A Study on Understanding Water Pollution from Bangalore's Perspective and Exploring Effective Water Management Systems in the Indian Context

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Abstract: **Water is considered to be an essential resource necessary for life on Earth. It is crucial for human health, agriculture, industry, and the upkeep of ecosystems. Unfortunately, the quality of water sources is increasingly jeopardised by pollution, presenting a significant challenge. There have been many attempts to study water pollution because it is a social issue that has prevailed for years and is still a part of the bigger problem for India. India is considered to be a rapidly developing nation. The country is home to some of the world's most polluted rivers, such as the Ganges and Yamuna, and many of its urban centers are grappling with severe water pollution issues. With over 600 million people in India experiencing high to extreme water stress. Water pollution has been a pressing issue for India for ages, for which the country has taken multiple initiatives. But, despite constant efforts, the issue still prevails and is still a part of the bigger issue. This paper, therefore, delves into the water management system of India and how it can be made more efficient such that it is no longer an issue for the developing nation.**

Keywords **– efficient, jeopardised, prevailed, grappling, water stress, contamination**

INTRODUCTION

The Central Pollution Control Board (CPCB) of India reports that more than 275 river stretches across the country are polluted due to untreated sewage and industrial effluents. According to NITI Aayog, 70% of India's freshwater sources are contaminated. Nearly 40 million litres of wastewater enter India's rivers and other water bodies each day, and only a small percentage is treated. According to NITI Aayog's 2018 Composite Water Management Index report, India ranks 120 out of 122 countries on the Water Quality Index. These numbers convey to us how important it is for us to have an efficient water management system.

In this paper, we have tried to understand the issue of water pollution and water management system from the perspective of developed cities such that we can curate efficient strategies to solve the issue. A well-planned city like Bangalore, often referred to as Silicon Valley, has fallen prey to many alarming climatic situations, with water pollution and severe water shortages being some of the common ones. Bangalore, in the last decade, has seen massive urbanisation and growth, which has led to an increased population. This sudden increase without proper infrastructure planning and development has led to the overexploitation of natural resources, mainly water. Studies have shown that over 70% of the city's water bodies, including lakes and rivers, are severely contaminated with pollutants such as sewage and industrial waste. This raises the issue of water pollution and how sources of clean water are being contaminated. Bangalore, which was once home to over 400 lakes and often termed the 'Garden City, has seen many of its water bodies disappear or degrade due to pollution. All the little remaining lakes and rivers suffer from high levels of contamination, mainly because of untreated sewage discharge.

While Bangalore faces severe water crises and shortages, a contrasting situation is seen in the monsoon season, where the city faces extreme flooding of the roads. Bangalore which is known as IT Hub, has also been termed as Mini Venice as it faces flood-like situations. Bangalore has been reeling under incessant rains every monsoon bringing several residential areas and roads under knee-deep water. One common reason for waterlogging is the increase of impervious surfaces, such as concrete roads and pavements. These surfaces do not allow water to percolate into the ground, leading to higher surface runoff during rains. This rapid runoff overwhelms the drainage system, contributing to waterlogging. The reduction in green cover and loss of open spaces contribute to the problem. A combination of urbanization and poor drainage infrastructure leads to waterlogging in the city.

Every year, the residents of Bangalore see two vast scenarios. The excessively hot summers lead to a severe water crisis where residents are forced to buy water tankers at shot-up prices. And during the monsoon season, heavy rains mean clogged roads and knee-deep water. Developed IT hubs such as Manyata Tech Park are also victims of such severe rain. These extreme situations point to the inefficient infrastructure and management in the city, also known as the IT hub. The Silicon city sees itself in a vicious cycle, where every summer the city faces extreme water shortages, while monsoon brings water-logged streets. Thus, through this paper, we have tried to understand how cities can come out of this deadlock such that a strategized framework is set for an efficient water management system.

Other major Indian cities and states with large populations also face severe water management issues. Maharashtra has battled drought, with dam levels at 41%. More than 70% of Maharashtra's talukas faced a severe drought. In 2022, Maharashtra had the highest number of polluted rivers stretches in India, with 55 polluted stretches. A Central Pollution Control Board (CPCB) study found that these stretches had high levels of Bio-Chemical Oxygen Demand (BOD). West Bengal, on the other hand, is contaminated with alarmingly high concentrations of iron. Along with iron, sporadic occurrences of nitrate, TDS, and hardness issues were also detected. Some common reasons include groundwater contamination, surface water pollution, human waste contamination, etc.

Even though some of the large cities in India have maintained their local water bodies that supply potable water, none of them are in a safe zone keeping in mind the ever rising population. New patterns of governance have to be found to ensure that water conservation and abetment to pollution help in the water governance of the large cities of the country.

By embracing initiatives such as rainwater harvesting, greywater reuse, etc. India can chart a course towards water security and resilience. However, the journey towards sustainable water management cannot be achieved without proactive governance, public engagement, and continuous investment in infrastructure and conservation efforts.

REVIEW OF LITERATURE

1. Water pollution in India – Current scenario (Niti B. Jadeja, Tuhin Banerji, Atya Kapley 2022) - Water scarcity in India is driven by factors such as rapid population growth, intensive agricultural practices, climate change, and pollution, leading to the discharge of untreated wastewater. While wastewater treatment technologies have advanced, challenges such as inadequate infrastructure, insufficient funding, and low public awareness hinder effective implementation. Additionally, groundwater depletion and contamination pose significant risks to both human health and ecosystems. Past urban planning initiatives, including the Jawaharlal Nehru National Urban Renewal Mission, have influenced current water management strategies. Addressing these challenges requires coordinated efforts between public and private stakeholders. This review highlights the importance of enhancing wastewater treatment, improving groundwater management, and refining policies to establish a sustainable and climate-resilient water management framework in India.

2. Water quality in Sustainable Water Management (Sudhakar M. Rao and P. Mamatha 2004) - Water pollution in India is a critical issue, with approximately 70% of surface water and increasing groundwater reserves contaminated by various pollutants. Pollution stems from both point sources, such as industrial effluents and sewage treatment plants, and diffuse sources, including agricultural runoff and natural contaminants like fluoride and arsenic. To address fluoride contamination, the Centre for Sustainable Technologies at the Indian Institute of Science (IISc) is developing a treatment method utilizing magnesium oxide. This innovative approach involves precipitation, sedimentation, and filtration, effectively catering to diverse groundwater chemistry conditions and aiming to provide safe drinking water, particularly for the rural population reliant on untreated sources.

3. Limnological analysis of an urban polluted lake in Bangalore city in India (Nihar R. Samal, Papita Saha, Pankaj K. Roy, Malabika Biswasroy, R. Venkat Ramana, Asis Mazumdar 2024) - Bangalore's lakes are rapidly vanishing, and those that remain, such as the 130-year-old Bellandur Lake, are experiencing severe environmental degradation. A year-long limnological study found the lake to be highly eutrophic, with low dissolved oxygen (DO)

levels and high concentrations of biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrates, phosphates, and heavy metals. The excessive discharge of sewage and industrial effluents has made the water unfit for drinking, bathing, or supporting aquatic life. Pollution levels were evaluated using the water quality index (WQI) method and multivariate analysis, emphasizing the lake's critically deteriorated state.

4. Addressing water stress through wastewater reuse: Complexities and challenges in Bangalore, India (Jamwal, P.; Thomas, B. K.; Lele, S.; Srinivasan, V. 2014) - Wastewater reuse is an essential approach to mitigating water stress in urban areas, but it presents considerable challenges in developing countries like India. In Bangalore, the Vrishabhavathy River receives nearly half of the city's wastewater, highlighting these issues. The sewage treatment plant along the river operates inefficiently, failing to improve water quality. While large-scale centralized treatment projects are in development, decentralized systems may provide more cost-effective solutions. However, both approaches encounter institutional barriers. Additionally, untreated wastewater poses health risks for downstream farmers, while upstream recycling could reduce irrigation water availability, complicating inter-state water sharing with the Cauvery River. Addressing these challenges requires an integrated techno-institutional approach at the basin level.

5. Putting the Citizen at the Heart of Water Management: A Study of Water in Bangalore (Bijani, Yasmin 2012) - This thesis explores how citizens in Bangalore, India, are addressing water management challenges through rainwater harvesting amid a severe water shortage of 500 million litres per day. Without significant changes, the city will face acute shortages by 2025. Effective management requires institutional restructuring, strong groundwater protection legislation, infrastructure improvements, and greater integration of science in planning. While these actions face numerous challenges, civil society has successfully advocated for mandatory rainwater harvesting through the Bangalore Water Supply and Sewerage (Amendment) Act, 2009. The thesis applies the scarcity-induced innovation framework to highlight rainwater harvesting as a citizen-engaged solution, emphasizing the need for a robust state role in regulation and implementation.

6. Awareness and participation towards encouraging sustainable urban water management: A case study of the Jakkur Lake, Bangalore (Baradwaj, Aajwanthi 2014) - This master's thesis examines how design interventions can enhance public participation in sustainable urban water management by raising community awareness. Using Jakkur Lake in Bangalore as a case study, it highlights the lake's role as a model for Integrated Urban Water Management (IUWM) through a sewage treatment plant that transforms raw sewage into potable water, benefiting local communities. The study employs ethnographic and design research methods to understand stakeholder interactions, revealing the complexity of their roles. It proposes an 'experiential' audio-visual walk to educate and engage residents, encouraging awareness of the lake's ecosystem and fostering community involvement in water management.

7. Urbanization and Water Supply: An Analysis of Unreliable Water Supply in Bangalore City, India (Raj, Urbanization and Water Supply: An Analysis of Unreliable Water Supply in Bangalore City, India , 2015) - The demand for urban water supply in India is rapidly increasing due to globalization, economic development, and demographic growth, particularly in cities like Bangalore. However, urban local bodies face significant budgetary constraints that hinder their ability to provide reliable and safe water, impeding progress toward the United Nations' Millennium Development Goals for sustainable drinking water access. Challenges include water scarcity, low pricing, high subsidies, poor cost recovery, and significant transmission losses due to inadequate maintenance. The Bangalore Water Supply and Sewerage Board (BWSSB) struggles with financial sustainability and performance gaps, further complicating the city's growing water supply needs.

8. Integrated Wetlands Ecosystem: Sustainable Model to Mitigate Water Crisis in Bangalore (T V Ramachandra D. M., 2014) - Urbanization in Bangalore has led to significant land cover changes and increased population density, resulting in severe environmental issues such as pollution, inadequate infrastructure, and water scarcity. Unplanned growth has caused untreated sewage to flow into water bodies, contaminating surface and groundwater sources. Currently, the Cauvery River supplies only 55% of the water for over 9 million residents, with the remainder drawn from rapidly depleting

groundwater. This study explores the feasibility of an integrated wetlands ecosystem for water reuse, including a sewage treatment plant and constructed wetlands, which has shown promising results at Jakkur, effectively removing contaminants and nutrients from wastewater.

9. Water situation in Bengaluru (T V Ramachandra, Durga Madhab Mahapatra, Sudarshan P. Bhat, Asulabha K S, Sincy Varghese, Bharath H. Aithal 2016) - This study examined Bengaluru's water availability for domestic needs, finding that while sufficient resources exist, ineffective management by local authorities has hindered sustainable usage. The report underscores the importance of water conservation through lake rejuvenation, interconnectivity, and decentralized rainwater harvesting and sewage treatment. Achieving sustainable water management requires strong political commitment, a departure from outdated bureaucratic practices, and proactive citizen involvement in demanding equitable access to clean and sufficient water.

10. Nitrogen pool, flows, impact, and sustainability issues of human waste management in the city of Bangalore (H. N. Chanakya and H. C. Sharatchandra 2008) - This study explores human and animal waste management in Bangalore, identifying four main treatment methods: underground sewage systems, decentralized soak pits and septic tanks, open defecation, and limited composting. Nitrogen (N) release levels are estimated between 0.44 and 1.4 tons per hectare of urban land, with human waste being the largest nitrogen source and sewage outflow the main efflux. A key concern is groundwater contamination by coliforms and nitrate nitrogen, often exceeding safe limits. The research underscores the need for alternatives to soak pits and improved nutrient recovery and reuse strategies to enhance sustainable waste management.

11. Macrophyte diversity in relation to the water quality of Bangalore lakes (Bhat, Sudarshan P., and T. V. Ramachandra 2014) - This study explores how macrophyte diversity is influenced by water quality in Bangalore's lakes. It finds that as water quality worsens, the diversity of aquatic plants diminishes, making macrophytes reliable indicators of lake health. The research underscores the importance of preserving macrophyte populations for the sustainable management of these water bodies. It recommends regular monitoring of macrophyte diversity to detect pollution and suggests that conserving these plants can help maintain ecological balance in urban lakes under stress from pollution and urbanization.

12. Review of Traditional Systems of Water Management in the Bengaluru Region for Clues to Mitigate Present-Day Urban Flooding (Kollarath, Reshmi Manikoth 2024) - This research reviews historical water management practices in Bengaluru to provide insights into tackling modern urban flooding. The study emphasizes the relevance of traditional methods, such as rainwater harvesting and tank systems, in addressing contemporary water issues. It argues that integrating these age-old techniques with modern infrastructure can help mitigate urban flooding, enhance water retention, and promote groundwater recharge. The findings suggest that blending traditional and modern approaches could improve flood management and ecological sustainability.

13. Predicting the parameters of water quality and calculating the water quality index of Ulsoor Lake, Bangalore, India using deep learning techniques (Prathibha, K. S., et al. 2022) - This research applies deep learning models to predict water quality parameters and calculate the Water Quality Index (WQI) for Ulsoor Lake, Bangalore. The study shows that artificial intelligence tools can improve water quality monitoring by providing more accurate predictions than conventional methods. The authors advocate for the use of AI for real-time water quality assessments to enhance the management of lake ecosystems, suggesting that machine learning could lead to more efficient responses to water quality issues.

14. Restoration of Tanks in Bangalore Metropolitan Area: Issues and Guidelines (Prasad, S. Gopi, and B. Shankar 2008) - This paper discusses the challenges associated with restoring water tanks in Bangalore, which have historically served as essential water sources. It highlights the deterioration of these tanks due to neglect and urbanization and proposes guidelines for their rehabilitation. The authors suggest that community involvement, technological improvements, and government support are key to restoring these water bodies, which could help alleviate water scarcity and improve urban water quality management.

15. On Water and Soil Quality Aspects of Catchment and Command Areas Of Irrigation Tanks In Anekal Taluk, Bangalore Urban District, Karnataka, India (Chandrashekar, H., et al. 2013) - This study examines the impact of agricultural runoff and waste disposal on water and soil quality in the catchment areas of irrigation tanks in Anekal Taluk, Bangalore. It identifies significant contamination from pesticides and fertilizers. The authors propose eco-friendly farming practices, better waste disposal systems, and regular monitoring to mitigate environmental damage. They advocate for coordinated efforts between local farmers, government bodies, and environmental organizations to restore and maintain the ecological health of the region's water and soil.

16. Evolution of Bangalore city's water tank system (Samana S, Fathima 2011) - This paper traces the history of Bangalore's water tank system, which was once crucial for managing the city's water supply. It details how urbanization has led to the neglect and deterioration of these tanks, reducing their effectiveness. The author advocates for the restoration of these tanks, arguing that they could help manage water scarcity, control flooding, and improve urban water quality. The paper suggests integrating traditional water management systems with modern technologies to enhance their functionality in today's urban context.

17. Ecological Status and Conservation Strategies of Lakes Case Study on Bangalore South (Nandini, N., et al.) - This study assesses the ecological status of lakes in Bangalore South and recommends conservation strategies for their restoration. The research reveals that urban pollution, primarily from industrial and domestic waste, has severely affected lake ecosystems. The authors propose a combination of pollution control measures, biodiversity conservation, and public involvement in protecting and restoring these water bodies. They argue that raising public awareness and enforcing environmental regulations are crucial to ensuring the long-term sustainability of urban lakes.

18. Case Study on effects of Solid waste management by landfill sites in Bangalore (Prashanth, N., et al. 2020) - This case study evaluates the environmental impact of solid waste management at landfill sites in Bangalore, particularly on water quality. It finds that the mismanagement of landfill sites is causing groundwater contamination and broader environmental degradation. The authors suggest adopting better waste segregation practices and recycling programs and enforcing stricter regulations on landfill operations. These steps are necessary to minimize pollution and protect urban water resources from the harmful effects of poor waste management.

19. The Transition from Water Scarcity to Water Pollution in Thippagondanahalli Halli Catchment (Srinivasan, V. & Ramaswamy, I. 2016) - This paper chronicles the transition from water scarcity to water pollution in the Thippagondanahalli Halli catchment of India. It postulates and discusses the historical systems of water management that have been developed, the failure strategies that underlie these systems, and the reasons why water pollution has become an intense issue at this location with increasing urbanization and industrial activities in this region. The authors again emphasize the need for improving land and water resource practices to avert further degradation of the environment in this critical watershed.

20. The Impact of Urbanization on Groundwater Resources (Reddy, M. S., & Prakash, A. 2012) - A Study on High Environmental Challenges This research work focuses on how urbanization has ruined groundwater resources, which caused major environmental challenges. Problems such as the problem of over-extraction, pollution, and falling water tables presented by unplanned urban sprawl are discussed. Better urban planning, technology to monitor water level at the site, and sustainable means for balancing urban water supply with environmental protection measures are discussed as a means of improving groundwater management.

Research Design

Research design is the overall strategy for integrating various components of a study logically, ensuring that the problem statement is addressed. In this paper, we have used a descriptive research approach where we have tried to understand the primary reasons for ineffective water management systems across India. For the research we have used a mixed approach of primary and secondary data. We have collected primary data from a survey of a sample population across India. Our secondary data is collected from studying various other research papers, journals, and articles.

Objective of the Study

The objective of our study is to understand the key reasons for water pollution in major metro cities in India and the common reasons for ineffective water management systems.

- To learn the initiatives that people and the government take and if they help in reducing water pollution and severe water crises.
- To understand why, despite continuous efforts over decades, the majority of India still faces water management issues and water shortages almost every summer.
- To analyse how India can come out of the vicious cycle of water shortages in summer and waterlogging during the monsoon season.

This paper will help us bring a balance between the two extreme situations that would help us frame strategies for a better water management system.

METHODOLOGY

We have collected primary data using a survey from a sample population to gain a general public opinion about the issue of water pollution and its management systems. We have collected a total of 145 responses from the general public. Apart from primary data, we have also used secondary data by studying various research papers, journals, and articles where authors have discussed the issue of water pollution and its possible solutions.

We have used a purposive sampling method where we have chosen our participants intentionally based on their geographical locations, age, profession, and other demographic factors. A sample size of 145 individuals with ages ranging from 12 to 85 years was chosen for conducting the research. Our sample population mainly belong to tier 1 and tier 2 cities that majorly capture the urban population that belongs to varied professional and cultural backgrounds.

Scope of the Study

The scope of our study is limited to 145 respondents belonging to tier 1 and tier 2 cities of India. The paper explores the extent, causes, and impact of water pollution in India, alongside the effectiveness of various water management strategies. The paper only covers issues on water pollution and water management systems in metro cities. The major stakeholders from whose perspective we have conducted the research are the Indian household, industrial units, and government bodies.

Limitations of the Study

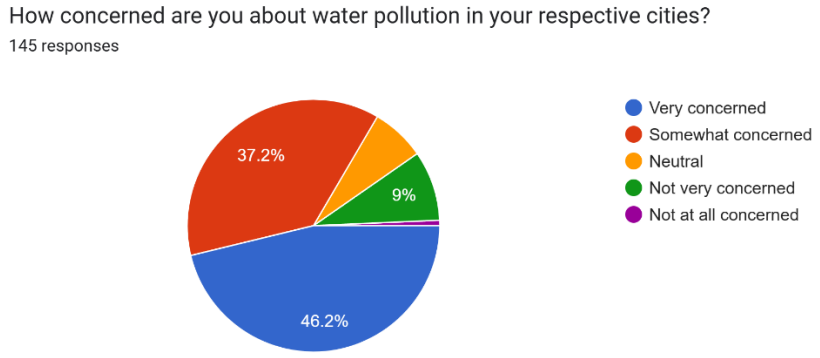
Although we have tried to analyse various aspects and perspectives of water pollution and effective water management systems, there are some limitations of our study which we have not covered in this paper.

- We have solely focused on major metro cities and how water management is a pressing issue, whereas there are many smaller cities that have a much better planned water management system like Assam, Sikkim, etc.
- The study mainly includes initiatives that Indian households and the government take, whereas many large-scale companies have implemented better water management strategies in their local premises that have proven to be beneficial.
- The study could also have included a global perspective of the water crisis and water management system. Many countries like South Africa and Nigeria face severe water crises, which we should have focused on to make the study even more relevant.
- Countries like Singapore, Australia, and the Netherlands have overcome water crises using many of the latest technologies. Our study does not include the recent technological advancements that can potentially reduce water pollution.
- Our study was only limited to water pollution, whereas there are many other water-related issues, like waterlogging during the monsoon season. Our paper does not essentially focus on these issues.

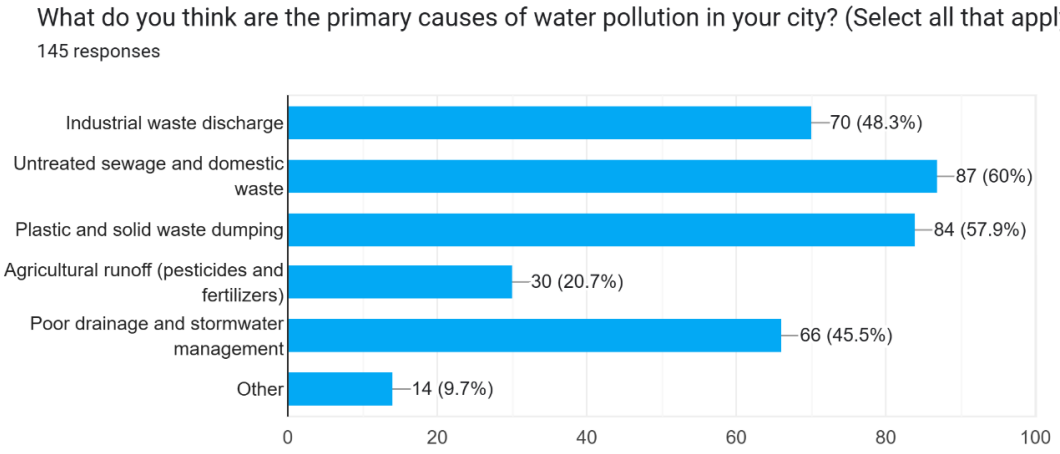
DATA ANALYSIS AND INTERPRETATION

Using primary and secondary data, we have tried to collect and analyse the key factors for water pollution and the strategies that can be implemented for efficient water management strategies. With a mixed approach of descriptive research, sampling, and data analysis, we have tried to evaluate the strategies of water management. We have used the survey sampling and have collected data using a questionnaire with a set of 15 diverse questions mainly about the issue of water pollution, their local water management system, and what steps have been taken to reduce the impact on the social lives of people.

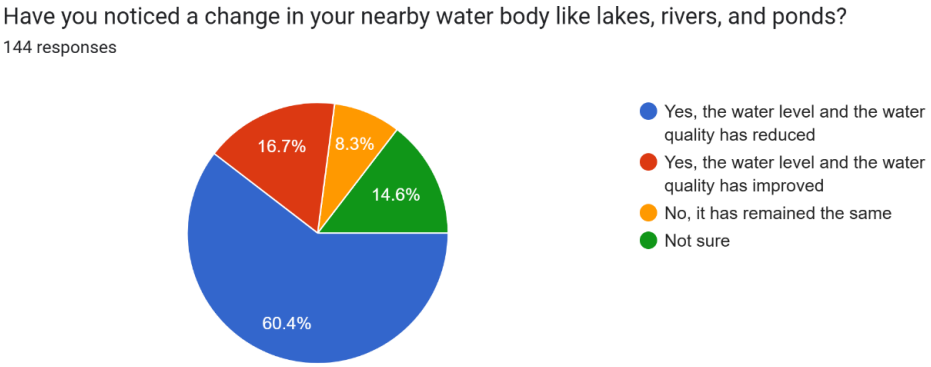
In the next phase of our analysis and interpretation, we analysed the categorical variables of our survey.



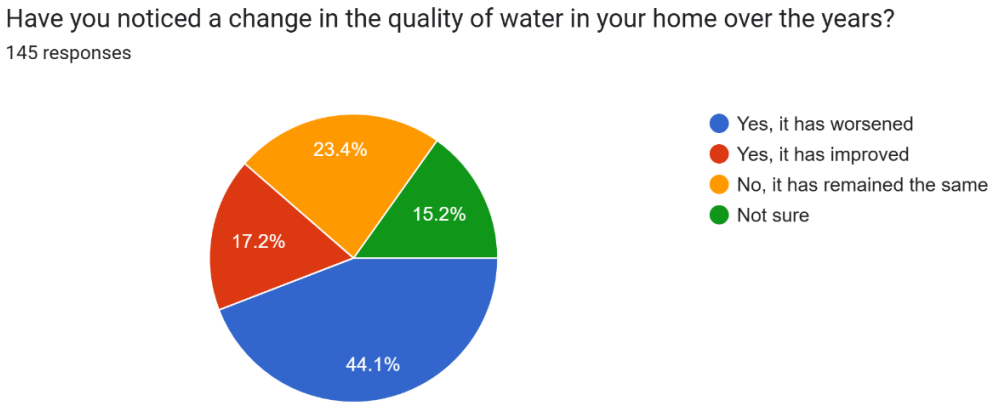
The majority of respondents are either "Very Concerned" or "Somewhat Concerned" about water pollution in their cities, indicating a high level of public awareness and worry regarding the issue. This concern of the general public must be leveraged by the policy makers to implement efficient strategies and also promote the public to openly suggest implementation plans.



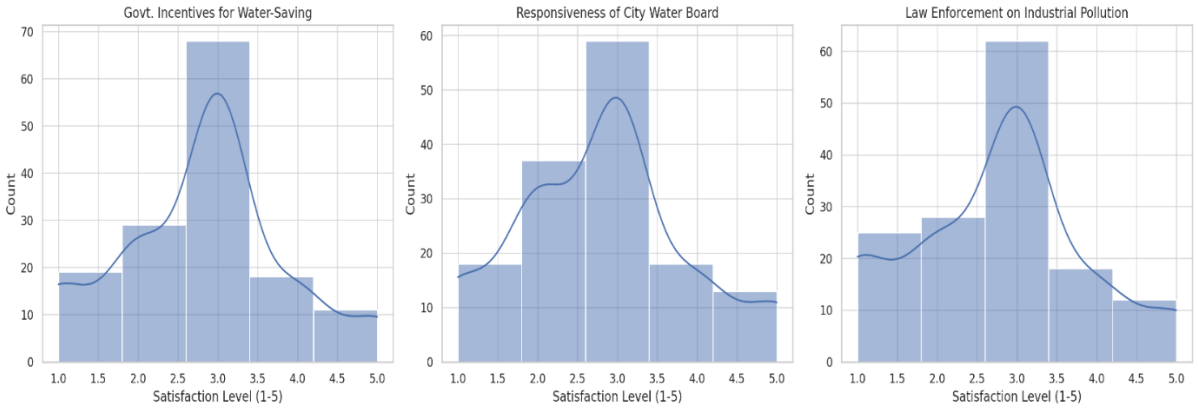
Next, when enquired about the top causes of water pollution, answers like industrial waste discharge, untreated sewage and domestic waste, and plastic and solid waste dumping were the most commonly chosen options. These indicate that respondents perceive poor waste management and industrial pollution as the leading contributors to water pollution. This part of the analysis helped us find out the major source of pollution, which will help us come up with efficient strategies to tackle the issue. We must start from these key aspects to ensure an efficient system is set up to overlook at these stakeholders.



60%, i.e., the majority of respondents, feel that water bodies are deteriorating, which aligns with increasing pollution and depletion concerns. However, 16.7% of the respondents believe that water levels have improved, which suggests some successful interventions, possibly due to local conservation efforts or policies. These policies must be highlighted for continued efficiency.



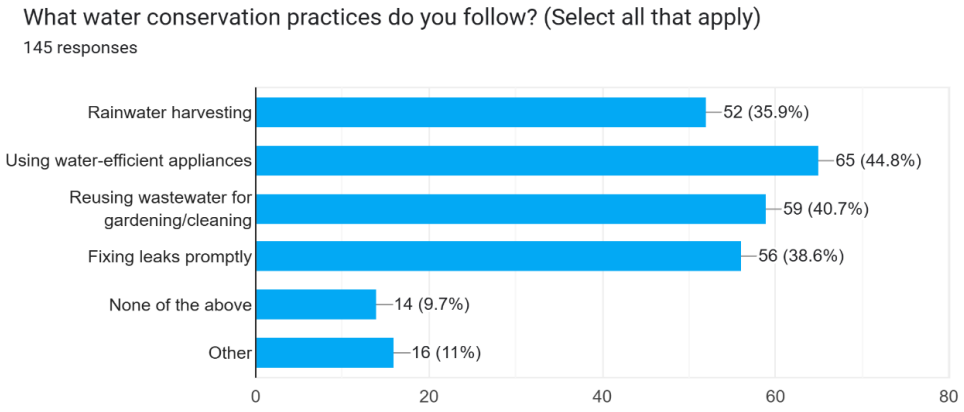
A significant proportion (44.1%) perceives a decline in household water quality, which may be attributed to increased contamination, supply issues, or infrastructure degradation. 17.2% of the respondents have voted that the water quality has improved. This indicates success, potentially due to better treatment facilities or municipal reforms. Although there is a success rate of policies, the positive change is slow, and further policy interventions are urgently required. The public perceives that a positive change has been implemented, just that they have to pick up speed to come out of the water crisis that we are currently facing.



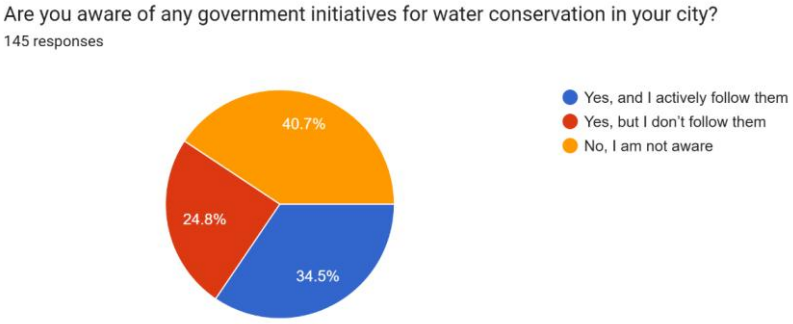
Using descriptive analysis, we have understood the satisfaction levels of the sample population. Regarding the government initiatives on saving water, the population was moderately dissatisfied. They also had a low satisfaction index with the city's water supply boards' responsiveness towards the issue and with the nation's law enforcement of the city against industrial pollution. The above histograms indicate that satisfaction levels for government incentives, city water board responsiveness, and law enforcement against water pollution are mostly on the lower side (centered around 2-3), suggesting widespread dissatisfaction.

With a correlation analysis, we have found that people who are dissatisfied with law enforcement regarding water management also tend to be dissatisfied with the government's incentives and the city water board's responsiveness to the same issue. With this, we can conclude that a common loophole has been highlighted in the initiatives of the local and government authorities of various cities.

While we conducted another correlation analysis between the satisfaction levels and the age of the sample population, we found no significant correlation, which suggests that dissatisfaction is not limited to a particular age group.

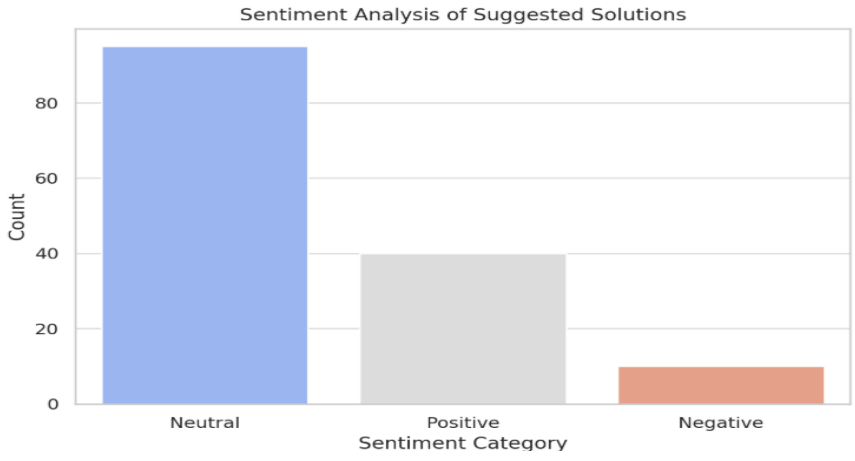


The most common water conservation practices followed in households are rainwater harvesting, using water-efficient appliances, and reusing wastewater for gardening. However, a notable number of respondents do not actively follow any conservation measures, highlighting a potential gap between awareness and action. This is an important point to be made a note of as government authorities must start from creating more awareness among Indian households. Bridging this gap in Indian households is important for the initiatives to become more efficient and relevant.



A significant portion of respondents are not aware of any government initiatives for water conservation. On the other hand, some respondents are aware but do not follow them, indicating a gap in public awareness and engagement. It is important to note that only a small fraction of the public actively follows these initiatives. This suggests that the government must invest highly in better outreach and awareness campaigns are needed to improve public participation in conservation programs.

Using a word cloud analysis, we have made a note of the most frequently suggested solutions. They include strict law enforcement & penalties, regular lake and river cleaning programs, increased public awareness and community participation, better wastewater management and recycling systems.



While conducting a sentiment analysis, we found out that the majority (95) of responses were factual or descriptive, without strong emotion, while there were some positive responses (40) as well that were optimistic suggestions like community participation and innovation in water management. A small portion were negative responses (10) that indicated frustration towards government inaction or worsening pollution levels. This indicates that while some respondents see hope in solutions, many are either indifferent or skeptical.

Cities like Mumbai and Chennai reported the lowest satisfaction levels regarding water board responsiveness and enforcement of laws. Second came Bengaluru where the overall satisfaction with government efforts is low. Cities like Pune and Kolkata showed higher satisfaction levels compared to other cities. A key takeaway is that larger metropolitan areas (Mumbai, Bangalore, Chennai) report lower satisfaction, possibly due to higher pollution levels and bureaucratic inefficiencies.

The last leg of our analysis is from a Cross-tabulation analysis where we found out that people who are aware of government initiatives are more likely to adopt conservation practices. 16% of aware and active respondents practice rainwater harvesting, compared to only 5% of unaware respondents. While 14% of aware respondents use water-efficient appliances, while only 5% of unaware respondents do. This suggests that awareness alone is not enough; government programs must also focus on motivating the general public.

FINDINGS OF THE STUDY

From the primary data and secondary data that was collected and analysed, the following are a couple of key notable findings that were highlighted.

- Although there are many reasons for water pollution, there are some commonly identified reasons. 60% of the respondents believed untreated sewage to be a reason, whereas 48.3% of the respondents said industrial waste discharge is the primary reason. 57.9% voted for untreated domestic waste and plastic and solid waste dumping.
- 60% of the respondents feel that water bodies are deteriorating, which aligns with increasing pollution and depletion concerns. 44.1% of the respondents have reported a decline in the water quality that is available for consumption.
- People who are dissatisfied with law enforcement regarding water management also tend to be dissatisfied with the government's incentives and the city water board's responsiveness to the same issue. This highlights a common loophole, i.e. lack of effective government initiatives.
- A significant number of respondents i.e. 40.7% are not really aware of the government initiatives for water conservation where as 24.8% of them do not actively follow any conservation measures. This typically highlights a potential gap between public awareness and action.
- The majority of responses were without a strong emotion, while some positive responses were optimistic about the government's participation. A small portion were also negative responses that indicated frustration towards government inaction or worsening pollution levels.
- People who are aware of government initiatives are more likely to adopt water conservation practices. 16% of aware and active respondents practiced rainwater harvesting, compared to only 5% of unaware respondents. 14% of aware respondents use water-efficient appliances, while only 5% of unaware respondents do.
- Major metro cities like Mumbai, Chennai, and Bangalore have reported a much lower satisfaction level compared to other cities like Pune and Kolkata in terms of government initiatives.

SUGGESTIONS AND RECOMMENDATIONS

- The government must invest highly in better outreach and awareness campaigns that would be aimed at improving public participation in water conservation programs.
- The policy makers include strict law enforcement & penalties, regular lake and river cleaning programs, and better wastewater management and recycling systems.
- Regulatory boards must ensure to keep a close eye on and conduct regular checks on industries regarding their waste disposal systems. Transparent reporting and communication must be followed by all the parties to have a clear understanding of the issue.
- Provide recognitions and incentives to industries that follow the regulations set by the local government authorities.

- Central and state governments must come together and invest sufficiently in initiatives and also conduct regular water-cleaning missions. The central government must also recognise and reward states that take the most number of successful initiatives.
- Local bodies and governments must also tie up with well-established companies and MNCs for taking effective water management steps in their company and industry limits.

CONCLUSION

Efficient water management systems are crucial for addressing the growing challenges of water scarcity, pollution, climate change, and inequitable access to water. While technological advancements and innovative approaches offer promising solutions, significant gaps remain in the implementation and governance of these systems. Addressing these challenges requires a coordinated effort from governments, the private sector, and civil society to improve water infrastructure, enforce regulatory frameworks, promote sustainable water use, and ensure that water management systems are resilient to future environmental and social pressures.

As the global community confronts growing challenges related to water pollution, a holistic and multifaceted approach to mitigation is essential. Technological advancements, effective policies, community involvement, and integrated management systems present promising pathways for improving water quality and sustainability. By prioritizing access to clean water, safeguarding ecosystems, and fostering responsible practices, we can work towards a healthier planet for future generations. The collaborative efforts of governments, industries, communities, and individuals will be crucial in shaping the future of water management and ensuring the availability of this vital resource for all.

The issue of water pollution in the Indian context is a multifaceted problem requiring a comprehensive and integrated approach. Effective water management in the city hinges on government action, corporate responsibility, and public participation. Through the combination of sewage treatment, lake rejuvenation, rainwater harvesting, water recycling, and public awareness, India can take significant steps toward safeguarding its water resources for future generations. However, sustained effort and innovative strategies are required to ensure long-term water security and pollution control in the face of continued urban growth.

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