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Climate Change's Impact on Water Resources in Jammu and Kashmir (India)

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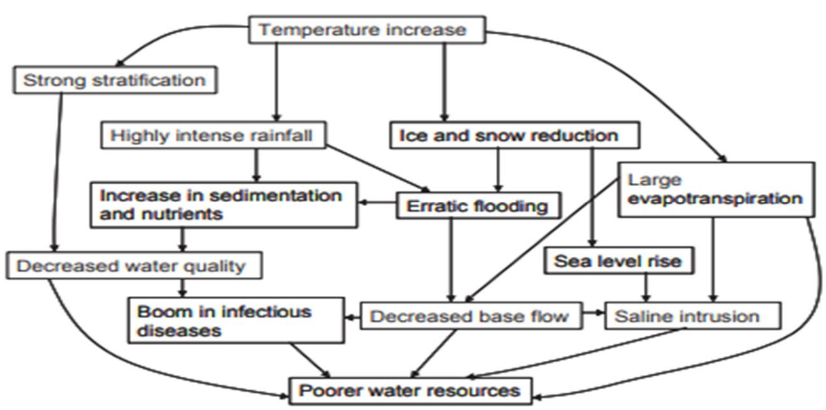
Abstract: The effects of climate change on water resources, adaptability, and Water resource-related issues are broadly and intricately intertwined. As a result, the tools used today to deal with these variables and create integrated assessments are complex and fraught with ambiguity. Nonetheless, a lot of researchers have worked hard to create numerical simulation methods that can assess each interaction as well as the combined impact. Problems with floods and droughts are being clarified by numerical simulations using GCM data. They also aid in our comprehension of the effects of human activity and the depletion of freshwater resources in coastal areas as a result of sea level rise. There is some qualitative understanding of the influence on water quality even though no models of water quality under the influence of global warming have been produced yet. Predictions of social and climatic changes have not yet been made, despite the fact that research and talks for the adaptation of water resources have already begun. As a result, it's essential to create numerical models that illustrate how socioeconomic situations and water resources interact.
Keywords: droughts, floods, snowfall, water environment

I. INTRODUCTION

Numerous domains that are closely linked to water, such as ecology, agriculture, and infectious illnesses, have already been influenced by global warming. Numerous phenomena are influenced by fresh water, both directly and indirectly, and both actively and passively. To grasp the intricate biological links intuitively would be too challenging. The connections between the basic mechanisms of global warming and issues with water resources are depicted in the following figure. We find it challenging to quantify even these affects because we need to determine the function of the feedback in addition to the function of each activity.

An integrated understanding of the intricate relationship is achieved through the use of numerical models. While many numerical models are unable to accurately capture real-world situations, they can more easily offer an objective quantitative assessment than can be obtained through intuition (Tosaka, 2003). The ability of numerical models to anticipate the future under many scenarios adds another rationale for their usefulness in policy and decision-making processes.

The scenario itself contains a great deal of uncertainty and is a future assumption in social or policy contexts. We are not able to accurately forecast the future. As a result, this model is too complex to explain how water resources and social settings interact. Even though predicting changes in water resources requires a lot of work, current assessments of water resources under global warming seem straightforward.



Influence propagation from temperature increase to water resources.

The term "green dam" has occasionally been used to describe the processes of late runoff and recharge in forests. The majority of extremely strong rainfall brought on by global warming diminishes the green dam effect because the groundwater level drops and the rainfall flows downstream without penetrating. Increased temperatures also cause less snow to accumulate. As a result, the river's base flow will drop and a steady supply of water will disappear. Heat islands are created by drought-related problems that raise local temperatures and hasten the depletion of water needed to lower them.

A. Danger of Droughts and Floods

Since floods and droughts are precipitation-related phenomena, GCM data are utilized to anticipate these events in the future. Precipitation patterns have been linked by numerous experts to global warming. For instance, Jammu and Kashmir saw an increase in the number of extreme hot events during the current year, this implies that although annual precipitation stays constant, there will be more intense rainfall and a longer period without rain. . These types of rainfall produce severe floods and droughts as was experienced in Kashmir during the current year

Subterranean diversion channels are a feature in certain metropolitan districts designed to safeguard high-economic zones. Budgetary restrictions for the kinds of infrastructure that are employed as countermeasures are being discussed these days. The master plan for integrated flood prevention by the government of India suggests percolation systems, retention ponds, and inundation allowances as common responses. That

make the control difficult under global warming. Stable runoff is provided predominantly by ground water storage in the mountainous forests. The name “green dam” has sometimes been applied to the forest function of recharge and late runoff processes. Most of highly intense

Rainfall due to global warming reduces the green dam effect because the rainfall flows downstream without infiltration and the groundwater level recedes. Also higher temperatures diminish snow storage. Therefore the base flow of the river will decrease and lose stable water supply will be lost. Drought problems heighten regional temperatures generating heat islands and accelerate the lack of water to suppress the temperature. As a result, the river's base flow will drop and a steady supply of water will disappear. Drought-related issues raise local temperatures, creating heat islands, and hasten the depletion of water to maintain a consistent temperature.

Some claim that future population declines will lessen the need for water, thereby solving the drought issues. For different purposes of water consumption, such as providing ecosystems with environmental water or providing water to mitigate the heat island effect, additional water resources will be required. Water supply and demand may continue to be impacted by socioeconomic changes and global warming. Reservoirs and dams are the best means of stabilizing water resources and bringing about a bearable scenario. In India, the primary means of adaptation are facilities that have lately become more widely used, such as housing tanks or infiltration masses. Both institutional and physical solutions, such as water amendments and land development restrictions, have been advocated. Physical countermeasures involve building facilities.

The distribution of rainfall, soil moisture, river discharge, and runoff in the 2014 flood in the Kashmir may all be understood quantitatively by numerical simulation. It is simple to identify weak spots and to understand the relative intensity that is present over a large area. Additionally, it can represent the distribution of water resources for future estimates using GCM data. These are great points that offer standards for an impartial assessment.

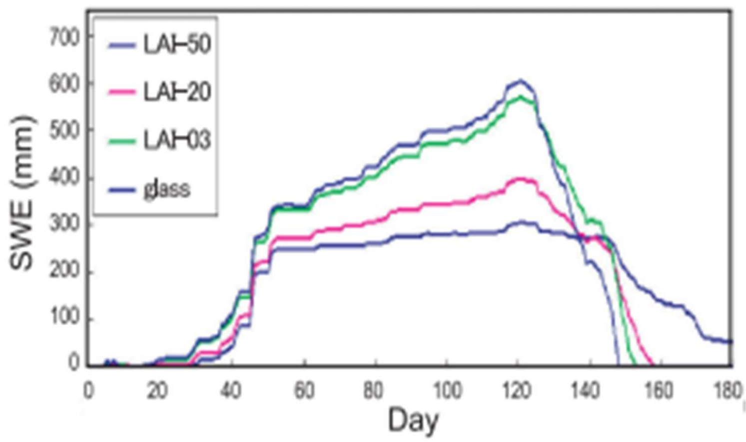
Issues related to drought are more severe. Even if reservoirs and dams have been able to maintain a steady supply of water up to this point, global warming will make it more difficult to maintain control over extreme rainfall patterns. The ground water storage found in the highland forests is primarily responsible for stable runoff. The recharging and late runoff processes that occur in forests have occasionally been referred to as "green dams." The majority of extremely strong rainfall brought on by global warming diminishes the green dam effect because the groundwater level drops and the rainfall flows downstream without penetrating. Increased temperatures also cause less snow to accumulate. As a result, the river's base flow will drop and a steady supply of water will disappear. Some claim that future population declines will lessen the need for water, thereby solving the drought issues. For different purposes of water consumption, such as providing ecosystems with environmental water or providing water to mitigate the heat island effect, additional water resources will be required. Water supply and demand may continue to be impacted by socioeconomic changes and global warming. The most practical solution for stabilizing water resources and bringing about a bearable scenario is the construction of dams and reservoirs. In India, the primary means of adaptation are facilities that have lately become more widely used, such as housing tanks or infiltration masses. Both institutional and physical solutions, such as land development and changing water right regulations, have been advocated. Physical countermeasures involve building facilities. Numerous rural governments have adopted these creative measures and passed important legislation pertaining to water resources.

It is sufficient to use numerical simulation to understand the quantitative efficacy of adjustments. The graphic depicts the distribution of runoff, river discharge, rainfall, and soil moisture during the 2014 flood in Kashmir. It is simple to identify weak spots and to understand the relative intensity that is present over a large area. Additionally, it can represent the distribution of water resources for future estimates using GCM data. These are great considerations that offer standards for unbiased assessment of post-global warming situations.

There are rumours that the rapid population growth in Africa and India would lead to increased food production and a shortage of water resources globally. Issues with water resources could affect international trade and have an effect on a number of goods worldwide, including services and crops. It's hardly hyperbole to argue that water can be used as a strategic element.

B. Snow Resources

One of the things that is most obviously impacted by global warming is snow. Rainfall replaces snowfall. Snow that has been stored melts quickly. Snow provides a long-term, steady recharge and storage volume, which is crucial for the preservation of water supplies. Our nation's India’s Sea coast is well-known for receiving some of the world's highest rainfall totals. Since there is less spring rainfall in the most of the District in particular, snowmelt water helps supply irrigation water for sizable paddy fields. According to estimates using remote sensing technology, there is roughly 4 km^3 of snow in the Kashmir, which is equivalent to four times the amount of water used for residential usage in the metropolitan area. Precipitation and temperature data can be utilized as input for a numerical simulation of snow variation, and a satellite image can be used to calibrate the model parameter. As seen in Fig. the simulation produces accurate variations. In the simulation, the amount of snowfall varies by more than 30% between light and heavy snow years. Additionally, the Kashmir snowfall is declining, according to the Regional Circular Model (RCM) Furthermore, ground water storage benefits from the lengthy, sluggish pace of snowmelt recharge. These findings point to a difficult management task for water resources.

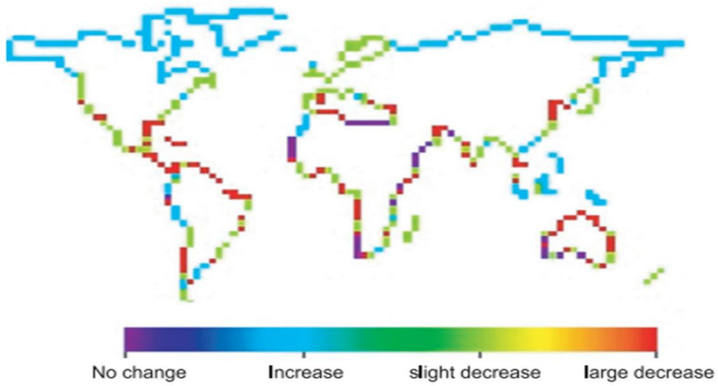


Snow variation with different LAIs.

C. Rise in Sea Level

There have been numerous reports of sea level rise linked to global warming, which is having an impact on coastal water resources. As sea levels rise, salt pollution is indirectly caused by tidal surges and tsunamis in addition to direct damage. Furthermore, when the sea level rises gradually, saline water will be able to infiltrate rivers and spread areas of salt pollution through lower places like deltas or aggraded valley plains, which are typically home to large urban areas or grain belts.

Because many lower-lying cities will require more fresh groundwater as their populations grow, both surface water and groudwater resources are impacted. Salinity intrusion is also a result of lower groundwater levels. Using GCM and sea level rise data, Ranjan et al. assessed the decline of fresh groundwater in coastal zones owing to global warming. As Fig. illustrates, they found bigger areas of reduction in northern Australia and eastern Africa. Although there is a great deal of ambiguity about the future social environments in these kinds of models, they do help us understand the key components impacting the outcomes



Decrease of fresh groundwater resources along the shore over the next 100 years

D. Water Quality

Water resource acquisition is impacted by issues with water quality. Water treatment facilities are a response to the issue posed by global warming, however this implies that increased prices are associated with lower quality. Increased water temperatures prevent rivers from self-purifying and reduce DO (dissolved oxygen). The opposite can also occur in chilly zones due to increased bacterial activity brought on by hot temperatures. In terms of water quality, heavy rainfall has a greater impact on global warming than high temperatures because it generates a lot of sedimentation and nutrients, which may intensify as runoff discharge rises. The nutrient and sedimentation deposits in reservoirs and lakes cause eutrophication and a growth in algae, which obstruct flocculation and filtration and give the water a moldy taste. It was discovered recently that treating with pre-chlorine as a preventative step for these issues results in the production of carcinogens .Additionally, silt deposition worsens environmental degradation and reduces reservoir capacity. Temperature changes can affect shallow water levels, and occasionally, abnormally high water temperatures can wipe out nearly all aquatic life.

II. CONCLUSIONS

Our research's primary findings focused on issues related to water supplies in the context of global warming. Determining societal scenarios is the primary factor that affects correct predicting of future effects on water resources, together with precise meteorological and climatic forecasting. Population and land use changes have a direct and dynamic impact on water consumption and hydrologic cycles, as well as on substance cycles and human activity.

Water resources and human activities are also impacted by policies, though models for these effects have not yet been developed. Social forecasting has greater uncertainty about future water than do hydrological and climate models. It is evident that the most crucial factor in forecasting future water resources is the ability to make precise social action forecasts. Future social situations and policy seem to be unpredictable, even a few years ahead of time. Right now, a lot of experts are working hard to anticipate future water issues and ways to adapt to climate change.

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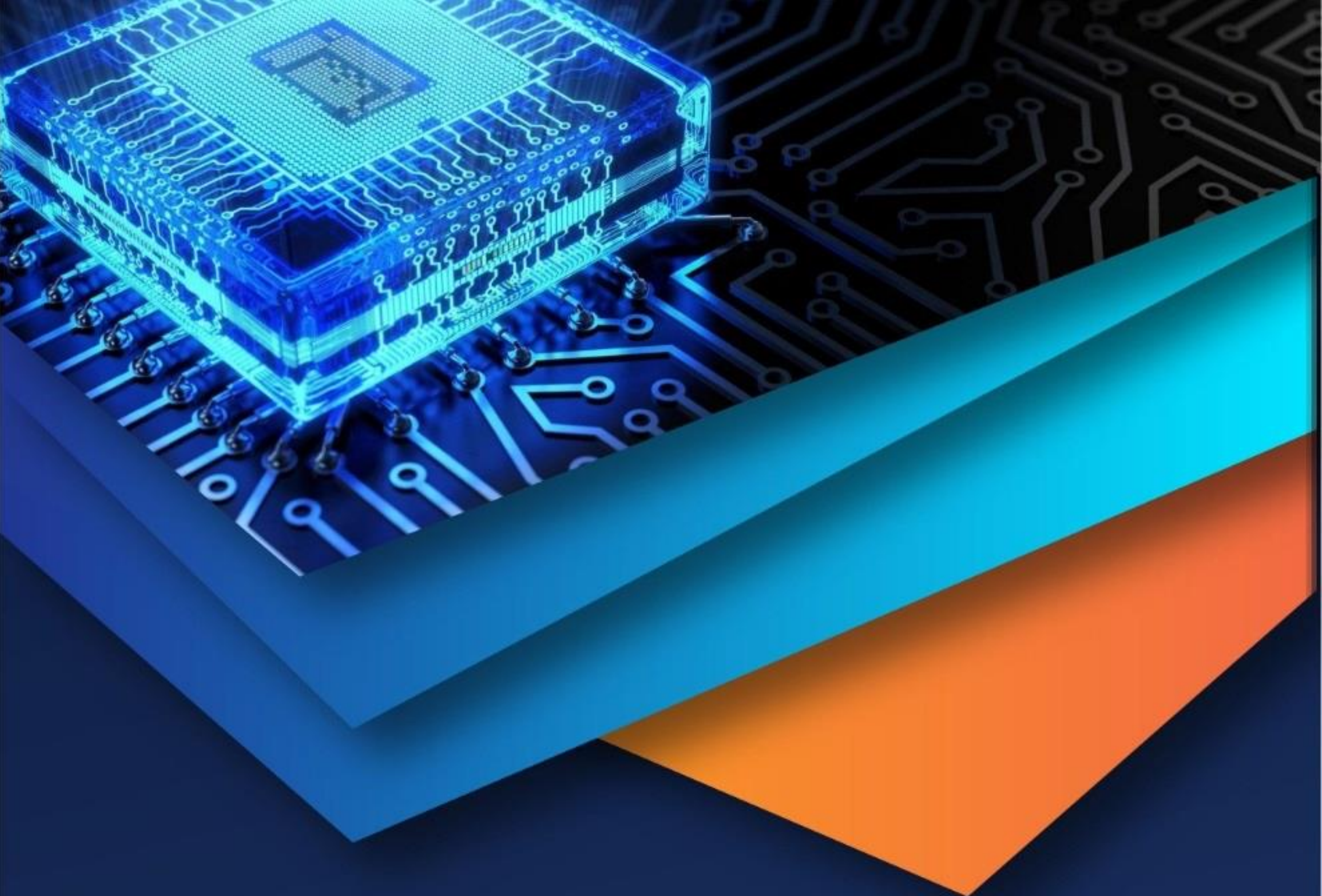

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