigation and drainage.

Kusangaya et al (2013) in their paper, they focused on three conditions in which first one is to improve the use of downscaled climate change information for input into hydrological modelling. Second is earth observation's refining use and data to increase understanding and improving the prediction of climate change. Last one is available model output's utility should be improved by acknowledging and quantifying compounded predictive uncertainty.

Madhusoodhanan and Sreeja and Eldho (2016) Water sector of India is highly dynamic, spatially heterogeneous. Climate change put a pressure on the nexus. There is a need to formulate coherent and integrated resources and climate change policies. For the relevant adaptation and mitigation measures: assessing the multiple interlinkages in the ELWC nexus and understanding the

responses/impacts/feedbacks of the ELWC nexus and climate change and the impact of global climate change should be distinguish and quantified from the human interventions on the water resources.

Kumar *et al.*, *(*2017) in this paper, researcher divided the paper into section. In first section, they gave their conclusion on the impact of climate change on the water balance and said rainfall pattern of the climate has a dominating impact on water balance components. Increasing the rainfall increase the risk of floods of low lying areas. By the increase in the rainfall on the surface and low effect on percolation. According to researcher, a wide gap is seen between availability of detailed research performed on the impact of climate change on water resources and urgent need for the adaption of water management strategies in time. In their study they tried to bridge this gap and gave suggestion to improve the information and knowledge that can support the decision makers aiming at sustainable water management.

Qatarneh *et al.*, (2018) proposed that the impact of climate change is very irrelevant to rainfall and streamflow. The falling temperature affects the activities of human life and agriculture both rain fed and irrigated area. Hence, there should a need of more attention in designing and analysis for both agriculture and urban planning projects. And also the temperature and rainfall observations should be taken in account for providing the resources of complete and reliable data. For future strategic water budget plans, the climate change impacts on resources should be taken into consideration.

Conclusion

Climate change is increasing rapidly due to which the rainfall and streamflow has been uncontrolled. In India, the main season of rainfall is June to September, if any change occur in the climate during this period cause the insignificant effect on the agriculture on which more than 80% people depends. There are many models for observing the climate changes. In these model, SWAT is a model that has been accepted universally because of the application handle the watershed management practices. In spite of the many models, there is a need of awareness among the people to reduce their activities that affect the climate.

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