MAHINDRA - TERI
CENTRE OF EXCELLENCE FOR SUSTAINABLE HABITATS

Water Sustainability Assessment
Of
Gurugram City
Suggested format for citation

T E R I. 2021
Water Sustainability Assessment of Gurugram City
New Delhi: The Energy and Resources Institute. 82 pp.

THE TEAM

Technical Team
Mr Akash Deep, Senior Manager, GRIHA Council
Ms Tarishi Kaushik, Research Associate, TERI

Support Team
Mr Dharmender Kumar, Administrative Officer, TERI

Technical Reviewer
Prof. Arun Kansal, Dean (Research and Relationships), TERI School of Advanced Studies,
New Delhi

For more information
Project Monitoring Cell
TERI
Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003
India

Tel. 2468 2100 or 2468 2111
E-mail pmc@teri.res.in
Fax 2468 2144 or 2468 2145
Web www.teriiin.org
India +91 • Delhi (0)11
Preface

Literature describes urban areas as open systems with porous boundaries and highlights the importance of a systems perspective for understanding ecological sustainability of human settlement. Similarly, a socio-ecological framework helps us to understand the nexus between social equity, environmental sustainability, and economic efficiency. India is urbanizing rapidly with characteristic inequality and conflicts across the social, economic, and locational axes. Following the global pattern, Indian cities use social and natural resources of the rural hinterland and their own resources for survival and growth and, in the process, generate large amount of waste. Water is the most important ‘resource flow’ in an urban area, driven by a complex set of intersecting socio-economic, political, infrastructural, hydrological, and other factors. These drivers vary a great deal within a city and has a significant impact on the water flow and management and requires both micro and macro level study in order to address it.

In order to enhance the water flow and management in cities, a water sustainability assessment of Chennai, Gurugram and Pune cities was conducted. The aim was to undertake an assessment of potential risks associated with the water sources and demand & supply at city level and provide recommendations to mitigate the same. This report shows the analysis of Gurugram city.

Approach

A number of studies have been conducted w.r.t. urban water management across the country. Most of these studies focus on certain aspects of water like storm water management, waste water treatment systems, water supply systems etc. But in these studies planning for water is oversimplified by governments by conducting assessment in isolated entities. Therefore, drifting from the age old approach, this report has taken the approach that considers ‘One Water’, which basically defies the segregation of water in various categories like storm water, waste water etc. Secondly, the approach and the methodology followed for the study is the metabolic approach. It is an emerging field and there have been a number of international studies being carried out since year 2013. To our assessment this type of metabolism approach towards water assessment is a new one, which to our understanding has not been attempted yet. Therefore it makes this water sustainability report different from the existing ones. Also, the past and existing data on water management has been studied, based on which projections for the year 2025 on potential risks has been computed. This has been followed by recommendations for combating these risks for 2025.
Outcome

As this study involves the metabolism approach which provides disaggregated understanding about areas where water could be secured without creating negative hydrological footprint to the surrounding regions, it is expected that the output of this approach will help in informing about (a) the new sources of water (b) the amount of water which goes out of the system unutilised, which could help in addressing the inefficiency in per capita water storage and availability (c) the seasonal problems like flooding and inefficient storm water management and the required balance for an equitable water distribution over time (d) the water related infrastructure (e) and the water recycling potential.

Audience

Given the issue of water scarcity which is being faced in the recent years and also the growing realization that the citizens have to contribute for the efforts towards achieving water sustainability, it is expected that this assessment report will not only help the urban planners, policy makers and administrative agencies but also every stakeholder who is involved with water sector including citizens to have an understanding of the present and the future challenges and means by which these challenges could be addressed.

Challenges

It has to be mentioned at this juncture that data gathering for this report was a challenging exercise. Therefore the data elements have been fed into the model to calculate the output metrics/indicators by extrapolations from the available historical data. In this context, the researchers have succeeded in tiding over the obstacles to data access.
Table of contents

PREFACE .............................................................................................................................................. i
  Approach ........................................................................................................................................... i
  Outcome ............................................................................................................................................ ii
  Audience ........................................................................................................................................... ii
  Challenges ....................................................................................................................................... ii

ABBREVIATIONS .................................................................................................................................. ix

EXECUTIVE SUMMARY ..................................................................................................................... xi

1. INTRODUCTION ................................................................................................................................. 1

2. CITY GROWTH AND ENVIRONMENT ................................................................................................. 3
    2.1 Geographic Characteristics ............................................................................................................. 3
        2.1.1 Location ............................................................................................................................... 3
        2.1.2 Physiography and Landform ............................................................................................... 4
        2.1.3 Climate ............................................................................................................................... 5
        2.1.4 Forest and Biodiversity ....................................................................................................... 6
    2.2 Urban Growth and Land Use ......................................................................................................... 6
        2.2.1 Spatial Growth Pattern ....................................................................................................... 6
        2.2.2 Land Utilization and Land Cover ....................................................................................... 7
    2.3 Demographic Description ............................................................................................................. 9
        2.3.1 Population Growth Trend .................................................................................................. 9
    2.4 Social and economic character ..................................................................................................... 13
        2.4.1 Economy ............................................................................................................................ 13
        2.4.2 Agriculture ......................................................................................................................... 13
        2.4.3 Industry .............................................................................................................................. 14
        2.4.4 Housing ............................................................................................................................. 15
    2.5 Inferences ..................................................................................................................................... 16

3. WATER GOVERNANCE AND ADMINISTRATION ........................................................................... 17
    3.1 Water Laws and Policy in India ................................................................................................... 17
        3.1.1 Institutional Setup at Central Level ....................................................................................... 17
        3.1.2 Institutional Set-Up at State Level ....................................................................................... 18
        3.1.3 Administrative Set-Up of Gurugram City (Tehsil) ............................................................. 19
    3.2 Inferences .................................................................................................................................. 20

4. WATER SOURCE MANAGEMENT AND INFRASTRUCTURE ......................................................... 23
    4.1 Water Sources ............................................................................................................................. 23
        4.1.1 Rainwater ............................................................................................................................ 23
        4.1.2 Surface Water ..................................................................................................................... 26
        4.1.3 Ground Water ..................................................................................................................... 28
    4.2 Water and Wastewater Treatment Infrastructure ........................................................................ 31
        4.2.1 Water Treatment Plants ...................................................................................................... 31
        4.2.2 Sewage Treatment Plants ................................................................................................... 31
        4.2.3 Water Meters ...................................................................................................................... 32
        4.2.4 Water Quality of Waterways Carrying Wastewater .......................................................... 33
    4.3 Inferences .................................................................................................................................. 34

5. POTENTIAL RISKS IN WATER MANAGEMENT ............................................................................ 35
    5.1 Urban Water Cycle ......................................................................................................................... 35
    5.2 Water Demand and Supply ........................................................................................................... 43
    5.3 Inferences .................................................................................................................................. 45

6. RECOMMENDATIONS FOR SUSTAINABLE WATER MANAGEMENT ............................................ 47
    6.1 Up gradation in Urban Water Cycle ............................................................................................ 47
    6.2 Stakeholder Engagement for Sustainable Water Management .............................................. 53
        6.2.1 Role of Construction sector in ensuring sustainable water management ......................... 55
        6.2.2 Role of Industries in ensuring sustainable water management through integrated water management framework .......................................................... 56
    6.3 Effective Implementation of Recommendations ........................................................................... 62

REFERENCES ......................................................................................................................................... 67
List of Tables

Table 1: Average month wise rainfall and evapotranspiration statistics of Gurugram city ............................................................... 24
Table 2: Month wise rainfall and rainy days statistics Gurugram city from year 2010-2020 ........................................................................... 24
Table 3: Details of Groundwater Development in Gurugram district in 2015 .............................................................. 29
Table 4: Water treatment plants serving Gurugram city (existing and proposed) .............................................................. 31
Table 5: Sewage treatment plants in Gurugram city as of 2019 .................................................................................. 32
Table 6: Water meter connections in MCG limits of Gurugram .................................................................................. 33
Table 7: Sectors in Gurugram district covered under different water supply zones .......................................................... 36
Table 8: Water supply and demand statistics for 2011, 2019 and estimations for 2025 .................................................. 43
Table 9: Stakeholders and their responsibilities in ensuring sustainable water management ........................................................................ 53
Table 10: Water efficient plant & equipment .................................................................................................................. 55
Table 11: Suggested Interventions for strengthening the implementation of the recommendations .......................................................... 62
List of Figures

Figure 1: Geographical location of Gurugram city in Gurugram district..................4
Figure 2: Hydrological map of Gurugram district...............................................5
Figure 3: Land use land cover change in Gurugram district (2007-2017) and estimated change in the year 2019 and 2025..........................................................7
Figure 4: Graphical representation of land use land cover change in Gurugram district (2007-2017)..........................................................8
Figure 5: Population increase in Gurugram district (1941-2011) and estimated population change in the year 2019 and 2025...........................................10
Figure 6: Percentage Decadal Variation in population of Gurugram district (1951-2011) 11
Figure 7: Population density change in Gurugram district (1991-2011) and estimated change in the year 2019 and 2015..........................................................12
Figure 8: Population increase in Gurugram tehsil (2001-2011) and estimated population change in the year 2019 and 2025..........................................................12
Figure 9: Institutional framework for the water sector in Gurugram city..................20
Figure 10: Month wise rainfall and rainy days statistics of Gurugram city from year 2010-2020 ........................................................................................................25
Figure 11: Schematic diagram of WYC highlighting the GWS channel....................26
Figure 12: Water supply network in Gurugram tehsil getting water from Chandu Budhera (A) and Basai water treatment plants (B)...........................................27
Figure 13: Surface water sources for Gurugram tehsil............................................28
Figure 14: Groundwater level in Gurugram city (2010-2020)....................................29
Figure 15: Change in water level depth in Gurugram city (2010-2020)....................30
Figure 16: Natural and Urban water cycle..............................................................35
Figure 17: Submerged DLF Phase 1 underpass on Golf Course road with rainwater collecting almost till its roof (a), a portion of caved in road near Gurugram’s IFFCO Chowk (b), a waterlogged 4 way roundabout intersection on Golf Course road (c), and vehicles wading through rainwater (d), following heavy rainfall in the region in August 2020. ........................................................................................................37
Figure 18: Drastic expansion of built up area over green cover and water bodies in Gurugram city from 1986 to 2016..........................................................39
Figure 19: Plan of Badshahpur drain starting at Ghata Lake and ending at Najafgarh drain 40
Figure 20: Dried Ghata lake (left) and shrunked Najafgarh lake (right) in Gurugram...40
Figure 21: Dilapidated traditional dams (bundhs) in Aravallis.................................41
Figure 22: Urban Water Cycle of Gurugram city....................................................42
Figure 23: Upgraded Urban Water Cycle of Gurugram City for 2025....................48
Figure 24: Encroached catchment areas of ponds in Ghata, Jharsa and Sukhrali by infrastructure projects and illegal settlements, dumped with municipal sewage. ........51
Figure 25: Approach for institutionalizing an integrated water management framework 57
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCG</td>
<td>Municipal Corporation of Gurugram</td>
</tr>
<tr>
<td>GMDA</td>
<td>Gurugram Metropolitan Development Authority</td>
</tr>
<tr>
<td>MCM</td>
<td>Million Cubic Meters</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>MoWR</td>
<td>Ministry of Water Resources</td>
</tr>
<tr>
<td>CWC</td>
<td>Central Water Commission</td>
</tr>
<tr>
<td>CGWB</td>
<td>Central Ground Water Board</td>
</tr>
<tr>
<td>CPCB</td>
<td>Central Pollution Control Board</td>
</tr>
<tr>
<td>SPCB</td>
<td>State Pollution Control Board</td>
</tr>
<tr>
<td>MoEFCC</td>
<td>Ministry of Environment, Forest and Climate Change</td>
</tr>
<tr>
<td>HWRA</td>
<td>Haryana Water Resources (Conservation, Regulation and management) Authority</td>
</tr>
<tr>
<td>HSPC</td>
<td>Haryana State Pollution Control Board</td>
</tr>
<tr>
<td>HSVP</td>
<td>Haryana Shahari Vikas Pradhikaran</td>
</tr>
<tr>
<td>HUDA</td>
<td>Haryana Urban Development Authority</td>
</tr>
<tr>
<td>HSIIDC</td>
<td>Haryana State Industrial and Infrastructure Development Corporation</td>
</tr>
<tr>
<td>ULB</td>
<td>Urban Local Body</td>
</tr>
<tr>
<td>RWH</td>
<td>Rain Water Harvesting</td>
</tr>
<tr>
<td>GSDA</td>
<td>Groundwater Survey and Development Agency</td>
</tr>
<tr>
<td>GMDA</td>
<td>Groundwater Management and Development Act</td>
</tr>
<tr>
<td>GHG</td>
<td>Green House Gas</td>
</tr>
<tr>
<td>STP</td>
<td>Sewage Treatment Plant</td>
</tr>
<tr>
<td>WTP</td>
<td>Water Treatment Plant</td>
</tr>
<tr>
<td>MLD</td>
<td>Million Litres per Day</td>
</tr>
<tr>
<td>lpcd</td>
<td>Litres per Capita per Day</td>
</tr>
<tr>
<td>IUWM</td>
<td>Integrated Urban Water Management</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>AMC</td>
<td>Annual Maintenance Contract</td>
</tr>
<tr>
<td>CPHEEO</td>
<td>Central Public Health and Environmental Engineering Organisation</td>
</tr>
<tr>
<td>RWA</td>
<td>Resident Welfare Association</td>
</tr>
</tbody>
</table>
Executive Summary

According to The World Bank, urban population in India was estimated to be 34.5% in the year 2019\(^1\). There has been an increase in urbanization by almost 4% in the last decade due to growing migration of people from rural areas to cities in search of better job opportunities. It is estimated that at this rate by year 2030 and further in 2050, population of people living in Indian cities will go beyond 40% and 50% respectively\(^2\).

With a growing population, expanding economies, urbanization, and changing lifestyles this has had a major impact on our economic, social and environmental wellbeing due to increasing pressure on already strained water resources. The rapid population growth along with rising consumption levels and pollution is contributing in increasing water insecurities in urban India. The depleting water resources on the one hand, rising water demand on the other, leave limited possibilities to augment the water supply in the coming future. Rising effects of climate change may further aggravate the situation by generating higher magnitude and frequency of extreme weather events and also by altering the precipitation volume & pattern, which shall have adverse effects on the available sources of fresh water supply.

Water stress has specifically magnified for metropolitan cities like Bengaluru, Chennai, Delhi, Pune, etc. with depleting groundwater levels, widening of water demand and supply gap and rising pollution of water bodies to name a few. And therefore in order to combat these rising urban water issues, there is a need to enhance the sustainable water flow and management in cities. In this context, Mahindra-TERI Centre of Excellence (MTCoE) carried out a study to assess the water sustainability in the cities of Chennai, Gurugram and Pune. This report shows the water sustainability assessment of Gurugram city.

To achieve the above objective, a desk based research has been carried out by exploring different types of literature. A number of official reports and documents, Acts etc. by the state government (Haryana), urban local bodies, municipalities and other concerned institutions including research by private organisations have been studied.

The study has analysed various parameters i.e. city growth, land use, demographics and social & economic character, water policies and institutional setup at central, state and city level, water sources and its related infrastructure, that are essential to find the avenues for water sustainability, quantify anthropogenic and natural flows into and out of the town, and develop a metaphorical framework of water metabolism of the area to analyse flows of water within it and selection of dominant indicators that impact urban hydrology.

The study of these parameters has led to the identification of potential risks associated with the urban hydrology and management of the Gurugram city, especially focusing on the aspects related to the stakeholder engagement and flood risk. To overcome these threats, lists of recommendations have been listed. The report also goes a step further to identify the reasons for the weak implementation of the proposed recommendations and suggest measures for strengthening it.

\(^1\) https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?end=2019&locations=IN&start=1960
1. Introduction

This report presents a study of metabolic flow of water within urban system of Gurugram city for water planning and illustrates the nexus between various urban goals. The central objectives of the study are (a) to account for inflows and outflows of water (including wastewater) and to construct a well-defined water mass balance, (b) to illustrate how the metabolic flow of water is shaped by economic, policy-related, social, and other variables and how it alters the background water hydrology of city region, and (c) to demonstrate the spatial diversity and variation among the drivers.

Chapter I: City Growth and Environment focuses on the geographic characteristics, city growth and land use, demographics, social and economic character of the city. These are important drivers for urbanization and have helped in the study of urbanization rate and its impact on water systems of the city.

Chapter II: Water Governance and Administration includes water policies and institutional setup at central, state and city level. Water use and management is influenced by the water governance, like who gets what water, when and how and who has the right to water and related services, and their benefits. It determines the equity and efficiency in water resource and services allocation and distribution, and balances water use between socio-economic activities and ecosystems. The study for this chapter has helped in identifying gaps pertaining to water governance in the city.

Chapter III: Water Source Management and Infrastructure covers various water sources available for the city and its related infrastructure - water treatment plants, sewage treatment plants, water meters and water quality of waterways carrying wastewater. The study helps in the analysis of availability of existing water sources in the city and deficiencies in the existing water related infrastructure.

Note: Water quality analysis of rivers has not been conducted in detail as it is out of the study scope and would require a separate assessment. Moreover, the objective of study focuses on the quantity aspect with a brief touch upon quality.

Chapter IV: Potential Risks in Water Management highlights the possible threats to the urban water cycle and water demand and supply of the city. This chapter is significant as it identifies all the issues interconnected with each other on projections for the year 2025, starting from water availability, its allocation, to capacities of water and sewage treatment plants.

Chapter V: Recommendations on Sustainable Water Management lays down a list of suggestions on combating the identified risks and improving the existing water management. The chapter gives recommendations through an upgraded urban water cycle for the city and it covers all the topics/drivers discussed in the previous chapters impacting the urban water management.

System Definitions
The system boundary is defined as the area at Gurugram city (municipal area) level which includes both urban and some rural parts of the city. For the purpose of water hydrology, water mass balance and for analysing water demand, the study is confined only to urban areas, due to inaccessibility of data for rural areas.
2. City Growth and Environment

2.1 Geographic Characteristics

The geographic characteristics section consists of parameters like location, physiography & landforms, climate, forest and biodiversity features.

2.1.1 Location

Gurugram is located in the Indian state of Haryana having latitude and longitude coordinates as 28.3606° N, 76.8721° E respectively. It is located 30 kms south of the National Capital New Delhi. The district is one of Delhi’s major satellite cities and is part of the National Capital Region. Gurugram is the industrial and financial centre of the state of Haryana.

The district is located in the south-eastern bulge of the State and is having common border with Delhi state in the north. Jhajjar district lies to its north west, Rewari district to its south west, Mewat district in south, Palwal district in south east and Faridabad district makes eastern boundary with the district. Gurugram contains many small hill ranges which are part of the Aravali and Mangar Bani ranges.

Gurugram district is one of the 22 districts located in the state of Haryana which covers an area of 1,257 km² containing 976 km² of rural area and 281 km² of urban area.

The district is divided into four sub divisions Gurugram (West), Gurugram (South), Badshahpur & Pataudi which are further divided into five revenue tehsils namely, Gurugram, Sohna, Pataudi, Farrukh Nagar and Manesar and four sub-tehsils namely Wazirabad, Badshahpur, Kadipur and Harsaru and also comprises of four rural development blocks, Gurugram, Sohna, Farrukhnagar and Pataudi.

Gurugram tehsil covers an area of 333 km² out of which 131.8 km² is rural area and 201.3 km² is urban area³. Gurugram city i.e. municipal area covers an area of 250 km²⁴.

For the purpose of the study we have considered the Gurugram city (municipal area) of Gurugram tehsil in Gurugram district only.

³https://villageinfo.in/haryana/gurgaon/gurgaon.html
2.1.2 Physiography and Landform

Gurugram district comprises of hills on the one hand and depressions on the other, forming irregular and diverse nature of topography. Two ridges: Firojpur Jhirka – Delhi ridge forms the western boundary and Delhi ridge forms the eastern boundary of the district. These hills are northern continuation of Aravalli hills. These rocks are one of the oldest mountain systems in the country. The hillocks are dissected by rain fed torrents. The north-western part of the district is covered with sand dunes lying in the westerly direction due to south western winds. The extension of the Aravalli hills and the presence of sand dunes collectively form the diverse physiography of the district.

Physiographically we can sub-divide the district into two sub-parts: Gurugram plain and Sohna undulating plain with Aravalli offshoots. Gurugram plain spreads over northern and north-western parts of Gurugram tehsil and whole of Pataudi tehsil. The region as a whole is plain area. Sohna undulating plain with Aravalli offshoots extends over parts of Sohna and Gurugram tehsils. The entire region is covered with rocky surfaces of Aravalli offshoots. Only some patches of land are under cultivation. Due to offshoots of Aravalli ranges, the region is undulating. There is little cultivation owing to rocky areas, poor soil cover and roughness of surface.

There is no perennial river in the district. Seasonal streams are only a few, smaller in size and are inland. The drainage of the district is typical of the arid and semi-arid areas. Because of topographic diversity, the streams do not flow in any uniform direction. Important depressions of the district are Khalilpur Lake, Chandani Lake, Sangel – Ujhina Lake, Kotla Dhar Lake and Najafgarh Lake. Sahibi and Indrani are two important seasonal streams of the district.

The Sahibi Nadi, which originates in the Sewar hills of Jaipur, makes its presence in Gurugram tehsil before losing itself in the topographic depression of Jhajjar district after flowing in northern direction through Rajasthan state and Rewari district. The Indori Nadi

---

5 https://gurugram.gov.in/about-district/map-of-district/
originates from Aravalli hills in Rajasthan near village Indauri flowing in northerly direction. After passing through many villages of the district it joins Sahibi Nadi near Pataudi.

Apart from the above streams, Badshahpur, Mehndwari, Kasan, Manesar and Landoha nullahs play havoc during heavy rains.

The district has light soils as sandy loam, medium soil particularly light loam (Seoti) and loam (Bhangar and Nardak), coarse loam (Dahar and choeknote) and rocky surfaces. The soils in Gurugram Sub-Division range between sandy to sandy-loam.

Various streams flowing across the Gurugram district and its watershed region are shown in Figure 2.

![Hydrological map of Gurugram district](image)

**Figure 2**: Hydrological map of Gurugram district.

### 2.1.3 Climate

The climate of the district is characterised by its dryness and extremes of temperature and scanty rainfall. The district has a sub-tropical continental monsoonal climate where we find seasonal rhythm, hot summer, cool winter, unreliable rainfall and great variation in temperature. Air is generally dry. During the greater part of the year scorching dust laden winds that blow during hot season render the weather very tiring. Dense fog sometimes occurs during winter months.

Four seasons are observed in a year. Mid-March to end of June is summer season, followed by rainy season from July to mid-September, after which a transition period of two months follows. Then the cold season comes from mid-November to mid-March.

January is the coldest month when mean daily maximum temperature is about 21.4°C and mean daily minimum at 5.4°C. May and June are the hottest months. The mean daily maximum temperature in the month of May is around 40.2°C. On individual days, the day temperature may occasionally exceed 45°C. The highest maximum temperature recorded at
Gurugram was 49° C on May 10, 1966 and the lowest minimum temperature was 0.4° C on December 5, 1966.7

As far as rainfall is concerned, 72% of the normal annual rainfall in the district is received during June to September, July and September being the rainiest months. Average annual rainfall in Gurugram district is 505.4 mm8.

2.1.4 Forest and Biodiversity

The district covers Gurugram, Sohna and Pataudi forest ranges. The area under forests is classified according to ownership, viz. Private and State. Forests owned by corporate bodies and private individuals are included under private forests. The State forests are categorized as reserved, protected and unclassed.

These natural forests contain species like Khairi (Acacia Senegal) Dhoulk (Anaogeisus pendula edgew), Dhak (Butea monosperma), Papri, (Holopetelea integrifolia planch) Rounj, (Acacia leucophloea) Inderjo, (Wrightia tincoria) Chamror (Erhetia laevis), Grevia populifolia etc. Shisham and Neem are found in the foothills and plains. Kikar grows in the plains. Its bark is good for tanning. Shisham, Neem and Kikar are valuable as timber, firewoods and for making agricultural implements. Plantation of Eucalyptus trees in the plains, along roads, canals and boundaries of agricultural fields are the latest phenomenon in forestry development. Kit is used as firewood and pulp wood for paper industry.

The district is inhabited by various groups of mammals. Primates are represented by rhesus macaque or bander and the langur. The tiger and the leopard once abundant in the district are now almost extinct. Panthers and wolves have also seen the same fate. The carnivorous animals found in the district are the jungle cat (banbilla), foxes, jackals, mongoose (neola) and hare are found in forested areas of the district. Rats and mice are very common. A large number of migratory water birds visit the district during winter. Various types of ducks and geese such as Eastern greylag goose, Barheaded goose, Brahminy duck, Common teal, Mallard, Gadwall, Wigeon, Blue winged teal, Shoveller, Common pochard, Ferruginous duck, Tufted duck etc can be seen at tanks and lakes during winter. Colourful birds add beauty to the varied wild life. Most common colourful birds are Flamingo, Large Indian Parakeet, Rose-ringed Parakeet, Kingfishers Woodpecker; Bulbul etc. The national bird of India, the Common Peafowl is quite common and is seen in orchards, fields and gardens.

2.2 Urban Growth and Land Use

The urban growth and land use consist of sections on spatial growth pattern, land utilization and land cover.

2.2.1 Spatial Growth Pattern

Existence of Gurugram dates back to the mythological period of Mahabharat. And over the period the region (Gurugram and Manesar tehsils) had witnessed changes & transformations

---

7 District Census Handbook Gurgaon 2011
8 District Census Handbook Gurgaon 2011
from ancient to medieval to modern history period. Gurugram became prominent only around 1970’s, when one of the leading automobile manufacturing company, in the name of Maruti Suzuki India Limited established a manufacturing plant in Manesar tehsil. Since then Gurugram has been **constantly expanding vertically as well as horizontally**. It has grown **organically** due to economic imperatives and incentives. But it is also, as the chaos created yearly by the monsoon shows, a warning of what happens when the state abandons its role of shaping and enabling that growth. There was no municipal body, with the state-level Haryana Urban Development Authority (HUDA) expected to build the connective infrastructure. This meant the lack of any semblance of planning—not helped by malfeasance where private developers were able to push projects through without adequate development plans.

### 2.2.2 Land Utilization and Land Cover

The study of land use classification for Gurugram district has been shown in Figure 3 (land use classification for Gurugram city is not available). The statistics of Gurugram district can be taken as a representation of the Gurugram city (part of Gurugram tehsil) as it has witnessed the maximum land use change with population 9 times than in the other 4 tehsils. The district has witnessed significant changes in land use pattern in the period 2007 – 2017.

![Figure 3: Land use land cover change in Gurugram district (2007-2017) and estimated change in the year 2019 and 2025](image)

---


12 By author
Gurugram is one of the fastest-growing urban regions due to industrial growth and population influx. As seen from figure 3 and 4, following land use land cover changes have been experienced in the Gurugram district:

1. As seen in Figure 3, the built-up area in Gurugram has grown almost 2 times from 2007 to 2017. The built up area increased from 189.67 sq.km in 2007 to 358.90 sq.km in 2017. This can be attributed to its emergence as a major industrial hub in the last two decade by doing large-scale acquisition of agricultural lands by the government along with the development of residential townships and infrastructure for multinational companies. It is estimated that if this urban growth trend continues, the built-up areas will be increased to 518.86 km$^2$ by the year 2025. As seen in figure 4, most of the built up expansion is witnessed in the Gurugram tehsil followed by Manesar tehsil.

2. Due to the development and expansion of industries and settlements; vast agricultural land saw a decrease in its areas from 2007 to 2017 due to its conversion to built up use. It is estimated that its area will continue to decrease till 2025, considering the existing declining rate. The agriculture land covering an area of about 656.23 sq.km in 2007 reduced to 515.59 sq.km in 2017. It is estimated that if this urban growth trend continues, the agricultural land will be decreased to to 413.25 km$^2$ by the year 2025. The agricultural land is mostly concentrated in Patudi, Farrukh Nagar and Sohna tehsils.

---

Figure 4 : Graphical representation of land use land cover change in Gurugram district (2007-2017)

---

3. Due to continuous built up expansion and encroachments from 2007 to 2017, the water body and vegetation area saw decrease from 55.25 sq.km to 12.43 sq.km and from 209.64 sq.km to 98.92 sq.km respectively. It is estimated that if this urban growth trend continues, the overall area of these two types of land use which is already less, vegetation area will be decreased to 38.27 km² by the year 2025 and area of water bodies to an alarming 0.42 km². Necessary interventions will be required from the authorities to conserve the water bodies, which are estimated to continuously shrink in future. The increase in annual monsoon floods in the city is the testament of impact of shrinking water bodies and green cover.

In 1950s, Gurugram was replete with water bodies that merrily captured both the rainwater and the water flowing downhill from the Aravallis slopes. As per a first-of-its-kind study done by the Gurugram Metropolitan Development Authority (GMDA), the district had some 644 small and large water bodies. This was inferred by collating data from three main sources — the revenue record of 1956, the Survey of India map 1976 and the world view satellite imagery of 2012. Out of the 644 water bodies:

- 153 were found to be vanished beyond recovery.
- Another 53 bodies face severe threat due to intentional landfilling, garbage and construction waste dumping, and encroachment.
- 132 water bodies face contamination due to discharge of industrial affluent and waste water.
- Remaining 44 cannot be called water bodies as they experience only seasonal waterlogging.

4. Barren land appears to be expanding due to the rising influence of human activities on the natural resource of the area. Increasing use of pesticides, fertilizers, herbicides and insecticides are polluting the agriculture soil and making it unproductive. The barren land area increased from 76.61 sq.km in 2007 to 201.56 sq.km in 2017.

2.3 Demographic Description

The demographic description discusses about the population growth trend in context of the study area.

2.3.1 Population Growth Trend

**Gurugram District**

Gurugram district was the fourth most populated city in Haryana in 2011 with 15,14,085 population. There has been a rapid increase in population of the district due to the magnificent growth with latest industrialization and infrastructure development. The population growth of the district till 2011 is shown in Figure 5. The population is estimated to increase in future, considering the existing rate of growing population.

---

⁴ https://www.hindustantimes.com/cities/all-stakeholders-need-to-work-together-to-revive-water-bodies/story-71yd5Poh14cXZy6sZ7UWWL.html
Figure 5: Population increase in Gurugram district (1941-2011) and estimated population change in the year 2019 and 2025.

With the initiation of economic reforms in 1991, Gurugram saw a massive expansion in its population and economy after the real estate major, the DLF Group, started buying farmland owned by the local people to start developing housing societies for the upper middle class residents of Delhi. Further to this, the government removed bottlenecks in obtaining permits and provided special incentives to information technology/IT enabled services and business process outsourcing sectors which attracted foreign investment. Due to this the decadal variation in population jumped from 28.6% to 44.1% from 1991 to 2001.

---

15 Source: A - 2 DECADAL VARIATION IN POPULATION SINCE 1901, Census of India and Census of India 2001 and Provisional figures of Census India, 2011 and Development Plan of Gurgaon

16 By author
Population density in the Gurugram district continued to increase from 716 persons/km² in 2001 to 1,241 persons/km² in 2011 due to rapid expansion of IT industry which generated more employment opportunities resulting in influx of migrant population giving push to the development of residential spaces. Considering the rate of change from 2001 to 2011, the population density is expected to further increase to 3,341 persons/km² by 2025.

---

17 Source: A - 2 DECADAL VARIATION IN POPULATION SINCE 1901, Census of India and Census of India 2001 and Provisional figures of Census India, 2011 and Development Plan of Gurgaon
Figure 7: Population density change in Gurugram district (1991-2011)\(^{18}\) and estimated change in the year 2019 and 2015.\(^{19}\)

**Gurugram City (Tehsil)**

Out of all the 5 tehsils, Gurugram tehsil has witnessed the maximum urbanisation and population growth due to following reasons.

- Job opportunities are available in large numbers in Gurugram in almost all the trades.
- Better Infrastructure development and a decent standard of living.
- Major IT companies have their main or branch office in Gurugram.
- Connectivity of Delhi Metro to Gurugram with Delhi and Noida offers better transport facilities at low cost.
- Universities and Colleges are available in large number in Gurugram.
- Better road connectivity with Delhi and NCR region plays another major role as traveling becomes easy and affordable.

The maximum increase in population has occurred in central Gurugram city, which forms the industrial region, contiguous to Delhi and is therefore the hub of multinational corporations’ expansion.

Considering the current rate of population growth, the population in Gurugram tehsil is expected to reach 4.3 million by 2025.

Figure 8: Population increase in Gurugram tehsil (2001-2011)\(^{20}\) and estimated population change in the year 2019 and 2025\(^{21}\).

\(^{18}\) A - 2 DECADAL VARIATION IN POPULATION SINCE 1901, Census of India and Census of India 2001 and Provisional figures of Census India, 2011 and Development Plan of Gurgaon

\(^{19}\) By Author

\(^{20}\) District Census Handbook Gurgaon, Village and Town Directory, Census of India 2011, Haryana

\(^{21}\) By author
2.4 Social and economic character

2.4.1 Economy

Gurugram has become a hub of multinational companies, industries giants, call centres, software companies, shopping malls and skyscrapers. With the collaboration of Suzuki Motors of Japan and Maruti Udyog Limited in early eighties, a new area of rapid industrialization of Gurugram started as a result of which the district came on the international map. The automobile industry of Gurugram is producing passenger cars, motor cycles, scooters and its components. The Gurugram –Manesar-Bawal belt has emerged as the auto hub of the country, Thereby offering ample opportunities to the entrepreneurs. There are many prominent and prestigious units involved in the manufacturing of telecommunication equipment, electrical goods, sports goods, rubber products and readymade garments, and in software development. Other industries include light engineering goods, pharmaceuticals, agro based and foods processing, leather, terry towels, air conditioners, shoes, pesticides, insecticides, etc.

The gross domestic product of Gurugram district had the highest share of 25.3% in the Haryana state income (2011-12).\textsuperscript{22} Gurugram recorded the highest GDP 26,99,055 lakhs in the sub-region in the year 2009-10 followed by Faridabad district\textsuperscript{23}.

The district wise per capita income in the state was highest in Gurugram with 2,29,208 lakhs in 2009-10\textsuperscript{24}, which continued to remain highest in 2011-12 with 3,16,512. 2011-12, making it the richest district of Haryana\textsuperscript{25}.

The workforce participation in primary sector was 52.9%, in secondary sector was 20.03% and in tertiary sector was 27% in year 2001\textsuperscript{26}. But the workforce engagement changed over the years and Gurugram district transformed its economy from “Agriculturally dominant” to “Developing” economy. Proportion of main workers engaged in agricultural activities (cultivators and agricultural labourers) came down from 53.9% of 1991 to 12.3% in 2011 Census. Tertiary activities like IT, software, service and sales with 81.4% of the main workers are now rapidly dominating the economy of the district\textsuperscript{27}.

2.4.2 Agriculture

Rural population forms a major portion of the city’s total population and agriculture is the predominant occupation of the majority of the people in Gurugram district. The main source of the irrigation is tube-well, which irrigates about 96.8% of the total irrigated area.

As can be seen from Figure 3, agriculture area in Gurugram district has decreased over the last two decades. The agriculture area decreased from 656.23 sq.km. in 2007 to 515.59 sq.km in 2017 and taking this as the declining rate, the agriculture area might be roughly decreased to 487.85 sq.km in 2019. The urban growth of the Gurugram and Manesar tehsils has transformed most of the agricultural and barren land into residential, commercial and office

\textsuperscript{22} Inter-Regional Disparities in Haryana, Institute for Development and Communication, 2014
\textsuperscript{23} Sub-Regional Plan for Haryana Sub-Region of NCR-2021, Chapter 5, Economic Scenario
\textsuperscript{24} Sub-Regional Plan for Haryana Sub-Region of NCR-2021, Chapter 5, Economic Scenario
\textsuperscript{25} Inter-Regional Disparities in Haryana, Institute for Development and Communication, 2014
\textsuperscript{26} Sub-Regional Plan for Haryana Sub-Region of NCR-2021, Chapter 5, Economic Scenario
\textsuperscript{27} District Census Handbook Gurgaon, Village and Town Directory, Census of India 2011, Haryana
area. The agricultural land today is mostly concentrated in Patudi, Farrukh Nagar and Sohna tehsils.

The agriculture water demand is met through groundwater supplied by canal systems and tube wells. Monsoon and non-monsoon rainfall, irrigation return flow, recharge from canals, lakes, ponds and floods contribute to ground water resources. This annual recharge of the aquifer contributes towards dynamic ground water resources, a significant quantity of which is stored in the aquifer and part of it contributes to the rivers as base flow.

Artificial irrigation systems such as canals, wells, tanks and tube wells etc. provide water for irrigating vast expanse of agricultural land. As previously mentioned, the district has a considerable topographic diversity. As the drains tend to flow towards inland depressions instead of some river, here irrigation is possible only by storing water by making bunds. Underground water level is relatively high in the district but under rocky surfaces water level is quite deep. Irrigation facilities are coming up in the district, giving a hope of prosperity to the farmers whose mainstay is agriculture.

Recent data on agriculture output is not available at Gurugram district level. Therefore agricultural water demand has not been considered in the final calculations for Gurugram’s water demand and supply.

2.4.3 Industry

Gurugram was envisioned as one of the four major satellite cities of Delhi to ease the pressure of industrial and economic growth in the national capital. The sleepy hamlet transitioned into an industrial hub in late 1970s with the establishment of one of the largest automobile manufacturing units by Maruti-Suzuki. The growth of ancillary industries like auto components, along with textile and chemical industries, transformed Gurugram into an industrial hub. After the liberalization of the Indian economy in 1990, the city developed rapidly into an information technology/business process outsourcing (IT/BPO) taking advantage of its proximity to the national capital international airport, New Delhi.

Gurugram district today has the largest number of large and medium units among the districts of the State. There were 425 large and medium industrial units upto 2010 in Gurugram district. Having about 27.5% of the large and medium industrial units, it was top ranking district of the State.

As per Statistical Abstract of Haryana, for the year 2012 there were 1,825 registered working factories in the district employing an estimated number of 250,202 workers therein. Major fields of concentration of industries included textile products; other manufacturing industries; transport equipment and parts; chemical & chemical products; electrical machinery, apparatus and appliances; machinery and machine tools etc; non-metallic mineral products; rubber, plastic and petroleum products; metal products and parts; and basic metal and alloys. Minor areas of concentration included food products; cotton textile; repair services; wool, silk and synthetic fibres; beverages, tobacco & products; gas & steam; water works & supply; and wholesale & retail trade.
Due to favourable industrial climate, better institutional, residential, commercial and entertainment facility, 35 multinational companies have set-up their industrial units and more than 60 multinational companies have set up their corporate offices in the district. Besides, 582 small scale/micro small-medium industrial units were also working in 2011 with an investment of Rs. 122.1 crores in the district. These units were providing employment to 4,587 persons and annual production was of Rs.152.0 crores.

The State government has set up Software Technology Park in Electronic City, Gurugram, functioning since 2002. The district, alone in the State, exported software of over Rs. 1,500 crores during 2000-01. Prominent information technology units in the district are Huge Software Systems Ltd; Tata Consultancy Senses Centre; G.E. Credit International; IBM; HCL Technology; Motorola Ltd; Polaris Ltd; Alcatel Modi Systems Ltd; etc.

**Data on industrial water consumption is not available at Gurugram district level.** Therefore industrial water demand has not been considered in the final calculations for Gurugram’s water demand and supply.

### 2.4.4 Housing

Gurugram city (tehsil) is divided into 36 wards, with each ward further divided into blocks. The housing type in the city consists largely of attached housing and also attached multi-dwelling units, including apartments, condominiums and high rise residential towers. Gurugram city has an estimated 1,100 residential high-rises.

The Gurugram city landscape presents a very contrasting picture where hundreds of jhuggis located in the slums can be seen with high-rise buildings and residential complexes in the backdrop. These slums are occupied with thousands of people which provide cheap workforce for the residences and offices in the nearby vicinity.

Gurugram is facing one of the worst problems due to massive migration of rural population moving to city peripherals, illegal encroachment by immigrants occupying several locations, and living in disdainful conditions. In 2015, According to the 2011 Census, Gurugram had a total of 30,888 slums with 1,44,805 population. In 2015, the city had 10.2% of slum population of Haryana with a large number of 1,69,549 slum dwellers.

The distribution of piped water to Gurugram began in the year 1990, when the city began drawing water from the Yamuna canal in Sonepat. Prior to this, the area was entirely dependent on groundwater as there was no other major source of surface water, such as a river, to draw from. The launch of city’s first water treatment plant in Basai, in 1995, helped augment this supply for the then developing sectors, between 1 and 57, which have since come to rely almost entirely on canal water. With the city’s continued urban boom today, the demand for piped water comes mainly from sectors 58 to 115.

Data on households with access to tap water is not available for Gurugram city area and thus

---


29 https://www.hindustantimes.com/gurgaon/haryana-chief-minister-okays-state-slum-in-situ-rehabilitation-policy/story-di164gg7p0qizjzr9kx9j0j.html#:~:text=%2C%E2%80%9D%20Jain%20said.-,According%20to%20the%202011%20Census%20of,Gurgaon%20has%20a%20total%20of,city%E2%80%948%
%2C86%2C519%20people.
has not been analysed.

### 2.5 Inferences

- **Gurugram city** is going to experience a **continuous exponential built up expansion** in coming years due to the rapid economic development. This shall lead to an unprecedented growth of the city in terms of population which in turn shall increase the demand for housing and other civic amenities like water supply. A major chunk of the migrated population shall constitute of lower strata group, which would be forced to live in the slums due to demand-supply gap of housing in the city. Providing water connections to growing population of the slums could pose a challenge for the authorities, as it further adds to the burden of water resources already under pressure and an overall urban infrastructure.

- Haphazard and uncontrolled growth in and around the city has had severe repercussions on local ecological systems; wetland and natural vegetation loss, and interruption of natural drainage channels. **Gurugram has experienced continuous rapid depletion of water bodies** due to alteration in the land topography to maximise real estate development in the city. Buildings have come up right upon low-lying places that once had johads (traditional name for ponds and lakes). **Rapid built up expansion in coming years** could put an enormous **pressure on land and water resources**, which could further alter the resource availability and ecology of the area. Ponds and lakes could continue to shrink due to encroachments, unauthorised constructions and poor disposal of municipal waste and construction debris into them. The **flood intensity during monsoons will keep on increasing** in Gurugram city due to **reduction in catchment area** with shrinking water bodies and green cover and expansion in built up land.

- Gurugram’s rapid expansion due to IT revolution and leveraging the city’s proximity to the airport in the last two decades has resulted in rapid increase in population of the city. Due to unplanned growth model the city could continue to face issues w.r.t. meeting the water demand for residential, commercial and industrial projects as Gurugram nears its urbanisation potential.

- **The major sectors of water consumption** in the cities over coming years will be majorly **residential housing, commercial and institutional establishments**. Agricultural land area is on a decline due to conversion into built up and would almost become negligible in near future. The agricultural land today is mostly concentrated in Patudi, Farrukh Nagar and Sohna tehsils.
3. Water Governance and Administration

3.1 Water Laws and Policy in India

Legal provisions related to water are available in the constitution, court decisions, central and state laws, and various irrigation acts. However, India does not have any exclusive or comprehensive water law. Water is included in the State List of the 7th Schedule of the Constitution of India and hence all activities related to planning, development, and management of water resources are undertaken by the respective states through their water resources or irrigation departments. In many cases, state governments have established autonomous bodies and corporations for the development and management of water resources.

India does not have any specific law defining the ownership of and rights over water sources. The laws are derived from court rulings and customs. Several court judgments in post-independent India have affirmed that all natural resources—resources that are by nature meant for public use and enjoyment—are held by the state in public trust. For example, the legal position on whether groundwater is a resource meant for public use is fuzzy, and India has no law that explicitly defines groundwater ownership. It is customarily accepted across India that a well on a piece of land belongs to the owner of that land, and others have no right to extract water from the well or to restrict the landowner’s right to use the water. This belief and practice is indirectly supported by various laws such as land acts and irrigation acts that list all the things to which the government has a right but groundwater is not mentioned in any such list.

As yet, no law or policy has been formulated asserting that water is a fundamental and inviolable right enjoyed by every citizen of the country. The ‘right to water’ can therefore be obtained in India on a case-by-case basis, by appealing to the court. At the same time, it has been implicitly accepted that the central and state governments have a primary responsibility to provide drinking water and, subsequently, water for other purposes. Accordingly, a host of programmes and policies have been framed and implemented at the central and state levels including the National Water Policy (National Water Policy, 2002; National Water Policy, 2012).

3.1.1 Institutional Setup at Central Level

At the central level, the Ministry of Water Resources (MoWR), set up in 1985, has been the nodal ministry responsible for developing, conserving, and managing water as a national resource.

In May 2019, Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Drinking Water and Sanitation were merged to form Ministry of Jal Shakti in order to streamline their functions i.e. to maintain the quality of drinking water and the natural water bodies, ensure efficient use of water resources to meet the growing demand and sensitization of citizens for water conservation thus contributing towards the enhancement of sustainable development. The ministry’s remit covers areas as diverse as irrigation, multipurpose groundwater exploitation, command area development, drainage, and flood control. The ministry also tackles issues related to waterlogging, soil erosion, dam safety, and...
creation of structures for navigation and hydropower and oversees the development and regulation of interstate rivers.

Three principal technical organizations are part of the ministry: the Central Water Commission (CWC) is responsible for developing and quality measurement of surface water in the basins of major and medium-sized rivers; the Central Ground Water Board (CGWB) monitors, develops, and regulates groundwater resources; and the National Water Development Agency was set up to assess the possibilities of inter-basin water transfers.

The Central Pollution Control Board (CPCB), in collaboration with the State Pollution Control Boards (SPCBs) in several states, has been separately monitoring aquatic resources at selected locations since 1977.

Water quality and environmental matters come largely under the Ministry of Environment, Forest and Climate Change (MoEFCC), which coordinates India’s Environmental Action Plan. The Ministry of Housing and Urban Affairs coordinates projects in urban water supply and sanitation. The Rajiv Gandhi National Drinking Water Mission, which is part of the Ministry of Rural Areas and Employment, handles rural water supply and sanitation. The Ministry of Power and the Central Electricity Authority handle water for power generation. Water is also a subject of several other ministries and departments, such as the Ministry of Agriculture (irrigation), the Ministry of Health and Family Welfare, the Ministry of Surface Transport, the Inland Waterways Authority of India, and, for planning and financing, Niti Ayog, the Ministry of Finance, and the Finance Commission.

3.1.2 Institutional Set-Up at State Level

Haryana Water Resources (Conservation, Regulation and Management) Authority (HWRA): HWRA has been constituted recently this year (2020) under The Haryana Water Resources (Conservation, Management and Regulation) Bill, 2020. The authority is established to ensure conservation, management and regulation of water resources i.e. ground water and surface water of the state for ensuring the judicious, equitable and sustainable utilization, management, and regulation.

Haryana State Pollution Control Board (HSPCB): The Haryana State Pollution Control Board was constituted in the year 1974, after the enactment of Water (Prevention & Control of Pollution) Act, 1974 to preserve the wholesomeness of water. Subsequently, with the enactment of other environmental laws the responsibility to implement the provisions of such laws was also entrusted to the Haryana State Pollution Control Board in the State of Haryana. Objectives of the board pertaining specifically to water are:

i. Control pollution at the source with due regard to techno-economic feasibility for liquid effluents.

ii. Ensure that natural waters are not polluted by discharge of untreated city sewage.

iii. Maximize reuse / recycling of sewage and trade effluents and to use the treated effluent on land for irrigation and for industrial purpose after appropriate treatment.
Haryana Shahari Vikas Pradhikaran (HSVP): Haryana Shahari Vikas Pradhikaran, formerly known as Haryana Urban Development Authority (HUDA) was established in 1977, is the urban planning agency of the state of Haryana in India. Until the formation of Gurugram Metropolitan Development Authority (GMDA) in 2017, Gurugram was governed by HSVP.

Irrigation and Water Resources Department, Government of Haryana: It looks after the water resources management, irrigation and flood works across the state.

Haryana State Industrial and Infrastructure Development Corporation (HSIIDC): HSIIDC is the nodal agency for development of industrial infrastructure in Haryana. Its functions are to provide water supply, drainage and sewerage services and industrial wastewater treatment services in the industrial designated areas.

3.1.3 Administrative Set-Up of Gurugram City (Tehsil)

The 74th Amendment to the Constitution mandates state government to transfer the responsibility for water supply services to urban local bodies (ULBs). The local bodies and development authorities in Gurugram is governed by important piece of legislation, namely The Haryana Municipal Corporation Act 1994 and The Gurugram Metropolitan Development Authority Ordinance, 2017 respectively.

Gurugram Metropolitan Development Authority (GMDA) was constituted in year 2017 in order to improve the governance, land acquisition for implementation of plans for infrastructure development and sustainable management of the urban environment and maintenance issues in the city by improving the coordination among the different government bodies in Gurugram to cut down the multiplicity of authorities. It provides treated raw water to the area under its jurisdiction (municipal area).

Whereas, Public Health Engineering Department, Haryana (PHED) provides piped drinking water supply in villages & towns, sewerage facilities and storm water disposal in towns and also construction of sewage treatment plants.

Municipal Corporation of Gurugram (MCG) was formed in 2008 in order to look after the water supply and drainage system in the city (sectors 1 to 57). Contrary to popular perception, the MCG does not have the responsibility of managing all areas of the city. There are a lot of areas especially in New Gurugram which are under the management of private RWA’s and HUDA.

Various agencies working in the water sector and their functions in Gurugram City are:

- **Water supply, sewerage services, rain water harvesting and storm water drain management** is partially under MCG, HUDA, GMDA and PHED. Post formation of GMDA in 2017, the services including water supply network and sewage infrastructure was handed over to them from HUDA except for two sectors i.e. Sector 29 which is purely commercial and Sector 53 where plots are yet to be given out. GMDA controls the master water supply and sewerage network while MCG looks after the internal lines.

- **The water quality monitoring** of water bodies is done by Haryana State Pollution Control Board (MPCB).
• **Groundwater** use forms an important part of water use in the Gurugram city. The onus of groundwater control, regulation, abstractions and transportation is on **Central Ground Water Board (CGWB)**.

• **Irrigation and Water Resources Department**, Government of Haryana looks after the irrigation and flood control works in Gurugram.

---

**Figure 9**: Institutional framework for the water sector in Gurugram city

### 3.2 Inferences

- Governance in the city has always been fragmented, HUDA, PWD of the Haryana state government, MCG, GMDA and private developers being responsible for service provisioning in different parts of the city depending on their respective jurisdictions. This jurisdiction issues have created infrastructure problems in certain areas. Gurugram was a relatively small urban area and did not acquire the status of a city till 2001. It was governed by a municipal council and was directly controlled by the Chief Minister’s Office, making it easy to get requisite clearances for changes in land use plans. The city landed its first Municipal Corporation in 2008. In 2017, GMDA was created by an Act of the State
Legislature. These multiple urban governance bodies in the city functions within a tangle of overlapping jurisdictions and poor coordination which weakens accountability and creates delay in finding and implementing solutions to the problems being addressed. For example a newly demarcated function depicts the MCG which does the front-end work and the GMDA which takes care of the back-end but this process is yet to percolate entirely.

- The model of development adopted by the state government was characterized by random nature of growth in the city. For example in 1975, the state government passed the Haryana Development and Regulation of Urban Areas Act, which gave space to the private sector in real estate development, due to which vast expanse of agricultural land was acquired by them. A number of water bodies in the city have said to be filled up to facilitate construction which resulted in the brazen destruction of ecology. This, coupled with the rampant flouting of planning and construction norms, has spelt disaster for the waterscape in the city. Due to this the city sprung up in a haphazard manner rapidly that ensured that several parts of it did not have basic amenities such as water supply and sewerage lines.
4. Water Source Management and Infrastructure

4.1 Water Sources

Gurugram doesn’t have any major lake or river that flows across the city. Most of the seasonal streams and ponds have dried up due to rampant concretisation and ill maintenance. Although it wasn’t always like this. The Najafgarh jheel (lake) used to be an immense wetland lying across Gurugram and Delhi. It was fed by the Sahibi River and floodwaters from Gurugram, Rewari, Jhajjar and north-west Delhi.

Old records indicate that the jheel was spread over 300 sq. km before its unfortunate draining. Its existence was recorded as far back as 1807. It played a vital role in the agrarian economy by supporting irrigation, animal husbandry and fishing. The Najafgarh jheel’s wetlands hosted innumerable migratory and resident birds, including the endangered Siberian crane, pink-headed ducks and greater flamingos. To date, wild animals and reptiles endemic to the region and several species of birds are sighted here. In addition, the jheel was a recharge source for the surrounding aquifers.

In 1960, the Flood Control Department of Delhi kept widening the Najafgarh drain in the pretext of saving Delhi from floods and eventually quickly drained the once huge and ecologically rich Najafgarh Lake completely. It was converted into farmland first and by now various large scale housing projects occupy the former lake basin. However, in case if the Najafgarh Drain ever breaches its man-made and fortified embankments during the monsoon season, large swaths of these housing colonies could be flooded, causing a major disaster.

Gurugram gets its water from the nearby flowing river Yamuna through manmade canals. Large-scale extraction of groundwater by private tube wells is also seen.

To fulfil the increasing demand of water in Gurugram city, a number of sources are being tapped to source and distribute water to the region. Both the areas receive their water from three main sources: rain water, surface water and ground water.

4.1.1 Rainwater

The monsoon period in Gurugram starts from late June and lasts till September. As shown in table 1, Gurugram city receives maximum rainfall from June to September with an average annual rainfall of 795.4 mm and with August being the wettest month (as per average data from 1956-2000). Water from monsoon rains fills the streams, ponds and replenishes the ground water periodically. This water is then distributed to meet the requirements of the city.
### Table 1: Average month wise rainfall and evapotranspiration statistics of Gurugram city30

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Rainfall (mm) (1956-2000)</td>
<td>18.9</td>
<td>16.6</td>
<td>10.8</td>
<td>30.4</td>
<td>29</td>
<td>54.3</td>
<td>216.8</td>
<td>247.6</td>
<td>133.8</td>
<td>15.4</td>
<td>6.6</td>
<td>15.2</td>
<td>795.4</td>
</tr>
</tbody>
</table>

### Table 2: Month wise rainfall and rainy days statistics Gurugram city from year 2010-202031

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>January Rain (mm)</td>
<td>5.95</td>
<td>1.17</td>
<td>0.58</td>
<td>7.18</td>
<td>11.96</td>
<td>0.9</td>
<td>0.01</td>
<td>11.05</td>
<td>1.91</td>
<td>18.3</td>
<td>44.1</td>
</tr>
<tr>
<td>Days</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>February Rain (mm)</td>
<td>2.55</td>
<td>18.17</td>
<td>0.03</td>
<td>26.49</td>
<td>7.84</td>
<td>6.91</td>
<td>1.69</td>
<td>0.06</td>
<td>3.72</td>
<td>16.1</td>
<td>34.5</td>
</tr>
<tr>
<td>Days</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>March Rain (mm)</td>
<td>0.88</td>
<td>0.93</td>
<td>1.06</td>
<td>2.44</td>
<td>11.15</td>
<td>31.41</td>
<td>6.48</td>
<td>4.87</td>
<td>4.51</td>
<td>16.9</td>
<td>95.7</td>
</tr>
<tr>
<td>Days</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>11</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>April Rain (mm)</td>
<td>0.41</td>
<td>11</td>
<td>9.81</td>
<td>6.7</td>
<td>3.02</td>
<td>21.08</td>
<td>1.23</td>
<td>2.7</td>
<td>4.67</td>
<td>129.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Days</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>10</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>May Rain (mm)</td>
<td>0.06</td>
<td>22.61</td>
<td>3.1</td>
<td>0.24</td>
<td>7.87</td>
<td>1.11</td>
<td>11.38</td>
<td>2.8</td>
<td>2.56</td>
<td>12.9</td>
<td>19.7</td>
</tr>
<tr>
<td>Days</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>June Rain (mm)</td>
<td>1.16</td>
<td>68.99</td>
<td>4.49</td>
<td>30.91</td>
<td>12.07</td>
<td>61.67</td>
<td>24.2</td>
<td>22.36</td>
<td>43.18</td>
<td>15.7</td>
<td>29.4</td>
</tr>
<tr>
<td>Days</td>
<td>2</td>
<td>19</td>
<td>2</td>
<td>11</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>July Rain (mm)</td>
<td>131.79</td>
<td>174.26</td>
<td><strong>68.98</strong></td>
<td><strong>45.27</strong></td>
<td><strong>17.64</strong></td>
<td><strong>121.7</strong></td>
<td><strong>96.24</strong></td>
<td><strong>38.9</strong></td>
<td><strong>153</strong></td>
<td><strong>240.8</strong></td>
<td><strong>156.7</strong></td>
</tr>
<tr>
<td>Days</td>
<td>20</td>
<td>28</td>
<td>20</td>
<td><strong>16</strong></td>
<td>9</td>
<td><strong>12</strong></td>
<td>28</td>
<td>15</td>
<td><strong>20</strong></td>
<td><strong>23</strong></td>
<td>25</td>
</tr>
<tr>
<td>August Rain (mm)</td>
<td><strong>157.65</strong></td>
<td><strong>311.17</strong></td>
<td>64.93</td>
<td>40.63</td>
<td>13.23</td>
<td>55.01</td>
<td>60.49</td>
<td><strong>57.56</strong></td>
<td>66.52</td>
<td>155.3</td>
<td><strong>229.4</strong></td>
</tr>
<tr>
<td>Days</td>
<td>29</td>
<td><strong>27</strong></td>
<td>21</td>
<td>22</td>
<td>12</td>
<td>18</td>
<td>17</td>
<td><strong>11</strong></td>
<td>20</td>
<td>28</td>
<td><strong>26</strong></td>
</tr>
<tr>
<td>September Rain (mm)</td>
<td><strong>212.46</strong></td>
<td>136.69</td>
<td>30.16</td>
<td>14.65</td>
<td><strong>30.86</strong></td>
<td>26.75</td>
<td>3.23</td>
<td>32.33</td>
<td>94.25</td>
<td>74.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Days</td>
<td>22</td>
<td>18</td>
<td>11</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>3</td>
<td>7</td>
<td>13</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>October Rain (mm)</td>
<td>2.65</td>
<td>0</td>
<td>0.03</td>
<td>1.49</td>
<td>0.62</td>
<td>1.11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Days</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>November Rain (mm)</td>
<td>6.5</td>
<td>0</td>
<td>0.23</td>
<td>0</td>
<td>0.17</td>
<td>0</td>
<td>0.07</td>
<td>0.31</td>
<td>22.2</td>
<td>15.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Days</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>December Rain (mm)</td>
<td>4.41</td>
<td>0</td>
<td>0.57</td>
<td>2.07</td>
<td>1.5</td>
<td>0.12</td>
<td>0</td>
<td>0.51</td>
<td>5.19</td>
<td>23.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Days</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Total annual rainfall (mm)</td>
<td>526.4</td>
<td>744.9</td>
<td>203.7</td>
<td>178.3</td>
<td>117.7</td>
<td>327.9</td>
<td>204.9</td>
<td>173.2</td>
<td>379.8</td>
<td><strong>803.9</strong></td>
<td>651.3</td>
</tr>
<tr>
<td>Total number of rainy days in a year</td>
<td>89</td>
<td>116</td>
<td>67</td>
<td>74</td>
<td>66</td>
<td>70</td>
<td>76</td>
<td>54</td>
<td>82</td>
<td><strong>120</strong></td>
<td>126</td>
</tr>
</tbody>
</table>

As seen in table 2, the rainfall pattern in Gurugram from 2010 to 2020 has been analysed:

- It can be seen that in the non-monsoon months i.e. from January to May the rainfall pattern shows an extremely inconsistent pattern over the mentioned span of last ten years. Especially in year 2019, the average rainfall intensity experiences a drastic increase in months January, February and April as compared to the previous years.

- Secondly, in the last 10 years July has become the wettest month in Gurugram as compared to data from 1956-2000 in which August used to be the wettest month, indicating the preponement of heavy spell of rain.

- The total annual rainfall saw six times the decrease from 2011 (744.9 mm) to 2014 (117.7 mm). In the next year in 2015 it shot up thrice to 327.9 mm. It continued to decrease again till 2017 to 173.2 mm. The annual rainfall intensity jumped to 803.9 mm in 2019, the year it saw one of the worst floods in the region which affected lives and property and making the city come to a standstill.

The major factor for such an unpredicted rain spell can be attributed to the changing climate across the world due to global warming of which GHG emissions are the most prominent reason. Earlier, the city used to witness continuous light rains over two-three days and was spread evenly across monsoon months. But in the last decade, the same quantum of rainfall occurs in just 2-3 hours showing an irregular downpour even in the monsoon months. These extreme events have been taking place across the entire tropical region for quite some time now.
4.1.2 Surface Water

The Western Yamuna Canal (WYC) command area is located between the north latitudes 28°20' and 30°29' and east longitudes 75°48' and 77°35' and comprises the eastern, central and southern parts of the state of Haryana. It has a geographical area of about 13,543 sq km spread over 49 blocks in the districts of Karnal, Panipat, Sonepat, Rohtak and Jhajjar and partly in the districts of Hisar, Bhiwani, Jind, Yamunanagar, Gurugram and Rewari (Amita Bhaduri, 2010).

Figure 11: Schematic diagram of WYC highlighting the GWS channel
The total length of the WYC with all its branches is 325 km. The Delhi Branch section (Khubru head till Kakroi head) is 45 km long and discharges 2000 cusec of water. The off take of raw water from this section is done by two channels that supply water to the city namely (Narain, 2017):

- **Gurugram Water Supply (GWS) Channel**: The water comes through the Western Yamuna Canal near Sonepat and then through the 70-km GWS channels from Kakaroi village to water treatment plant in Basai in Gurugram. It is under the jurisdiction of the Delhi Water Services Division of the Irrigation Department. The channel was constructed in the year 1994–95 with a capacity of 135 cusecs, which has since been increased to 200 cusecs. The remaining requirement of 800 cusecs of water, out of the ultimate projected demand of 1000 cusecs, is expected to be met through the new NCR Water Supply Channel.

- **National Capital Region (NCR) Water Supply Channel**: It was built to supply water to the fast growing Gurugram city and other proposed townships of HSIIDC and SEZs by corporate developers in the area. NCR channel runs parallel to GWC. Initially the channel had water carrying capacity of 500 cusecs, with a provision to increase its carrying capacity to 800 cusecs. The channel has been obliged to meet the requirement of drinking water in the embryonic metropolitan city of Gurugram and also for other areas like Bahadurgarh, Sampla, Badli, rural areas of Jhajjar district, SEZs and industrial townships at Manesar, Bahadurgarh and Kharkhoda. Finally now the NCR channel is being constructed for a length of 75.536 Km to meet the ultimate demand of 800 cusec discharge up to the year 2021 for meeting drinking, industrial and tourism water requirements.

---

32 Source: https://onemapggm.gmda.gov.in/GIS/Auth/OneMap2D/
Figure 13: Surface water sources for Gurugram tehsil.

4.1.3 Ground Water

Gurugram ever since it came into being has been drawing groundwater at an alarming rate. The withdrawals accelerated after the Haryana government invited private enterprises to set up base in the city. Residential and office complexes came up at dizzying speed, and went on guzzling even larger amounts of groundwater, all free of cost. The inevitable result being with the city’s expansion in the 1980s, Gurugram’s water table has fallen by over a metre each year (CSE India, 2012).

The average depth of water in Gurugram district is critical and continuously increasing. The average water level depth in 1974 was 6.64m which increased to 22.62m in 2014 (Aneja, 2017).

Table 3 shows the groundwater development in Gurugram district. The statistics given below reflect that, ground water development is way too high more than 200% in Gurugram. This stage of development comes under the overexploited category (Gangurde, 2015).
Table 3: Details of Groundwater Development in Gurugram district in 2015

<table>
<thead>
<tr>
<th>District</th>
<th>Ground water Availability (Hectare meter)</th>
<th>Ground water Consumption for Irrigation (Hectare meter)</th>
<th>Domestic and Industrial consumption of Ground water (Hectare meter)</th>
<th>Total consumption of Ground Water (Hectare meter)</th>
<th>Ground water development (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gurugram</td>
<td>23261</td>
<td>35777</td>
<td>18150</td>
<td>53927</td>
<td>231.83</td>
</tr>
</tbody>
</table>

The average depth of water in Gurugram block (tehsil) is also extremely critical and is continuously increasing as shown in figure 14. The water table fell to 36.21m below ground level in 2016. In 2006, this was 19.85m, showing an alarming decline of about 17m over the decade (Pati, 2020).

Figure 14: Groundwater level in Gurugram city (2010-2020)

Rapid real estate development has outpaced both city planning and the public infrastructure related to water supply, waste water treatment and recharge. This rapid development is also impacting the water bodies, green spaces, nullas as well as air quality and the overall quality of life. Rapid population growth in Gurugram has led to an imbalance between annual groundwater extraction and recharge levels.
Rainfall variability has a potential impact on the groundwater resources. More rain means higher ground water levels. But if we observe the annual rainfall statistics in table 2, the change in groundwater levels are found to be abrupt as far its dependence on rainfall intensity is concerned. For example the groundwater level in year 2020 was 36.2m (lowest amongst year 2010-2020) while the annual rainfall was 803.9 mm (which was highest as compared to other years). This recurring anomaly can be due to the following reasons as stated below:

- **Raid population increase** has led to **higher levels of extraction of groundwater than the recharge** because of which there has been a decline in the city’s groundwater table by 1.5m to 2m on an average each year over the last decade. This is faster than the rate of depletion of groundwater table in Delhi. It has more than 40% area which does not have water connection provided by the civic agencies, and thus are dependent on groundwater (Pati, 2020).

- **CGWA in 2008, has declared Gurugram as a dark zone but illegal groundwater extraction is being carried out openly** (Pati, 2020).

- **There are about 9,140 bore wells officially registered in Gurugram city, and more than 15,000 operating without permission** (Jha, 2020). The actual number of illegal bore wells is unknown which makes it difficult for monitoring the illegal extraction and control it.

- **The Aravalli hills in the city do have high level of cracks and fissures which makes it a superior zone for groundwater recharge. But due to dilution of protective laws, illegal felling of trees and encroachment are wiping out the hills affecting the groundwater levels.**

- **Excessive concretisation due to infrastructure development has led to shrinking of catchment areas**, thus resulting in flooding. Due to which the downpour is either evaporated or lost as storm water runoff and is unable to seep inside the ground.
4.2 Water and Wastewater Treatment Infrastructure

In order to meet the various types of city’s water demand, this requires infrastructure for a safe and continuous supply to the end user.

To meet the minimum water quality standards, Water Treatment Plants are installed where the water tapped from the reservoirs/rivers/canals is treated and further supplied to the city.

The waste water from cities is further collected and treated in Waste Water Treatment Plants in order to remove as much of the suspended solids as possible before the remaining water, is discharged back to the rivers.

4.2.1 Water Treatment Plants

Gurugram gets its water from the Yamuna River’s Tajewala headworks near Yamunanagar. The ever increasing fresh water demand of the growing city has been met by acquiring lands from the peripheral villages, namely, Basai, Chandu & Budhera to build water treatment plants and the construction of two canals. The two raw water canals, cutting through the periurban villages that lost both land and the water sources located on them in the process are GWS channel and NCR channel.

The GWS channel feeds the Basai WTP while the NCR channel feeds the Chandu Budhera WTP. It is then distributed to different parts of the city and supplied for different end uses for domestic and industrial purposes. At treatment plant, the raw water is made potable up to the standards of safe drinking water by pre-chlorination, primary treatment and filtration. Quality control is assured through laboratory testing at the WTPs.

Table 4: Water treatment plants serving Gurugram city (existing and proposed)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of WTP</th>
<th>Treatment Capacity (MLD)</th>
<th>Status/Targeted year of completion</th>
<th>Source of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basai WTP</td>
<td>272</td>
<td>Existing</td>
<td>GWS Canal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>90</td>
<td>2024</td>
</tr>
<tr>
<td>2</td>
<td>Chandu Budhera WTP</td>
<td>300</td>
<td>Existing</td>
<td>NCR Canal (Yamuna)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>300</td>
<td>2024</td>
</tr>
<tr>
<td></td>
<td><strong>Total Augmentation</strong></td>
<td><strong>962</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.2 Sewage Treatment Plants

The city has five major sewage treatment plants, three at Dhanwapur and two at Behrampur as shown in table 5 (GMDA, 2020).
Table 5: Sewage treatment plants in Gurugram city as of 2019

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of STP</th>
<th>Capacity (MLD)</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dhanwapur- STP I</td>
<td>68</td>
<td>Haryana Shahari Vikas Pradhikaran</td>
</tr>
<tr>
<td>2</td>
<td>Dhanwapur- STP II</td>
<td>50</td>
<td>Municipal Corporation of Gurugram</td>
</tr>
<tr>
<td>3</td>
<td>Dhanwapur- STP III</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Behrampur- STP I</td>
<td>120</td>
<td>Haryana Shahari Vikas Pradhikaran</td>
</tr>
<tr>
<td>5</td>
<td>Behrampur- STP II</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Capacity</td>
<td>388</td>
<td></td>
</tr>
</tbody>
</table>

As of now, sewage from sectors 1-57 goes to both Dhanwapur STPs and Behrampur STPs. Waste from 58-80 goes to Behrampur STP. One STP is run by HSVP and one by MCG at Dhanwapur and another at Sector 48 by HSVP. Besides, there are 24 more small STPs installed at different places in the city. The sectors between 99 and 115 do not have an STP for their waste and are not connected to the master sewage line either.

In addition private developers if want can install separate STPs in their respective premises by taking construction licenses from the town and country planning department. But random checking by the officials found that a number of such developed sites have not installed STPs or are not using it and directly throwing sewerage water in the drain thus polluting it.

The treated effluents from STPs are disposed off into an unlined drain which travels about 8 km to meet the Najafgarh drain in Delhi. Here, they get mixed with untreated sewage discharged by the Khost drain, the Badshahpur Nullah, drain nos 1 and 2 from Gurugram and several other drains falling in from Delhi, before meeting the river Yamuna (CSE India, 2012).

4.2.3 Water Meters

Water metering is the process of measuring the water use. It helps in cutting losses due to theft and ageing infrastructure and also makes the end user to use the water judiciously. More the coverage of metered water connections, more efficient is the revenue collection by the municipality. Due to its numerous benefits, water meter installation is seen to be increasing in Indian cities both by municipalities and private entities.

As of 2007, there were 27,758 connections in the Gurugram city, of which about 10,729 (about 38%) were metered as shown in table 6. In other words, about 61% of the connections were paying water charges on the basis of flat rates. Due to the inadequacy in metered connections, this resulted in low revenue collection for the water supply department. High number of unmetered water connections further led to non-judicious use of water.

Recently in 2019, MCG expanded their water connections to 36,000. Last year in 2020, the number increased to 76,000. In order to overcome the shortage of water meters in the city, the MCG had started the drive to install meters in all the zones in the city, but only about 20% have been installed till the month of November. This investment in installing smart water
meters was done to monitor measure and manage activity across its network covering both commercial and residential sites. The objective is to encourage customers to reduce consumption levels and ensure continuous water supply.

Table 6: Water meter connections in MCG limits of Gurugram

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Year</th>
<th>No. of connections</th>
<th>No. of metered connections</th>
<th>No. of unmetered connections</th>
<th>Ratio of metered to total no. of connections (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2007</td>
<td>27,758</td>
<td>10,729</td>
<td>17,029</td>
<td>38.6</td>
</tr>
<tr>
<td></td>
<td>(CSE India, 2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2019</td>
<td>36,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(Kachhwaha, 2020)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Nov. 2020</td>
<td>76000</td>
<td>15,200</td>
<td>60,800</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>(Kachhwaha, 2020)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.4 Water Quality of Waterways Carrying Wastewater

Gurugram land comprises of Najafgarh jheel along with other small streams. Najafgarh jheel is Delhi and Gurugram’s biggest natural water reservoir, rainwater catchment area and groundwater recharger. It has been slowly destroyed over the years due to poor policies and planning. Once fed by the Sahibi nadi and storm water runoff from the surrounding areas, the Najafgarh jheel was vastly spread across 300 sqm. It is now fed primarily by the waste water from the Badshahpur drain and the Outfall drain No.8 and the rain water in monsoons.

The water of Najafgarh jheel, now comprises largely of sewage from the drains of the surrounding urban sprawl with the bulk of it being disgorged by the Badshahpur Drain flowing through Gurugram. The major factors for its pollution are untreated domestic waste water discharge into the jheel due to inadequate sewerage system (including pumping stations) and sewage treatment capacity. The Sahibi canal on the other hand has now transmogrified into the Najafgarh Nala which receives its own share of waste water from a multitude of drains on the Delhi side. The pollutants from the jheel are leaching into the soil and also contaminating the aquifers. Furthermore, the jheel’s ability to recharge aquifers has been severely compromised. As a result, the water woes of residents of South-west Delhi and Gurugram have intensified as they have limited access to piped water and are heavily dependent on groundwater. To add to this, Delhi had constructed an embankment on its side of the jheel after the floods of 1964, depriving its arable lands of the regular inundation and recharge cycle.

As it can be seen, that the water quality of the jheel in Gurugram has degraded and is in need of immediate interventions. This would require a detailed study analysing the data to fill in the gaps and generate solutions to improve the quality of these water bodies.
4.3 Inferences

Surface source

- Looking at the data of last decade it can be concluded that the region is going to experience an unpredicted pattern of rain spell over the coming years due to rapidly changing climate, thus making it difficult to predict the rainfall intensity and period. Further due to poor rainwater management by the authorities accompanied by intense concretisation and groundwater contamination, this shall lead to continues loss of water levels in streams and ponds, making them disappear soon. Therefore, the authorities would have to emphasize on tapping alternative sources of water like treated STP water and adoption of water efficient technologies to cope up with the challenges of water scarcity that could be faced in the future. Adaptation strategies would also be required to put in place to avert the rising flood risk due to excessive rainfall.

Groundwater Source

- Over exploitation of groundwater sources in order to meet the growing water demand has resulted in depleting water table in Gurugram. It can be estimated that if the built up expansion is not controlled and water flow is not properly managed, the groundwater levels and quality will keep on decreasing in near future as well. In addition, the cultivation of water hungry crops like paddy and sugar cane in certain regions of the district is also responsible for continuously declining the ground water level. All these factors have resulted in declining water table in Gurugram and now has become a serious threat in socio-economic development. In future, if precautions are not taken to reduce the use of ground water, then the city is going to face the problem of scarcity of water.

Water Metering

- As per the study the expansion of water connections by MCG in Gurugram have been extremely slow until 2019, due to which the coverage of water metre connections has been poor. And therefore to overcome this issue recently in 2019, authorities have proposed and are in the process of installing water meters across the city. This shall help in efficient monitoring of water use and losses, thus making a significant step towards building the future water secure.

Water Quality of Waterways Carrying Wastewater

- The quality of Najafgarh jheel in Gurugram is in deteriorating state due to discharge of untreated domestic sewage into it and encroached catchment area for developing housing infrastructure.
5. Potential Risks in Water Management

5.1 Urban Water Cycle

Water is continuously cycling around, through and above the Earth in a natural water cycle that has existed for billions of years. As water moves between the land, ocean, rivers and atmosphere it changes from solid to liquid to gas. This Natural Water Cycle is our planet’s way of recycling water, and is essential for life on Earth. It can be defined as a conceptual model describing the storage and circulation of water between the biosphere, atmosphere, lithosphere, and the hydrosphere. The stages of natural water cycle includes environmental evaporation, condensation, precipitation, infiltration, run-off and transpiration. Water can be stored in the atmosphere, oceans, lakes, rivers, streams, soils, glaciers, snowfields, and groundwater aquifers. Circulation of water among these storage compartments is caused by such processes as evapotranspiration, condensation, precipitation, infiltration, percolation, snowmelt and runoff, which are also referred to as the water cycle components.

Combined effects of urbanisation, industrialisation, and population growth affect natural landscapes and hydrological response of watersheds. Although many elements of the natural environment are affected by anthropogenic factors with respect to pathways and hydrologic abstractions (or sources of water), the principal structure of the hydrological cycle remains intact in urban areas. However, the hydrologic cycle is greatly modified by urbanisation impacts on the environment and the need to provide water services to the urban population, including water supply, drainage, wastewater collection and management, and beneficial uses of receiving waters. This makes the hydrological cycle more complex in urban areas, because of many anthropogenic influences and interventions the resulting “urban” hydrological cycle is then called Urban Water Cycle.

![Image showing the natural water cycle and the urban water cycle](image_url)

**Figure 16**: Natural and Urban water cycle

The main steps of urban water cycle for Gurugram city are:
1. **Source:** The major source of water supply in Gurugram city is surface water which is used to meet the domestic and non-domestic water requirements of residential, commercial, industrial, agricultural and vegetation spaces. Major source of water supply remains the GWS and NCR water supply channels extracting water from the Yamuna River. Ground water is also another important source for meeting the water supply demand of Gurugram but is unregulated, resulting in exploitation of the groundwater resource. The groundwater extraction is found to be carried out by private entities (housing societies, individual houses etc.). Tankers are also found to be used during months of water scarcity. There is also a lake called Najafgarh jheel located on the Delhi-Gurugram border but is found to be shrunk and heavily polluted due to waste discharge.

2. **Treatment, Storage and Distribution:** Water tapped from the GWS and NCR water supply channels is then transferred to the Basai and Chandu Budhera WTPs respectively built across the city for treatment. The treated water is then distributed and stored in several large water storage tanks. This treated water is then supplied from these water service reservoirs to the respective zones through a network of pipes consisting of different diameter. There are 8 water supply zones in Gurugram as shown below (GMDA, 2018).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Zone</th>
<th>Sector covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I-III</td>
<td>1-57 (covers Gurugram city under MCG jurisdiction)</td>
</tr>
<tr>
<td>2</td>
<td>IV</td>
<td>58-67, 63A, 67A and outer</td>
</tr>
<tr>
<td>3</td>
<td>V</td>
<td>71, 72, 72A, 73, 74, 74A, 37C, 37D</td>
</tr>
<tr>
<td>4</td>
<td>VI</td>
<td>68, 69, 70, 70A, 75, 75A, 76-80</td>
</tr>
<tr>
<td>5</td>
<td>VII</td>
<td>81-98, ISBT/METRO</td>
</tr>
<tr>
<td>6</td>
<td>VIII</td>
<td>99-115</td>
</tr>
</tbody>
</table>

3. **Use:** The supplied treated water from water service reservoirs is then used by residential, commercial, public, agriculture and landscape spaces in the city. There are no heavy automobile industries inside the Gurugram city; therefore industrial waste water has not been included in the water cycle of the city.

4. **Collection:** The waste water from residential, commercial and public spaces is then collected and conveyed by sewer systems to wastewater treatment plants. Waste water from vegetation and agriculture land collected and conveyed through storm water drains into water bodies.

5. **Wastewater Treatment and Discharge:** The storm water drainage of Gurugram is divided into six zones having outfall into Najafgarh Jheel falling on the western part of the town having further outfall into river Yamuna through Najafgarh drain.

Waste water generated from the city goes into the various public STPs for treatment through sewer drains after which the treated waste water is discharged into drains carrying waste water. Due to running of STPs below their existing capacities a significant amount of domestic and industrial effluents are being discharged into the natural drains making...
them heavily polluted and ultimately joining the Yamuna river. A number of sites developed by private developers have been found flouting the rules by not installing STPs or are not using the installed STPs and directly throwing sewerage water in the drain thus polluting it.

6. Urban floods

In the last few years, The ‘Millennium city- Gurugram’ has been bearing the brunt of annual floods disrupting lives and damaging property and infrastructure as shown in figure 17. A few hours of rainfall floods the streets of the city with the master drainage lines getting choked at critical points or are bursting at their seams during monsoon. Most of the rainwater flows back into Gurugram due to lack of outlet for it to release.

![Image](a)
![Image](b)
![Image](c)
![Image](d)

**Figure 17**: Submerged DLF Phase 1 underpass on Golf Course road with rainwater collecting almost till its roof (a), a portion of caved in road near Gurugram’s IFFCO Chowk (b), a waterlogged 4 way roundabout intersection on Golf Course road (c), and vehicles wading through rainwater (d), following heavy rainfall in the region in August 2020.
The broken natural water body linkage and obstructions in the water flow in the city due to frantic construction during the last decade has resulted in the increased frequency of the urban floods coupled with inadequate levels of flood preparedness. The identified reasons for the recurring floods in the Gurugram city in detail are:

a. **Disrespecting the Natural Topography:** The main cause of flood in the Gurugram city can be attributed to not taking into account the heterogeneous topography of the region while designing the city’s drainage. There is no perennial river in the district, on the other hand a number of barsati nallahs and hills can be found here which criss cross the entire region and is blamed for floods during rainy season. The truth being that undulations, natural drainage systems, etc. have not been considered for planning the city. The city’s topography has been continuously flattened to maximize the area of developable land. With no natural drainage, even a moderate rainfall causes flooding.

b. **Poor Development and Planning:** Gurugram has been time and again been regarded as the ultimate planning disaster. City planners despite being aware of the fact that Gurugram was the natural drainage for rainwater from Delhi and nearby areas, they constructed built infrastructure with buildings and roads on water bodies, natural drains and flood plains by filling them up with mud.

c. **Rapid Urbanisation and Population Boom:** There has been a population boom in recent years in Gurugram due to development of IT sector and its proximity to the capital city. Figure 18 shows the drastic expansion of the built up area from 1986 to 2016 occupying the green cover and water bodies in city. This has resulted in the rampant construction of built infrastructure in Gurugram followed by rapid urbanization in order to meet the demands of people flocking to the city in search of work from all over the country. This unplanned increase in built infrastructure has reduced the permeable surfaces by impermeable concrete floors.
d. **Blocked natural drains, encroached water bodies and destruction of traditional water control infrastructure:** Gurugram of the 1980s was a pristine landscape, dotted with “jheels”, or water bodies in the low-lying parts of what has since morphed into a millennium city with its distinctive skyline of glitzy skyscrapers and glass-fronted offices and trendy shopping malls. The water bodies in the Aravallis were ideal to drain the rainwater. Rapid urbanisation through the 1990s and the turn of the new millennium led to blockage of natural drains due to encroachment by builders, dumping of sewage, silt and construction waste. A land revenue record from 1956 showed Gurugram had around 640 water bodies, which has since whittled down to 251 in 2018-19. A 2014 report by the Delhi Parks and Gardens Society indicates at least 200 water bodies out of 251 that exists in the city in the 20th Century, have been encroached.

A few documented lakes, drains and other structures that were instrumental in preventing water-logging in Gurugram and that have been slowly disappearing over the years:

- ** Shrinking lakes and vanishing natural drains:** The water bodies in the Aravallis were ideal to drain the rainwater. Rapid urbanisation through the 1990s and the turn of the new millennium led to blockage of natural drains due to encroachment by builders, dumping of sewage, silt and construction waste. A land revenue record from 1956 showed Gurugram had around 640 water bodies, which has since whittled down to 251 in 2018-19. A 2014 report by the Delhi Parks and Gardens Society indicates at least 200 water bodies out of 251 that exists in the city in the 20th Century, have been encroached. Mentioned in the Gazette of India (1883), Ghata Lake is a seasonal water body that covered almost 370 acres until the early 2000s. The natural lake could hold some 50 feet of water until a few years ago. But unfortunately, it has been converted into a dumping ground. This is even more shocking since the Ghata lake bed serves as a floodplain for storm water drains — especially those that enter Gurugram from Delhi. Located in the Ghata village, this network is known as the Badshahpur drain (the most important drain in Gurugram city) and aids the drainage around the city,
especially during monsoon. But, with the lake reducing to less than 50 acres and poor maintenance of the drain, flooding is almost inevitable.

![Plan of Badshahpur drain starting at Ghata Lake and ending at Najafgarh drain](image1)

**Figure 19**: Plan of Badshahpur drain starting at Ghata Lake and ending at Najafgarh drain

The Ghata Lake also recharges groundwater, something Gurugram is quickly growing short of.

The continuous shrinking of the Najafgarh jheel is another such prominent water body which is dying slowly due to over concretization (covered in Chapter 4, 4.2.4).

![Dried Ghata lake (left) and shrunk Najafgarh lake (right) in Gurugram](image2)

**Figure 20**: Dried Ghata lake (left) and shrunk Najafgarh lake (right) in Gurugram

- **Bundhs (Traditional Dams)**: Old survey maps of Gurugram that date back to the 1970s show that the area had several natural drainage lines and channels. There have been records of the existence of small dams in Gurugram. Most of them existed in areas like Nuthupur, Wazirabad, Ghata, Manesar and Jharsa. But with increased urbanization of the cities and construction of roads, these seem to have disappeared over time resulting in the flooding of the Golf Course Road and its neighbouring areas. Reports state that there were at least 118 bundhs present in the Gurugram-Faridabad area. But much information on them has ceased to exist over time. These small channels are helpful because they break the flow of water into smaller rivulets. Traditionally, they were also used to irrigate agricultural fields and recharge groundwater levels.
Climate Change: Because of climate change and rising temperatures, the number of days on which it rains has decreased but the intensity of rainfall has increased. It has become evident that short bursts of intense rainfall are expected to be more common across India and will continue to result in extreme weather events in coming years.

The urban water cycle of Gurugram city has been shown in Figure 22.
Figure 22: Urban Water Cycle of Gurugram city
5.2 Water Demand and Supply

The sustainability and quality of water in any city is closely linked to the quantity and quality of basic infrastructure facilities that support it.

Water demand is normally classified as domestic water demand and non-domestic water demand. Domestic water demand covers the use of water for drinking, washing, bathing, flushing etc. Nondomestic water demand includes the water demand for industries and other uses.

Here we have considered only the domestic water demand (for residential, commercial, institutional and other public spaces) of Gurugram city for computation.

Table 8 depicts the water demand and supply statistics for 2011 and 2019. Quantities have been listed considering as water supply for 2011 and as water demand for 2019. Some of the attributes for 2019 like population and total water demand has been computed by author due to unavailability of data. Taking this as reference, water demand estimations for 2025 have been computed.

Table 8: Water supply and demand statistics for 2011, 2019 and estimations for 2025.

<table>
<thead>
<tr>
<th>Head</th>
<th>2011</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Population</td>
<td>9,77,337*</td>
<td>23,00,556**</td>
</tr>
<tr>
<td>Per capita average water supply (lpcd)</td>
<td>136***</td>
<td>200 lpcd*****</td>
</tr>
<tr>
<td>Total water supply (MLD)</td>
<td>132.9**</td>
<td>450**********</td>
</tr>
<tr>
<td>Actual water demand of city (MLD)</td>
<td>195.4********</td>
<td>460.1********</td>
</tr>
<tr>
<td>WTP Installed capacity (MLD)</td>
<td>273****</td>
<td>572******</td>
</tr>
<tr>
<td>Waste water generation (MLD)</td>
<td>(80% of 195.4) = 156.3</td>
<td>(80% of 460.1) = 368</td>
</tr>
<tr>
<td>STP Installed Capacity (MLD)</td>
<td>148 ***</td>
<td>388********</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Head</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Population**</td>
<td>43,71,939</td>
</tr>
<tr>
<td>Total Domestic Water Demand (MLD)**</td>
<td>874.3</td>
</tr>
<tr>
<td>Per capita average water demand (in lpcd)*****</td>
<td>200</td>
</tr>
<tr>
<td>WTP installed capacity (MLD)*****</td>
<td>962</td>
</tr>
<tr>
<td>Waste water generation (MLD)</td>
<td>(80% of 874.3) = 699.4</td>
</tr>
<tr>
<td>Required STP Installed Capacity (MLD)*****</td>
<td>Increase to 734.37 MLD</td>
</tr>
</tbody>
</table>

* District Census Handbook Gurugram, Village and Town Directory, Census of India 2011, Haryana
**Computed by author by considering exponential growth in population**

***Sub-Regional Plan for Haryana Sub-Region of NCR-2021, Chapter 9- Sewerage, Solid Waste Management, Drainage and Irrigation***


****** National Building Code (NBC) 2016, IS1172 (1993) Code of basic requirements for water supply, drainage and sanitation, for communities with more than 1 lakh population and full flushing systems

******* Work to double treatment capacity of Chandu Budhera plant to start March 10, Gurugram News, Dhananjay Jha , March 04, 2019

******** Comments on Final report of the Yamuna Monitoring Committee dt 29.6.2020, NGT

********* Computed by author, required capacity is 5% (peak load) of waste water generation in addition to waste water generation capacity

********** Is the Millenium City fast running out of water?, The Hindu, Ashok Kumar, June 24, 2019

*********** Computed by taking 200 lpcd water demand from National Building Code (NBC) 2016, IS1172 (1993) Code of basic requirements for water supply, drainage and sanitation, for communities with more than 1 lakh population and full flushing systems

**Past scenario in 2011**

1. In 2011, **average per capita water supply** in city was 136 lpcd, which is less than the suggested standard of National Building Code of 150-200 lpcd.

2. The **total water supply** to city was 132.9 MLD which was low as compared to the total water demand which was 195.4 MLD (considering average water demand of 200 lpcd).

3. The **water treatment plants** were found to have adequate capacity (273 MLD) according to the water demand by the population.

4. The quantity of wastewater generated in CMA was around 156.3 MLD. Out of this, approximately around 148 MLD was treated in the treatment plants. Remaining wastewater was being let into the streams thereby contaminating it. This reflected the scarcity of STPs in the city.

**Existing Scenario in 2019**

1. Due to significant increase in population the total domestic water demand of the city increased to 460.1 MLD from 195.4 MLD in 2011.

2. The **total water supply** to city was 450 MLD which was low as compared to the total water demand which was 460.1 MLD (considering average water demand of 200 lpcd).

3. To meet the increasing demand of water, the installed capacity of **water treatment plants** was increased to 572 MLD. This treatment capacity was found to be adequate for the population, having 460.1 MLD of total domestic water demand.

4. The quantity of wastewater generated in Gurugram City increased to 368 MLD. The installed STP capacity was also increased to 388 MLD. This was found to be sufficient to treat the total sewage generated in the city.
Future Scenario in 2025

1. Gurugram city is going to experience a rapid rise in population by 2025 which will stand at around 43,71,939. This is going to increase the water demand of the city to 874.3 MLD.

2. The installed capacity of water treatment plants is proposed to increase to 962 MLD by 2025, which is found to be adequate for the population, having 874.3 MLD of total domestic water demand in 2025.

3. The quantity of wastewater generated in Gurugram city is estimated to increase to 699.4 MLD in 2025. The current STP infrastructure (388 MLD installed capacity) would fail to treat the wastewater being generated, thus polluting the natural water ways. The installed capacity would have to increase to 734.37 MLD.

5.3 Inferences

Groundwater

Rapid real estate development has outpaced both city planning and the public infrastructure related to water supply, with rampant increase in groundwater extraction. Rapid population growth in Gurugram has led to an imbalance between annual groundwater extraction and recharge levels which if not controlled is going to worsen the situation in near future.

The actual number of illegal bore wells is unknown which makes it difficult for monitoring the illegal extraction and control it.

Water Treatment Plants

The installed capacity of water treatment plants is proposed to increase to 962 MLD, is found to be sufficient for the population, having 874.3 MLD of total domestic water demand in 2025.

Sewage Treatment Plants

As of 2019, the current number of STPs in the city and there capacities was found to be sufficient to treat the total sewage generated in the city. But the quantity of wastewater generated is estimated to increase to 699.4 MLD in 2025. The current STP infrastructure (388 MLD installed capacity) would fail to treat the wastewater being generated, thus polluting the natural water ways. The installed capacity would have to increase to 734.37 MLD.
6. Recommendations for Sustainable Water Management

To achieve sustainability in water management in cities, it becomes imperative to study and analyse all the aspects related to it. It should cover both micro scale green development measures like rain water harvesting to macro scale water source management, water/wastewater/storm water infrastructure and landscape preservation. This is known as integrated urban water management (IUWM), a water management approach that has become quite popular in the last decade. IUWM is based on designing solutions which are not isolated in nature but are interconnected water management clusters.

Same approach has been followed in the study of this report, in order to recommend most appropriate and practical measures to the identified potential risks in the previous chapter for water management in Gurugram city.

6.1 Up gradation in Urban Water Cycle

Suggestive up gradation of water cycle for the Gurugram city has been shown in figure 23, where the lacunas of existing water management of the city has been tried to fill. This is based on the projections computed for year 2025 in the last chapter: Potential Risks to Water Management.
Figure 23: Upgraded Urban Water Cycle of Gurugram City for 2025

Projected values in the upgraded water cycle have been computed and shown in table 8.
1. **Identification and filling up of data gaps**
   
   It should be emphasized on collecting information by research for filling in the missing data in order to find best suited solutions to issues of poor water management in Gurugram city. For example, there is a dearth of data on groundwater availability and extraction for Gurugram city due to which it poses a challenge in regulating the groundwater use thus resulting in its exploitation. Therefore, identification of such gaps related to water data in Gurugram city should be done and required measures should be taken for data generation.

2. **Modifications in existing water infrastructure**
   
   - **Water Transmission and Distribution:**
     
     Minimizing the distribution and transmission losses of water by refurbishing the old water supply network and covering the newly added areas.
     
     Ensuring equitable distribution of water supply in all areas of the city with 24X7 pressurized water supply.
   
   - **Water Treatment Plants:**
     
     There is no need of enhancing the treatment capacity of existing WTPs till year 2025. The proposed increase in capacity of WTPs i.e. 962 MLD from 572 MLD as of today would be sufficient for the population having 874.3 MLD of total domestic water demand in 2025.
   
   - **Sewage Treatment Plants:**
     
     Increasing the capacity of public STPs (~734.3 MLD) in order to treat the entire sewage generation of the city in 2025. The quantity of wastewater generated is estimated to increase to 699.4 MLD in 2025, which the current STP infrastructure (388 MLD installed capacity) would fail to treat it.
     
     Provision of city wide sewerage network (including slums and the suburbs) covering each and every household which shall ensure complete collection of sewage.
   
   - **Water Metering:**
     
     100% coverage of metered connection across the city to ensure fair revenue collection and controlled water usage is required.
   
   - **Water Quality of Water ways Carrying Wastewater:**
     
     Zero discharge of untreated waste water from the city into the natural drains and local ponds and lakes should be ensured in order to protect it from polluting and maintain its natural good quality. Complete waste water from Gurugram city should be treated in STPs, ensuring there is no direct untreated waste water discharge into the water bodies.

3. **Potential Water Sources for Use in Future**
   
   Gurugram city is located in a semi-arid region with no major lake or river in its vicinity. The ones that existed such as Najafgarh Lake and Ghata Lake are on the verge of drying up due to its poor management amidst rapid urban sprawl in the city. The only stream found in the city is Sahibi River, a tributary of Yamuna which originates from the Aravalli range in
Water Sustainability Assessment of Gurugram City

Rajasthan and flows through west and South Haryana into Delhi, known as Najafgarh drain today and is found to be heavily polluted due to excess sewage and other waste discharge. Nearly 50% of the city’s water requirement is met by Yamuna water that comes via canals through water treatment plants and the remaining is met by groundwater which due to rampant exploitation had deteriorated its quality and lowered its levels as of today. This has increased the water availability concerns with city facing frequent water shortage periods. Therefore it altogether becomes more essential for the identification and assessment of potential water sources in the region. There are potential alternative water sources available which if tapped efficiently could help in overcoming the issue of water scarcity in Gurugram.

- **Restoration of degraded water bodies in the Gurugram region:**

Revival of water bodies can help in adding potential freshwater source for the region in future. Over the years due to rapid urbanisation these lakes and ponds got degraded and today lie in a pathetic condition due to which the groundwater availability has gone down.

Recently, a positive step towards this was taken in 2019, when the Haryana Government formed ‘GuruJal’ an integrated water management initiative which aims to address the issues of water scarcity, ground-water depletion, flooding and stagnation in the Gurugram district. It started the project on restoration of water bodies in the region with an ambitious target of reviving 250 water bodies such as Ghata lake, Kasan and Khaintwas ponds etc. in Gurugram by 2022. At present, the organisation is working on the revival of 25 ponds. In these 25 ponds, 13 are in the possession of MCG and 12 are owned by the Panchayati lands (Ohrie, 2020). The initiative would require study of all the documented water bodies to check their revival potential and use as drinking water source.

Encroachment of agricultural/vacant land around these water bodies should be stopped as these areas play a crucial role in providing water for irrigation purposes and recharge structures.

Artificial water bodies/reservoirs could also be constructed which shall not only increase the freshwater availability but also enhance the groundwater table in the region.
Figure 24: Encroached catchment areas of ponds in Ghata, Jharsa and Sukhrali by infrastructure projects and illegal settlements, dumped with municipal sewage.

- **Ground water sources:**
  The concerned authorities should ensure controlled groundwater extraction in the region to keep a check on its level and quality by studying it on regular intervals. In fact, groundwater use should be completely restricted citing its decreasing levels and should only be used during emergency times when the water availability falls shorts.

- **Treated waste water source:**
  The treated water from STPs can be a potential resource for saving the groundwater and water fetched from the Yamuna River. Thus treated STP water which is being discharged into drains could be reused for non-domestic purposes. This shall also help in reviving the heavily polluted Najafgarh and subsidiary drains.

  In order to carry out its successful implementation, installation of STPs and reuse of the treated sewage for flushing, gardening, construction etc. in upcoming residential housing and commercial projects should be promoted.

  To ensure 100% no direct untreated waste water discharge into the water bodies, capacities or number of STPs should be increased, if required.
• **Rainwater harvesting systems:**

Use of rainwater harvesting systems for storage and reuse should be promoted. This could be done by promoting installation of localised rain water storage systems at individual level in new buildings for domestic purposes. As this will help in reducing the potable water supply and also reduces runoff, this shall contribute in reduction of water related infrastructure cost and water bills.

Localised tapping of rainwater for developing manmade water bodies should be done. Channelizing of storm water through drains before finally merging with the main drain, takes a considerable amount of time due to which it experiences evaporation loss, contamination along the way. Instead this rainwater could be fully utilised by these local manmade water bodies to improve the groundwater recharge. Contamination of groundwater also reduces due to the natural percolation of rainwater.

Treated waste water from STPs could be discharged into these local water bodies for enhancing the groundwater levels as well.

4. **Implementation of flood resilience measures**

As explained in section 5.1, chapter 5 ‘Potential Risks to Water Management’, the frequency of floods has increased in Gurugram over the last decade creating havoc. Therefore there is a need for designing and implementing the flood resilience measures in order to reduce the damage caused by the recurrence of floods in the region especially during the monsoons, such as:

• **Accounting natural topography in city planning**

For the proposed and upcoming development plans, housing schemes etc. in Gurugram, the natural drainage profile of the city must be taken into consideration while developing it. Also, any project that blocks the natural drainage should not be approved, unless there is an alternate drainage plan. Topographical conditions of the area and the natural drainage should be respected and preserved in all development projects of any city.

• **Reducing concretisation and increasing permeable spaces**

In many instances, the city has seen, right from roads to drains or from public spaces to parks and playgrounds and rows of plantations getting concretized. For most of the people living in urban areas, the solution to most problems lies in more construction, which means using building materials such as bitumen, steel and cement. In most of the cases it aggravates the problem instead of solving it. The result is that water can’t be absorbed and with encroached and blocked drains, the water is stagnant for hours and days.

Waterlogging was not an issue in Gurugram till it entered this millennia because the city had enough porous spaces for water to seep through. Therefore, the city needs to have permeable spaces which can easily be done by turfing, using interlocking tiles, etc.

• **Developing resilient infrastructure and built environment**

There is growing evidence from the climate change fraternity that the changes in atmospheric conditions have resulted in, and will continue to result in, extreme weather events. While climate change is a complex subject that is being debated and addressed at international levels,
many resulting issues are crippling our cities, such as downpour and deluge. Therefore, cities need to plan for resilient infrastructure and the built environment.

For example, it can be easily seen in Gurugram that a slight downpour causes the failure of traffic signals, but the city can overcome this by investing in all-weather signals. Yes, they will be costly, but their impact is also very high. Similarly, innovations such as porous bitumen should also be tested, especially in parking areas.

Therefore, the natural drainage of the city must be taken into account while planning. Unnecessary concretizing of the city’s elements, be it footpath, drains, etc. should be stopped. The city should invest in green and resilient infrastructure and projects such as the Bio Diversity Park should not only be preserved and protect, but also scaled up.

5. Capacity building and training:
Capacity building and training of existing and new recruits of government staff, municipalities, boards and other parastatal working in water supply and management in the city should be done, to strengthen work practices and thereby improving their overall performance.

6.2 Stakeholder Engagement for Sustainable Water Management
An effective implementation of the measures mentioned above for enhancing water sustainability in the city requires a robust stakeholder involvement. This is an important step which ensures that the water management plans for the city takes into consideration the local requirements, interests and experiences of all the stakeholders. It bridges the gap between experts, implementers and policy makers. In order to make a sustainable change w.r.t. water management it is essential for the stakeholders to cooperate and collaborate with each other and carry out their responsibilities efficiently. Following are the ways by which the stakeholder participation could be enhanced for ensuring sustainable water management in the city:

Table 9 : Stakeholders and their responsibilities in ensuring sustainable water management

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Stakeholders</th>
<th>Roles and Responsibilities</th>
</tr>
</thead>
</table>
|       | International, Regional and Multilateral Organizations | • Provide funds for city water management projects and conduct promotion programs.  
• Provide technical assistance and documentation.  
• Create knowledge exchange platforms. |
|       | National and State Governments | • Develop policies and legal frameworks that enable and strengthens sustainable water management in cities. |
3. **Standardization Bodies** like Bureau of Indian Standards, CPHEEO etc.
   - Developing new standards related to water consumption and management w.r.t to changes in technology of the water infrastructure
   - Identification of gaps and renewing the standards.

City Level

4. **Urban Local Bodies, Municipalities, City Administration and State Water Regulatory Authorities**
   - Promote and design the roadmap to follow sustainable water management initiatives and specific solutions for its implementation.
   - Enhancing citizen engagement and sensitize them with benefits of sustainable water management practices.
   - Strengthening monitoring and tracking of city services by defining KPIs and evaluating them.

5. **City Services Companies**
   - Provide expertise to collaborate with municipalities and ICT companies to develop integrated collaborative models for smart water management.
   - Development of smart and KPI-based city service models.

6. **Utility providers**
   - Deployment of sustainable water management practices like smart water management

7. **ICT Companies (Start Ups and Software Companies)**
   - Provide the ICT infrastructure to support and integrate smart water management services.
   - Provide technical solutions through research and innovation.
   - Develop financially sustainable business models to enable smart water management implementation.

8. **Urban Planners**
   - Inclusion of water management plan in the studies and city planning processes as a part of a broader approach.
   - To give guidance to concerned stakeholders on city planning needs.

9. **Non-Government Organisations**
   - Raise awareness regarding citizen concerns related to water availability.
   - Increase public awareness on urban water issues.

10. **Academia, Research Organizations and Specialized Bodies.**
    - Conduct research and advice and assist the city managers and the policy makers on measures to achieve sustainable urban water management in the city.
    - Drive research and innovation in city water management field.

Building/Site Level
11. Citizens and Citizen Related Organizations like RWAs
   • Participate actively in city’s urban water management projects.
   • RWAs and end users should take the necessary documents from the facility manager like plumbing, WTP drawings, AMC etc. during handing over of the property.
   • Practice water saving measures at an individual level.

12. Construction Sector
   • Refer section 6.2.1

13. Industries
   • Adopt Integrated Water Management Framework (Refer section 6.2.2)

Disclaimer: This is an indicative list and not an exhaustive list.

6.2.1 Role of Construction sector in ensuring sustainable water management

Scarcity of water has hampered various industries in North India in some way or the other and this includes the construction industry as well. Water is needed in large amounts in the construction industry for various purposes. Reducing water consumption and improving water efficiency in buildings is a major step towards sustainable water management. Key opportunities to reduce water use on site are:

- Use of gunny bags, ponding technique, or curing compound.
- Use water-reducing admixture in concrete mix.
- Meter and monitor the consumption of water during construction. Tracking usage over time will show where water is being used and will help identify leaks or inefficiencies
- Use of treated wastewater and/or captured storm water, to offset mains or tanker water supplies. Abstracted water will be lower cost & reduces the need to treat water that does not need to be of a potable standard.
- Using water efficient taps and fixtures in site offices delivers quick savings with high returns on investment.
- Finalise water efficient plant and equipment when discussing options with suppliers/subcontractors to ensure water efficiency is considered. Some key considerations are shown in Table 10.

Table 10: Water efficient plant & equipment

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Plant</th>
<th>Saving</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dust suppression (general)</td>
<td>~90%</td>
<td>• Avoid - high capacity ‘rain guns’ and hoses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Choose - misting/atomising systems which use less water and are more effective</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Consider - consider using non-potable water (ideally rainwater harvested on site)</td>
</tr>
<tr>
<td>2</td>
<td>Dust suppression (vehicles)</td>
<td>~90%</td>
<td>• Avoid – use of high pressure water jets diffused by a splash plate</td>
</tr>
</tbody>
</table>
• Choose – misting/atomising systems which use less water and are more effective

<table>
<thead>
<tr>
<th></th>
<th>Road sweeping</th>
<th>~30%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avoid - use of an open hose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure - operators are trained in water efficient practices, that vehicles have adjustable spray bars/nozzles and that any stand-alone washers are high pressure (low flow) with trigger controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consider - water recirculation systems</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Wheel washing</th>
<th>~40%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avoid - manual wheel washing (except when the need is very limited)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Choose - drive-on recirculating systems with a sensor-controlled shut off (where demand is ongoing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ensure - Water top-up to settlement tank is controlled (e.g. a float valve), supply pressure reflects site conditions and that the filter in the settlement tank is kept clean to avoid overflows</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.2.2 Role of Industries in ensuring sustainable water management through integrated water management framework

Given the state of resource availability, use and competing demand, the critical challenge lies in foresight of the issues and preparedness to respond to them for sustainable business operations. Management of water resources need a multifarious approach of not only improving the in-plant water use efficiency, but also to look beyond the paradigm of in-situ water management. This involves critical extrinsic factors such as source vulnerability, climate, allocation, access, competing use (irrigation, domestic & industrial), regional water quality & availability, regional policies & regulations, socio-economic setup, and importantly the stakeholders (Govt. agencies, local community, etc.) including the industrial value chain. With growing demand, competing use and scarcity scenarios in a region, there may not be enough water to meet societal, environmental, agricultural, or industrial needs. Besides, with the growing awareness, industries have a reputational stake if perceived as mismanaging their water resources or impacting on others directly or indirectly. Thus, there is a need of holistic approach to management of water resources necessitating formulation of an integrated water management framework, as a first step, with responsive corporate water policies and programs in order to respond to the potential challenges related to water within and outside the plant boundaries.

The following generic framework has been developed for industries and businesses across the board who want to better manage their water footprint and ensure efficient water management34.

---

1. ASSESSMENT

- **Water Use Mapping:**
  To begin with, industry should map the water use from source till the end point which is generally the discharge point. This information should include all possible information related to the type, capacity, source, infrastructure type, age, leakage if any, and storage structures. This will also include documenting information related to water treatment and effluent treatment plants of the industry, including the type of treatment options, capacity, O&M (Operations and Management) schedule, etc.
  This exercise should also include identification of alternate source of water for the industry and all the pertinent information related to the available sources of water.

- **Water Quantity and Quality Assessment:**
  Industries should document the overall water consumption in the industry, based on the inflow to the industry and outflow from the industry. Similarly water quality of the inflow and outflow should be assessed and documented by the industries.
  For detail assessment, specific water use for the various process or products manufactured in the industries will be assessed to understand the water cycle of the industries. Based on this, a baseline for the water consumption should be established for the year of assessment and recorded properly. This will be helpful to assess the future water needs of the industry.
The water availability should be considered at the watershed level. The surface and groundwater availability in the watershed should be assessed. Also future water availability considering the effects of climate change should be considered. Besides this it is important to assess the water footprint of the industry as well. A water footprint is a way of assessing potential environmental impacts related to water. It also helps in identifying opportunities to reduce water related potential impacts associated with products at various life-cycle stages, and with processes and organizations.

- **Regulatory Risk Assessments:**
  Industry should list down all the applicable regional regulatory and policy framework and programs. Besides the applicable standards and norms specific to the industry, they should consider the applicable regional regulations, restrictions, notifications, as well as government policies and programs crosscutting various sectors such as water, land use, agriculture, urban/ rural development, industrial development, sensitive zones, environment & ecosystem etc. Also the effectiveness of the policies on groundwater extraction, wastewater disposal, capacity building should be assessed.

- **Stakeholder Need Assessment:**
  Industry should assess their relationship with the following important stakeholders to understand their water related concerns:

  **Local communities:** There are several areas of concern for a community when an industry is set up in their vicinity. Critical issues such as adequate availability of clean water for drinking, sanitation and cooking are all very important considerations for the communities operating around the facility. Community becomes non-cooperative if the industry operating in the region, depletes, or pollutes, the ground water tables. Therefore, gauging the needs of the local communities, while engaging with them is critical to the operations of the organization.

  **Regulators:** The regulators are also an important stakeholder, therefore it is quintessential for organizations to engage with regulatory bodies while staying abreast with the latest regulatory and compliance related developments for the industry.

  **Other competing industries:** It is important to build a rapport with the other competing industries operating in the same watershed and sourcing water from the common resource. As such the competition for water increases many folds as generally all the industries are water intensive units. This can also lead to decrease in availability of water share and also may cause pollution into the common source by discharging un-treated effluent. If the source of water is ground water for all the industries in the watershed then the situation becomes more serious as groundwater is a limited source and as per the hydro-geological setup of the area, yield can be a limiting factor.

  Therefore it is important, to know the water demand, use and discharge practise of competing users in the same watershed and accordingly adopt sustainable practices.
2. IDENTIFY INTERVENTIONS
   
   • **Source Sustainability:**
     
     The most important aspect for a plant’s operation is sustainability of the source. A source should be able to provide good quality and quantity of water to sustain the plant’s operation. Depending on the source type, plant can take necessary actions to enhance its sustainability. Also it is important to know if the source is shared with some other user or not. If the source is common and shared with more stakeholders in the watershed, a common responsibility to protect the source and to enhance its sustainability can be taken up by industries in lead.

     Industry should ensure that the source of water for them is well maintained, is cleaned and all the important aspects of it like level, quality are recorded regularly. An alternate source of water for the industries should also be identified and characterised as a contingency measure. An important exercise in this regard is to conduct Source Vulnerability Assessment (SVA).

     SVA is a systematic examination process to assess a water system’s sensitivity to potential threats (un-checked exploitation, pollution, etc.), which would further help in identifying the crucial challenges to the system in managing these risks that arise as a consequence of such threats. Usually, an assessment of this sort takes into account the water balance of the system at the watershed scale (water supply/allocation and demands), the policy and legal framework to support water resources conservation and management; it would also include the hydrological variations under changing climate and other environmental factors.

   • **Reducing specific water consumption & implementing water conservation interventions:**
     
     Reduction of specific water consumption is very important to reduce the water footprint and this can be done by adopting various water conservation measures which follows the priority order of potential options at industry level. This will help to reduce the water stress at watershed level ultimately by reducing the intake of fresh water by industries. Specific water consumption level should be brought down using various techniques to a level which can be set as a benchmark level for future reference of the industry.

     Water audit is one of the key processes to be taken up by the industries to identify the leaks, water flows, and then take necessary measures to reduce losses and increase efficiency. Regular water audits should be taken by industries to ensure prevention and mitigation of leakages and unnecessary water loss.

     Apart from reducing water losses, it is important to focus on the aspects of water conservation. Below are some of the interventions that can enable in-situ or ex-situ conservation of water.

a. **In-situ conservation**
Rooftop Rainwater harvesting - It is both an economical and eco-friendly technique of collecting rainwater and utilizing it for immediate and future use, thereby helping in reduction of the stresses on the public water supply and other sources. The implementation of this intervention involves site assessment, estimation of rainwater harvesting potential, designing the harvesting system, implementation and operation & maintenance.

Wastewater recycling - This involves setting up of a system for recycling of wastewater generated in the industry through appropriate treatment methods. This water can be reused for different purposes in the industry. Wastewater recycling can be planned in a centralized or decentralized manner depending on site conditions. Recycling provides an opportunity for zero discharge or even positive water balance for the plant. Wastewater recycling system should approach to recycle wastewater at source and thus reduce the pollution load at the ETP, ensure material recovery and reduction in treatment costs besides reduce the overall water demand of the plant.

Reduction in leakages/losses and process optimization - Often a significant scope lies for potential water savings by optimization of water use in various processes such as cooling towers, boilers etc. Besides in many cases leak detection coupled with, metering and regular water audits help reduce leakages/losses in the network or process thus saving water and reducing freshwater intake.

b. Ex-situ conservation

Watershed-level rainwater harvesting - This involves the setting up of surface water harvesting interventions or watershed structures such as check dams, gabions, bunds, percolation tanks, storage ponds etc. In addition to storing rain water during monsoons, it also helps groundwater recharge.

Artificial recharge of groundwater - Water from surrounding streams and drains are collected through constructed streams and further run through a man-made filtration system from where it flows into a shallow aquifer thus recharging the groundwater. There are several groundwater recharge technologies such as shafts etc.

- Zero liquid discharge:
The effluent discharged from industries is equally or even more important than inflow to industries as it can be a challenge or an opportunity for the water security. If discharged untreated it can lead to pollution of water and land bodies but if treated and re-used it can decrease pressure on the existing water sources in the watershed. Therefore, it is important to ensure that a multiple stage ETP is installed in the Industrial facility for treating the industrial waste so that the river / water bodies remain free of contamination.

- Efficient Water Use Planning:
For effective water use it is important to integrate ICT tools in with planning which will include Management Information System, Decision Support System, etc. ICT system can be used for controls and monitoring. They can be simply put to use for avoiding wastage of water and for providing regular information for better management of the resource, automation of systems, etc. In addition, ICT is the driving force behind innovation, and
also helpful in transforming business models and value chains. With the growing technological advancements, economically feasible options are available. All the industries should integrate ICT tools for management of water resources in their plant.

3. PRIORITIZE AND IMPLEMENT
   - Prioritizing Material Issues:
     It is important for organizations to earmark and identify specific issues within the ambit of water management which are of higher relevance to them. After identification, organizations must be able to assign them priority in accordance to their impact on the business. In this way, it becomes easier for organizations to align themselves towards the higher priority tasks first, while being able to mitigate the risks associated with them.
   - Sensitize and Capacitate Internal Stakeholders:
     The engagement and involvement of the employees is critical towards successful implementation of the effective water management and conservation interventions. Employees must be sensitized on the relevance of the subject and must be trained towards implementation of the measures.
   - Engaging with community:
     One of the foremost elements of efficient water management planning involves engaging communities and other stakeholders regularly. All the water positive actions taken up by industries should be showcased to locals and with them responsibility of ensuring water security at watershed level should be shouldered as a lead. It is important to return back to nature what is taken so making an efficient use of water by avoiding losses, and conserving water through different methods, the ultimate goal can be achieved for both plant and surrounding watershed.
   - Implementing high priority interventions:
     Once all the aforementioned issues are addressed, the highest priority interventions should be with the involvement of the internal stakeholders and the community at large.

4. MONITOR & EVALUATE
   After taking the necessary actions it is equally important to monitor and evaluate the implemented actions regularly to learn from their benefits and weaknesses and to fix the issues, if any, on time. This will help to strengthen the system further and help to understand the overall benefits accrued by the industry.
   It is suggested that Industry can hold an internal audit to evaluate the implemented plans twice a year and hold an external third party assessment for evaluation once a year. Evaluating and benchmarking the water performance on a regular basis is the key to a successful and integrated water management plan.
   Remedial measures from the evaluation and monitoring must be then undertaken to sustain continual improvements in the system while the organization tries to optimize its water use and management performance.
6.3 Effective Implementation of Recommendations

One finds that many of the recommendations suggested for achieving sustainable water management (refer Chapter 6, Section 6.1 and 6.2) against the identified potential risks in chapter 5 are an extension to the already existing proposed measures by the concerned authorities like groundwater extraction monitoring, restoration of dying water bodies, installing rainwater harvesting systems etc. But when it comes to their implementation it is found to be missing on ground. In fact, despite having an extensive National Water Policy in place and existence of various state and centred level institutions, water resource development and management has not been very satisfactory and pose a few questions such as whether the policy recommendations and institutions till now really been effective in providing safe and sufficient water to all for all types of purposes be it domestic, industrial and irrigation? Has it been instrumental in improving the water management, protecting natural water resources and maintaining the water quality?

Answering these pertinent questions, a list of areas that need immediate interventions to strengthen the implementation of these suggested recommendations are given below:

Table 11 : Suggested Interventions for strengthening the implementation of the recommendations

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Identified Issue</th>
<th>Required Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Governance and Institutional Challenges</td>
<td>Development of an Integrated Water Resource Management (IWRM) along with bottom-up approach.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IWRM is a process which promotes the coordinated development and management of water, land and other related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. It is a cross sectoral policy approach, designed to replace the traditional, fragmented sectoral approach to water resources and management that has led to poor services and unsustainable resource use.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As the local nature and needs of water related services, resources and management vary, it is ideal that the task of managing them is handed over to institutions in a decentralized manner. A bottom-up approach for institutional framework with the active involvement of local stake holders is essential for the effective planning and execution of any programme aimed at water management in a region.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of high level Political Commitment</td>
<td>Decentralization of Water Governance Structure</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Most attempts at building political commitment are targeted at national governments because the budgets, laws, policies and regulations that can sustain a water management programme in the long term often flow from governments. However, even when it appears that the political commitment established in a national government is sufficient to sustain a programme, the commitment may still evaporate with elections and a new leadership or simply because of shifting priorities and policy concerns.</td>
<td>Firstly, there should be a sustained political will and strong commitment for the implementation of the designed water related plans and policies which can translate into prioritization through different layers of government and effective course correction. But due to probability of shifting leadership due to elections the commitment changes. Therefore, it becomes important to decentralise the decision making powers to local levels of governance which largely then will remain unaffected by the election results.</td>
</tr>
</tbody>
</table>
| 3 | Inefficiency in creating Water related Databases | There are possibly two processes by which the databases can be strengthened. Firstly, there is a constant need to update and convert capacity building into an ongoing process for the water administering bodies. It is time to reimagine capacity building by creating a municipal capacity building management system for all stakeholders, including municipal employees, councillors and citizens. This system could be involved in conducting a training-need analysis, creating quality training materials and arranging for field training. The system could assess the need for lateral hiring of professionals, engaging private institutions, research agencies and corporates for capacity enhancement. Also, for training an urban local body needs funds. The system could create blocks which will look at tying up with national and
But not everything looks in dim light as far as development of sustainable water management is concerned. It becomes extremely important to mention here about India’s efforts in initiating adoption of water related technologies and innovation in the country especially on the digital water management. This creation of innovation and implementation cycles is expected to reduce gaps between research and practice in fields. India is a rising economic power and an increasingly important locus of innovation. Spurred by competition unleashed by a liberalization of once stifling regulations, India’s private-sector firms are fast improving the quality of their products and services and are rapidly expanding their global presence as well. Efforts are on to use digital technologies, drones, radar and satellite technologies, artificial intelligence solutions and many more, which shall play critical role in water resources and management in the country.

Indeed, there is a long list of technological trends and advances that are likely to benefit rapid and effective adaptation of the water sector as mentioned below:

- Cybernetics, artificial intelligence and instantaneous information technology (smarter internet)
- Nanotechnology
- Cost-effective energy technology (solar, space-based energy, algae as fuel)
- Biotechnology (genetic engineering) to help feed the populace and save endangered species
- Space-based environmental monitoring systems and instantaneous feedback to predictive models even to remote areas
- Geo engineering to reverse global warming (e.g., giant reflectors in orbit; greening deserts; iron fertilization of the sea; aerosols in the stratosphere)
- Effective, reliable prediction of most weather and climate events
- Renewable energy replacing fossil fuel entirely – low carbon societies
- Desalinization (in conjunction with cheap fusion energy) becoming cost-effective and providing water for most large coastal urban areas and megacities
- Vastly improved sanitation and wastewater treatment technologies and recycling
• Biotech approaches to pest control for improved agricultural yields
• Ecological engineering to preserve habitats, reverse species extinctions and combat invasive species
• Mapping groundwater resources and sustainable extraction levels

Computer-based optimization and simulation models incorporated with interactive graphics, audio-based decision support systems will continue to help us identify those plans, designs and policies that maximize the desired impacts and minimize the undesired ones as well as making clearer the trade-offs between the two.

Science, technology and innovation strategies are integral parts of sustainable development strategies. Many innovations in sustainable water management are high risk and with uncertain return. Government financing and policies for innovation, supported by public-private partnerships, can be purposely designed and implemented to reduce risks and promote research and development and diffusion and transfer of technologies.
References


Jha, B. (2020, January 22). In one month, 15 illegal borewells sealed in Gurugram. The Times of India.


Pati, I. (2020, September 24). Gurugram’s groundwater level down by 3m in two years, says report. The Times of India.
The Mahindra-TERI Centre of Excellence (MTCoE) is a joint research initiative of Mahindra Lifespaces (MLDL) and The Energy and Resources Institute (TERI). It focuses on developing science-based solutions for India’s future built environment, with a view to reduce the energy footprint of the real estate industry.

The overall scope of the project includes standardization and measurement of building material, thermal and visual comfort study, development of performance standard matrices, guidelines and numerical toolkits and water related activity for sustainable water use in habitats.

The activities related to the sustainable use of water in habitats, includes both macro and micro level analysis in terms of water efficiency, conservation and management within a premise by end users in Indian cities. The study identifies potential risks associated with water sources, governance, infrastructure and demand & supply and provide recommendations to combat those risks.

MTCoE is located at TERI Gram, Gual Pahari, Gurugram, Faridabad, Haryana.