



RESEARCH ARTICLE

ISSUES AND CHALLENGES FOR WATER MANAGEMENT IN URBAN INDIA

Faraz Ali¹ and Sharmin Khan²

¹M. Plan (3 Sem.), Department of Architecture, ZHCET, AMU, Aligarh, India

²Professor, Department of Architecture, ZHCET, AMU, Aligarh, India

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*Corresponding author:

Faraz Ali

ABSTRACT

The most valuable and widely available resource on the planet Earth is water. However, fresh water, which is required for drinking, irrigation, and other uses, is extremely limited and is running out very quickly. Given the importance of this resource, its effective management and conservation are of utmost importance because its disappearance could have disastrous effects. This paper aims to understand the current issues and challenges related to water management in India, with the help of available literature. The paper identifies water availability and accountability, demand and supply, infrastructure management, fast rate of ground water deterioration, unforeseen droughts and floods, waste water management, the growth in urbanization, poor sanitation, and pollution as some of the major issues related to water management in India. The major challenges related to water management in India have been identified as conservation strategic planning, availability of scientific database and estimates of consumption, emphasis on rainwater harvesting systems, and lack of regulatory frameworks etc. The paper also presents a brief of possible solutions, for enhancing the management of water resources in India.

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INTRODUCTION

India is home to 1.2 billion people (GOI G. o., 2011) but it has only 4% of the world's water resources despite having 16% of the world's population (GoI, 2017). India has made great strides in the development of its water resources and associated infrastructure, but due to the country's rapid industrial and agricultural growth, population expansion, and unequal water distribution, the demand now exceeded the supply. Consequently, it is difficult to manage demand across all market groups (Cronin, 2014). Water is the basic necessity for survival, and it may be argued that water is the source of life because it makes up to 60% of the human body. No aspect of human activity is complete without water. The world is currently arguing whether information flow or energy flow is more crucial that sounds to be a valid query. However, water flow continues to be most significant. It is essential to human equity, the environment, and both the economy and ecology. The issue of water is becoming even more urgent in light of climate change and related environmental problems. Some of India's most prestigious programmes are focussed on issues related to water and India's modernization may be heavily reliant on improving its water management. Indian agriculture and industry are facing problems related to efficient use of water (Kumar C. P., 2018). Although the right to clean, inexpensive water is one of the core human rights guaranteed by international human rights law, it is not explicitly recognised in the Indian Constitution for personal or domestic usage. Freshwater is a limited resource and a fundamental need for human life. Food production is largely dependent on water levels at the farm and industrial levels, and water is commonly used for residential, agricultural, and industrial purposes.

Agriculture faces highest demand on fresh water resources as 70% of developed water supplies are utilised for irrigation purpose. Approximately 300 to 3000 litres of water are required to generate one kilogramme of food grain (Panwar & Antil, 2015). India's water demand has dramatically expanded over the past few decades due to a combination of factors, including an expansion in population, particularly in urban areas. This raised demand for household water supplies and food production; industrial growth; which consequently increased demand for production uses and exacerbated pollution in recent decades. In order to fulfil demand, supplies have greatly expanded by utilising both surface and groundwater. As a result, many arid and semiarid regions experience misuse of their groundwater resources, which results in considerable water level drops, poor groundwater quality, and considerable reduction in the availability of high-quality groundwater. Surface water supplies are being abused in a number of basins. Freshwater sources are increasingly in danger due to industrial effluents and urban garbage contamination (Kumar & Ballabh, 2000). The World Bank claims that water resources management aims to maximise the benefits of water by ensuring that there is enough water of sufficient quality for drinking purpose, sanitation services, food production, energy generation, inland water transport, water-based recreation, sustaining healthy water-dependent ecosystems, and safeguarding the aesthetic and spiritual values of lakes, rivers, and estuaries. (aquatechtrade-news, 2019).

NEED FOR WATER MANAGEMENT

The 7.6 billion people that inhabit the planet Earth require more fresh water than is currently available, especially during the summer season.

According to NASA satellite data, the world's water reserves are under severe stress in many places. By 2030, there will be a 40% gap between water availability and demand worldwide, according to a World Bank estimate. This is primarily attributable to the fact that in the last 100 years, the demand for water has increased globally by 600%. Additionally, catastrophic weather (such as floods and droughts) and chronic water scarcity are seen as some of the largest dangers to world peace and prosperity. Water resource management planning will guarantee its growth, proper distribution, best use, and sustainability in the future. The management of water resources becomes even more crucial in locations where water availability is either excessive (prone to flooding) or insufficient (prone to drought). Furthermore, the problem has become worse due to the shifting environment. Along with quantity, water quality must also be taken into consideration. The natural system has been severely disrupted as a result of the enormous economic advancements, and water is by far the resource that has been overused the most. Due to this, the water's quality has drastically declined, and in many locations, the water is now unfit for human consumption. Water is a major factor behind agriculture in an agrarian nation like India and directly affects its production and sustainability. However, uncontrolled exploitation and a lack of replenishment have dramatically reduced groundwater supplies and lowered its quality. Climate change has made the issue worse by causing unpredictable and heavy rainfall. This results in the loss of valuable freshwater into the ocean, along with a lack of runoff storage capacity. Additionally, there is a severe shortage of infrastructure in communities for the safe disposal of sewage, which contributes to contamination of water sources. Water pollution is a significant issue that raises issues with hygiene and health (Foundation, n.d.).

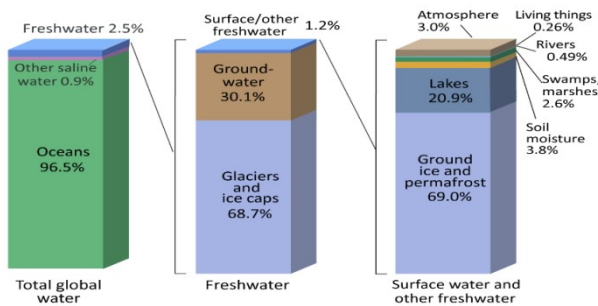


Figure 1. The percentage of Earth water availability (Shikdmanov, 1993)

LITERATURE REVIEW

An exhaustive literature review was conducted through available secondary sources to identify the issues and challenges in the present scenario, in urban India. The papers focussed on discussion related to the issues and challenges faced in the domain under study were shortlisted after review, as presented in Table 2. The selected papers were thoroughly examined and summarised as follows;

Issues related to water management: Only 1% of the entire amount of water is suitable for human consumption. The majority of Indian cities rely on underground water to supply their water needs. The water table is rapidly declining in all cities with pumping stations nearby. Chennai has a severe drought in 2005, and a significant. To meet their metropolitan area water needs, subsurface water is drained, causing the water table to drop by 8 to 10 metres. For example, Haryana's water table along the Yamuna River is rapidly declining as a result of extensive use in agriculture and supply for urban areas. The reduction in ground water table has been seen for the pumping location on seasonal and perennial rivers. Such instances abound both in Punjab and throughout India. Impervious surfaces or surfaces with a very high runoff coefficient define cities, the "concrete jungle." As a result, water that should fall as rain and soak into the earth is likewise rapidly evaporated, further depleting the water supply. Rainfall availability is declining as a result of climate fluctuation, and rainfall patterns are

changing (Panwar & Antil, 2015). The majority of urban expansion in India is anticipated to occur in small and medium-sized towns. With rising demand and limited ability to handle such services, such communities do not generate enough cash to maintain the rate of infrastructure development. It is particularly likely to occur in unplanned peri-urban areas with slow infrastructure development (Norstrom, 2009).

Table 1. Water supply in India in comparison to other world countries (Panwar & Antil, 2015)

Percentage of total population connected with households' connection and stand posts		
1.	India	64
2.	China	91
3.	South Africa	86
4.	Brazil	80
Comparison of Duration of water supply		
1.	India	1-6
2.	Brazil	24
3.	China	22
4.	Vietnam	22
Per capita water supply litre per capita per day (lpcd)		
1.	India	37-298 lpcd (limited period)
2.	Mexico	150 lpcd continuously
3.	Paris	171 lpcd continuously

There is little doubt that increased human activity is causing the earth system to shift extremely quickly. It is widely acknowledged that these alterations have caused changes in the natural cycles to occur on a worldwide scale and it is obvious that these changes will have a significant impact on the urban water cycle and their management. Water supply, wastewater treatment, urban drainage, and other elements of the urban water cycle are often planned with a lifespan of several decades. Therefore, it is important for us to consider these developments in light of how these systems will be created and run in the "city of the future." Climate change will affect different cities in different ways with some experiencing more frequent droughts and water shortage while others will have more intense storm events with subsequent flooding issues. Flexible and adaptable solutions are hence required to reduce the vulnerability of cities to these changes (Khatri & Vairavamoorthy, 2008). Rising sea levels are leading to increased saline intrusion into coastal and island aquifers (GOI, 2004). Water is a key element in each of the over 88 separate industrial clusters that are dispersed throughout India, the tenth most industrialised nation in the world (CPCB, 2009). It is impossible to exaggerate the vitality of water for maintaining India's GDP development. By 2030, the industrial sector's share of India's overall freshwater withdrawals is predicted to be three times from its current 2% share. All industries including the thermal power plants, the textile industry, the iron and steel sector, and the pulp and paper, use a lot of water and generate trash. Indian industries are coming up at a fast rate and hence failing to do enough to uphold the country's environmental regulations, consecutively resulting in the contamination of its major rivers. The current real estate boom has increased the need for construction, particularly in metropolises and large towns, adding to an abrupt and unsustainable rise in the mining of riverine areas. All this is leading to a detrimental effect on both the ecology and its dependents (Anappara, 2005). India ranks as the 10th largest consumer of bottled water in the world, making the bottled water industry one of the fastest expanding industrial sectors in the nation (Bhushan, 2021). In many locations where groundwater is the only supply of freshwater, this industry's unrestricted growth has negative effects on water security. Numerous bottled water brands have joined the market as a result of liberalisation and rising water quality awareness. The USD 250 million market for bottled water is expanding at a pace of 75-80% (Cronin, 2014). Of course, policies require tools for their implementation, and India needs to greatly improve its systems for environmental protection and surveillance. The Government of India has put forth a model "bill for the protection, conservation, management and regulation of groundwater" and a "national water framework law" to essentially clarify who is responsible for aquifer protection and water management at various levels (Shah, 2013).

Table 2. Review of existing literature on issues, challenges and solutions for water management in India

Author (Year)	Title	Issues	Challenges	Possible solutions
McIntosh, A.C. (2003)	Asian Water Supplies Reaching the Urban Poor	Poor Governance, Low Consumer Awareness, Intermittent Water Supply, Low Water Accountability, Poor Construction And Operation Maintenance, Polluted Water Ways, Exploitation Of Ground Water	Demand Management and Water Conservation, Managing Water Resources to Meet Megacity Needs, Conflict of Water Users	Transparent policies, paradigm shift in tariffs, organization development, waste water recycling, demand management, rainwater harvesting, urban sanitation improvements, private sector participation
Kumar, M.D. (2000)	Water Management Problems And Challenges in India: An Analytical Review	Groundwater Quality Deterioration, Growing Demand, Increasing Competition and Growing Conflicts, Surface Water	Availability of Scientific Database, Estimates of Water Availability and Use, Water Quality, Water Demands and Use Rates,	Centralised and Segmented Approach, Regulatory Approach to Management, Sectoral and Segmented Approaches, Institutional Frameworks and Market Instruments
Kumar, C.P. (2018)	Water Resources Issues And Management in India	Water for Agriculture, Water Quality, Management of Ground Water Resources, Drought and Flood, Groundwater Contamination		Groundwater Legislation and Aquifer Recharge, Groundwater Resources: Assessment and Planning, Participatory Water Management
Jaiswal, M. (2017)	Sustainable Water Management: Issues And Challenges in India	Sectoral Demand of Water, Sectoral Consumption of Water, Demand Supply and Shortage, Waste Water Generation and Its Treatment	Rainwater Harvesting, Key Obligations for Various Stakeholders in the Water Sector	
Mishra, P.K. (2016)	Urban Water Resource Management for Sustainable Development	Increasing Population-Migration, Land-Use Change, Climate Change, Urban Flash Flood		Low impact development, water sensitive urban design, urban water supply management, urban water demand management, rain water harvesting, water demand management
Panwar. M.& S, Antil. (2015)	Issues, Challenges and Prospects of Water Supply In Urban India	Water Availability, Water Supply Infrastructure, Waste Water Disposal	Water quality, Financing of Infrastructure for Water Supply, Lack of Regulatory Framework, Water Utilization and Infrastructure Management	Rain water harvesting, water reuse or water from waste water, conservation of supplied water, improving water distribution and its use, ground water recharge, public private partnership
Cronina, A. et al. (2014)	Water in India: Situation and Prospects	Water Scarcity, Need of New Indices to Measure Water Budget, Climate Change, Population Pressure, Industrial Growth, Water Quality and Pollution, Water, Gender and Equity	Role and accountability of key stakeholders, Governance deficit	All stakeholders need to work together to achieve desired goals, Government should harness community participation especially for sanitation and for a safe sustainable water supply.
Norstrom, A. (2009)	The Complexity Of Water And Sanitation Provision in Peri-Urban Areas In Developing Countries	Water Supply and Sanitation Services, Poor Governance, Water Supply, Waste Water Disposal	Integrated Infrastructure and Spatial Logistics, Social Welfare and Education, Internal Organization, Rights and Obligations	
Vairavamorthy, K. et al. (2008)	Challenges for Urban Water Supply and Sanitation in The Developing Countries	Water Supply, Poor Sanitation, Waste Water	Climate Change, Population Growth and Urbanization, Deterioration of Infrastructure Systems	Learning Alliances, Institutional Development, Interventions over entire Urban Water Cycle, Application of Natural Systems, Adequate provision of urban water supply and sanitation

Such initiatives will need strong commitment for their enforcement to be successful.

Challenges related to water management: Nearly 60% of the world's population will live in cities during the next two decades, up from the current 50%. The developing world experiences the fastest urban expansion, with cities adding on an average of 5 million people per month. Unprecedented issues are brought about by the explosive urban population increase, with access to water and sanitation being the most urgent and keenly felt when they are scarce. The sustainability of human urban settlements is being threatened by two key water-related issues: the lack of access to safe water and sanitation, and the rise in water-related natural disasters like; floods and droughts. The effects of these issues on human health and well-being, safety, the environment, and economic growth and development are significant (Mishra, Khare, Singh, L., & Chandrakar, 2016).

The treatment of wastewater and its utilisation are critically important due to the dwindling availability of fresh water resources and the rising industrial, agricultural, and home demand. Priority should be given to utilising treated wastewater in the urban, municipal, and industrial climates to close the gap between India's water supply and demand. There are currently 920 sewage treatment facilities in India, but only approximately 30% of the country's sewage is actually processed. This leaves India with the capacity to handle just 37% of its daily sewage production, or 22.963 MLD. Industries produce 13,468 MLD of wastewater, of which only 60% is managed. Wastewater generated by industries totals to an amount of 13,468 MLD, although only 60% of it is treated. Only 20% of the wastewater is processed and is accessible for reuse, despite the fact that around 80% of the water collected for household consumption should be recovered as wastewater for additional treatment and reuse (Jaiswal, 2017). To continue providing water that meets quality standards, it is imperative

to prevent pollution of water sources. The information that is currently available indicates that both groundwater and surface water contamination levels have grown. Urban regions are home to more than 100 million individuals who are exposed to contaminated water. The issue is made worse by the lack of adequate infrastructure, services, and resources to support the water and wastewater treatment facilities needed for an urban region. Additionally, most metropolitan areas lack proper drainage and solid waste collection facilities (Dkhar, 2018). Similar to water availability, water quality has also been on the political agenda in many countries, with Delhi, the capital of India, serving as the greatest illustration. In the lack of stringent regulations, home and industrial waste water is dumped into underground water sources, rivers, and canals. According to (Rao & Mamatha, 2004) the contamination level among India's surface and subterranean water resources is over 70%. The printing and dyeing businesses in Pali and Jodhpur in Rajasthan, Jetpur and Rajkot in Gujarat, and the tannery business in the North Arcot district of Tamil Nadu have significantly contaminated the groundwater. Other instances are printing and dyeing businesses in Panipat and Sonipat districts of Haryana. Nearly all Indian cities experience erratic water supplies. Indian cities lag in a 24-hour water supply, except for a few public-private partnership systems. There is a serious issue with inadequate water supply because only 64% of homes have connections and stand posts. The average amount of time that water is supplied is between one and six hours (Ahluwalia, 2011). A significant portion of the population lacks access to public water facilities and as a result, they must rely on private water suppliers and pay higher prices than for public water delivery. The poor are more at risk from this system since they are less involved in managing the public water system and suffer the most from insufficient water delivery. Most often, lower-income households without access to public networks rely on market sources to obtain water, which is more expensive. Water utilities in India, often only recoup 30-35% of the cost of operations and maintenance, whereas most water utilities in the Philippines and Cambodia are able to recoup all O&M expenses, and roughly 64% of their O&M costs in Bangladesh (ADB, 2007).

The middle-income groups and the weaker sections of society in metropolitan India experience more severe and frequent problems with water quality in the piped water distribution system because they lack the resources to maintain their water supply infrastructure and disinfect residuals. Rapid urbanisation in developing nations is frequently accompanied by excessive water demand and unauthorised connections to distribution networks in underprivileged neighbourhoods. According to an international study conducted in 1991, on water loss as a proportion of water delivered, water loss in developed nations ranged from 8% to 24%. However, water loss ranged from 15% to 24% in middle-income or newly industrialised nations, and it was estimated that water loss in underdeveloped nations like India was between 25% and 45% (WHO, 2001).

Increased lavish water use by consumers is a result of unmetered water supply. Because of this, municipalities and other relevant authorities are unable to recoup expenditures, which prevents them from investing further in the development and upkeep of the water delivery infrastructure (McIntosh, 2003). As a result, consumers lose trust in the business and become less inclined to pay for billed water. In order to maintain financial sustainability, only a small percentage of homes are linked to a piped water supply (Singh, et al., 1993). Since Indian towns do not have adequate income collection to rebuild them, and ageing water delivery infrastructure is another major issue they must deal with. The summary of available literature is presented in Table 2, highlighting various issues, challenges, and possible solutions as observed by various researchers.

RECOMMENDATIONS

The paper suggests and proposes some recommendations on the basis of literature review conducted. These can be discussed under following heads;

Governance and Policy Reform

- To implement policies to solve concerns with governance.
- To ensure equitable pricing, taking into account a paradigm change in water rates.
- To improve the effectiveness of water management and concentrate on organisational development.

Demand Management and Conservation:

- Encourage demand management techniques to deal with the water shortage.
- Encourage rainwater collection to increase water availability.
- Promote water recycling to reduce waste.

Groundwater Management

- Enforce the laws governing groundwater to avoid contamination.
- Start aquifer recharge programmes to use groundwater sustainably.
- Encourage community participation in water management.

Sectoral Water Management

- Address consumer demand and consumption trends by industry.
- Establish important responsibilities for numerous water sector stakeholders.
- Focus on low-impact development and water-sensitive urban planning.

Infrastructure and Financing

- Invest in upgrading the infrastructure for water supply.
- Examine public-private partnerships for managing infrastructure.
- Make sure initiatives involving water supply have suitable finance methods.

Climate Change and Sustainability

- Create plans of action to address the effects of climate change on water supplies.
- Promote the sustainability of water resources by using integrated strategies.
- Think about utilising natural systems to remediate wastewater.

Community Involvement

- Encourage community involvement, particularly in projects involving water and sanitation.
- Promote institutional growth and learning collaborations.
- Clearly define their rights and obligations for both water providers and users.

Accountability and Governance

- Enhance the responsibility and role of important stakeholders in water management.
- Improve governance by enacting strong laws and regulations.

Urbanization Challenges

- Reduce the negative consequences of urbanisation on sanitation and water supply.
- Improve infrastructure to handle population expansion.
- Create plans to control urban flash floods.

CONCLUSION

To successfully manage water resources, planned action is urgently required. Urban issues in developing nations are especially concerning since many people continue to live without access to

basic sanitation facilities and safe water supplies. It is widely acknowledged that a number of urban water interventions in the past, especially in developing nations, have failed. This failure has been partially attributed to the institutional context in which these interventions are applied and to the absence of stakeholder participation in the design and implementation of these interventions. Controlled usage of water in urban areas will result from employing metered connections to conserve water. Water reuse will also enhance water supply and reduce environmental pollution, through sanitation disposal programmes. It is proposed to replenish and adopt techniques for replenishing the reservoirs in Indian cities, much as urban settlements grew from villages through time, those were dependent on natural reservoirs. Regulations are also required to be implemented for the recharge of the groundwater. Private investment is absolutely necessary to increase the effectiveness of the water supply, provide new physical infrastructure, collect revenue through adequate water charging those aid in capacity building and operation and maintenance of the water system, reduce leaks and water theft, and implement an effective monitoring system. Achieving sustainable water management in India is a challenge that requires coordinated efforts from all stakeholders in light of the country's fast urbanisation and population growth along with creative solutions to the many issues raised in the paper.

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