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Groundwater in India is Decreasing Because of Growing Urban Estates, Multiple Cropping Patterns and Excessive Water Use for Irrigation/Agriculture.

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ABSTRACT

India is seeing a significant reduction in groundwater levels, which can be attributed to changes in agricultural techniques, urbanisation, and unsustainable water exploitation. This puts agriculture, the security of the water supply, and the daily lives of nearly 1.5 billion people at danger. The study explores the varied terrain of India, the different types of soil, and how heatwaves and rainfall patterns are affected by climate change. The water crises in Chennai and Bengaluru highlight the need for strict water management techniques in the socioeconomic environment. In addition, the health consequences of tainted groundwater, which may contain dangerous substances like arsenic and chromium, demand prompt attention for appropriate disposal and surveillance in order to protect the public's health and welfare.

KEYWORDS: Groundwater depletion, Urban expansion, Agriculture, Water extraction, Water security, Climate change, Heatwaves, Rainfall patterns, Topography, Soil types, Socio-economic, Water crises, Health risk, Contaminated groundwater, Water management, Sustainable practices.

INTRODUCTION

India's groundwater levels have been declining due to a combination of factors, including the expansion of urban areas, changes in cropping patterns, and the overuse of water for irrigation and agriculture. As the demand for water continues to increase in these sectors, more and more groundwater is being extracted from underground sources, leading to a decrease in the overall water table. This trend is especially concerning given that groundwater is a vital resource for many communities and is essential for sustaining agriculture, industry, and daily life.

India is experiencing a decline in its groundwater levels due to the expansion of urban areas, the adoption of multiple cropping patterns, and the excessive use of water for irrigation and agriculture. The depletion of groundwater is concerning because it is a crucial resource that supports food security, water availability, and the economic development of over 1.5 billion people in the country. Despite the implementation of irrigation projects that rely on surface water, many regions continue to depend on groundwater for irrigation purposes. The depletion of groundwater is attributed to both natural and human-induced factors. Therefore, managing groundwater resources sustainably is crucial in addressing the increasing water availability challenges in India.

Fig:1

India's varied topography spans from arid deserts and towering mountains to coastal regions, plateaus, and islands. The northern region is primarily covered by the fertile Ganges Plain, which formed over time due to the deposition of soil carried by rivers flowing from the Himalayas. Some areas of this plain have a deep layer of silt that extends more than 25,000 feet (7,620 meters) below the surface.

The Western Ghats, on the other hand, are characterized by dense forests that cover their western slopes. These forests thrive due to the heavy rainfall they receive during the monsoon season, which is caused by moisture-laden air moving eastwards across the mountain range. In contrast, the Eastern Ghats consist of discontinuous, low-height mountain ranges that have been eroded over time by rivers such as Krishna, Kaveri, Mahanadi, and Godavari. The Eastern Ghats include significant mountainous hills like the Javadi Hills, Palconda Range, Nallamala Hills, and Mahendragiri hills.

SOIL

In India, there exist various types of soils, including:

1. **Laterite Soil**: which can be found in multiple regions throughout the country, such as the Western and Eastern Ghats, Vindhyas, Malwa plateau, and Satpuras. States where this soil type is present include West Bengal, Andhra Pradesh, Bihar, Meghalaya, Assam, and Odisha.
2. **Mountain Soils**: depending on the climate of the region, mountain soils can be divided into two broad groups: Loamy Podzols and High Altitude Soils. The mid-altitudinal zone in the Himalayas has Podzols, which are acidic with low humus and can be found in Assam, Darjeeling, Kashmir, Uttaranchal, and Himachal Pradesh .In the Himalayan region, farmers cultivate crops like maize, barley, wheat, and temperate fruits in the soil. These crops are well-suited to the local climate and soil conditions and are an important source of food and income for many communities in the area. With careful management and sustainable farming practices, these crops can continue to thrive and support the livelihoods of farmers in the region.

3. **Black Soil**: predominantly found in areas such as Gujarat, Madhya Pradesh, and Maharashtra, as well as states like Tamil Nadu, Andhra Pradesh, and Karnataka.
4. **Red Soil**: found in regions such as Tamil Nadu, Madhya Pradesh, Jharkhand, Odisha, some parts of Karnataka, and southeast Maharashtra.
5. **Alluvial Soil**: the most significant soil type in the country, covering about 40% of the total land. This soil is located in the northern plains, starting from Punjab to West Bengal and Assam. It is also found in deltas of various rivers such as Krishna, Godavari, Kaveri, and Mahanadi in peninsular India.
6. **Desert Soil**: primarily found in arid and semi-arid areas of Rajasthan extending to Rann of Kutch, as well as some areas of Haryana and Punjab.
7. **Saline and Alkaline Soil**: this soil type can be found in Uttar Pradesh and Punjab, as well as some parts of Gujarat.
8. **Peat Soil**: marshy soils can be found in coastal areas of states such as Tamil Nadu, Bihar, Almora district of Uttaranchal, and Sundarbans of West Bengal.

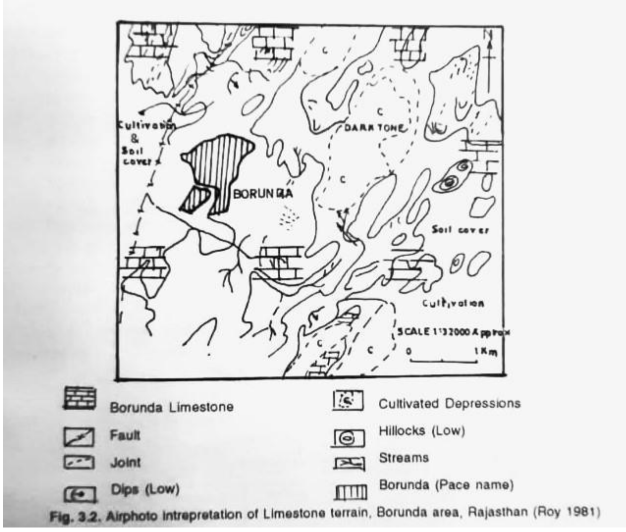


Fig. 3.2. Airphoto intrepretation of Limestone terrain, Borunda area, Rajasthan (Roy 1981)

Fig:2

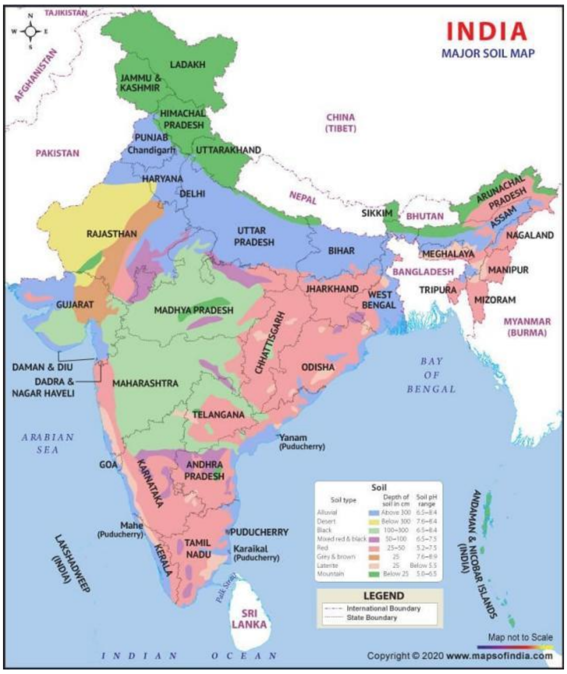


Fig:3

ANALYSIS OF CLIMATIC CONDITIONS

ANALYSIS OF HEAT WAVES

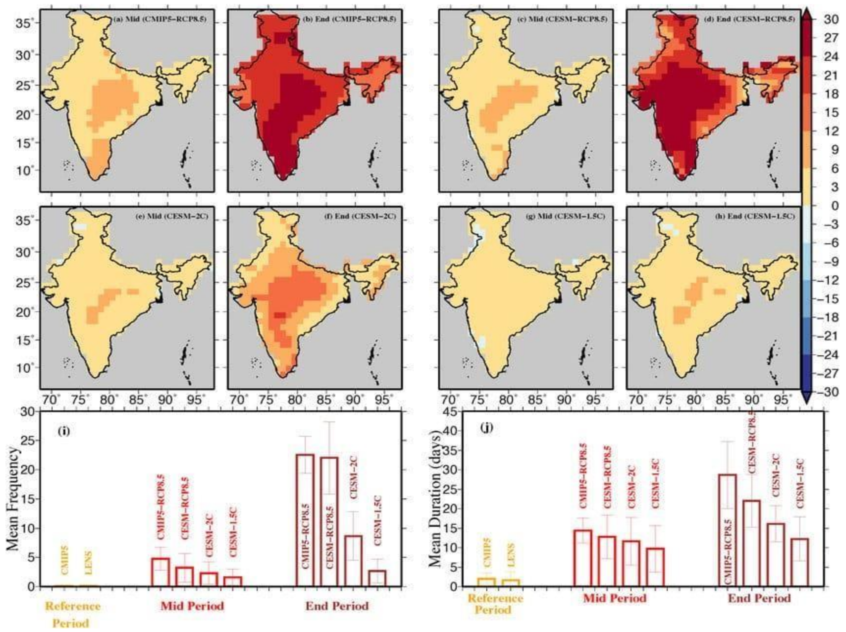


Fig:4

This study examines the frequency of heat waves in India under different warming scenarios. The results are presented as follows:

(a) The average difference in F-HW (heat wave frequency) with magnitude greater than 16 between the mid-period (2021-2050) and the reference period (1971-2000) based on data from 27 CMIP5-GCM's Hist and RCP8.5 scenario.

(b) Same as (a) but for the end-period (2071-2100).

(c) Same as (a) but based on data from CESM-RCP8.5 scenario.

(d) Same as (c) but for the end-period (2071-2100).

(e) Same as (a) but based on data from CESM-1.5C.

(f) Same as (e) but for the end-period (2071-2100).

(g) Same as (a) but based on data from CESM-2.0C.

(h) Same as (f) but for the end-century (2071-2100).

(i) An error-bar plot showing the multimodel ensemble mean of F-HW with magnitude greater than 16 for the reference period, mid-period, and end-period based on 27 CMIP5-RCP8.5 and 11 ensemble members from CESM-RCP8.5, CESM-1.5C, and CESM-2.0C. The error bars represent intermodal variability during the current, mid, and end periods.

(j) Same as (i) but for the multimodel ensemble mean of duration of heatwave having magnitude greater than 16.

ANALYSIS OF RAINFALL

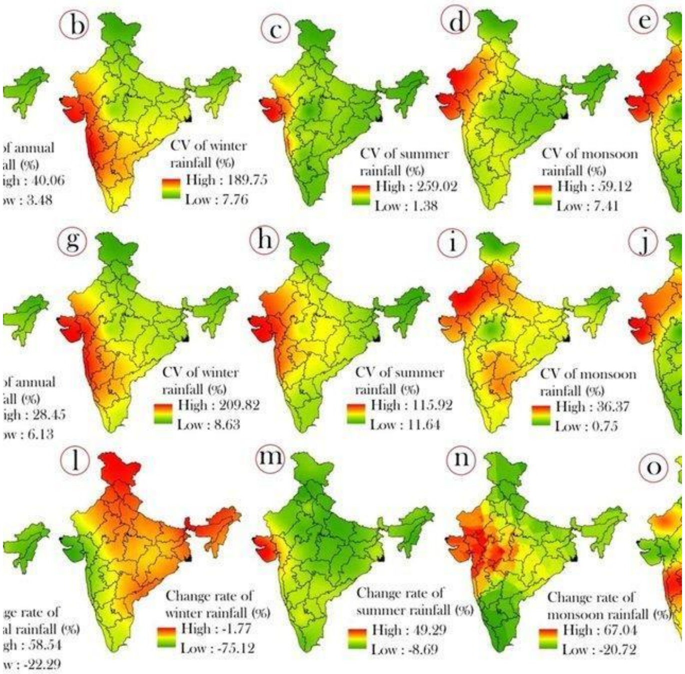


Fig:5

This study examines the changes in rainfall patterns in India from 1901 to 2015 at the meteorological divisional level, and forecasts these changes for the next 15 years using Artificial Neural Network-Multilayer Perceptron (ANN-MLP). The Pettitt test was used to detect abrupt changes in the data, while the Mann-Kendall (MK) test and Sen's Innovative trend analysis were employed to analyze rainfall trends. We also created a rainfall trend map for the entire country using geo-statistical techniques such as Kriging in the ArcGIS environment. Our results show that most meteorological divisions experienced significant negative trends in annual and seasonal rainfall, with the exception of seven divisions. Out of 17 divisions, 11 showed a significant decline in rainfall during the monsoon season. In contrast, insignificant negative trends were detected for the winter and pre-monsoon seasons. Overall, there was a significant negative trend (-8.5) in annual rainfall. Change detection analysis revealed that the most likely year of change detection occurred primarily after 1960 for most meteorological stations. The study also found that rainfall had increased from 1901-1950, but significant declines were observed after 1951. The rainfall forecast for the next 15 years shows a significant decline in precipitation. The study's findings suggest that changes in precipitation convective rate, elevated low cloud cover, and insufficient vertically integrated moisture divergence may have influenced the change in rainfall patterns in India, as shown by the ECMWF ERA5 reanalysis data. These results have implications for water resources management, considering the limited availability of water resources and the projected increase in future water demand.

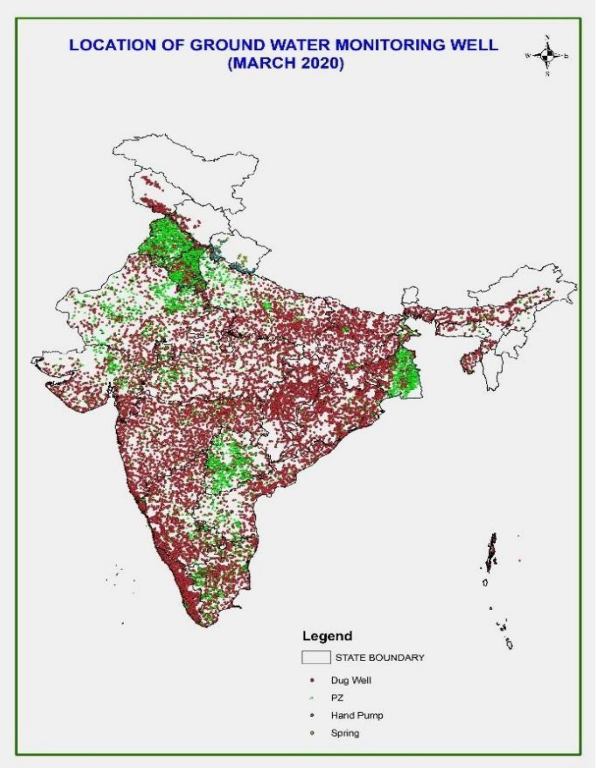
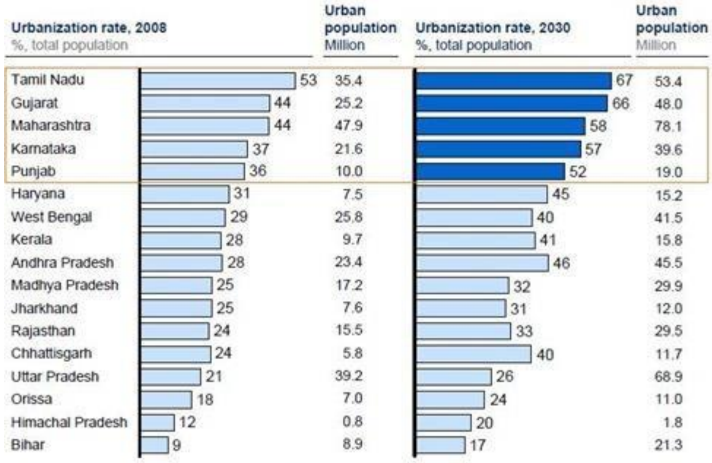


Fig:6



SOURCE: India Urbanization Econometric Model; McKinsey Global Institute analysis

Fig:7

SOME CITY HIGHLIGHTS

Chennai and Bengaluru, cities that were once abundant in water, have both faced significant water security challenges in recent times. Chennai experienced one of its worst water crises in 2018-19, while Bengaluru postponed its impending water day zero in 2019 by exploiting the Cauvery river with tankers providing water to more than 50% of the city. In both cities, water resources are overutilized and not adequately replenished, and many natural areas that allow for recharge have been built upon and concertized.

It is predicted that by 2030, unless Banglore implements and enforces strict measures for water management and consumption patterns, the gap between supply and demand could reach up to 80%. This not only poses an extreme risk to the population but also to the economy of the city, which is home to 40% of India's information technology sector and the start-up ecosystem that attracts USD 3.5 billion in investments annually.

HEALTH

Contaminated groundwater can cause a multitude of health problems in humans, plants, and animals. Chemicals such as chromium and lead, commonly used in pesticides, can seep into the water supply if the pesticides are not disposed of properly or if there is a lingering residue. Ingesting contaminated plants or animals can lead to permanent and irreversible damage to the brain, nervous system, and kidneys, with children being especially vulnerable due to their smaller size. It is important to seek the help of an experienced attorney to receive rightful compensation for damages caused by exposure to these harmful chemicals.

Chemicals such as benzene, found in contaminated areas, have been linked to higher incidences of leukemia and can cause damage to the nervous system and kidneys. Flu-like symptoms such as headaches, nausea, fatigue, rashes, and eye irritation may be early indicators of exposure.

Arsenic, a naturally occurring chemical that becomes dangerous at higher concentrations, is another common contaminant. Arsenic poisoning can lead to skin, lung, and bladder cancer, as well as cardiovascular damage and an increased risk of type 2 diabetes.

SOLUTION

Use solar energy to extract water from deep underground aquifers which are below surface pockets of water, the resulting solution

The process is as follows:

Our system is designed to combine the benefits of solar energy with advanced electro-mechanics in a single, large metal container. This design allows us to create a self-contained solution that can operate independently of traditional power sources, making it ideal for remote or off-grid locations.

To power the system, we rely on state-of-the-art solar panels that generate electricity from the sun's rays. This electricity is then used to power a variable frequency drive that optimizes energy usage to extract water from underground sources. By using this mechanism, we can extract water more efficiently while minimizing energy waste, which ultimately saves money and resources.

Once the water has been extracted, we filter it using ultrafiltration with 0.1-micron membranes. These membranes are specially designed to have a Hall of fibers containing u-shaped micro pores that efficiently trap 99.9999% of all bacteria, including e.coli and other harmful strains. By removing these bacteria from the water, we ensure that the water is safe and clean for consumption.

Overall, our system is a reliable and efficient solution for providing clean water in remote or off-grid locations. By combining solar energy, advanced electron-mechanics, and ultra filtration technology, we are able to create a self-contained water extraction and filtration system that is both environmentally friendly and cost-effective.

FESABILITY

1. It is a scalable and innovative design that we think could save millions of lives over the years to come.

2. It is budget friendly which costs less than 2 lakhs.
3. Easy to understand and implement.

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