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Impact of environmental issues on future drinking water crisis in India and its management process for sustainability urban area of country

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Abstract

India faces significant challenges in managing its water resources, despite receiving adequate average rainfall. The country's water supply is primarily sourced from surface water bodies like rivers, lakes, and reservoirs, as well as groundwater, which accounts for over 80% of domestic water use. However, factors like climate change, water pollution, and groundwater depletion threaten the sustainability of these resources. This study highlights the pressing issues affecting India's water security, including the impact of climate change, water pollution, and groundwater depletion. It also explores potential solutions, such as sustainable water management practices, rainwater harvesting, and wastewater treatment, to ensure equitable access to safe drinking water for all. Some potential themes to explore further:

- **Water Scarcity:** Investigate the causes and consequences of water scarcity in India, including its impact on agriculture, industry, and human consumption.
- **Water Pollution:** Examine the sources and effects of water pollution in India, including industrial effluents, agricultural runoff, and domestic sewage.
- **Sustainable Water Management:** Discuss strategies for sustainable water management in India, including water conservation, efficient irrigation systems, and watershed management.
- **Climate Change:** Analyze the impact of climate change on India's water resources, including changes in precipitation patterns, glacier melting, and sea-level rise.

Keywords: Sustainability, agriculture, effluents management, ground water, preservation, conservation, precipitation

Introduction

India's drinking water comes from a variety of sources, both surface and groundwater. The main sources of drinking water in India: Surface water like major rivers (the Ganga, Yamuna, Brahmaputra, Godavari, Krishna, and Cauvery), Lakes and Reservoirs. India depends heavily on groundwater, especially in rural areas. Wells, Borewells, springs provide water to a considerable section of the population. Groundwater is the backbone of India's drinking water supply, accounting for over 80% of domestic water use in both rural and urban areas. Rainwater harvesting and Desalination are other sources of water. Major River Systems and Their Role in Drinking Water Supply: Ganga-Brahmaputra-Meghna System: This is the largest river system in India, encompassing 43% of the catchment area of all major river systems. It plays a crucial role in supplying water for various uses, including drinking water, to a significant portion of the population.

Yamuna River: The Yamuna is a vital source of water for several states, including Delhi, Haryana, and Uttar Pradesh. Notably, it accounts for more than 70% of Delhi's water supply, underscoring its importance in meeting the drinking water needs of the capital. Wikipedia Krishna and Godavari Rivers: These Rivers are essential for water supply in southern states. For instance, Hyderabad relies heavily on the Krishna River, sourcing nearly half of its daily water requirement from it. The monsoon plays a critical role in determining the availability and sustainability of drinking water across India. Given that over 80% of India's annual rainfall occurs during the southwest monsoon (June-September), this seasonal phenomenon significantly influences water security for both rural and urban populations.

Distribution of Drinking Water Sources in India: According to data from the Ministry of Statistics and Programme Implementation (MoSPI), the distribution of households by their principal source of drinking water is as follows:

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- **Tap Water (Treated and Untreated):** Approximately 43% of households rely on tap water, with treated sources being a more prevalent in urban areas. Hand Pumps and Tube Wells: These are the main sources for about 42% of households, predominantly in rural regions. Wells (Covered and Uncovered): Around 8% of households use wells for their drinking water needs.
- **Other Sources:** The remaining 7% depend on springs, rivers, canals, tanks, ponds, lakes, and other sources.

What is the situation in India now?

India is on the brink of a severe drinking water crisis, driven by a convergence of environmental challenges that threaten the sustainability of its freshwater resources. With 18% of the world's population but only 4% of its freshwater resources, the country faces mounting pressure to secure safe and reliable drinking water for its citizens.

- **Climate change is significantly altering India's hydrological cycles:** Rising temperatures and erratic rainfall patterns have led to prolonged droughts and reduced water availability. Projections indicate that under a 1.5 °C warming scenario, India's water gap could increase by 11.1 cubic kilometers per year, escalating to 17.2 cubic kilometers under a 3°C rise. The Himalayan glaciers, crucial for feeding major rivers like the Ganga and Brahmaputra, are retreating rapidly, threatening long-term water supplies. Climate change is disrupting traditional monsoon patterns, leading to: Droughts in some regions (e.g., Bundelkhand, Marathwada), Flooding in others, which washes away topsoil and damages infrastructure, Shorter, more intense rain spells that reduce effective groundwater recharge.
- **Water pollution exacerbates the crisis:** A significant portion of India's water bodies are contaminated due to untreated sewage, industrial effluents, and agricultural runoff. For instance, the Ganges River, serving over 500 million people, suffers from severe pollution levels, with untreated waste being a primary contributor. In urban areas like Delhi, investigations have revealed faecal contamination in tap water, posing serious health risks. India's rivers, especially the Ganga, Yamuna, and Godavari, are becoming severely polluted due to:

Industrial waste discharge

Untreated sewage

- **Agricultural runoff (pesticides and fertilizers):** India is the world's largest user of groundwater, accounting for over 25% of global extraction. However, unsustainable withdrawal rates have led to alarming depletion levels. Nearly 70% of the country's groundwater is contaminated, and projections suggest that groundwater depletion will triple by 2041-2080, further intensifying the crisis. Over-extraction, especially for agriculture, Reduced recharge due to deforestation and urban sprawl, Pollution from arsenic, fluoride, and nitrates are depleting this critical source and threatening long-term water security.
- **Forests and wetlands help filter rainwater and recharge groundwater:** Their loss leads to: Reduced natural water storage, higher runoff and lower infiltration, Soil erosion and siltation of reservoirs.

Rapid urbanization has outpaced the development of adequate water infrastructure. Cities like Mumbai are exploring desalination projects to meet growing demands, but such initiatives face delays and high costs. Meanwhile, many urban residents still lack access to safe drinking water, highlighting the need for comprehensive urban water management strategies. The water crisis has profound socioeconomic implications. According to NITI Aayog, nearly 600 million Indians face high to extreme water stress, with over 200,000 deaths annually attributed to inadequate access to safe water. The crisis also threatens agricultural productivity, public health, and economic stability, potentially leading to a 6% loss in GDP by 2030.

- **Communities across India are increasingly opposing projects that threaten local water sources:** In Punjab, residents from approximately 50 villages have strongly opposed the establishment of a proposed paper mill in an ecologically sensitive area, citing potential pollution risks to nearby water sources. Similarly, environmentalists and leaders in Karnataka have planned protests against projects like the Kalasa Banduri and Mahadayi diversion, emphasizing the ecological importance of the Western Ghats.
- **If these environmental problems continue unaddressed, India faces the risk of:** Acute drinking water shortages in major cities by 2030 (as per NITI Aayog's 2018 report) Health epidemics due to waterborne diseases like cholera, dysentery, and typhoid. Agricultural collapse due to lack of irrigation water, affecting food security Increased inequality, with marginalized communities suffering most from water inaccessibility.

Sustainable Water Management Strategies:

To avert a full-blown crisis, India must adopt an integrated and sustainable approach to water management. Here are some key processes and strategies:

- **Rainwater Harvesting:** Mandatory rooftop rainwater harvesting in urban areas. Use of community tanks and recharge wells in rural regions Revival of traditional water systems (e.g., baolis, johads) Rainwater harvesting helps recharge aquifers and reduces dependence on depleting groundwater.
- **Wastewater Treatment and Reuses:** Invest in decentralized sewage treatment plants (STPs). Promote reuse of treated grey water for gardening, flushing, and industry Encourage zero-liquid-discharge practices in industries. This will reduce pollution and make more water available for human use.
- **Watershed Management:** Forest conservation and afforestation Soil conservation and contour bunding Protection of wetlands and recharge zones. A healthy watershed ensures better rainwater retention and reduces erosion.
- **Smart Agriculture Practices:** Shift from water-intensive crops (like paddy and sugarcane) to millets or pulses in dry zones. Promote drip and sprinkler irrigation to save water Educate farmers on water budgeting and soil moisture monitoring. Efficient farming can reduce the strain on water resources significantly.
- **Urban Water Planning:** Replace leaky pipelines and

improve infrastructure efficiency. Implement water metering and pricing to reduce wastage. Develop city-level water security plans in collaboration with communities urban areas need smart and decentralized water systems that are resilient to climate shocks.

- **Policy and Governance:** Strengthen regulations on industrial and sewage discharge Empower local governments and panchayats for water governance. Implement the “Right to Water” as a basic service, not a commercial commodity. Transparent, accountable governance is the backbone of sustainable water management.
- **Role of technology and Innovation:** Technological solutions can accelerate progress: IoT-based water meters to monitor usage and detect leaks GIS and satellite mapping for groundwater monitoring AI-based climate prediction to guide water storage and distribution Mobile apps for water delivery tracking in rural schemes Smart water tech can bring transparency, efficiency, and inclusiveness in delivery systems.
- **Community Participation:** Sustainability isn't possible without the people: Involve local communities in water budgeting. Encourage school water clubs and youth awareness campaigns promote “catch the rain where it falls” campaigns at household level Water conservation is a shared responsibility that must be rooted in local action.

Recent developments in India's water management efforts

- **Revival of Traditional Water Bodies:** In Tamil Nadu's Thirukazhukundram, the government has initiated a ₹5.62 crore project to restore seven neglected ponds. This effort aims to enhance water retention and environmental sustainability, benefiting over 8,300 households that rely on these sources for daily water needs.
- **Addressing Inter-State Water Disputes:** Haryana has intensified measures to prevent illegal water extraction from canals, particularly in regions with high water-demand farming like paddy and maize. A Special Task Force has been formed to curb unauthorized water use, following disputes over allocations from the Bhakra canal system with Punjab.
- **Urban Water Supply Enhancements:** Hyderabad has experienced improved water inflows due to early monsoon rains, reducing the city's reliance on emergency water tankers. Reservoirs like Nagarjuna Sagar and Srisailem have seen increased water levels, alleviating immediate water supply concerns.
- **Sustainable Agricultural Practices:** Farmers in Chandigarh are adopting the Seeding of Rice on Beds (SRB) method, a water efficient technique that complements the government-promoted Direct Seeding of Rice (DSR). This shift aims to conserve underground water resources while maintaining crop productivity.
- **Infrastructure Development in Odisha:** In Keonjhar district, Odisha, the Principal Secretary of Housing and Urban Development conducted an inspection of urban infrastructure, focusing on resolving chronic waterlogging and inadequate drainage issues. The review emphasized the urgency of addressing these problems ahead of the monsoon season.

- **Promotion of Eco-Friendly Irrigation:** Uttar Pradesh is modernizing and reconstructing 1,750 tubewells across the state to boost farmers' income through eco-friendly initiatives. The project aims to increase irrigation capacity by 1.75 lakh hectares and promote sustainable farming practices. Flood Control Measures in Maharashtra.

Maharashtra has approved a ₹963 crore project under the Maharashtra Resilient Development Programme (MRDP) to implement flood control measures in the Krishna-Bhima river basins, particularly in Kolhapur and Sangli. The project includes enhancing municipal drainage systems and desilting rivers to mitigate flood risks.

Conclusion

However, this crisis also presents an opportunity for transformative change. Through sustainable water management practices such as rainwater harvesting, wastewater recycling, watershed development, efficient irrigation, and strong community participations, India can build a water-secure future. Policies must be backed by robust governance, local empowerment, and technological innovation. Equally important is a societal shift toward water conservation as a collective responsibility. Ensuring equitable, sustainable access to drinking water will not only protect public health but also strengthen the resilience of India's economy and environment for generations to come. In short, the path to water sustainability is clear. The time to act is now. The water crisis in India is a complex and multifaceted challenge that requires a holistic approach combining policy reforms, technological innovations, and community engagement. While the government has introduced several ambitious programs to address water scarcity, their success hinges on effective implementation, coordination, and long-term planning.

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