

Potentials and Utilization of Water Resources in India: An Overview

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Abstract

Water resources in India play a crucial role in sustaining various sectors of the economy, agriculture being the primary consumer. This abstract delves into the multifaceted aspects of India's water resources, evaluating their potentials and examining their utilization across diverse sectors such as agriculture, industry, and domestic consumption. The paper highlights the challenges faced in harnessing these resources effectively, including issues of distribution, management, and sustainability. Furthermore, it discusses the significance of innovative technologies and policies in optimizing water usage and addressing water scarcity concerns. By analysing current trends and future prospects, this abstract provides insights into the strategies required for sustainable water resource management in India, essential for ensuring food security, economic growth, and environmental conservation.

Keywords: Water resources, India, Utilization, Sustainability, Management

Introduction

Water is an indispensable resource for life on earth, playing a vital role in sustaining diverse aspects of human existence. Despite India accounting for only 4 per cent of the global water resources, it shoulders the responsibility of supporting 18 per cent of the world's population and overseeing 15 per cent of the global livestock (Saroha, 2017). The significance of water transcends mere agricultural development, impacting crucial sectors such as transportation, fisheries and industrial water supplies. Hence, the strategic development and optimal utilization of water resources emerge as central objectives in national planning. Acknowledging water is a fundamental driver of socio-economic progress, India must prioritize the efficient management and conservation of its varied water sources, encompassing rivers, lakes, groundwater and monsoon rains. Amidst challenges posed by population growth and climate change,

addressing concerns like water scarcity and pollution. To unleash the complete potential of water resources, India needs to employ cutting-edge technologies, adopt effective irrigation methods and implement resilient conservation strategies. It is essential to thoroughly understand and purposefully harness India's abundant water resources, not only to guarantee water security but also to promote sustainable economic development and preserve ecological balance for the benefit of succeeding generations.

Distribution of water on earth

The distribution of water on the Earth's surface is extremely uneven. Only 3 per cent of water on the surface is fresh; the remaining 97 per cent resides in the ocean. Of freshwater, 69 per cent resides in glaciers, 30 per cent underground, and less than 1 per cent is located in lakes, rivers, and swamps. Looked at another way, only one percent of the water on the Earth's surface is usable by humans, and 99 per cent of the usable quantity is situated underground.

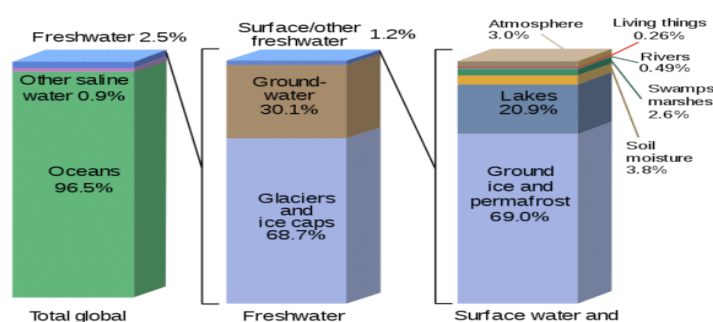


Fig. 1: Distribution of water on earth

Scenario of water resources in India

India faces a complex and challenging scenario when it comes to water resources, given its vast population and geographical diversity. Here is a brief overview of the water resources situation in India: Geographical Area: India covers approximately 2.4 per cent of the world's land area. Population: Despite having only 2.4 per cent of the world's land area, India is home to around 17.1 per cent of the

global population. **Water Availability:** India has about 4 per cent of the world's water resources, making it a significant player on the global stage. **Per Capita Availability:** India ranks 132nd globally in terms of per capita water availability, indicating the pressure on water resources due to its large population. **Average Annual Rainfall:** The country receives an average annual rainfall of 1190 mm. However, this rainfall is not uniformly distributed across the country. **Rainfall Distribution:** The distribution of rainfall ranges widely, from as low as 150 mm to as high as 11690 mm. This uneven distribution poses challenges for water availability and management. **Rainy Days:** The range of rainy days varies from 5 to 150 days, further highlighting the diversity in weather patterns across different regions of the country.

Table 1: Scenario of water resources in India

Area of the country as % of world area	2.4%
Population as % of world population	17.1%
Water as % of world water	4%
Rank in per capita availability	132
Average annual rainfall	1190 mm
Range of distribution	150-11690 mm
Range rainy days	5-150 days

Source: Anon., Central Water Commission, GoI, 2023d

Overview of water resources of India

Per capita average availability is very low (about 1543 m³ per annum 2022) and it is continuously decreasing due rapid increase in the population growth in India. India's water availability is influenced by various factors, with an annual precipitation of 4000 km³, of which 75 per cent (3000 km³) occurs during the monsoon season. However, challenges arise as 53 per cent of this water is lost to evaporation and soil absorption, leaving 47 per cent (1869 km³) as the average annual potential flow in rivers. The estimated utilizable water resources stand at 28 per cent (1123 km³), with surface water contributing 17 per cent (690 km³) and groundwater accounting for 11 per cent (433 km³). This breakdown highlights the significant impact of evaporation and

soil absorption on overall water availability, emphasizing the need for efficient water management strategies to harness and utilize the available resources effectively. The country faces the dual challenge of meeting the water demands of its growing population and managing water resources sustainably, especially in the context of changing precipitation patterns and increasing water stress in certain regions.

Table 2: Total quantity of water availability in India

Sl. No	Water resource at glance	Quantity (km ³)	%
1	Annual precipitation	4000	100
2	Precipitation during monsoon	3000	75
3	Evaporation + soil water	2131	53
4	Average annual potential flow in rivers	1869	47
5	Estimated utilizable water resources	1123	28
6	Surface water	690	17
7	Ground water	433	11

Source: Anon., Ministry of Statistics and Programme Implementation, GoI, 2023f

Water Requirement

The estimated annual water requirement for various sectors in India, spanning the years 1990 to 2050, reflects a substantial increase in demand across domestic, irrigation, industrial, energy, and other uses. In 1990, the total water requirement was 502 billion cubic meters (BCM), which rose to 634 BCM in 2000, 813 BCM in 2010, and is projected to reach 1093 BCM in 2025 and 1447 BCM in 2050. The demand for domestic water has steadily increased, growing from 32 BCM in 1990 to a projected 102 BCM in 2050. Irrigation remains a significant consumer, with the requirement escalating from 437 BCM in 1990 to an anticipated 1072 BCM in 2050. Industrial water demand has shown remarkable growth, from 8 BCM in 2000 to a projected 63 BCM in 2050. Energy-related water needs, starting at 2 BCM in 2000, are expected to surge to 130 BCM in 2050. Other uses, including miscellaneous sectors, have also witnessed an increase, rising from 33 BCM in 1990 to an estimated 80 BCM in 2050.

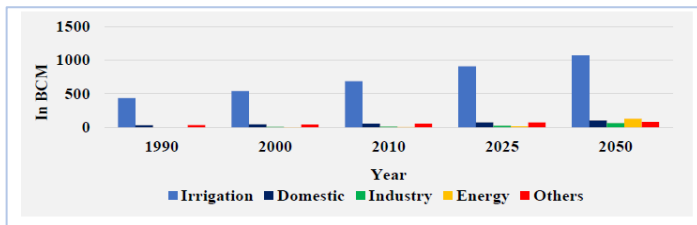


Fig. 3: Estimated annual water requirement for various sectors in India

Source: Anon., Ministry of Statistics and Programme Implementation, GoI, 2023c

Potentials

India possesses diverse water resource potentials, encompassing surface water and groundwater, contributing significantly to the nation's water availability. The country's river basins, including the Ganga, Brahmaputra, Godavari, and Krishna, among others, offer substantial surface water potential, supporting agriculture, industry, and domestic needs. Additionally, India has a vast network of aquifers, providing substantial groundwater potential. The annual precipitation, with an average of 4000 billion cubic meters (BCM), adds to these water resources. However, the distribution of water resources is uneven, with certain regions facing water stress and scarcity. Sustainable management practices, harnessing the potentials of both surface water and groundwater, are imperative to meet the growing demands of India's population, agriculture, and industries, ensuring water security and resilience in the face of climate variability.

The major rivers of India, such as the Indus, Ganga, and Brahmaputra, originate from various regions and contribute significantly to the country's water resources. The Ganga, originating from Gangotri, spans 2,525 km with a vast catchment area, providing an extensive water potential of 529 BCM. The Brahmaputra, originating in the Kailash Range, has a length of 916 km and a catchment area of 1,93,252 sq.km, contributing 527 BCM. Other rivers, like the Godavari, Krishna, and Narmada, also play crucial roles in India's water landscape. Additionally, the West and East flowing rivers, along with inland drainage and minor rivers, contribute to a total water potential of 1,999.2 BCM across the country.

Basin wise recharging of ground water resources under different seasons in India

Groundwater recharge in different seasons across various river basins in India reflects a dynamic pattern. During the monsoon season, the Brahmani, East Flowing Rivers, Godavari, Krishna, Mahanadi, Mahi, Narmada, Pennar, Cauvery, Sabarmati, Subarnarekha, Tapi, and West Flowing Rivers basins experience substantial recharge, totalling 205.2 billion cubic meters (BCM) through rainfall and 63.5 BCM through other sources. In the non-monsoon season, recharge by rainfall decreases, but other sources contribute significantly, amounting to 17.1 BCM. The annual total recharge, combining both seasons, is 358.0 BCM. Noteworthy contributions come from the East Flowing Rivers and West Flowing Rivers basins, with 51.7 BCM and 52.4 BCM, respectively. This data underscores the seasonal variability and the importance of diverse recharge sources in sustaining groundwater resources across India's river basins, emphasizing the need for integrated water management strategies to ensure continued groundwater availability.

Utilization

The utilization of water resources is a multifaceted process crucial for sustaining life, ecosystems, and various human activities. Water is extensively used across sectors, with irrigation being a major consumer, accounting for 78 per cent of the total water requirement in India. Domestic use, industrial processes, power generation, inland navigation, and ecological preservation also contribute to the diverse water demands. In India, the total annual water utilization is approximately 702 billion cubic meters, with surface water meeting 64 per cent of the requirements and groundwater supplying the remaining 36 per cent. While irrigation dominates water usage, other sectors such as industry, domestic needs, and power generation play significant roles in shaping the country's water utilization patterns. Managing water resources efficiently, minimizing losses, and adopting sustainable practices are imperative for ensuring water security and meeting the growing demands of a rapidly expanding population and developing economy.

Utilization pattern of available water resources

The utilization pattern of available water resources in India reveals a comprehensive breakdown of water consumption across various sectors. Of the total annual water requirement of 702 billion cubic meters (BCM), irrigation dominates with a significant share of 78 per cent, requiring 335 BCM, with surface water contributing 48 per cent and groundwater 31 per cent. The domestic sector accounts for 6 per cent of the total water requirement, with 24 BCM needed, out of which 3 per cent comes from surface water and 3 per cent from groundwater. Industries demand 5 per cent of the total water, with 26 BCM from surface water and 2 per cent from groundwater. The power sector requires 3 per cent of the total water, mainly relying on surface water (2%) compared to groundwater (1%). Inland navigation and environmental needs each represent 1 per cent of the total water requirement, sourced entirely from surface water. Evaporation losses account for 6 per cent of the total water demand, entirely from surface water. This utilization pattern underscores the significant role of surface water in meeting the demands of various sectors, particularly in irrigation and industries, emphasizing the need for sustainable water management strategies to ensure water security across the country.

Conclusion

India's water resources hold immense potential for sustaining diverse ecosystems, supporting agriculture, industry, and meeting domestic needs. However, effective management, equitable distribution, and sustainable utilization are imperative to harness these resources efficiently. Implementing innovative technologies, fostering community participation, and prioritizing

conservation efforts are essential steps towards achieving water security and mitigating challenges posed by pollution, climate change, and overexploitation. By adopting integrated approaches and collaborative strategies, India can unlock the full potential of its water resources, ensuring resilience, prosperity, and equitable access for present and future generations.

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Table 03: Basin-wise catchment area and average water resources potential in India

Sl. No.	River	Origin	Length (km)	Catchment area (sq.km)	Average water resources potential (BCM)
1	Indus	Mansarovar (Tibet)	1,114	3,17,708	46
2	Ganga	Gangotri	2,525	8,38,803	529
3	Brahmaputra	Kailash Range (Tibet)	916	1,93,252	527
4	Barak & others	Manipur Hills (Manipur)	564	86,335	87
5	Godavari	Nasik	1,465	3,12,150	118
6	Krishna	Mahabaleshwar (MH)	1,400	2,59,439	89
7	Mahi	Dhar (MP)	583	39,566	15
8	Subarnarekha	Nagri (JK)	395	26,804	15
9	Brahmani	Nagri (Jharkhand)	799	53,902	36
10	Mahanadi	Nazri Town (MP)	851	1,44,905	73
11	Pennar	Kolar (KA)	597	54,905	11
12	Cauvery	Coorg (KA)	800	85,167	28
13	Sabarmati	Aravali Hills (RJ)	371	31,901	13
14	Narmada	Amarkantak (MP)	1,312	96,659	58
15	Tapi	Betul (MP)	724	65,805	26
16	West flowing rivers	-	-	3,04,703	264
17	East flowing rivers	-	-	1,83,730	53
18	Inland drainage	RJ	-	14835	-
19	Minor river draining	Myanmar & Bangladesh	-	31382	31
	Total			32,71,953	1,999.2

Source: Anon., Ministry of Agriculture & Farmers Welfare, GoI, 2023b

Table 04: Basin wise recharging of ground water resources under different seasons in India
(Billion Cubic Meters)

Basin	Monsoon season		Non-monsoon season		Total annual recharge
	Recharge by rainfall	Recharge by other sources	Recharge by rainfall	Recharge by other sources	
Brahmani	7.4	1.6	1.1	1.5	11.7
East Flowing Rivers	20.9	17.6	2.9	10.3	51.7
Godavari Basin	34.6	7.4	2.1	12.6	56.7
Krishna Basin	21.0	10.6	3.3	11.8	46.7
Mahanadi Basin	17.2	3.3	1.8	3.8	26.1
Mahi Basin	7.8	1.6	0.0	3.0	12.4
Narmada Basin	21.0	1.8	0.3	5.6	28.7
Pennar Basin	5.7	3.1	0.7	3.2	12.6
Cauvery Basin	7.8	6.8	1.8	2.9	19.3
Sabarmati Basin	8.4	1.6	0.0	2.2	12.2
Subarnarekha Basin	6.5	0.8	1.5	1.2	9.9
Tapi Basin	11.9	1.1	0.0	4.5	17.5
West Flowing Rivers	35.0	6.2	1.7	9.5	52.4
Grand Total	205.2	63.5	17.1	72.2	358.0

Source: Anon., Ministry of Statistics and Programme Implementation, GoI, 2023e

Table 05: Utilization pattern of available water resources (ground and surface water) for various sectors in India
(Billion Cubic Meters)

Use	Total water		Surface water		Ground water	
	Water req.	%	Water req.	%	Water req.	%
Irrigation	550	78	335	48	216	31
Domestic	43	6	24	3	19	3
Industries	37	5	26	4	11	2
Power	19	3	15	2	4	1
Inland Navigation	7	1	7	1	-	-
Environment & Ecology	5	1	5	1	-	-
Evaporation Losses	42	6	42	6	-	-
Total	702	100	453	64	250	36

Source: Anon., Central Water Commission, GoI 2023a

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