

WATER MANAGEMENT: DO WE HAVE ENOUGH POTABLE WATER FOR OUR FUTURE GENERATIONS?



Gauri Arora & Jatin Chugh, M. Com Students
DAV Centenary College Faridabad

Ambika Saran
Assistant Professor, DAV Centenary College, Faridabad

Abstract

Do we have enough drinkable water for our future generations? The paper focuses on water management measures and the causes of the decline in water supply level in India. This paper supports planning efficient strategies to maintain and manage aquatic habitats. This paper is entirely based on secondary data. Numerous secondary sources, including research papers, Wikipedia, periodicals, journals, newspapers, etc., are used to gather the data. Based on information collected from these sources, we can understand that water stress is caused by many problems, such as poor supervision of existing water bodies, lack of groundwater, pile up in water waste, lack of water recycling, and contamination of river water. Water bodies are drying up, and both towns and nations may eventually have to deal with completely dry situations. Water scarcity is becoming a global problem, regardless of how wealthy a country is. Food security, biodiversity, and ecosystems are all negatively impacted by water scarcity. Water shortage may result from a number of factors, including population increase, climate change, water body depletion, pollution in water bodies, inefficient water usage practices, etc. Since the use of groundwater has grown throughout time in places where it was easily accessible, that's why this research emphasizes the importance of protecting groundwater levels. Oceans, lakes, ponds, rivers, streams, estuaries(delta), and all wetlands are examples of aquatic ecosystems. There are three primary types of aquatic habitats: freshwater, marine, and brackish(salty). These ecosystems contain living things that rely on water for survival, such as various fish species, plants, aquatic insects, and water microorganisms. The management of these ecosystems is extremely delicate and can be easily disrupted by pollution in the form of chemical waste, household waste, construction waste, and metal pollutants, among other things. A few physical aspects of water quality, such as temperature, haziness, and others, as well as chemical aspects, such as PH, hardness, alkalinity, dissolved gases, and salinity, should be considered.

Introduction

One of the most essential and limited resources for maintaining ecosystems and life is water. It is essential for energy production, sanitation, industrial operations, agriculture, and drinking. However, numerous environmental problems and the continuous rise in water consumption have sparked both water scarcity and its effect on socioeconomic growth, making the availability of drinkable water a significant issue on a global scale (Varma, 2022). Lack of water is a major worldwide concern that both developed as well as developing nations need to solve jointly. Furthermore, water scarcity hurts ecosystems, biodiversity, and food security.

Growing global pressures such as urbanization, population growth, and climate change may cause accessible water supplies to become a more scarce issue in the future. Moreover, inadequate management of urban water distribution networks might lead to severe shortage situations (Dandapa, Biswas, Lakshminarayan, 2022). Shortage of water is a problem that has become serious in many places due to several issues such as climate change, an increase in population, and inefficient water usage methods. For many countries, managing water resources effectively is a major concern. Numerous issues, such as a shortage of ground level water, inadequate water bodies

management, pile up of waste water, and pollution in stream water, are reasons for the Water scarcity. Most of the sources of water bodies are have dried up and both city and nations

S.No	Title	Author's Name	Year	Objectives	Findings	Scope/Limitations
1.	"Industrial water conversation by water footprint and sustainable development goals"	Ashish Kumar, Abhinay Thakur	2024	Convergence of water footprint analysis, industrial water conservation, and SDG pursuit.	Understanding water use and conservation initiatives are improved when water footprint assessment is included in industrial processes.	To further enhance industrial water conservation measures, a number of important areas and problems must be tackled.
2.	"Water efficient technologies for sustainable development"	V. Geetha Varma	2022	Various water-saving innovations for sustainable growth.	India is expected to reach per capita domestic water demand between 46 and 62 m3/person/year during the years 2025 and 2050.	A comprehensive and interdisciplinary strategy that tackles environmental, technological, economic, sociological, and cultural challenges is required to achieve sustainable water management.
3.	"India's achievement towards sustainable development goal-6"	Biswajit Dandapa, Sourav Biswas, Lakshmi narayan	2022	The significance of SDG 6 concerning other sustainable development objectives is highlighted in this study.	India's fault in meeting SDG 6 targets for clean water and sanitation between 2012 and 2020 is highlighted in this report.	The analysis shows that several states are falling short of meeting SDG 6.2 targets.
4.	"Framework for a smart water management system in the context of smart city initiatives in India"	Mohammed Shahana s.Ka, Dr.Bagavathi Sivakumar P.	2016	Smart water management system implementation	This report recommended a Smart Water Management (SWM) system to improve water resource management in smart cities by leveraging Internet of Things (IoT) technology.	The paper addresses issues in data transmission and power consumption for devices using wireless technology.
5.	"Overview of groundwater in India"	Roopal Suhag	2016	To determine the country's groundwater availability statistics, the policy framework, and certain important sector-related concerns.	It is unclear how water will be distributed to those who has low financial means in the absence of an appropriate business model. Furthermore, it has been shown that the absence of precise rules and legally binding	The paper emphasizes the necessity of a thorough policy to deal with groundwater problems.

					procedures renders the policy unclear and ineffectual.	
6.	"Policy transformations and translations: lessons for sustainable water management in peri-urban Delhi, India"	Pritpal Randhawa, Mr Fiona Marshall	2014	The intricate relationships that arise during the interpretation and application of formal policies to the creation of water management plans in Delhi's peri-urban area.	The deficiencies in the current water management systems as they pertain to supply for numerous peri-urban villages have been graphically illustrated by our research.	There is minimal interaction between official organizations and local entities, which causes plans to be interpreted incorrectly.
7.	"Implications of climate change for sustainable water resources management in India"	Mr P.P. Mujumdar	2008	To examine the state of India's water resources today and recent studies conducted there to evaluate the effects of climate change on hydrology and water supplies.	Water scarcity is predicted to affect all river basins by 2050, with the exception of the Godavari, Brahmani-Baitarani, Mahanadi, and Narmada.	The analysis of dual terrestrial water measurement methods at miniature scales and broad environment change fluctuations demands continued investigation.
8.	"Water for India in 2050: first-order assessment of available options"	S.K. Gupta and R.D. Deshpande	2004	To research India's changing water resource situation.	It has been estimated that the nation will need 1450 km ³ /year of water overall for all of its operations by 2050.	No other place in the world has used large-scale groundwater recharge, suggesting that its usefulness is limited.

Objective

- The main aim behind the study of water management is to determine whether there will be enough potable water in the future for consumption or not.
- Detect several substances in the sample of water that include dissolved solids and chemical components affecting the pH levels.
- The study will also describe the currently available level of groundwater and future predictions.
- To plan effective ways to manage and preserve aquatic ecosystems.

Research Methodology

The entire research is based on secondary data collection only. The classification of secondary data is second-party data since someone else

collected and recorded the information in published sources or journals. The data which is used in this paper is collected from various sources such as magazines, research papers, Wikipedia, books, journals, internet searches, government data, newspapers, articles, and some research sites, etc. The statistical data used belongs to the past twenty years.

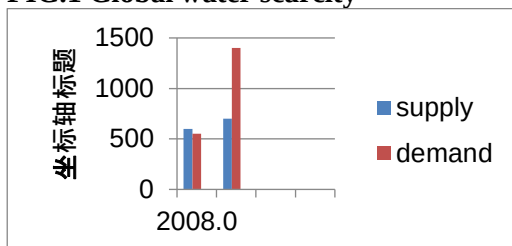
As per **UNICEF**, global water scarcity is also a growing concern:

- Water shortages affect at least 400 crore individuals, or half of the globe's population, for at least one month out of the year.
- "Absolute water scarcity" is expected to impact 1.8 billion individuals by 2025.

- By 2030, 700 crore individuals may have to relocate due to severe water constraints.
- By 2040, about one in four children worldwide will live in areas with abnormally high levels of water stress.

Water scarcity is anticipated in India by 2025 as a result of growing demands. According to a 2019 study by the “National Institution for Transforming India (NITI Aayog)”, the most realistic estimates indicate that by 2030, India's water usage will double that of its supply.

FIG.1 Global water scarcity



(Source: As Per UNICEF)

Water Resources:

The main types of water resources are:

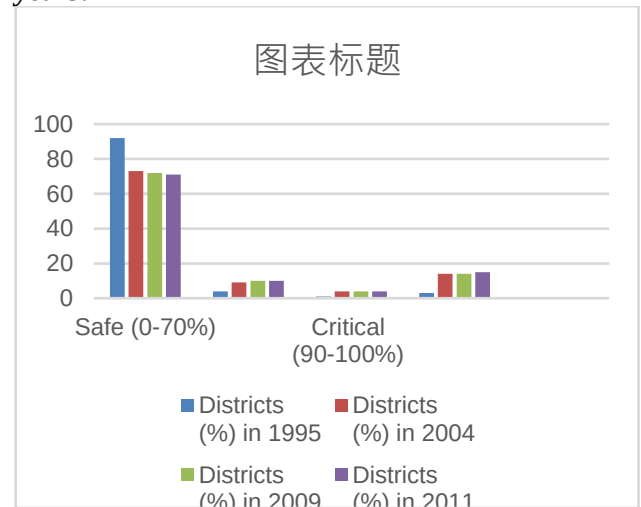
Groundwater: water that is found underground in rock pores and fissures. It is regarded as the most plentiful source of fresh water. The yearly extractable groundwater resource in India is 398.08 billion cubic meters (BCM), while the annual groundwater recharge is 437.60 BCM. On the other hand, 239.16 BCM of groundwater is really extracted.

Surface Water: It includes water found in ponds, rivers, and lakes. Water covers approximately 71% of the Earth's surface out of which surface water is as follows:

- “1,386,000,000 cubic km (332,519,000 cubic miles) of water” in total.
- “1,335,000,000 cubic km (321,003,271 cubic miles) of ocean water”.
- The volume of fresh water on Earth is 3%.
- Fresh water that can be used makes up about 0.5% of the water on Earth.

Rainwater: Water collected from rooftops during rainy seasons is known as rainwater.

FIG.2 Comparative analysis of India's groundwater development during the last 20 years:



(Sources: Central Ground Water Board; PRS Legislative Research)

- Safe: The development of groundwater is feasible in areas designated as safe zones.
- Semi-Critical: The recommendation exists for areas where groundwater development requires close attention.
- Critical: Intensive supervision along with assessment must be carried out in areas suited for groundwater development.

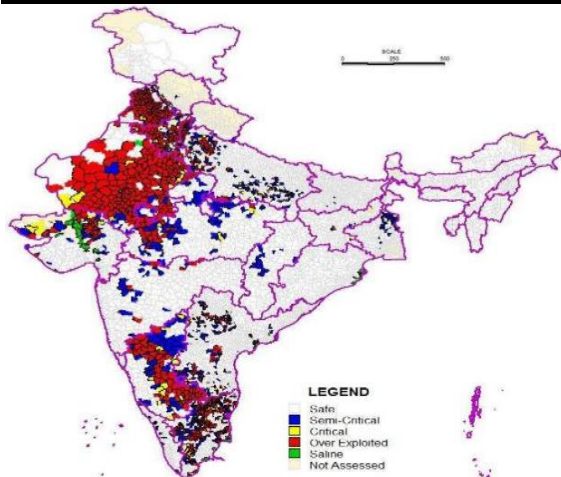
Overexploited: Future groundwater development areas become linked with existing water management plans.

FIG.3 Statistics on India's water resources:

Variables	Billion Cubic Meter/Year(Approx)
Water availability per year	1,870
Usable water	1,120
Surface water	700
Groundwater	430

(Sources: Water and Related Statistics, April 2015, Central Water Commission; PRS Legislative Research)

FIG.4 Classification of groundwater assessment units (2014)

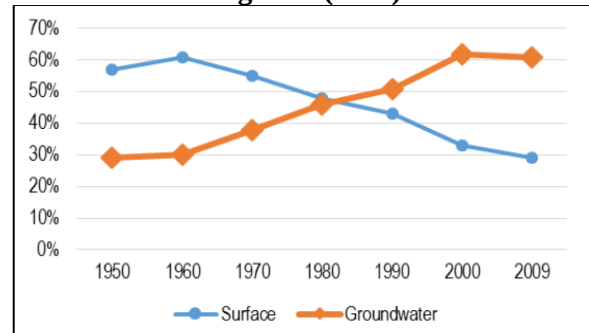


(Sources: Groundwater scenario in India, November 2014, Central Ground Water Board; PRS Legislative Research)

A very high level of groundwater development is indicated in Rajasthan, Haryana, Punjab, and Delhi. It suggests that the yearly recharging of groundwater in certain states is less than the annual groundwater consumption. 70% or more of the groundwater is developed in the Union Territory of Puducherry, the states of Uttar Pradesh, Himachal Pradesh, and Tamil Nadu. In other states, less than 70% of groundwater is developed. Over time, the development of groundwater raised from 58% to 62%, 2004 to 2011 respectively, with the use of groundwater increasing in regions where the supply was easily accessible (Suhag, 2016). Professionals say that India is running towards groundwater overexploitation and contamination. It is a situation in which the average extraction rate of groundwater is more than the average recharge rate. Surface water is generally more easily available than groundwater in India. But, due to its decentralized accessibility, groundwater is readily available and acquired for the majority of India's agricultural and drinking water supply. 89.2% of the extracted groundwater is consumed in the irrigation of field, making it the largest consumer in the country. Domestic groundwater, which accounts for 9.1% of the extracted groundwater, comes next. Industry uses 2 percent of groundwater. Furthermore, groundwater fulfills 85.2% of rural home water

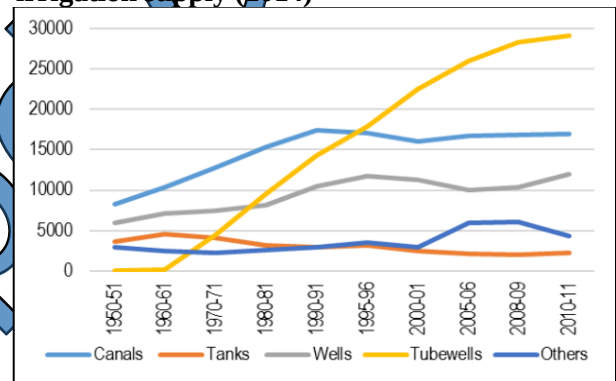
demands and roughly 50% of urban water needs.

FIG.5 Increase in the use of groundwater utilization for irrigation (2014)



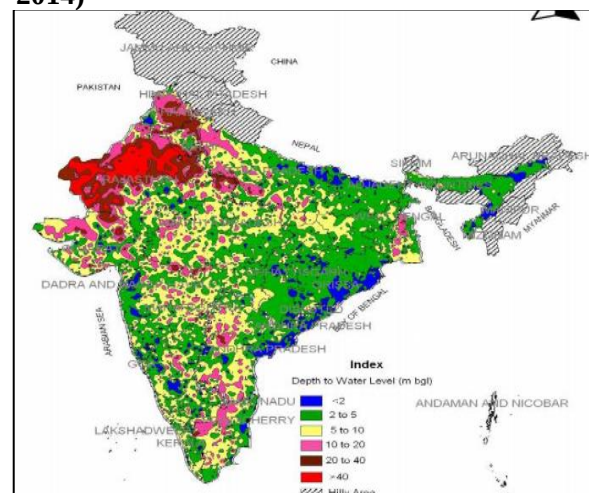
Sources: Agricultural Statistics at Glance 2014, Ministry of Agriculture; PRS Legislative Research

FIG.6 Tube wells are becoming the primary irrigation supply (2014)



Source: Agricultural Statistics at Glance 2014, Ministry of Agriculture; PRS Legislative Research

FIG.7 Depth to water level (pre-monsoon, 2014)



Note: m blog denotes meters below ground level
(Sources: Central Ground Water Board; PRS Legislative Research)

Statistics show that groundwater availability is lower in the northwest of the country. Other significant locations with water levels greater than 10 meters deep can be found all around the country. This implies that additional excavation may be necessary in some places to reach the water table. In order to extract the groundwater, advanced machinery is required when the level exceeds 10 meters (Suhag, 2016).

- As per The Indian Express report published in the year 2024 – the number of individuals in the nation impacts how much water is accessible per person. The country's per capita water availability is continuously dropping. “The average annual per capita water availability in the years 2021 and 2031 was assessed as 1,486 cubic meters and 1,367 cubic meters correspondingly which may further decline due to growth in population” (The Indian Express, 2024).
- When a nation's per capita water availability drops below 1,700 cubic meters, it is deemed to be under water stress.
- Water scarcity is indicated when per capita water availability falls below 1,000 cubic meters.
- Absolute water scarcity is indicated by levels falling below 500 cubic meters.

As per “Annual Report 2023-24 of - Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India”

The regular yearly water accessibility of a district or nation is primarily influenced by geological and hydro-meteorological factors. The total amount of water that India receives from rainfall is approximately 3,880 billion cubic meters (bcm). Geological and other constraints limit the amount of usable water available to 1,139 bcm annually, which includes 449 bcm of renewable groundwater and 690 bcm of surface water. The water potential used from this is approximately 691 bcm, which is

made up of 241 bcm of groundwater and 450 bcm of surface water. Under high-demand scenarios, the country's overall needs for a variety of applications are projected to be 843 bcm in 2025 and 1,180 bcm in 2050.

The Central Ground Water Authority (CGWA), which oversees and regulates the country's groundwater development and management, has been a part of the Central Ground Water Board (CGWB) since 1997. The majority of CGWB's operations are carried out under the "Ground Water Management and Regulation (GWMR) scheme," which is a central sector initiative. And on top of that, CGWB is a National Hydrology Project (NHP) implementing agency. As a component of the GWMR plan scheme, the National Aquifer Mapping and Management Programme (NAQUIM) was launched in 2012 with the goals of characterizing and defining the aquifers and developing groundwater management strategies.

The general goals of NAQUIM 2.0, which was launched in 2023, were to:

- provide more detailed information with a focus on dynamic data density, including groundwater level and quality, among other things.
- offering printed maps to users, establishing a plan to guarantee the application of the suggested techniques, and making scientific contributions to groundwater management at the Panchayat level including government agencies in the study to instill a sense of pride in them.

Monitoring groundwater levels is one of CGWB's main initiatives. Recording how different artificial i.e. man-made and natural pressures affect the groundwater regime and how that affects recharge and outflow characteristics is the main goal of groundwater monitoring. Currently, CGWB maintains a nationwide grid of around 27,000 groundwater observation wells.

Through a nationwide network of over 17,000 wells, groundwater samples are taken once a year during the pre-monsoon season for quality monitoring. The samples are examined for both heavy metals and basic elements. Additionally, as part of other scientific investigations, samples

of groundwater are also gathered and examined. The findings are extensively disseminated to all relevant entities, including state governments, for appropriate action when needed.

CGWB created a Master Plan for Artificial Ground Water Recharge. A proposal exists to adopt the Master Plan on Artificial Recharge through Central/State programs in one selected district from each State or UT. Thirty-six districts throughout India serving one district from each state and UT follow the Artificial Recharge-2020 master plan. The Master Plan for Artificial Recharge-2020 works through 33 Indian States and Union Territories by selecting one experimental district from each state for its implementation. The collaborative dynamic groundwater resource evaluation conducted by CGWB and State Governments in 2023 classified 6553 assessment units where 736 (11%) units were over-exploited and 199 (3%) units were critical while 698 (11%) units were semi-critical and 4793 (73%) units were safe along with 127 (2%) units being saline. (approx. %)

The National Water Mission(NWM) was launched in India in 2011. It is one of the 8th National Missions under the National Action Plan on Climate Change. The National Water Mission's (NWM) five objectives are stated as:

- A public, comprehensive water database.
An evaluation of how climate change affects water supplies.
- Supporting local and state efforts to conserve, augment, and preserve water resources, as well as focussing on areas that are vulnerable and overfished.
- A 20% increase in water consumption efficiency.
- Encouragement of integrated water resources management at the basin level.

By putting the 31 schemes and 73 action plans outlined in the Mission Document into practice, NWM has been working to achieve the aforementioned five goals.

According to "Hindustan Times" (February 2025) –

The groundwater usage in Bengaluru matches the rate of replenishment therefore no water

remains for future residents. Modern data from the Central Groundwater Board reveals a concerning status of groundwater consumption in Bengaluru since both urban settlements and rural areas extracted 100% of their underground supply in 2024.

As per the **"National Compilation on Dynamic Ground Water Resources of India", 2023**, declared by Central Ground Water Board, Ghaziabad extracted a shocking 123% of its total groundwater last year. Ghaziabad a hectic city known for its rapid industrial growth with 56,000 industries and a population of 48.6 lakh is currently facing a major water crisis as its groundwater continues to decrease rapidly. Another NCR town located in the U.P. i.e. Noida is not far behind in facing a water crisis.

As per **"Climate Trends latest report" (September 2022)-**

West Bengal, Bihar, Jharkhand, and Uttar Pradesh have been forced to change the sowing patterns of rice due to a deficiency in rainfall so far. Due to drought, millions of farmers are suffering food and water crisis.

Oceans, lakes, ponds, rivers, streams, estuaries, and all wetlands are examples of aquatic ecosystems. Freshwater, marine, and brackish habitats are the three primary categories of aquatic environments. Numerous fish species, plants, aquatic insects, and water microorganisms are among the living things that depend on the water to survive in these aquatic habitats. These ecosystems' delicate management is readily disrupted by pollution, including metal pollutants, household garbage, building waste, and chemical waste. Ecosystems exchange energy to function on a daily basis. The physical and biological elements of an ecosystem recycle this energy that is traded. Every component of the ecosystem, whether living or non-living, is dependent upon the others to survive. An excellent illustration of how the non-living(abiotic) and living(biotic) components of an ecosystem are interdependent is a watershed. All of the living things in a watershed will be impacted if it is disturbed. We must safeguard our water supplies to preserve the aquatic interaction since contaminated water may cause these organisms to die, leaving the fish without food (Dey, 2022).

Management Of Water Standard For Aquatic Eco system

Tangible aspects of water quality -

Temperature: Since fish have cold blood, the most crucial physical element affecting their life and growth is the temperature of the water. Fish habits, feeding, growth, and reproduction, as well as their degree of activity, are all impacted by body temperature and, consequently, water temperature. Fish body temperatures will be either too high or too low, their growth may be disturbed, or they may even perish if the water temperature falls outside of the ideal range.

Turbidity: Turbidity is caused by fine solid particles floating in water. "Cloudy" is another term for turbid water. Plankton, a single-celled creature, or suspended particles like clay can cause turbidity. Fish health, respiration, and pond productivity can all be negatively impacted by clay turbidity, or murky pond water.

The following methods can be used to manage and maintain clay turbidity in ponds:

- Applying agricultural limestone or animal manures at approved rates to enhance soil pH and water alkalinity every three weeks.
- Steer clear of stocking species that agitate the mud on the bottom of ponds within the system.

Chemical components of water quality -

- Salinity
- Hardness
- Alkalinity
- Essential nutrients: K, P, N
- PH

Water in the pond may be acidic, alkaline, or neutral. Water will react with things that dissolve in water in a variety of ways depending on this level. Additionally, it will have an impact on the distinct lifestyles of aquatic plants and animals. The pH value of water indicates how alkaline or acidic it is. Water with a pH of 7 is considered neutral. The pH scale ranges from 0-14. Acidity is indicated if the range is less than 7, and alkalinity is required if it is larger than 7. Fish productivity may be significantly impacted by a pH range that is either too high or too low (Dey, 2022).

How Can the ph of the Pond Water Level be Fixed?

Pond water with a pH unfavorable for fish production can be rectified by:

- If the pH level is below 6.5 (at sunrise), use lime and alkaline fertilizers.
- If the pH level is above 8.5 at sunrise, use acid fertilizers to stabilize the water pH level.

The aquatic life cycle must be preserved to maintain a proper balance in life, and the disposal of chemical and man-made waste in water bodies is not only causing toxic materials to enter the water and endangering the lives of aquatic plants and animals, causing abnormalities among them, but also upsetting our natural values. The water ecosystem is becoming an increasingly important area to study. Maintaining the ideal pH, acidity-alkalinity, nutrients, turbidity, and removal of heavy metals, grease, and oil from the water's surface, as well as regulating the water's dissolved oxygen content, are all necessary for aquatic water management.

Conclusion

A Swedish specialist named "Falken Mark" claims that water stress happens when there is less than 1,000 cubic meters of water available per person per day.

The main objective of this study was to determine whether there would be drinkable water available in the future or not. We must acknowledge that water shortage is a genuine issue. Furthermore, once we have recognized it, we must be cautious to conserve it. There are numerous avenues for both national and individual action. Conserving water is the only method to deal with the problem of future water shortages. To ensure that everyone has access to water in the future, it is imperative to implement effective irrigation techniques, protect groundwater quality, and include water conservation measures.

In India and other countries, water shortage is a serious issue that forces the typical person to travel long distances to get the water they need for everyday tasks and to drink. People in areas where there is ample water, on the other hand, waste more than they use each day. We all must acknowledge the importance of water and the problems that will result from its future shortage. We should encourage water

conservation and avoid contaminating and degrading the potable water that we consume daily.

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7. FIG.2: Source: Water and Related Statistics, April 2015, Central Water Commission; PRS Legislative Research
8. FIG.3: Sources: Central Ground Water Board; PRS Legislative Research
9. FIG.4: Source: Groundwater scenario in India, November 2014, Central Ground Water Board; PRS Legislative Research
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