Water and Poverty: Unlocking Rural Prosperity Through Effective Water Management in India

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Abstract

"Harnessing Water for a Prosperous Rural India"

Water management strategies are pivotal in addressing both environmental challenges and socio-economic issues in rural India, particularly in the context of poverty alleviation. This research explores the critical role that effective water management plays in enhancing agricultural productivity, improving health outcomes, and providing economic opportunities in rural communities. By examining a combination of traditional and modern water management techniques, such as rainwater harvesting, drip irrigation, and groundwater recharge, this study assesses their impact on sustainable rural development. Additionally, the research analyzes the effectiveness of key government policies like the Jal Shakti Abhiyan and Atal Bhujal Yojana in alleviating poverty by ensuring reliable access to clean water for agriculture and drinking purposes. Empirical evidence from five selected states—Uttar Pradesh, West Bengal, Punjab, Bihar, and Rajasthan—highlights how water contamination and management practices influence rural poverty. Through a detailed investigation of contamination levels, fund allocations, and water-related initiatives, this study offers insights into improving water governance to foster rural prosperity and reduce poverty.

Keywords*: Water Management, Poverty Alleviation, Water Contamination, Agricultural Productivity, Sustainable Development, Rural India.*

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I. Introduction

Water management in India is a critical issue that directly impacts the country's socioeconomic development, particularly in rural areas where the majority of the population depends on agriculture. Effective water management is crucial for poverty alleviation, as it directly influences agricultural productivity, health outcomes, and economic opportunities. According to the 2011 Census, approximately 68% of India's population lives in rural areas, where agriculture accounts for about 18% of GDP but employs around 58% of the workforce.[1] Yet, nearly 22% of the rural population still lives below the poverty line, as per the National Sample Survey Office (NSSO) data from 2017-18.[2]

The management of water resources in India is governed by a combination of traditional practices and modern legislative frameworks. One of the cornerstone policies is the National Water Policy, first introduced in 1987 and revised in 2002 and 2012, which emphasizes the need for a holistic and sustainable approach to water resource management. The policy advocates for the integrated development of water resources, prioritizing drinking water and irrigation while also considering the needs of industry and environmental conservation. Proper implementation of this policy could significantly improve water availability for irrigation, directly impacting agricultural yields and thereby reducing poverty.

In the legislative realm, the Water (Prevention and Control of Pollution) Act of 1974[3] is significant, establishing the regulatory framework for the prevention and control of water pollution, thereby safeguarding water quality. Another pivotal piece of legislation is the Environment (Protection) Act of 1986[4], which provides a comprehensive approach to environmental protection, including water resources. Ensuring clean water supply can prevent water-borne diseases, which disproportionately affect the poor and can trap families in a cycle of poverty due to healthcare costs and lost productivity.

[1] Ramesh Chand, S.K. Srivastava & Jaspal Singh, Changing Structure of Rural Economy of India: Implications for Employment and Growth, NITI Aayog, Govt. of India (Nov. 2017).
[2] National Sample Survey Office, Key Indicators of Household Consumer Expenditure in India, 2017-18, Ministry of Statistics and Programme Implementation, Govt. of India (2019).
[3] Water (Prevention and Control of Pollution) Act, No. 6 of 1974 (India).
[4] Environment (Protection) Act, No. 29 of 1986 (India).

Case laws have also shaped water management in India. For instance, the landmark Supreme Court judgment in the case of Narmada Bachao Andolan v. Union of India (2000)[5] highlighted the need for balancing developmental projects with environmental sustainability and the rights of displaced populations. Similarly, the M.C. Mehta v. Union of India (1997)[6] case, concerning the pollution of the Ganga River, led to significant judicial interventions to protect water bodies from industrial pollution. These rulings have profound implications for the rural poor, who rely on these water bodies for drinking, agriculture, and daily living.

Several initiatives have been launched to address water scarcity and improve water management. The Jal Shakti Abhiyan[7], launched in 2019, is a campaign focused on water conservation, rainwater harvesting, and the rejuvenation of water bodies across the country. Additionally, the Atal Bhujal Yojana (ABHY)[8], launched in 2020, aims to improve groundwater management through community participation and robust data systems. These initiatives are crucial in ensuring sustainable water supply, which can enhance agricultural productivity and provide stable livelihoods for rural communities, thereby addressing poverty.

Despite these efforts, rural India continues to face significant challenges related to water scarcity and quality. According to the Composite Water Management Index (CWMI) report of 2019 by NITI Aayog, 70% of the country's water supply is contaminated, affecting both health and productivity. Effective water management is vital for reducing poverty, as it impacts multiple facets of rural life including agriculture, health, and employment[9]. This research paper will delve into the various water management practices in rural India, analyzing their impact on poverty alleviation through case studies, policy analysis, and empirical data, ultimately providing recommendations for enhancing water management strategies to support rural development and reduce poverty.

[5] Narmada Bachao Andolan v. Union of India, (2000) 10 SCC 664 (India).
[6] M.C. Mehta v. Union of India, (1997) 2 SCC 353 (India).
[7] Jal Shakti Abhiyan, Ministry of Jal Shakti, Govt. of India (2019), https://jsactr.mowr.gov.in/.
[8] Atal Bhujal Yojana, Ministry of Jal Shakti, Govt. of India (2019), https://ataljal.mowr.gov.in/.
[9] NITI Aayog, Composite Water Management Index (CWMI) Report of 2019, https://niti.gov.in/sites/default/files/2023-03/Composite%20Water%20Management%20Index%202.0.pdf.

1.2 OVERVIEW OF WATER MANAGEMENT CHALLENGES IN INDIA

Water management in India presents a complex and multifaceted challenge that spans historical practices, contemporary issues, and future uncertainties. Historically, India has relied on traditional water management systems such as tanks, wells, and stepwells, which were ingeniously designed to harvest rainwater and manage groundwater resources. Ancient civilizations, including the Indus Valley Civilization, demonstrated advanced water management techniques, evident from the sophisticated drainage systems and reservoirs found in archaeological sites. These traditional methods were well-suited to the local geography and climate, promoting sustainable water usage for centuries.

In the modern era, rapid population growth, urbanization, and industrialization have placed unprecedented pressure on India's water resources. According to the Central Water Commission, India has 18% of the world's population but only 4% of its water resources, creating a significant mismatch between supply and demand.[10] The Green Revolution of the 1960s, while boosting agricultural productivity, also led to the over-extraction of groundwater through the widespread use of tube wells, contributing to the depletion of aquifers. Presently, India faces severe water stress, with a significant portion of its population lacking access to safe drinking water. The NITI Aayog's Composite Water Management Index (CWMI) report of 2019[11] revealed that 21 major cities, including Delhi, Bengaluru, and Chennai, are expected to run out of groundwater by 2020, affecting around 100 million people.

Contemporary challenges in water management are compounded by climate change, which has altered precipitation patterns and increased the frequency of extreme weather events such as droughts and floods. The variability in monsoon rains, which account for about 70% of India's annual rainfall, further exacerbates water scarcity. Additionally, the contamination of water bodies due to industrial effluents, agricultural runoff, and untreated sewage poses serious health risks and reduces the availability of potable water. The CWMI report[12] also highlighted that 70% of India's water is contaminated, impacting both rural and urban populations.

[10] Ministry of Water Resources & Central Water Commission, Guidelines for Improving Water Use Efficiency in Irrigation, Domestic & Industrial Sectors (Govt. of India).
[11] Supra Note 9
[12] Supra Note 9

Looking to the future, India must adopt a multi-pronged approach to address its water management challenges. This includes enhancing water-use efficiency, promoting rainwater harvesting, and investing in advanced technologies for wastewater treatment and desalination. The National Water Policy of 2012[13] advocates for the integrated management of water resources, emphasizing the need for a paradigm shift from the current supply-oriented approach to a demand-oriented one. Additionally, community participation and the revival of traditional water management practices can play a crucial role in sustainable water management.

Innovative initiatives such as the Jal Shakti Abhiyan and the Atal Bhujal Yojana are steps in the right direction, focusing on water conservation, groundwater recharge, and the rejuvenation of water bodies. However, the success of these initiatives hinges on robust implementation, effective governance, and the active involvement of local communities. As India navigates its water management challenges, it must balance the needs of development with the imperatives of sustainability to ensure a secure and equitable water future for all its citizens.

1.3 THE IMPORTANCE OF WATER RESOURCES IN RURAL ECONOMIES

Water resources are the lifeblood of rural economies, underpinning agriculture, livelihoods, health, and overall economic development. In India, where nearly 68% of the population resides in rural areas, agriculture is the primary occupation and accounts for approximately 58% of the rural workforce.[14] The availability of water directly affects agricultural productivity, which in turn influences food security, income levels, and the economic stability of rural households. Irrigation is crucial for agriculture, especially in regions with erratic rainfall patterns. Access to reliable irrigation can increase crop yields, enable multiple cropping cycles, and support the cultivation of high-value crops, thereby enhancing farmers' incomes and reducing poverty.

[13] National Water Policy, 2012, Ministry of Water Resources, Govt. of India, https://nwm.gov.in/.
[14] Economic Survey Highlights Thrust on Rural Development, Press Information Bureau, Govt. of India, https://pib.gov.in/PressReleasePage.aspx?PRID=1894901.

Beyond agriculture, water resources are essential for livestock rearing, which is a significant component of rural economies. Livestock provides a source of income, nutrition, and employment, particularly for small and marginal farmers. Access to clean water is vital for maintaining the health and productivity of livestock, thereby contributing to the economic resilience of rural communities. Water resources also play a critical role in non-farm rural activities such as fisheries, handicrafts, and small-scale industries. For instance, inland fisheries depend on well-managed water bodies, and these activities can provide supplementary income to farming households. Furthermore, water is necessary for various rural industries, including textile dyeing, pottery, and food processing, which generate employment and contribute to the rural economy.

The health and well-being of rural populations are intimately linked to the availability and quality of water. Access to safe drinking water and sanitation facilities reduces the incidence of water-borne diseases, which are prevalent in rural areas. Improved health outcomes lead to increased productivity and reduced healthcare costs, allowing families to invest more in education and economic activities. According to the World Health Organization, every dollar invested in water and sanitation yields a return of four dollars in increased productivity and reduced healthcare costs.[15]

Moreover, water resources are integral to maintaining ecological balance and supporting biodiversity, which rural communities rely on for various ecosystem services. Wetlands, rivers, and lakes not only provide water for domestic and agricultural use but also support a diverse range of flora and fauna, contributing to the environmental sustainability of rural areas.

Given the multifaceted importance of water resources in rural economies, effective water management is critical for ensuring sustainable development. Policies and initiatives that focus on improving water accessibility, quality, and management can drive economic growth, enhance livelihoods, and reduce poverty in rural areas. Therefore, investing in water infrastructure, promoting efficient water use practices, and involving local communities in water governance are essential strategies for strengthening rural economies and achieving broader developmental goals.

[15]https://news.un.org/en/story/2014/11/484032#:~:text=For%20every%20dollar%20invested%20in,United%20Nations%20World%20Health%20Organization

II. WATER MANAGEMENT PRACTICES IN INDIA

2.1.1 Traditional Water Management Techniques

1. **Johads:**
    - **Description:** Johads are small earthen check dams that capture and store rainwater, recharging groundwater and maintaining the water table.
    - **Historical Significance:** Predominantly used in Rajasthan, johads have been a critical water conservation tool in arid regions, providing water for agricultural and domestic use during dry seasons.
    - **Impact:** They help in groundwater recharge, increase soil moisture, and improve agricultural productivity. Communities managing johads report better water security and resilience against droughts.

2. **Baolis (Stepwells):**
    - **Description:** Baolis are wells with steps leading down to the water, allowing easy access even as water levels fluctuate.
    - **Historical Significance:** Common in Gujarat, Rajasthan, and Karnataka, stepwells were social and cultural hubs in addition to being water sources.
    - **Impact:** Stepwells have historically provided reliable water access, especially during dry periods. They also act as natural coolers, reducing local temperatures.

3. **Tank Systems:**
    - **Description:** Tanks are large, open reservoirs constructed to store rainwater.
    - **Historical Significance:** Used extensively in South India, particularly in Tamil Nadu and Karnataka, tanks have been integral to the region's water management for centuries.
    - **Impact:** Tanks support irrigation, drinking water supply, and groundwater recharge. Well-maintained tanks can significantly enhance agricultural productivity and water availability.

4. **Ahar-Pyne System:**
    - **Description:** A traditional floodwater harvesting system consisting of ahars (reservoirs) and pynes (canals) that distribute water to agricultural fields.
    - **Historical Significance:** This system is prevalent in Bihar and parts of Eastern India, adapted to the region's flood-prone geography.
    - **Impact:** The ahar-pyne system maximizes the use of floodwaters for irrigation, reducing flood damage and increasing agricultural yields.

5. **Zabo System:**
    - **Description:** A water conservation method combining water harvesting, soil conservation, and forestry management, prevalent in Nagaland.
    - **Historical Significance:** Zabo (meaning "impounding water") integrates agriculture with livestock and forest management.
    - **Impact:** The system enhances soil fertility, supports multiple cropping, and ensures water availability throughout the year.

2.1.2 Modern Water Management Techniques

1. **Drip Irrigation:**
    - **Description:** A micro-irrigation system that delivers water directly to the plant roots through a network of valves, pipes, and emitters.
    - **Impact:** Drip irrigation significantly reduces water wastage, increases crop yield, and is suitable for various crops, including fruits, vegetables, and cash crops. It is highly efficient in arid and semi-arid regions.
2. **Sprinkler Irrigation:**
    - **Description:** A method that simulates natural rainfall by spraying water over crops using a network of pipes and sprinklers.
    - **Impact:** This technique is useful for evenly distributing water across large areas, reducing water usage compared to traditional flood irrigation. It is effective for most field crops and improves water efficiency.

3. **Rainwater Harvesting:**
    - **Description:** The collection and storage of rainwater from rooftops or other surfaces for future use.
    - **Impact:** Rainwater harvesting reduces dependency on traditional water sources, recharges groundwater, and provides a sustainable water supply for domestic, agricultural, and industrial use.

4. **Groundwater Recharge Techniques:**
    - **Description:** Methods like recharge wells, percolation tanks, and injection wells are used to enhance groundwater replenishment.
    - **Impact:** These techniques help counteract groundwater depletion, ensuring long-term water availability and sustainability.

5. **Desalination:**
    - **Description:** The process of removing salts and other impurities from seawater to produce fresh water.
    - **Impact:** Desalination provides a reliable source of potable water in coastal areas facing freshwater scarcity. However, it is energy-intensive and requires significant investment.

6. **Constructed Wetlands:**
    - **Description:** Engineered systems that use natural processes involving wetland vegetation, soils, and microbial activity to treat wastewater.
    - **Impact:** Constructed wetlands provide effective wastewater treatment, enhance biodiversity, and can be integrated into urban and rural landscapes for sustainable water management.

7. **Integrated Water Resources Management (IWRM):**
    - **Description:** A holistic approach that coordinates the development and management of water, land, and related resources to maximize economic and social welfare without compromising the sustainability of vital ecosystems.
    - **Impact:** IWRM promotes sustainable water use, balancing the needs of various sectors and ensuring equitable access to water resources.

8. **Remote Sensing and GIS:**
    - **Description:** Technologies used for monitoring and managing water resources through satellite imagery and geographic information systems.
    - **Impact:** These tools provide real-time data on water availability, usage patterns, and environmental conditions, aiding in efficient water resource planning and management.

The combination of traditional and modern water management techniques offers a comprehensive approach to addressing India's water challenges. Traditional methods, rooted in local knowledge and practices, provide sustainable and community-centric solutions, while modern technologies introduce efficiency and scalability. Integrating these approaches can enhance water security, agricultural productivity, and resilience against climate change, contributing to overall socio-economic development.

2.2 Government policies and programs related to water management.

The Government of India has implemented a range of policies and programs aimed at managing water resources efficiently while addressing the pressing issue of poverty alleviation, particularly in rural areas where water scarcity and poverty are deeply intertwined.

One of the cornerstone policies is the **National Water Policy (NWP),** revised in 1987[16], 2002[17], and 2012[18]. The NWP emphasizes integrated water resources management (IWRM) to ensure the sustainable and equitable distribution of water. By focusing on conservation, efficient use, and community participation, the NWP aims to improve water availability and reduce the vulnerability of poor communities to water scarcity. The policy's 2012 revision notably addresses climate change impacts, which disproportionately affect the poor by exacerbating water shortages and agricultural instability.

[16] National Water Policy, 1987 (India).
[17] National Water Policy, 2002 (India).
[18] National Water Policy, 2012 (India).

The Atal Bhujal Yojana (ABY)[19], launched in 2018, targets critical groundwater depletion areas in seven states, with the objective of improving groundwater management through community participation. By promoting water budgeting and sustainable usage practices, ABY seeks to ensure long-term water availability, which is crucial for agricultural productivity and rural livelihoods. This program directly impacts poverty alleviation by enhancing water security for small and marginal farmers, who rely heavily on groundwater for irrigation.

Pradhan Mantri Krishi Sinchai Yojana (PMKSY), initiated in 2015, aims to achieve "Har Khet Ko Pani" (Water for Every Farm)[20] and enhance water use efficiency. By integrating components like the Accelerated Irrigation Benefit Program (AIBP), Per Drop More Crop, and Watershed Development, PMKSY promotes the creation and restoration of water sources and the adoption of micro-irrigation technologies. These measures help increase agricultural yields and incomes, directly lifting rural populations out of poverty by ensuring more reliable and efficient water usage.

The Jal Jeevan Mission (JJM), launched in 2019[21], focuses on providing functional household tap connections (FHTCs) to every rural household by 2024. By ensuring adequate and safe drinking water supply, JJM reduces the time and effort rural families, especially women and children, spend on water collection, allowing them more time for education and income-generating activities. This initiative significantly contributes to improving health outcomes and economic stability in impoverished rural areas.

The **Namami Gange Program**, started in 2014[22], aims to rejuvenate the Ganga River and ensure sustainable management of its resources. This program involves pollution abatement, river surface cleaning, and the construction of sewage treatment infrastructure. By improving water quality and availability, Namami Gange supports agricultural activities and fisheries, which are vital for the livelihoods of millions of people living along the river.

[19] Supra note 8
[20] Pradhan Mantri Krishi Sinchai Yojana, Har Khet Ko Pani, https://pmksy.gov.in/ (last visited August 15, 2024).
[21] Jal Jeevan Mission, https://ejalshakti.gov.in/JJM/Login.aspx?Ty=se (last visited August 15, 2024).
[22] Namami Gange Program, https://nmcg.nic.in/NamamiGanga.aspx (last visited August 15, 2024)

National Rural Drinking Water Programme (NRDWP), implemented in 2009, targets the provision of safe and adequate drinking water to rural populations. This program emphasizes sustainable management and maintenance of water supply systems, crucial for reducing waterborne diseases and improving overall health and productivity in rural communities. Access to clean drinking water directly impacts poverty alleviation by decreasing healthcare costs and increasing the workforce's productivity.[23]

River Basin Management (RBM)[24] Programs focus on the holistic and sustainable management of water resources within river basins. By promoting stakeholder participation and interstate cooperation, these programs address water scarcity, pollution, and ecological degradation. Effective RBM ensures that water resources are managed in a way that supports sustainable agricultural practices and economic activities, thereby reducing poverty.

Groundwater management policies, guided by the Model Bill for the Conservation, Protection, Regulation, and Management of Groundwater (with iterations in 1970, 1992, 1996, 2005, and 2011), encourage states to develop their own regulations for sustainable groundwater use. These policies aim to control over-extraction and promote groundwater recharge, ensuring that groundwater remains a viable resource for agricultural and domestic use, which is crucial for rural populations dependent on it.

The **Mahatma Gandhi National Rural Employment Guarantee Act** (MGNREGA)[25], established in 2005, provides livelihood security through guaranteed wage employment. A significant component of MGNREGA involves the creation of water conservation and harvesting structures, rejuvenating traditional water bodies, and constructing new irrigation facilities. These efforts enhance water availability for agriculture, directly benefiting the poor by improving food security and creating job opportunities.

[23] Comptroller & Auditor General of India, Audit Report Summary on National Rural Drinking Water Programme, 2018 (India).
[24] River Basin Management, https://jalshakti-dowr.gov.in/river-basin-management/ (last visited August 15, 2024).
[25] National Rural Employment Guarantee Act, 2005, No. 42 of 2005 (India).

Lastly, the **Swachh Bharat Mission** (SBM)[26], launched in 2014, aims to achieve universal sanitation coverage and eliminate open defecation. By integrating water management with sanitation, SBM ensures that sanitation facilities have adequate water supply, promoting health and hygiene. Improved sanitation reduces water contamination and disease prevalence, which in turn lowers healthcare costs and increases productivity among impoverished populations.

One notable initiative is **Mission Amrit Sarovar**[27], launched in 2022 by the Government of India. This mission aims to create and rejuvenate community-owned water bodies, including ponds, lakes, and reservoirs, across the country. The goal is to develop 50,000 Amrit Sarovars by 2025. This initiative focuses on increasing water storage capacity, improving water availability for irrigation and drinking, and enhancing groundwater recharge. By reviving traditional water bodies and improving their management, Mission Amrit Sarovar helps to secure water resources, especially in drought-prone and water-scarce regions.

The impact of Mission Amrit Sarovar on poverty alleviation can be seen in several ways. In Haryana, the creation of new water bodies and the rejuvenation of existing ones under the mission have improved water availability for agriculture. Farmers in the region have reported increased crop yields and the ability to diversify their crops due to more reliable irrigation. This improvement in agricultural productivity translates into higher incomes and better economic stability for rural households, thereby contributing to poverty reduction.

Together, these government policies and programs form a comprehensive strategy to manage water resources effectively while simultaneously addressing the multifaceted issue of poverty in India. By enhancing water security, improving agricultural productivity, ensuring safe drinking water, and promoting sustainable practices, these initiatives contribute significantly to the economic and social upliftment of rural communities.

[26] Swachh Bharat Mission, https://swachhbharatmission.ddws.gov.in/ (last visited August 15, 2024).
[27] Mission Amrit Sarovar, https://amritsarovar.gov.in/login (last visited August 15, 2024).

2.3 Case Laws

i. M.C. Mehta v. Union of India (1987)[28]

The Supreme Court of India, in the landmark case M.C. Mehta v. Union of India, took significant steps to address the pollution of the Ganga River. This case was pivotal in highlighting the severe environmental degradation caused by industrial effluents and untreated sewage being discharged into the river, which is a lifeline for millions of people. The petitioner, M.C. Mehta, a renowned environmental lawyer, filed a Public Interest Litigation (PIL) seeking the Court's intervention to protect the Ganga River from rampant pollution. The Supreme Court's judgment mandated the installation of treatment plants by industries located along the riverbanks and ordered the closure of industries that failed to comply with pollution control measures. This decision underscored the judiciary's role in enforcing environmental regulations and protecting water resources, directly impacting the health and livelihoods of communities dependent on the river. By ensuring cleaner water, the judgment helped in reducing waterborne diseases and improving the quality of life for impoverished populations living along the Ganga, thereby linking water management with poverty alleviation.

ii. Narmada Bachao Andolan v. Union of India (2000)[29]

In the case of Narmada Bachao Andolan v. Union of India (2000), the Supreme Court of India faced the complex issue of balancing development and environmental sustainability. The case involved the construction of the Sardar Sarovar Dam on the Narmada River, which was projected to provide significant benefits in terms of irrigation, drinking water, and electricity. However, the project also threatened the displacement of thousands of people and the submergence of vast tracts of forest and agricultural land. The petitioner, Narmada Bachao Andolan, a social movement led by activist Medha Patkar, argued against the displacement and environmental impact without adequate rehabilitation measures. The Supreme Court ultimately allowed the construction to proceed but emphasized the need for proper rehabilitation and resettlement of the affected people. This case highlighted the importance of equitable water resource management and the need to protect the rights and livelihoods of vulnerable communities.

[28] M.C. Mehta v. Union of India (AIR 1987 SC 965)
[29] Narmada Bachao Andolan v. Union of India, (2000) 10 SCC 664 (India).

It demonstrated the court's role in ensuring that large-scale water projects do not exacerbate poverty but rather contribute to sustainable development.

iii. Vellore Citizens' Welfare Forum v. Union of India (1996)[30]

The Supreme Court's decision in Vellore Citizens' Welfare Forum v. Union of India (AIR 1996 SC 2715) was another significant case addressing water pollution and its socio-economic impacts. This case involved the extensive pollution of groundwater and rivers by tanneries in Vellore, Tamil Nadu. The petitioner, a welfare forum, brought the case to highlight the environmental damage caused by the untreated effluents discharged by the tanneries, affecting the health and agricultural productivity of local communities. The Supreme Court recognized the "precautionary principle" and "polluter pays principle" in environmental jurisprudence and directed the tanneries to adopt appropriate measures to treat their effluents. The judgment also mandated compensation for those affected by pollution. This case underscored the court's commitment to environmental protection and its recognition of the direct link between environmental degradation, water management, and poverty. By addressing industrial pollution, the judgment helped in improving the health and livelihoods of rural communities dependent on clean water for agriculture and daily needs.

iv. Subhash Kumar v. State of Bihar (1991)[31]

In Subhash Kumar v. State of Bihar, the Supreme Court of India dealt with the right to clean water as part of the fundamental right to life under Article 21 of the Constitution. The petitioner, Subhash Kumar, brought attention to the severe pollution of the Bokaro River due to the discharge of untreated sewage and industrial effluents. The Supreme Court affirmed that the right to life includes the right to enjoy pollution-free water and air. The court directed the state authorities to take necessary steps to prevent and control water pollution and to ensure the supply of clean water to the affected communities. This judgment reinforced the idea that access to clean water is essential for a dignified life and highlighted the state's responsibility in ensuring water quality. By protecting water resources, the court's decision contributed to reducing health risks and improving the living conditions of impoverished communities, thereby linking water management with the alleviation of poverty.

[30] Vellore Citizens' Welfare Forum v. Union of India (AIR 1996 SC 2715)
[31] Subhash Kumar v. State of Bihar (AIR 1991 SC 420)

These cases illustrate the critical role of the judiciary in ensuring effective water management and addressing the socio-economic impacts of water-related issues in India. The judgments not only enforced environmental regulations but also recognized the fundamental right to clean water, thus contributing to poverty alleviation by safeguarding the health and livelihoods of vulnerable populations.

3.1 ANALYSIS OF SPECIFIC REGIONS OR PROJECTS WHERE WATER MANAGEMENT HAS SUCCESSFULLY ALLEVIATED POVERTY

Ralegan Siddhi, Maharashtra

Ralegan Siddhi, a village in the Ahmednagar district of Maharashtra, presents a compelling example of how effective water management can alleviate poverty. In the 1970s, Ralegan Siddhi faced severe water scarcity and economic distress, with depleted groundwater levels and degraded agricultural land contributing to widespread poverty. Under the visionary leadership of social activist Anna Hazare, the village embarked on a comprehensive watershed management program. The key interventions included constructing check dams and percolation tanks to capture rainwater and recharge groundwater, implementing contour trenching and afforestation to prevent soil erosion and enhance water retention, and banning water-intensive crops in favor of water-efficient agriculture. These measures led to a significant increase in groundwater levels, ensuring year-round water availability for irrigation and drinking purposes. As a result, agricultural productivity soared, enabling farmers to adopt multiple cropping patterns and significantly increase their incomes. This transformation uplifted the entire village from poverty to prosperity, with improved living standards and better health outcomes. Ralegan Siddhi's success in water management has made it a model village for sustainable development.[32]

Hiware Bazar, Maharashtra

Hiware Bazar, another village in Maharashtra's Ahmednagar district, faced severe droughts and economic hardship in the 1990s due to poor water management practices. Under the leadership of

[32] B. Mishra, A Successful Case of Participatory Watershed Management at Ralegan Siddhi Village in District Ahmadnagar, Maharashtra, India, PCSD/FARM, RAS/93/067

Popatrao Pawar, the village implemented a series of effective water conservation measures. These included constructing check dams, percolation tanks, and recharge wells, as well as implementing watershed development techniques such as contour bunding and tree planting. Community participation was a cornerstone of the initiative, with the entire village involved in planning and executing the water management projects. These measures led to a remarkable rise in groundwater levels, ensuring adequate water supply for agriculture and household use. With reliable water resources, farmers in Hiware Bazar shifted to high-value crops like vegetables and fruits, significantly increasing their income. The village experienced a drastic reduction in poverty, with improved health, education, and infrastructure. Hiware Bazar's success story showcases the transformative potential of effective water management in enhancing rural economies and alleviating poverty.[33]

3.2 COMPARISON OF DIFFERENT APPROACHES AND THEIR OUTCOMES

The comparison of various water management approaches highlights their diverse strengths and impacts on poverty alleviation and resource sustainability. **Traditional water harvesting techniques**, such as johads (check dams) and percolation tanks, have proven effective in arid and semi-arid regions. These methods, exemplified by the successful projects in Ralegan Siddhi and Alwar, involve the construction of small-scale, community-driven structures designed to capture and store rainwater. In Ralegan Siddhi, the implementation of such traditional techniques under Anna Hazare's leadership resulted in a significant rise in groundwater levels, leading to increased agricultural productivity and improved livelihoods. Similarly, in Alwar, the restoration of johads by Tarun Bharat Sangh revitalized water resources, enabling local farmers to return to agriculture and lift many families out of poverty. Traditional methods are valued for their simplicity and community involvement, fostering local ownership and sustainable practices. However, their scalability can be limited, and they may lack the technological advancements needed for broader application.

In contrast, **modern technological solutions** leverage advanced tools such as remote sensing, GIS, and automated irrigation systems. The Neeranchal National Watershed Project exemplifies this approach, integrating cutting-edge technology with traditional practices to enhance watershed management across several Indian states. This project utilizes data-driven techniques to optimize water management, allowing for precise planning and efficient resource use.

[33] https://www.downtoearth.org.in/environment/hiware-bazar--a-village-with-54-millionaires-4039

The application of modern technology has demonstrated significant improvements in water availability and agricultural efficiency, contributing to poverty reduction on a larger scale. While modern solutions offer scalability and advanced efficiency, they often require substantial investment and technical expertise, which can be challenging for resource-limited communities.

Community-driven initiatives represent another critical approach, focusing on local involvement in water management. Projects in Hiware Bazar and Ralegan Siddhi highlight the effectiveness of this model, where local communities actively participate in constructing and maintaining water infrastructure. In Hiware Bazar, community-led efforts to build check dams and implement soil conservation measures led to remarkable improvements in groundwater levels and agricultural productivity. This approach fosters strong local engagement and sustainable practices, resulting in long-term benefits and reduced poverty. However, community-driven initiatives may face limitations in scaling up and securing external funding, which can restrict their broader impact.
On the other hand, **government-led initiatives** involve large-scale projects and policy frameworks designed to address water management challenges. Programs such as the Jal Jeevan Mission (JJM) and Pradhan Mantri Krishi Sinchai Yojana (PMKSY) focus on expanding water supply infrastructure and improving irrigation efficiency. The JJM aims to provide tap water connections to rural households, while the PMKSY seeks to enhance agricultural irrigation systems. These initiatives benefit from substantial funding and resources, achieving broad coverage and significant impact. Nevertheless, government-led projects may encounter challenges related to implementation efficiency, bureaucratic delays, and the need for local adaptation.

Finally, the comparison between **Integrated Water Resources Management (IWRM)** and **sectoral management** approaches reveals different strategies for addressing water challenges. IWRM promotes a holistic approach, integrating various water uses and stakeholders to achieve balanced and sustainable management. The Neeranchal National Watershed Project and Atal Bhujal Yojana (ABY) exemplify this approach, coordinating efforts across agriculture, drinking water, and environmental conservation. IWRM enhances coordination and efficiency but can be complex to implement due to the need for stakeholder engagement and comprehensive planning. In contrast, sectoral management focuses on specific water uses, such as agricultural irrigation or drinking water supply. While this approach provides targeted improvements within each sector, it may lack coordination between different water needs, potentially leading to inefficiencies and conflicts.

In conclusion, the effectiveness of water management approaches varies based on their context and implementation. Traditional methods excel in community involvement and sustainability, modern technologies offer precision and scalability, community-driven initiatives foster local engagement, and government-led projects provide extensive coverage. Understanding these differences helps in selecting the most appropriate strategies to address water management challenges and promote sustainable development.

4.1 IMPACT ON AGRICULTURE

Water management has a profound impact on agriculture, especially in a country like India where a significant portion of the population depends on farming for their livelihood. Effective water management practices can enhance agricultural productivity, ensure food security, and contribute to poverty alleviation. Historically, Indian agriculture has relied heavily on monsoon rains, leading to variability in crop yields. Traditional water management practices, such as the construction of tanks, step wells, and check dams, were integral to managing this variability. For instance, in the semi-arid regions of Rajasthan and Maharashtra, the revival of traditional water harvesting structures, such as johads and percolation tanks, has led to improved water availability. These structures capture and store rainwater, recharging groundwater levels and ensuring a stable water supply for irrigation even during dry spells. The success stories of Ralegan Siddhi and Alwar highlight how these traditional practices have revitalized agriculture, enabling farmers to switch from single to multiple cropping patterns and significantly increasing their agricultural output. In recent decades, modern water management techniques have been introduced to address the increasing demand for water in agriculture. Technologies such as drip and sprinkler irrigation systems have revolutionized water use efficiency. Drip irrigation, for example, delivers water directly to the plant roots, minimizing evaporation and runoff, and ensuring that crops receive the optimal amount of water. This method has been particularly beneficial in regions like Maharashtra and Gujarat, where water scarcity is a persistent issue. The adoption of these modern techniques has led to higher crop yields, better quality produce, and increased income for farmers. Government initiatives like the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) aim to extend these benefits by promoting the use of micro-irrigation and improving irrigation infrastructure across the country. Furthermore, watershed management projects, such as the Neeranchal National Watershed Project, have integrated modern technology with traditional practices to enhance water conservation and agricultural productivity.

By using remote sensing and GIS for effective planning and monitoring, these projects ensure the efficient use of water resources. Improved water management practices have also enabled farmers to diversify their crops, moving from low-value staple crops to high-value fruits, vegetables, and cash crops, thereby increasing their income and reducing poverty. Additionally, effective water management mitigates the adverse impacts of climate change on agriculture. As weather patterns become increasingly erratic, ensuring a reliable water supply through efficient management practices becomes crucial for sustaining agricultural production. Overall, the integration of traditional and modern water management techniques has significantly boosted agricultural productivity, improved livelihoods, and contributed to poverty reduction in rural India.

4.1.1 EXAMINATION OF HOW WATER MANAGEMENT AFFECTS AGRICULTURAL PRODUCTIVITY

Water management plays a critical role in determining agricultural productivity, particularly in a country like India where a substantial portion of the population relies on farming. Efficient water management ensures that crops receive the necessary amount of water at the right time, which is essential for healthy plant growth and optimal yield. Proper irrigation techniques, whether traditional or modern, help maintain soil moisture at levels conducive to crop growth, prevent water stress during critical growth phases, and reduce the likelihood of crop failure. In regions like Maharashtra and Rajasthan, traditional water harvesting structures such as johads and check dams have proven effective in capturing and storing rainwater, which recharges groundwater levels and provides a reliable source of water for irrigation even during dry periods. This has enabled farmers to cultivate multiple crops per year, rather than just one, thereby increasing agricultural productivity and income. Modern water management techniques, such as drip and sprinkler irrigation, have further enhanced agricultural productivity by improving water use efficiency. Drip irrigation systems deliver water directly to the root zone of plants, minimizing evaporation and runoff, and ensuring that water is used optimally. This method is particularly beneficial in water-scarce regions, allowing farmers to produce higher yields with less water. Studies have shown that drip irrigation can increase crop yields by 20-50% while reducing water use by 30-60%.[34]

[34] Ishwa Jyoti Baruah et al., Precision Irrigation Management: A Step Toward Sustainable Agriculture, in *Remote Sensing in Precision Agriculture* 189-215 (Salim Lamine et al. eds., 2024), https://doi.org/10.1016/B978-0-323-91068-2.00021-7.

Similarly, sprinkler systems distribute water more evenly across the fields, reducing water wastage and promoting uniform crop growth. The implementation of these technologies has resulted in higher crop yields, better quality produce, and increased agricultural incomes.

Government initiatives like the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) have played a significant role in promoting efficient water management practices. By subsidizing the cost of micro-irrigation systems and improving irrigation infrastructure, these programs have made modern irrigation technologies more accessible to farmers. Additionally, integrated watershed management projects, such as the Neeranchal National Watershed Project, combine traditional and modern techniques to enhance water conservation and agricultural productivity. These projects use advanced tools like remote sensing and GIS to plan and monitor water resources effectively, ensuring that water is used efficiently and sustainably.

Effective water management also allows for the diversification of crops, enabling farmers to shift from low-value staple crops to high-value fruits, vegetables, and cash crops. This diversification not only increases farm incomes but also enhances food security and nutritional outcomes for rural communities. Moreover, efficient water management helps mitigate the impacts of climate change on agriculture. With changing weather patterns and increasing instances of droughts and floods, having reliable water management systems in place is crucial for sustaining agricultural production. In conclusion, water management significantly impacts agricultural productivity by ensuring a reliable water supply, improving water use efficiency, enabling crop diversification, and mitigating the effects of climate variability. The combination of traditional and modern water management practices has proven effective in boosting agricultural productivity, enhancing farmer incomes, and contributing to rural development and poverty alleviation in India.

4.2 RELATIONSHIP BETWEEN WATER AVAILABILITY AND CROP YIELDS

The relationship between water availability and crop yields is direct and significant, as water is a crucial input for plant growth and development. Adequate water supply ensures that crops can carry out essential physiological processes, leading to higher yields and better quality produce. Conversely, water scarcity or poor water management can lead to reduced yields, crop failures, and economic hardship for farmers. Real-time examples from various regions in India illustrate this critical relationship.

In the state of Punjab, known as the "Granary of India," the availability of water from extensive canal systems and groundwater irrigation has been pivotal in achieving high yields of wheat and rice. The Green Revolution in the 1960s and 1970s, which introduced high-yielding varieties of crops along with enhanced irrigation infrastructure, dramatically increased food production in Punjab. For instance, wheat yields in Punjab increased from around 1,000 kg per hectare in the early 1960s to over 4,500 kg per hectare by the mid-2010s.[35] The reliable water supply from both canals and tube wells ensured that crops received sufficient water during critical growth stages, leading to substantial yield improvements.

In contrast, the state of Maharashtra provides an example of how water scarcity can negatively impact crop yields. Maharashtra frequently experiences droughts, particularly in the Marathwada and Vidarbha regions, where farmers depend heavily on monsoon rains. During the severe drought of 2012-2016, water shortages led to significant reductions in crop yields, with some areas reporting up to a 40% decrease in agricultural output. The drought not only affected staple crops like rice and wheat but also cash crops like cotton and sugarcane, causing widespread economic distress among farmers.

Hiware Bazar, a village in Maharashtra, demonstrates the positive impact of effective water management on crop yields. Under the leadership of Popatrao Pawar, the village implemented a series of water conservation measures, including the construction of check dams, percolation tanks, and contour bunding. These efforts significantly improved water availability, even during dry seasons. As a result, the village saw a dramatic increase in agricultural productivity. Farmers in Hiware Bazar were able to switch to high-value crops such as vegetables and fruits, which require reliable water supply, and saw their incomes rise substantially. The village's success in managing water resources transformed it from a drought-prone area to a prosperous agricultural community.
In Gujarat, the Sardar Sarovar Project on the Narmada River has had a significant impact on water availability and crop yields. The project, which provides irrigation water to drought-prone regions of Gujarat, has enabled farmers to achieve higher yields of crops such as cotton, wheat, and pulses.

[35] Karam Singh, P.S. Rangi & Sajla Kalra, Wheat Production and Sustainability in Punjab: Growth and Varietal Diversity, 59 Ind. Jn. of Agri. Econ. 4, Oct.-Dec. 2004.

For example, in the command area of the Sardar Sarovar Project, cotton yields increased from 600-700 kg per hectare to over 1,200 kg per hectare after the introduction of reliable irrigation.[36] This improvement in water availability has not only boosted crop yields but also enhanced the overall economic well-being of farmers in the region.

The Pradhan Mantri Krishi Sinchai Yojana (PMKSY) is another initiative that highlights the importance of water availability for crop yields. By promoting micro-irrigation techniques such as drip and sprinkler systems, PMKSY aims to increase water use efficiency and ensure that crops receive adequate water. In regions like Tamil Nadu and Andhra Pradesh, the adoption of drip irrigation has led to significant increases in yields of crops like sugarcane, tomatoes, and chillies. For instance, farmers using drip irrigation for sugarcane in Tamil Nadu reported yield increases of up to 30% compared to traditional flood irrigation methods.[37]

4.5 HOW IMPROVED WATER MANAGEMENT CONTRIBUTES TO BETTER HEALTH AND SANITATION

Improved water management plays a pivotal role in enhancing health and sanitation, directly impacting the quality of life in communities. By ensuring a consistent supply of clean water and promoting effective sanitation practices, better water management can significantly reduce the prevalence of waterborne diseases and improve overall public health. Several initiatives and examples illustrate this impact in diverse contexts across India.

i. Water Supply and Sanitation Collaboration in Kerala

In Kerala, the Jalanidhi project, a World Bank-supported initiative, has made significant strides in improving water management and sanitation in rural areas. The project focuses on community-driven water supply schemes and has successfully provided sustainable access to clean drinking water. By involving local communities in the planning and management of water resources, the project ensures

[36] Irrigation Planning and Command Area Development, https://www.nwda.gov.in/upload/uploadfiles/files/0885199804.pdf (last visited August 15, 2024).

[37] Vasant P. Gandhi, Nicky Johnson & Gurpreet Singh, The Performance and Impact of Micro Irrigation in Improving Water Use Efficiency in India's Agriculture: Study of the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) - Per Drop More Crop (PDMC), Indian Institute of Management, Ahmedabad (IIMA), March 2021.

that water supply systems are maintained and operated effectively. This has led to a substantial reduction in the incidence of waterborne diseases such as diarrhea and cholera. The improved water supply has also enabled better hygiene practices, contributing to enhanced health outcomes.

ii. Community-Led Total Sanitation (CLTS) in Bihar

The implementation of Community-Led Total Sanitation (CLTS) in Bihar has demonstrated how improved water management can lead to better sanitation and health outcomes. CLTS focuses on behavioral change to eliminate open defecation and promote the construction of household latrines. In Nalanda district, the CLTS approach led to the construction of over 100,000 household toilets, significantly reducing open defecation. The availability of clean water through improved water management practices, such as the installation of hand pumps and community wells, supported these sanitation efforts. As a result, there was a marked decrease in the incidence of diseases such as dysentery and typhoid, improving the overall health of the community.

iii. Integrated Water and Sanitation Project in Gujarat

The Gujarat government's Integrated Water and Sanitation Project in the Sabarmati Basin is another example of how improved water management contributes to better health and sanitation. This project integrates water supply, sanitation, and hygiene education to create a holistic approach to community health. By constructing water treatment plants, installing pipelines, and building latrines, the project has ensured a steady supply of clean water and improved sanitation facilities. This comprehensive approach has led to a reduction in waterborne diseases and enhanced public health. Moreover, the hygiene education component of the project has encouraged better personal hygiene practices, further contributing to improved health outcomes.[38]

iv. Rainwater Harvesting in Meghalaya

In Meghalaya, the implementation of rainwater harvesting systems has significantly improved water availability and quality, leading to better health and sanitation. The state government, in collaboration with local communities, has constructed numerous rainwater harvesting structures to capture and store rainwater.

[38] Urban Management Centre, Urban Water and Sanitation in Gujarat (June 2011).

This initiative has ensured a reliable supply of clean water for drinking and domestic use, even during dry seasons. The availability of clean water has facilitated the construction of household toilets and improved sanitation practices. In villages like Mawlynnong, known as Asia's cleanest village, the emphasis on rainwater harvesting and sanitation has led to a drastic reduction in waterborne diseases and improved community health.

v. Urban Water and Sanitation Initiative in Pune

In urban areas, improved water management also plays a crucial role in health and sanitation. The Pune Municipal Corporation's (PMC) 24x7 Water Supply Project aims to provide continuous water supply to all residents, replacing the intermittent supply that often leads to water contamination. By upgrading the water distribution infrastructure and ensuring consistent water quality monitoring, the project has significantly reduced the risk of waterborne diseases in Pune. Additionally, the PMC has implemented robust waste management and sewage treatment systems, further enhancing sanitation. The continuous water supply and improved sanitation infrastructure have led to better health outcomes for the city's residents, reducing the burden of diseases like gastroenteritis and hepatitis.

4.6 WATER-BORNE DISEASES

Improved water management is essential in reducing the incidence of waterborne diseases, which directly impacts poverty alleviation in rural India. Waterborne diseases, such as cholera, typhoid, and diarrhea, disproportionately affect impoverished communities that lack access to clean and safe water. These diseases not only lead to high medical expenses but also decrease the productivity of affected individuals, trapping them in a cycle of poverty. By addressing water contamination issues through effective water management, rural communities can experience significant improvements in health and economic stability.

One major approach is the rejuvenation and maintenance of clean water bodies, as seen in initiatives like Mission Amrit Sarovar. By focusing on the creation and restoration of community-owned water reservoirs, these projects ensure that rural populations have access to uncontaminated and safe water. This access to clean water reduces reliance on polluted sources that are breeding grounds for pathogens, which are the primary cause of waterborne illnesses.

When communities no longer face constant health threats from unsafe drinking water, they save on medical costs, and individuals, especially children and the elderly, experience fewer illnesses, allowing families to invest more in productive activities.

Furthermore, integrated water supply and sanitation programs also contribute significantly to both health improvements and poverty reduction. Initiatives that focus on providing safe drinking water, along with proper waste management and sanitation, help break the link between poor hygiene and the spread of diseases. When households gain access to clean water, it not only improves health outcomes but also enhances productivity, as fewer days are lost to illness. This reduction in waterborne diseases allows individuals to engage in economic activities more consistently, improving household incomes and helping to lift families out of poverty.

Additionally, clean water initiatives, such as tap water connections under various government schemes, ensure that rural households have reliable access to treated water. These programs are instrumental in eliminating the dependence on contaminated sources and reduce the burden of waterborne illnesses. As a result, fewer resources are spent on medical care, and healthier populations contribute to higher economic productivity, further supporting poverty alleviation efforts.

Overall, improved water management directly influences health by reducing waterborne diseases, which, in turn, plays a critical role in alleviating poverty. By ensuring access to clean water, these strategies reduce healthcare costs, enhance productivity, and improve the quality of life for rural communities, helping them break free from the cycle of poverty.

CONCLUSION

Water management is integral to the socio-economic transformation of rural India, where a significant portion of the population depends on agriculture and natural resources for their livelihoods. This study reveals how effective water governance, when combined with robust community participation, can alleviate poverty and ensure sustainable development. However, current realities highlight the urgent need to address the complex interplay of water scarcity, contamination, and inadequate fund allocation across Indian states.

India faces a dual crisis: the over-extraction of groundwater and widespread water contamination. According to the Composite Water Management Index (CWMI) by NITI Aayog (2019), about 70% of India's water supply is contaminated, and 21 major cities are projected to run out of groundwater soon. States like Rajasthan, Maharashtra, and Tamil Nadu grapple with acute water scarcity, while regions like Punjab and Uttar Pradesh face high groundwater contamination due to excessive use of fertilizers and untreated industrial waste.

Additionally, climatic variability has made monsoons unpredictable, exacerbating water shortages in traditionally rain-fed agricultural areas. For instance, Marathwada in Maharashtra witnessed one of its worst droughts in recent years, affecting millions of farmers and leading to a surge in rural distress. Similarly, arsenic and fluoride contamination in groundwater have severely impacted health and productivity in states like West Bengal and Bihar.

The role of state governments in addressing water challenges is pivotal. However, disparities in fund allocation often determine the success or failure of water management strategies. For example, states like Gujarat, which have invested significantly in irrigation and groundwater recharge projects, have seen marked improvements in agricultural productivity and poverty reduction. In contrast, states with lower investments in water infrastructure, like Jharkhand and Odisha, continue to face challenges in ensuring water security.

Analyzing fund allocation becomes necessary to ensure resources are directed toward high-impact projects. Programs such as the Atal Bhujal Yojana (ABY), which focuses on groundwater management, require precise targeting to regions facing critical groundwater depletion. Without transparent and needs-based allocation, the benefits of such programs cannot be fully realized.

Water contamination is another pressing issue requiring immediate attention. The lack of adequate sewage treatment plants and industrial regulations has resulted in water bodies becoming polluted, with downstream communities bearing the brunt. For example, the Ganga River, despite significant efforts under the Namami Gange initiative, continues to face pollution from untreated effluents. Monitoring contamination levels, particularly in rural water sources, is essential to prevent health crises and ensure safe drinking water.

The future of India's rural prosperity hinges on the sustainable management of water resources. Tackling contamination and ensuring equitable fund allocation are not just administrative tasks but moral imperatives to safeguard the livelihoods of millions. A concerted effort involving state governments, communities, and policymakers is crucial to transform water management into a tool for poverty alleviation, health improvement, and agricultural resilience. By addressing the gaps in current strategies and adopting a proactive approach, India can pave the way for a future where clean water and sustainable development are accessible to all.