Review of Climate Change and India's Water Supply

Dr. Gargi
Assistant Professor, Department of Zoology, MMH College, Ghaziabad, Uttar Pradesh, INDIA

Corresponding Author: gargirana26@gmail.com

ABSTRACT

Some of the predicted consequences of climate change include an increase in the frequency and severity of extreme weather events, increased monsoon variability, and the emergence of new disasters, such as sea level rise, as well as new vulnerabilities with differential spatial and socioeconomic impacts on communities. The hydrological cycle, water supply for drinking water, forests and ecosystems, losses of coastal wetlands and mangroves, food security, public health, and other associated areas are all projected to be severely impacted by this unprecedented increase. The impoverished and vulnerable sections, which make up anywhere from a quarter to half of the population in most Indian towns, would be hit the hardest. This would be especially devastating for emerging countries like India. In most of India's agro climatic regions and river basins, human activities like land use change, water uses, inter-basin transfers, cropping patterns, irrigation, and drainage are altering the hydrological cycle in both quantitative and qualitative ways. With the water table dropping, many previously secure areas are becoming vulnerable and overexploited. As a result, surface water, ground water, and the natural environment they rely on have all become increasingly important to manage sustainably in recent years. For resource planning and sustainable development to serve as a foundation for economic and social growth, it is essential to assess the availability of water resources in light of future national requirements, paying special attention to the increasing demands for water and the anticipated impacts of climate change and variability. This research examined the potential for water-related developments and the availability of surface and groundwater resources in India in light of the potential effects of climate change on this country's ability to meet future demand. Water security, community resilience, and disaster preparedness must all be addressed simultaneously, so a comprehensive strategy is needed.
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Keywords-- Water Supply, Climate Change, Human Health, Hydrological, Rivers

I. INTRODUCTION

Maintaining biodiversity, human health, social welfare, and economic growth all rely heavily on water (Donald, 1968). There have been more and fewer cold days recorded, with the former tendency expected to persist into the next millennium. There has been a general decline in seasonal mean rainfall over India, which is consistent with the rising prevalence of monsoon break days and falling incidence of monsoon depressions (IPCC 2014). More than 80% of rural and 50% of urban people use ground water for domestic purposes, and it also provides irrigation for around 50% of irrigated crops. Even though groundwater accounts for over half of the region's water supply, the effect of rainfall variation on these resources is poorly known. This is mostly because of the intricate relationships between factors including land cover, aquifer features, preexisting water table levels, and the precise timing and intensity of individual rainfall episodes. It's possible that a drop in precipitation won't have much of an immediate impact on water tables if the aquifer systems are already at capacity, but in other situations, precipitation levels below a crucial threshold could completely shut off infiltration beyond the root zone of plants. While it is reasonable to assume that less rain would lead to less runoff, the same cannot be said for the water table aquifer, which supplies the vast majority of our groundwater. Cross-correlation analysis was performed by Chen et al. (2004) to look at how much of an impact climate has on groundwater level variation through time. According to their findings, annual precipitation adequately accounted for the observed groundwater level changes. Water demand, quantity, and quality are all influenced by the weather. Water scarcity, exacerbated by climate change, would increase competition for its use across a wide spectrum of economic, social, and environmental uses, particularly in India's arid and semi-arid regions. Future scenarios with and without climate change are compared to determine the probable socioeconomic implications of climate change. Possible sources of error in such an evaluation include:

1. In terms of when, how much, and what kind of climate change to expect;
2. Natural or human-induced adaptability of ecosystems to change;
3. projections for population growth and economic activity, as well as how these things will affect the natural resource system,
4. How people and businesses respond to events as they happen, and how changes in policy create the conditions and incentives for people and businesses to adapt.

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II. CONSIDERATIONS FOR INDIA'S POPULATION

The average yearly rainfall over a long time span in India is roughly 117 centimeters, but this number varies greatly across the country. Almost three-quarters (74 cm, 10 SD) of the entire year's average precipitation falls between June and September (SW monsoon). Northeast India and the Western Ghats of peninsular India receive the greatest rains, with amounts of 200 to 400 centimetres or more not uncommon. Average annual precipitation in the northern Indo-Gangetic plains, which run parallel to the Himalayan foothills, varies from around 150 centimetres (cm) in the east to 50 centimetres (cm) in the west.

2.1 Our Water Supply Comes from the Surface

The Himalayan river systems, which drain India's major plains, are the most prominent rivers in India's vast and complex river network. In addition, the abundance of water resources throughout the subcontinent makes it one of the second-wettest regions on Earth, right behind South America. There is an estimated 4000 billion cubic metres of precipitation and snowfall each year in the country (BCM).

2.2 Potential of Underground Water Supply

We can keep using the water that's already underground forever. However, in some areas, canal seepage and irrigation return flow, in addition to rain, also significantly recharge groundwater.

Table 1: Climate change is affecting our water resources

Location	Effects	References
Orissa and West Bengal	One-meter sea levels rise would inundate 1700 km2 of prime agricultural land	IPCC, 1992
Indian coastline	One-meter sea level rise on the Indian coastline is likely to affect a total area of 5763 km2, and put 7.1 million people at risk	JNU, 1993
Indian subcontinent	Increase in monsoonal and annual runoff in the central plains • No substantial change in winter runoff. • Increase in evaporation and soil wetness during the monsoon and on an annual basis.	Lal and Chander, 1993
All India	Increases in potential evaporation across India	Chattopadhyay and Hulme, 1997
Central India	Basin located in a comparatively drier region is more sensitive to climatic changes	Mehrotra, 1999
Kosi Basin	Decrease in runoff by 2-8%	Sharma *et al.*, 2000
Southern and Central India	Soil moisture increase marginally by 15-20% in monsoon months	Lal and Singh, 2001
Damodar basin	Decreased river flow	Roy et al., 2003
Rajasthan	An increase in ET	Goyal, 2004
River basins of India	General reduction in the quantity of the available runoff, increase in Mahanadi and Brahmini basin	Gossai and Rao, 2006
River basins in northwest & central India	Increase in heaviest rainfall and reduction in number of rainy days	Singh et el., 2008

There are two types of groundwater resources: dynamic, which exist in the area where the water table rises and falls, and static, which exist outside this area and remain permanently saturated. After setting aside 34 bcm for natural discharges in the dry season, the countries annual replenish able groundwater reserve is 433 bcm, making 399 bcm available in the dry season. Over-exploitation of the resource, continually declining water levels, seawater ingress in coastal areas, and ground water pollution in various parts of the country are all problems brought on by the rising demand for water in agriculture, industry, and the home, as well as by ground water development. In many places, groundwater levels have dropped below what it would cost to pump, which threatens the long-term use of the resource.

2.3 Effects of Climate Change

Heavy and very heavy rainfall events have extremely significant increasing trends in both frequency of occurrence and severity, while low and moderate events have significantly decreasing trends over Central India (Goswami et al., 2006). Over the western Indo-Gangetic Plain Region (IGPR), summer monsoon rainfall has

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increased by 170 millimetres per hundred years (significant at the 1% level) since 1900. In the central IGPR, however, it has decreased by 5 millimetres per hundred years (not significantly) since 1939. In general, it appears that rainfall activity over the IGPR has shifted westward.

III. CLIMATE CHANGE PROJECTIONS

Even though warming is expected to be uniform across the country, Rupa Kumar et al. (2006) found large regional disparities in the predicted changes to precipitation. The west central region of India is expected to see the most rainfall increase. Both the highest and lowest temperatures are expected to rise in the coming decades, but the lowest temperatures are expected to rise more quickly.

There are widespread increases in the frequency and intensity of extreme precipitation, most notably along the west coast and in central India. CO2 levels are expected to rise to between 607 and 755 parts per million by 2070, according to research by Lal et al. in the east and in central India. CO2 levels are expected to rise to between 607 and 755 parts per million by 2070, according to research by Lal et al. (2001). They predicted that the average annual temperature rise would be between 1 and 1.4 degrees Celsius by 2020 and between 2.23 and 2.870 degrees Celsius by 2050. A majority of the country is seeing fewer wet days overall. The number of wet days is expected to drop by more than 15 days in the west and central regions but to increase by 5–10 days in the northeast and along the Himalayan foothills (Uttarakhand). While some regions of northwest India may see a decrease in rainfall intensity of 1 mm/day due to a rise in GHG levels, this may not be the case for the entire region.

3.1 Effects on Water Supply

Select reports on the effects of climate change on India's water supplies in the next century are shown in Table 1. By the end of the next century, the Indian subcontinent will have warmed to the point where pre-monsoonal and monsoonal rainfall will increase while central plains winter rainfall will remain relatively unchanged. This would boost monsoonal and annual runoff in the central plains while having little effect on runoff during the winter. They also showed that evaporation and soil wetness both peak during the monsoon and on a yearly basis.

IV. WATER LEVELS AND CLIMATE CHANGE

India's groundwater management issues may have far-reaching effects on the climate. In the best-case scenario, India's total carbon emissions would rise by more than 1 percent due to a drop in groundwater levels of just 1 meter. For every metre that groundwater levels fall, carbon emissions could go up by 4.8%, based on a more realistic assumption that takes into account the area expected to be irrigated by groundwater in 2003. Chadha (2003) suggested researching the impact of melting glaciers on the recharge potential of the aquifer in the Ganga basin, as well as its effect on the trans-boundary aquifer system, especially in arid and semi-arid regions, and determining the location of saline-fresh interfaces within 20 km of the coastal area. Repeated droughts and increased anthropogenic pressure on Orissa's groundwater levels were investigated by Panda et al. (2007). A preliminary study showed that the groundwater levels of the network observation wells are very sensitive to the monsoon rainfall, and any irregularity in the rainfall directly influences the groundwater levels. Due to the drought in 2002, the groundwater level dropped significantly in the consolidated formation that covers 80% of the geographical area of Orissa.

It is clear that the global warming threat is real, and the consequences of the climate change phenomenon are many and alarming. The impact of future climatic change may be felt more severely in developing countries such as India, whose economy is largely dependent on agriculture and is already under stress due to the current population increase and associated demands for energy, fresh water, and food. In spite of the uncertainties about the precise magnitude of climate change and its possible impacts, particularly on regional scales, measures must be taken to anticipate, prevent, or minimise the causes of climate change and mitigate its adverse effects. The models also have a lot of trouble predicting extreme flood and drought events. If less rain falls and less water flows into rivers and lakes as a result of climate change, this could increase the pressure on groundwater supplies and decrease the flow of water elsewhere, suggesting that the Indian subcontinent is particularly vulnerable to the effects of global warming. Uncertainties exist in dealing with the vulnerabilities associated with climate change and variability, and the currently at-risk elements and sectors are likely to be extremely vulnerable to both. Climate change may have both direct and indirect effects on both recharge and discharge to an aquifer. Temperature increases may increase potential evapotranspiration and water use demand. As a result, effective groundwater resource management necessitates an integrated strategy for both planning and implementing schemes. In order to effectively manage groundwater resources in a climate that is always shifting, it is necessary for various water resources, climate, agriculture, and other organisations to work together and release policies based on scientific considerations. Rising water use in the future is more likely to deplete groundwater reserves than climate change-induced reductions in recharge. In light of the growing water shortage, governments and communities alike need to coordinate efforts toward a more holistic approach to water management that can ensure a secure supply of fresh water for future generations.

V. CONCLUSION

Since temperatures appear to be rising steadily, climate change has become an issue that requires immediate attention. This emerging problem can only be mitigated and minimised to an extent, so proper planning and implementation of such plans at all levels should get started as soon as possible.

The effects of climate change on water supplies have been analysed in this review. Previous research primarily used models to represent alterations in river flows, ice melting, precipitation, and temperature. Several studies have shown that climate change has caused a significant rise in global temperature over the past century and that this trend will continue at an accelerated rate over the next century. Annual river discharge, global runoff, global temperature, global mean sea level, and numerous mega-deltas have all been affected by climate change in the present scenario. A mega-delta like the one formed by the confluence of the Ganges, Brahmaputra, and Meghna (GBM) is among the most at risk from climate change. The dramatic shift in weather patterns in the GBM basin is likely to have far-reaching effects on its rivers, which could exacerbate the region's already serious flooding and drought issues. These changes to the GBM river basin may also affect the water supply, biodiversity, and agricultural output of the Indian subcontinent. When coupled with the effects of climate change and the rapid rise of sea levels, the situation may worsen. However, there is still a lot of doubt surrounding estimates of how climate change will affect water supplies. In order to enhance regional climate models and climate projections, it is crucial to obtain more information about long-term observations of climate variables in water resources.

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