

P-ISSN: 2706-7483
E-ISSN: 2706-7491
NAAS Rating (2026): 4.5
IJGGE 2026; 8(5): 70-75
www.geojournal.net
Received: 08-03-2026
Accepted: 13-04-2026

Pooja Malik
Research Scholar, Department
of Geography, Maharshi
Dayanand University, Rohtak,
Haryana, India

Urmila Devi
Professor, Department of
Geography, Pt. Nekiram
Sharma Government College,
Rohtak, Affiliated to Maharshi
Dayanand University, Rohtak,
Haryana, India

Corresponding Author:
Pooja Malik
Research Scholar, Department
of Geography, Maharshi
Dayanand University, Rohtak,
Haryana, India

The dynamics of domestic water in Gurugram: An assessment of water supply, urban economics, and sanitation ecosystems

Pooja Malik and Urmila Devi

DOI: <https://doi.org/10.22271/27067483.2026.v8.i5a.816>

Abstract

Gurugram is located in the National Capital Region (NCR) of India. It has transitioned from a modest agricultural town into a global 'Millennium City' and also the economic engine of Haryana. This staggering demographic and economic expansion in this region where the population has grown nearly five times over three decades. Along with this, it has placed unparalleled and often critical strain on its civic utilities (Sharma *et al.*, 2023). The study discusses Gurugram's municipal water management system from a citywide perspective. Water supply in Gurugram is the joint responsibility of the Municipal Corporation of Gurugram (MCG), Gurugram Metropolitan Development Authority (GMDA), and Haryana Shehri Vikas Pradhikaran (HSVP). The paper uses secondary data from municipal engineering reports, water tariff audits, sanitation surveys, and pertinent literature to evaluate the state of water supply in the city and analyse the implications of the findings. The research findings reveal that the city is majorly dependent on surface water from the Yamuna river basin as a water source, which meets about 94% of the municipal water requirements in Gurugram. However, the water distribution system faces a lot of challenges, including aging pipeline networks, rising demand, and declining groundwater levels. The Central Ground Water Board reports that the groundwater levels have dropped below 30 meters in several parts of the city, signaling an impending water crisis (CGWB, 2023). The paper also highlights the proliferation of an informal shadow water market in the city, alongside a huge revenue shortfall in the municipal budget as revealed by the 2023-2024 audit. About fifty percent of the municipal water demands in the city are in arrears, indicating a huge deficit in the collection of water charges (MCG, 2025). In addition, the study discusses the Shit Flow Diagram of the city waste management system, with 38% of the city's faecal sludge recorded as poorly managed, thus threatening groundwater contamination (Dey Sarkar *et al.*, 2021). The paper finally assesses the proposed 24x7 water supply scheme, including the transition in engineering development towards District Metered Areas (DMA), Variable Frequency Drive (VFD) pump installations, and SCADA system inclusion and discusses the reuse of agricultural wastewater in Tauru and Nuh (GMDA, 2024).

Keywords: Urban water management, Gurugram, Groundwater depletion, Water supply infrastructure, Sustainable water governance

Introduction

Urban sprawl, the growth of cities and towns towards less developed areas, is one of the outstanding phenomena of contemporary geopolitics. In emerging economies in South Asia, this trend often takes the form of 'hyper growth,' as the population increases at a phenomenal rate, overwhelming existing urban infrastructure. Gurugram is one of the prototypical examples of such a city. This erstwhile cluster of semi-arid villages around Delhi has turned into a financial and IT hub hosting hundreds of industries. However, the rapidity and scale of this development have come at a steep price - the local water management system is now under severe stress due to surging demand.

Multiple problems plague water management in Gurugram, from sporadic water supply interruptions to groundwater depletion, extensive Non-Revenue Water losses, and overlapping administrative control. Notably, water supply in the city is only available for two hours a day in the outer wards. At the same time, the number one concern for the local administration is the depletion of groundwater resources. Physical water losses account for 35% of supplied water, with rusty pipes being a major cause. Water management in Gurugram is complicated by the fact that it is the responsibility of several local authorities.

Thus, MCG is in charge of local water distribution, while GMDA is responsible for treatment works and trunk sewers. In addition, there are other authorities, such as HSVP and HSIIDC, that are responsible for water distribution within particular developmental jurisdictions. As per NITI Aayog Composite Water Management Index (CWMI) report of 2018, twenty-one Indian cities, including several metropolises from the National Capital Region (NCR), were at risk of reaching Day Zero, defined as the point when reservoirs reach the lowest level before drying up completely (NITI Aayog, 2018). To quench the thirst of 3,500 MLD water at the time of peak saturation, the authorities need to adopt a paradigm shift from the current practice of random groundwater tapping to science-based circular water economies through engineered precision and economic viability (TERI, 2021) ^[11].

Objectives of the Study

To rigorously align with the macro-level engineering, financial, and sanitation data available from municipal authorities and central environmental agencies, the scope of this research has been strictly focused on the following three comprehensive objectives:

To assess gaps in water infrastructure, treatment capacity, and localized groundwater depletion.

To analyze unequal water access, informal water markets, and municipal financial losses (tariffs and NRW).

To evaluate sanitation systems using SFDs, alongside technical upgrades like DMA, SCADA, and wastewater reuse.

Theoretical Framework and Literature Review

Urban Water Metabolism and Politics of Access

This research is based on the theory of 'Urban Water Metabolism.' The said theory was developed within the framework of urban ecology and defines a city as a metabolic entity that ingests huge amounts of matter and energy and subsequently excretes a considerable amount of waste (Kennedy *et al.*, 2011) ^[5]. In the past, Gurugram has demonstrated a severe linear metabolism and has focused on the consumption of local groundwater and its subsequent treatment and disposal with little regard for the amounts used (TERI, 2021) ^[11]. Sustainable urbanism now requires a transition to a circular metabolism. In this paradigm, Treated Water Waste (TWW) is reintroduced into the economy (Kennedy *et al.*, 2011) ^[5]. In addition, this study also employs the concept of Political Ecology of Water, which is used to understand how water is distributed based on power relations. This is particularly relevant to the situation in Gurugram, where master-planned areas can access subsidized surface water, whereas informal

settlements have to rely on private and costly water tankers.

Climate Change and Environmental Stressors (UHI Effect)

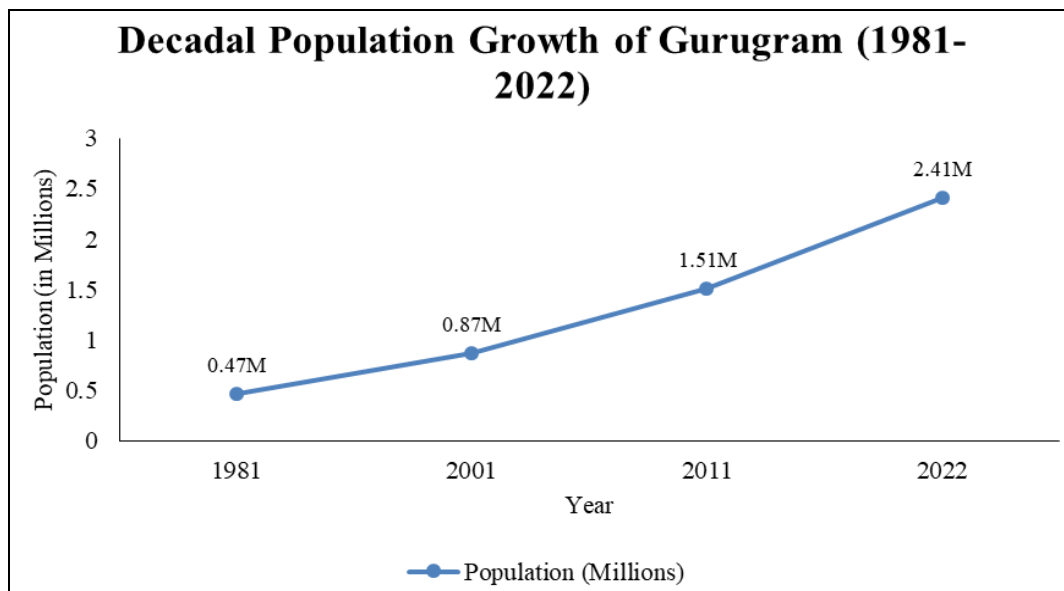
A critical external factor affecting the water security of Gurugram is global climate change as well as local climatic variations. According to recent meteorological studies, the South-West Monsoon, a vital rainfall pattern with regard to the region, is demonstrating new trends related to a shorter period of rainfall with more intensity. Added to this the Urban Heat Island (UHI) effect has caused an increase in evapotranspiration due to the loss of green cover in the form of the Aravalli hills and an extensive number of glass facades, which in turn has led to an exponential rise in water demand during peak summer as well as lower replenishment of the underlying geological formations (TERI, 2021) ^[11].

The Groundwater Depletion Crisis

The city of Gurugram is underlain by Pleistocene alluvium of the plains and quartzite of the Aravallis belt; previously, the municipal piped water could not meet the increased demand of the periphery, and the exploitation of groundwater at greater depths has become widespread. The study determined the block-wise distribution pattern of groundwater in the Gurugram district for the period of rapid infrastructure development during the last two decades. In 2000, the static water level was mostly in the range of 10-25 meters below ground level (mbgl) (Sharma *et al.*, 2023) ^[10]. However, due to its severe exploitation, it dropped significantly to below 30-40 mbgl in 2020, with several blocks reporting even lower levels. Thus, the CGWB categorized the district as a dark zone because of the overuse of groundwater with its withdrawal nearly double its annual recharge, being 195% higher than the same in the current year (CGWB, 2023).

Study Area Profile and Demographics

Gurugram is a city located 30 km from Delhi to the south. According to the Köppen-Geiger classification system, the climate of Gurugram falls under tropical steppe, hot, and semi-arid (BSh). The average amount of rainfall obtained by Gurugram is relatively low, only 505.4 per year, with the majority falling during the two hottest months - July and August, which makes this territory especially vulnerable to water shortages (Sharma *et al.*, 2023) ^[10]. Currently, MCG states the total number of administrative wards constitutes 36 covering an area of 298.25 square kilometers. Between 1981 (0.47 million) and 2022 (2.41 million), there has been a significant increase in the population growth rate, putting high pressure on the water supply infrastructure, namely, the pipeline distribution system (Sharma *et al.*, 2023) ^[10].



Source: Compiled by the researcher based on Census data.

Fig 1: Decadal Population Growth of Gurugram (1981-2022)

Research Methodology

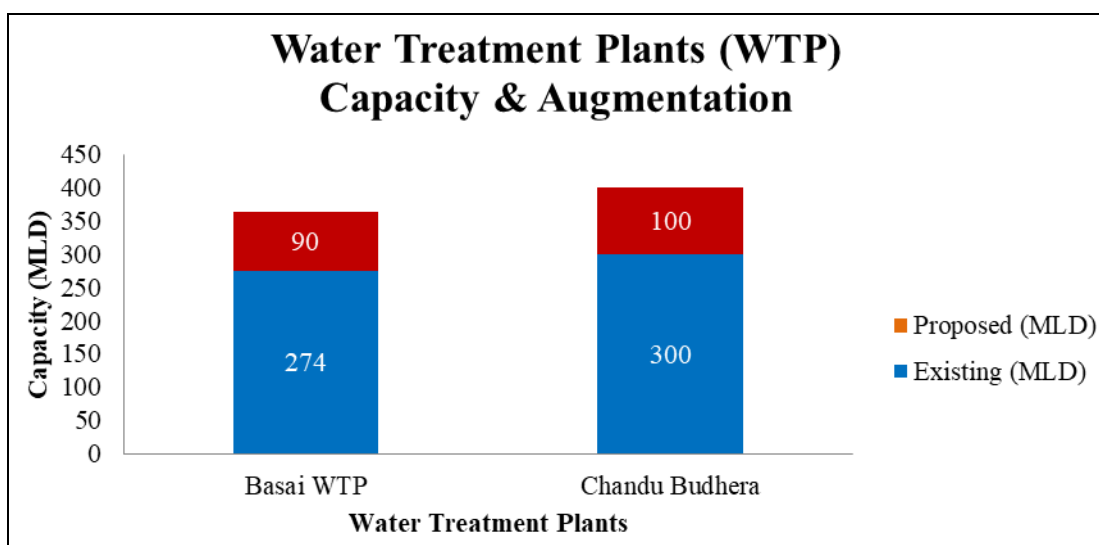
This study utilizes a quantitative descriptive and diagnostic geographical research design. This is done while employing hard secondary institutional data to conduct a macro level systems analysis. This information was collected from civic, engineering and environmental sources. Information on engineering data including storage capacities and tubewell status was obtained from the MCG and GMDA (MCG, 2024) [7]. Water billing data from 2021 to 2024 was retrieved from the MCG Revenue Department (MCG, 2021-2025). Sanitation data was evaluated from the SFD Lite report developed by TRCSS-JNU and CSE (Dey Sarkar *et al.*, 2021).

Spatial Infrastructure and Water Treatment Capacity

Raw Water Importation and WTP Augmentation

As of now, municipal water supply in Gurugram amounts to 520 MLD. Due to a significant decline in aquifer levels, the city is forced to depend on external sources for 94% of its municipal water. Water is sourced from distant surface water bodies in the Yamuna River basin and treated at two Water Treatment Plants, namely, Basai and Chandu Budhera. There is an upgrade proposal for the Basai Water Treatment Plant to treat an additional 90 MLD of water on top of the current 274 MLD.

Similarly, the Chandu Budhera Water Treatment Plant will see an increase in its current 300 MLD by 100 MLD (GMDA, 2024) [3, 4]. Thus, the total water grid in Gurugram will be able to provide a municipal water supply of 764 MLD once the upgrades have been completed.



Source: Compiled by the researcher based on data from GMDA and MCG.

Fig 2: Water Treatment Plants (WTP) Capacity & Augmentation

Distribution Network and UGR Storage Disparities

Once treated, potable water is distributed via a municipal distribution system involving a total route spanning approximately 3,500 km of underground pipeline systems.

In this regard, the MCG reports that the city has 81 underground reservoirs (UGRs) and local boosting stations that provide water supply with sufficient pressure for the entire metropolis. At the same time, there is an apparent

variation in the reservoir sizes as illustrated by the Chakkarpur UGR with an overall capacity of more than 2.8 million liters, whereas the old Carterpuri villages have only 1.2 million liters reserves (MCG, 2024) [7].

▪ **Micro-Spatial Analysis of Tubewell Mortality**

While the macro-grid is reliant on the imported water resources, the periphery remains dependent on the municipal tubewell ecosystem. A micro-spatial forensic assessment highlights the localized incidence of infrastructural deficit. In Ward 2, for instance, out of the 21 municipal tubewells, 13 are complete failures recording the highest proportion of 61.9% failed tubewells. Other wards that record significant proportions of failed tubewells include Wards 21 and 22 reporting 66.6% and 25% of total municipal tubewells (MCG, 2024) [7]. The tubewell pumps that have been utilized in the area are appropriate for static water levels below 30 mbgl and record high instances of cavitation and burning at depths beyond this threshold.

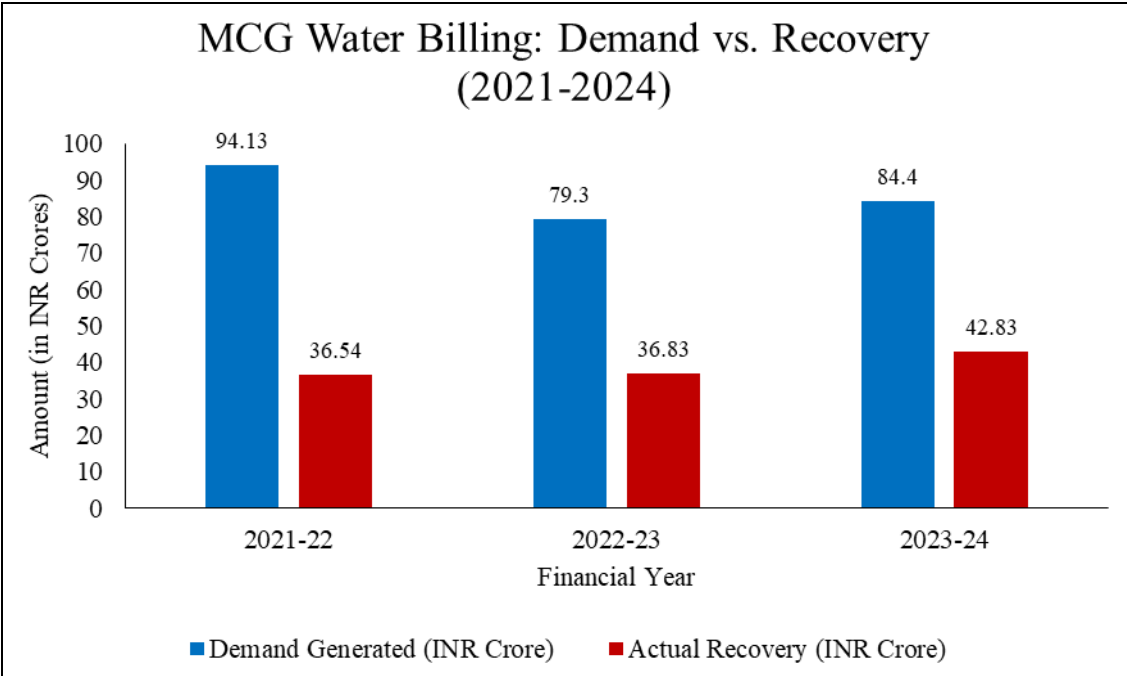
The Rise of the Informal Water Economy (Tanker Shadow Markets)

The enormous failure of local tubewells and the erratic availability of piped water have created a black market for water supplied by private tanker operators. When municipal water supplies ran out, people turned to black-market water

dealers who tapped into deep boreholes. Water prices spiked by up to 300% per 5,000-liter tanker during summer. This exploits the poor and depletes groundwater at a phenomenal rate.

Economic Recovery and Tariff Matrix

Water supply system in Gurugram wastes a lot of water. In fact, it has one of the shares of wasted water in the country. The way people pay for water has an impact on the water sectors economy. The current billing policy focuses on who owns a house over how water they actually use. Metered connections get a discount and do not show the real cost of treating and bringing in Yamuna water. The official bill shows that the civic body loses a lot of money because it can't collect the money it is owed. The water utility had a demand of INR 94.13 Crores. Collected INR 36.54 Crores for the year 2021-22. This means they only collected 38.8% of what they were owed. Although they collected 50.7% for 2023-24, they still had a deficit. The demand for water was INR 94.13 Crores, INR 83.19 Crores, INR 57.48 Crores, INR 85.16 Crores and INR 133.46 Crores for the years 2021-25. The MCG only gets about 50% of the billed amount through arrears and subsidy. As a result, the MCG operates at, about 50% capacity. This limits its ability to fund operations.



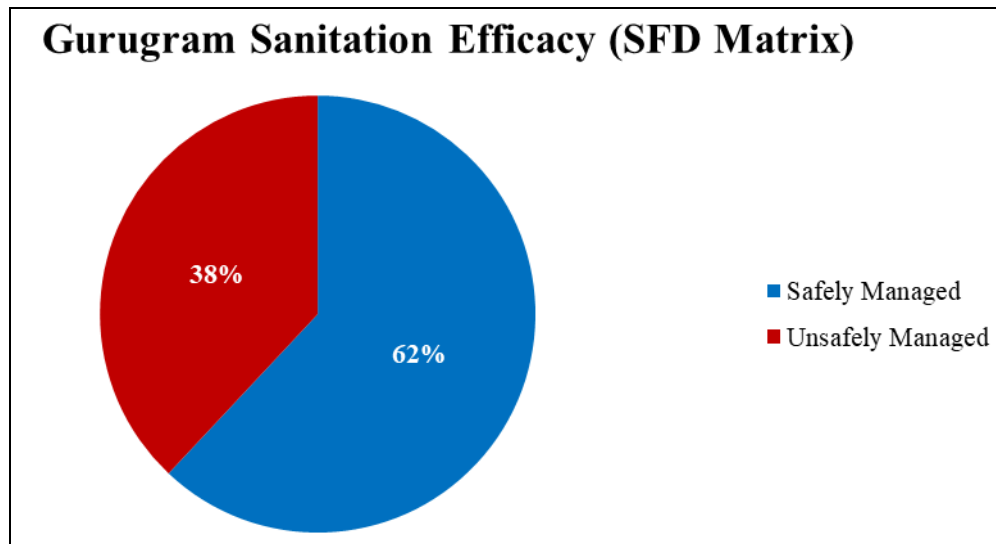
Source: Compiled by the researcher based on data from MCG.

Fig 3: MCG Water Billing: Demand vs. Recovery (2021-2024)

Sanitation Efficacy and Wastewater Management (SFD)

The sustainable urban water supply is inseparable from the sewage management system. The SFD Lite Report demonstrates the flow of human waste in Gurugram. Overall, the city has a sanitation level of 62%, which is a moderate level, leaving nearly 38% of waste ‘Unsafely Managed’ (Dey Sarkar *et al.*, 2021). The offsite sewerage

system category accounts for the largest percentage of the city’s sanitation system, amounting to 78%. Nonetheless, about 14% of the waste is lost before it reaches Sewage Treatment Plants (STPs). At the same time, onsite systems accommodate 14% of the total faecal waste in the city, of which only 3% was safely emptied. The rest was illegally dumped by private entities into the municipality’s gutters.



Source: Compiled by the researcher based on data from GMDA.

Fig 4: Gurugram Sanitation Efficacy (SFD Matrix)

The GMDA realises the gravity of the sanitation crisis and explores ways to exploit the potential of a circular economy to devise Treated Waste Water (TWW) recycling schemes. The largest TWW recycling scheme currently utilises the 200 MLD of water from the Behrampur STP for use in drip irrigation in the agricultural lands in Tauru and Nuh districts. By using the TWW instead of freshwater drawn out from the groundwater for irrigation, Gurugram is not only recycling the waste but also helping to recharge the groundwater (GMDA, 2024) [3, 4].

Advanced Engineering Interventions: The 24x7 Supply Project

The MCG and GMDA want to fix the problems with money and physical things. So, they are working together on a plan to change the way they supply water. Now, they do not give water all the time. The MCG and GMDA want to give water all the time.

To do this they are dividing the water area into parts called District Metered Areas. The MCG and GMDA are putting machines in these areas that can measure how much water is flowing. The MCG and GMDA are also using computers that can watch what is happening with the water. This helps the people, in charge see how much water is being wasted. The MCG and GMDA can see this on their computers. Fix the problems right away.

The MCG and GMDA are also putting in pumps. These pumps are special because they can change how fast they work based on how much water people need. The MCG and GMDA are doing this so that the old pipes do not break under much pressure. The MCG and GMDA are putting in 319 of these pumps. This will help keep the water clean and safe to drink. The MCG and GMDA are working hard to make sure people have water all the time.

Comprehensive Policy Recommendations

Based on the geographical realities synthesized, the following actionable policy interventions are recommended:

- **Strict Auditing of Rainwater Harvesting (RWH):** The MCG must digitize RWH compliance and explicitly link annual property tax renewals to certified RWH inspection certificates.
- **Mandatory Decentralized Wastewater Treatment**

System (DEWATS): The GMDA must enforce the operation of localized DEWATS in all new high-rise societies, treating and reusing greywater on-site for non-potable purposes.

- **Transition to Dynamic Telescopic Pricing:** Transition to 100% smart household metering must be accompanied by a telescopic tariff structure where excessive consumption is exponentially taxed.
- **Regulation of the Informal Water Economy:** Private water tankers must be aggressively licensed, regulated, and GPS-tracked to curb illegal groundwater extraction.
- **Desludging Tracking to Protect Aquifers:** A digital tracking manifest system must be implemented for private vacuum truck operators to ensure sludge is delivered to designated STPs.

Conclusion

Gurugram is trying to develop its infrastructure quickly to keep up with the fast economic growth in the area. The city is increasing its water treatment capacities. However, a lot of the tubewells in most areas are not working properly with more than 60 percent of them failing, which is a big threat to the groundwater in the region. This information is based on a report by the Central Ground Water Board in 2023.

The municipal water supply system is also facing problems because it cannot recover a lot of the money it costs to build and maintain the system over its lifetime. This is according to the Municipal Corporation of Gurugram from 2021 to 2025. Furthermore, a lot of the wastewater is not safe to use which is bad for the environment. This is stated in a study by Dey Sarkar and others in 2021 which found that 38 percent of the wastewater is not safe.

The only way to provide water for the people living in Gurugram, which is growing very quickly is to quickly put into action the 24x7 water project. This project uses technologies like DMAs, SCADA, smart meters and TWW to recycle water and make sure it is used efficiently. The 24x7 water project is very important, for the city of Gurugram and its water supply system. The 24x7 water project will help Gurugram to have a water supply system.

References

1. Central Ground Water Board. National compilation on

- dynamic ground water resources of India, 2023. New Delhi: Ministry of Jal Shakti, Government of India; 2023.
2. Dey Sarkar U, TRCSS-JNU, Centre for Science and Environment. SFD Lite report: Gurugram, Haryana, India. New Delhi: CSE; 2021.
 3. Gurugram Metropolitan Development Authority. Annual administrative overview and infrastructure updates. Gurugram: GMDA; 2024.
 4. Gurugram Metropolitan Development Authority. Utilization of treated waste water (TWW) through Dhanwapur STP and Behrampur STP. Gurugram: GMDA; 2024.
 5. Kennedy C, Pincetl S, Bunje P. The study of urban metabolism and its applications to urban planning and design. *Environmental Pollution*. 2011;159(8-9):1965-1973. doi:10.1016/j.envpol.2010.10.022.
 6. Miglani AS. Assessment of RO wastewater management and reuse: Concerning households in Gurugram, Haryana, India. *International Journal of Applied Engineering and Sustainability*. 2024;11(5):42-49.
 7. Municipal Corporation of Gurugram, Engineering Department. List of boosting stations and tubewell list of MCG area. Gurugram: MCG; 2024.
 8. Municipal Corporation of Gurugram. Water billing details ledger (2021-2025). Gurugram: MCG; 2025.
 9. NITI Aayog. Composite water management index: A tool for water management. New Delhi: Government of India; 2018.
 10. Sharma M, *et al.* Block wise distribution of underground water in Gurugram district. *International Journal of Creative Research Thoughts*. 2023;11(11):342-349.
 11. The Energy and Resources Institute. Water sustainability assessment of Gurugram city. New Delhi: TERI; 2021.