सत्यमेव जयते

THEMATIC PAPER

WATER CRISIS IN INDIAN CITIES: A SYSTEMIC FAILURE OR WRATH OF CHANGING CLIMATE



nidm

Resilient India - Disaster Free India

National Institute of Disaster Management (NIDM)
Ministry of Home Affairs, Government of India

सत्यमेव जयते

WATER CRISIS IN INDIAN CITIES: A SYSTEMIC FAILURE OR WRATH OF CHANGING CLIMATE

2022

nidm
Resilient India - Disaster Free India

National Institute of Disaster Management (NIDM)
(Ministry of Home Affairs, Government of India)

Plot No.15, Pocket 3, Block-B, Sector-29, Rohini, Delhi-110042
Website: https://www.nidm.gov.in

Water Crisis in Indian Cities: A Systemic Failure or Wrath of Changing Climate

ISBN No: 978-81-957965-3-3

Copyright © 2022, National Institute of Disaster Management, Delhi

Edition: 2022

Authors:

Prof Anil K Gupta

Dr Aditi Madan

Ms Pritha Acharya

Published by:

National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India, Delhi-110042

Citation:

Gupta, A.K., Madan, A. and Acharya, P. (2022). Water Crisis in Indian Cities: A Systemic Failure or Wrath of Changing Climate. National Institute of Disaster Management, Delhi, India. Pages 22

Disclaimer:

This publication is based on the research case study carried out by National Institute of Disaster Management, Ministry of Home Affairs, Government of India. The study is based on various published, unpublished literature, reports, documents and web-resources and data collected through primary survey. Authors gratefully acknowledge the contributors and their original sources. This report – full or in parts, can be freely referred, cited, translated and reproduced for any academic and non-commercial purpose, with appropriate citation of authors and publishers.

Dr. Akhilesh Gupta
Secretary, SERB and Senior Advisor

सत्यमेव जयते

Department of Science and Technology (DST)
Government of India
Technology Bhavan, New Mehrauli Road,
New Delhi-110016



MESSAGE

India is the second most populous country in the world. Opportunities in India are associated with their own set of challenges like over-utilization of natural resources, drastic climate-changing patterns, and socio-cultural and political diversity, transboundary issues as well as rural-urban divide and population migration. It is at a crucial point of development, on one hand, it is emerging as one of the fast-growing economies post COVID-19, whereas, on the other hand, it is focusing on a sustainable development path. Water is the most important provisional resource, which plays a multi-functional role in securing and safeguarding socio-ecological systems.

The increasing rate of population growth, encroachment and urbanization against the backdrop of climate change, hazards and disasters and environmental degradation have resulted in a water scarce situation. In addition to depleting groundwater and surface water pollution, our important wetlands are also vanishing rapidly. Water Scarcity can be considered as one of the inhibitors of growth and development, it also increases the vulnerability and risks to hydro metrological disasters. Region-specific models focusing on climate resilient water resource management in addition to effective prevention, preparedness and mitigation measures is imperative to address the dichotomy of development.

I congratulate NIDM, for taking out this publication which will act as a knowledge-sharing document for students, researchers, academicians, and policy makers.

(Akhilesh Gupta)

nidm
Resilient India - Disaster Free India

ताज हसन, भा. पु. से.
कार्यकारी निदेशक

Taj Hassan, IPS
Executive Director

सत्यमेव जयते
आज़ादी का अमृत महोत्सव

राष्ट्रीय आपदा प्रबंधन संस्थान
National Institute of Disaster Management
(गृह मंत्रालय, भारत सरकार)
Ministry of Home Affairs, Govt. of India
प्लॉट नं. 15, ब्लॉक बी, पॉकेट 3,
सेक्टर 29, रोहिणी, दिल्ली – 110042
Plot No. 15, Block B, Pocket 3,
Sector 29, Rohini, Delhi-110042



FOREWORD

India is a land of diverse geographies, topologies and microclimates, enhancing its vulnerability to climate risks and related disasters. In recent past, India has become more sensitive to hydro-metrological challenges, as water scarcity in India is one of the greatest threats that the country faces today. According to NITI Aayog report released in 2019, almost 600 million of India's population is water deprived. Metropolitan cities like Delhi, Bengaluru, Hyderabad, etc., are on the verge of exhausting their groundwater resources.

This publication discusses two case studies focusing on the looming water crisis in the National Capital Region of Delhi and the Metropolitan area of Chennai, as both the cities faced acute water crises in recent years, which has affected the marginalized community disproportionately. It also highlights the proactive measures for ensuring long-term sustainability in this regard.

This publication is brought out under the CAP-RES project supported by DST and holds much relevance given the increasing climate change and overutilization and exploitation of groundwater resources within the country. I hope that this publication will turn out to be a good resource material for researchers, academicians and other professionals.

tajhassan

(Taj Hassan)

Dr. Anil Kumar Gupta
Project Director: CAP-RES (DST)
Professor and Head - Environment, Climate and Disaster Risk Management Division

राष्ट्रीय आपदा प्रबंधन संस्थान
(गृह मंत्रालय, भारत सरकार)
National Institute of Disaster Management
(Ministry of Home Affairs, Govt. of India)
Plot No. 15, Pocket-3, Block-B, Sector-29,
Rohini, Delhi-110042



PREFACE

Water plays a functional role in resilience i.e. in safeguarding and sustaining a socio-ecological system. It serves several functions and simultaneously is a critical generator of food, energy, and other ecological services. Besides this, water also regulates the climate of the earth, thereby maintaining the stability of the regional weather and climatic conditions.

As climate change begins to manifest itself, in the form of increased frequency and intensity of hazards including hydro-metrological disasters, there is an urgent need to address climate-induced risks. Many Indian cities are experiencing acute water shortages with more than 25% gap in demand and supply and some are even on the verge of exhausting their resources. Instances from the Delhi (NCR) and Chennai are suggestive of the fact that there is a need for effective water crisis management plans.

This publication has been developed under the 'Climate Adaptive Planning for Resilience and Sustainable Development in Multi-Hazard Environment (CAP-RES)' with the support of the Department of Science and Technology (DST). It focuses on the water crisis situations in the metropolitan cities of India- Chennai and Delhi NCR. The study suggests prevention, mitigation, and preparedness measures for proactive urban management. It also discusses various measures undertaken at a local scale for water crisis management and key challenges faced in risk management.

(Anil K. Gupta)

ACKNOWLEDGEMENT



The thematic paper on "Water Crisis In Indian Cities: A Systemic Failure or Wrath of Changing Climate," is carried out under the Project Climate Adaptive Planning for Resilience and Sustainable Development in Multi-Hazard Environment (CAP-RES) supported by Department of Science & Technology (DST), Government of India. A special note of thanks to Dr. Akhilesh Gupta, Senior Advisor and Secretary, Science and Engineering Research Board (SERB) for entrusting NIDM with the opportunity to take up and work on the CAP-RES project. The project team is thankful to Shri Taj Hassan, Executive Director, NIDM, Dr Nisha Mendiratta, Advisor and Head of Climate Change at the Department of Science and Technology, Dr Susheela Negi, Principal Scientist, and Dr Rabindra Panigrahi, Senior Scientist of Department of Science and Technology, Government of India for their support to this study.

Contributions of the authors Dr Aditi Madan (Associate Fellow, Institute for Human Development, Delhi) and Ms Pritha Acharya (Research Associate, CAP-RES, NIDM) are acknowledged for joining hands with us in undertaking this study which takes into account both technical understanding and policy interventions at the same time.

A special thanks to Ms Pritha Acharya for designing and coordinating for publishing this study. The project team also extend thanks to Shri Surendra Thakur Ji (Consultant & I/C, Admin & HR), Shri S.K. Tiwari (Librarian, NIDM) and the entire publication cell of NIDM including Ms. Karanpreet Kaur Sodhi, Junior Consultant for helping in printing and publication of this report.

Prof. Anil K. Gupta
Project Director
CAP-RES, NIDM

TABLE OF CONTENTS

1 INTRODUCTION 2

2 OBJECTIVES AND EXPECTED OUTCOMES 4

3 METHODOLOGY 4

4 CASE STUDY: WATER CRISIS IN DELHI, 2021 7

5 CASE STUDY: WATER CRISIS IN CHENNAI, 2019 13

6 KEY GAPS AND CHALLENGES 17

7 RECOMMENDATIONS 20

8 REFERENCES 22

WATER CRISIS IN INDIAN CITIES: A SYSTEMIC FAILURE OR WRATH OF CHANGING CLIMATE?



ABSTRACT

Many large cities in India are facing acute water scarcity today, affecting millions of people. The data shows that only a few of the Indian cities have efficient water management systems set up in place amidst the ever-so-rising population of the country. The case studies discuss the looming water crisis in the National Capital Region of Delhi and the Metropolitan area of Chennai. India is linked to a deficiency in monsoon rainfall due to climate change, rapid & unplanned urbanization, reckless evolution and privation of operative planning for the management of water. Both the cities faced acute water crises in recent years, disproportionately affecting the marginalized. Based on the available literature, the case studies discuss the systemic risk and key drivers resulting in the water crisis and its social, physical, and economic implications in the two cities as well as suggests recommendations to tackle the issue.

The study reports a large-scale impact on socio-economic, environmental, and political systems has been triggered due to failing agriculture, political conflicts in the urban and rural areas, economic challenges due to the closure of businesses, and an increasing number of suicides among farmers. The case study suggests prevention, mitigation, and preparedness measures for proactive urban management. The case study discusses various measures undertaken at a local scale for water crisis management and key challenges faced in risk management. The case study concludes by highlighting the significance of proactive measures for long-term sustainability and resilience-building along with the promotion of social behaviour change communication campaigns and capacity-building programs among stakeholders and citizens for the effective management of the risk.

Keywords: Water Scarcity, Systematic Risk, Chennai Water Crisis, Delhi Water Crisis

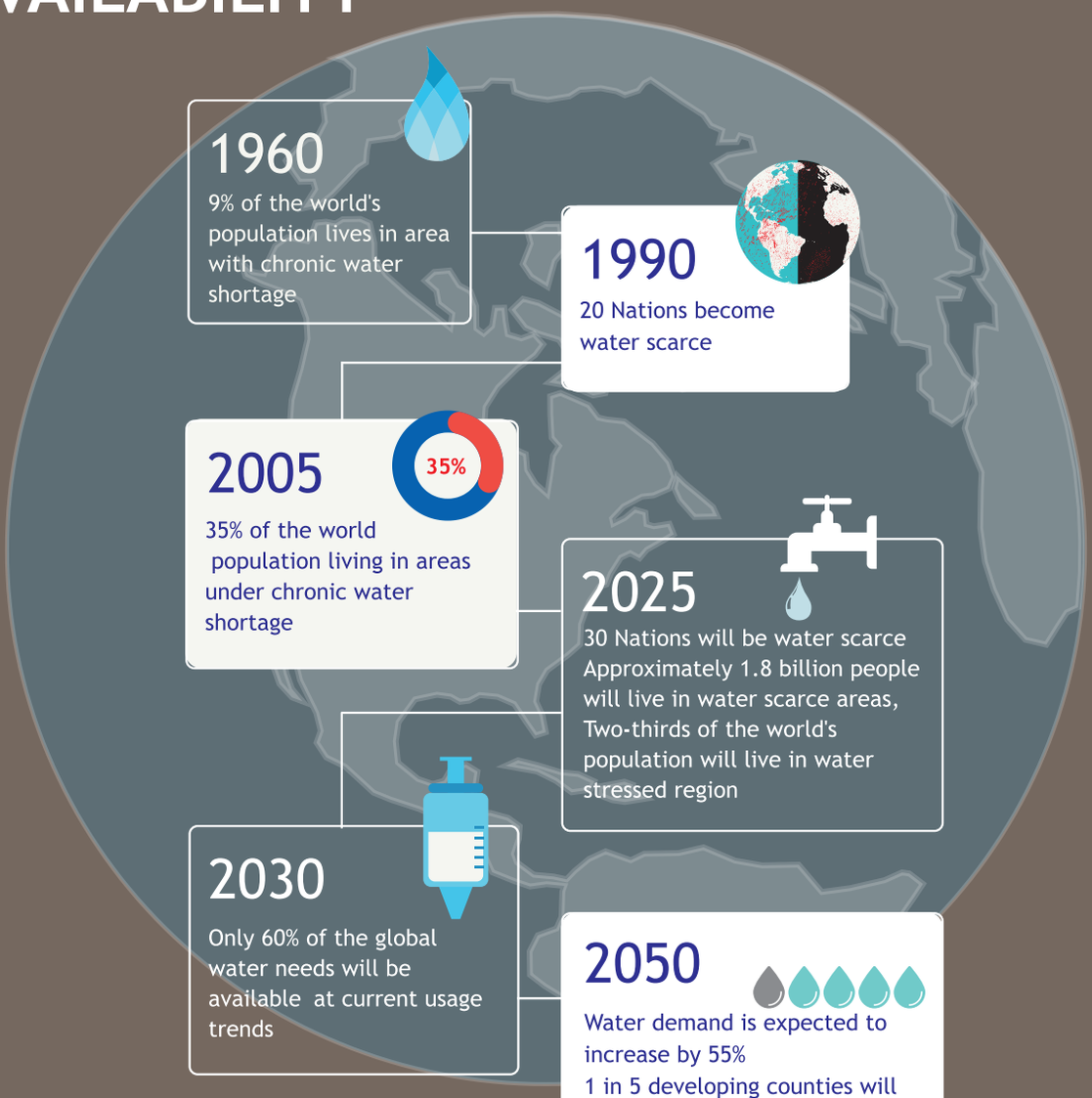
INTRODUCTION

Water plays a functional role in resilience i.e. in safeguarding and sustaining a socio- ecological system. It serves several functions and simultaneously is a critical generator of food, energy, and other ecological services. Besides this, water also regulates the climate of the earth, thereby maintaining the stability of the regional weather and climatic conditions. It also acts as a recipient and transmitter of the changes through global warming- induced floods and droughts. Further, there has been rapid urbanization, industrialization, degradation of the environment and development within the areas that are highly prone to numerous risks only to suffice the need of the growing population and achieve development goals. This poor and unplanned development has resulted in socio-economic and environmental consequences (Bloom et al., 2008; Dahiya, 2012) as witnessed by Chennai and Delhi recently.

The city of Chennai became one of the first major cities in the world to run out of water—trucking in 10 million liters a day to hydrate its population on 19th June 2019. However, even less than 6 years ago, in 2015, the same city saw catastrophic floods which sunk the city for countless days, devastated lives and impacted businesses, with most of that rainwater flowing into the sea than Chennai's parched groundwater reserves.

Another case in discussion is the water-stressed city of Delhi-National Capital Territory which has been seeing frequent modifications in the existing land use and land cover pattern contributing to increasing flood levels, especially in the low-lying areas during monsoon months, while water supply gets hit during summer months in the city resulting in an acute water crisis consequence (Bloom et al., 2008; Dahiya, 2012).

GLOBAL PER CAPITA FRESHWATER AVAILABILITY



SDG: Water & Urban Connect



(Source: CSE, 2022)

OBJECTIVES AND EXPECTED OUTCOMES

Considering the above, the study discusses the water resilience of metropolitan cities of Chennai and Delhi as part of case studies. The case studies look into the looming threat of water scarcity and the causative factors behind such water scarcity affecting people disproportionately. It covers various aspects such as a description of the event/water crisis, causative factors responsible for the crisis as well as the impact of the situation on different sectors and at multiple levels. This increasing risk from disasters especially water-related hazards calls for preparedness and mitigation measures to safeguard people from future disasters. This study aims to:

- Describe the crisis event.
- Identify triggering factors leading to the crisis.
- Understand the impact of the crisis.
- Discuss key gaps, challenges, and good practices and suggest recommendations to enhance preparedness and response to inform policies.

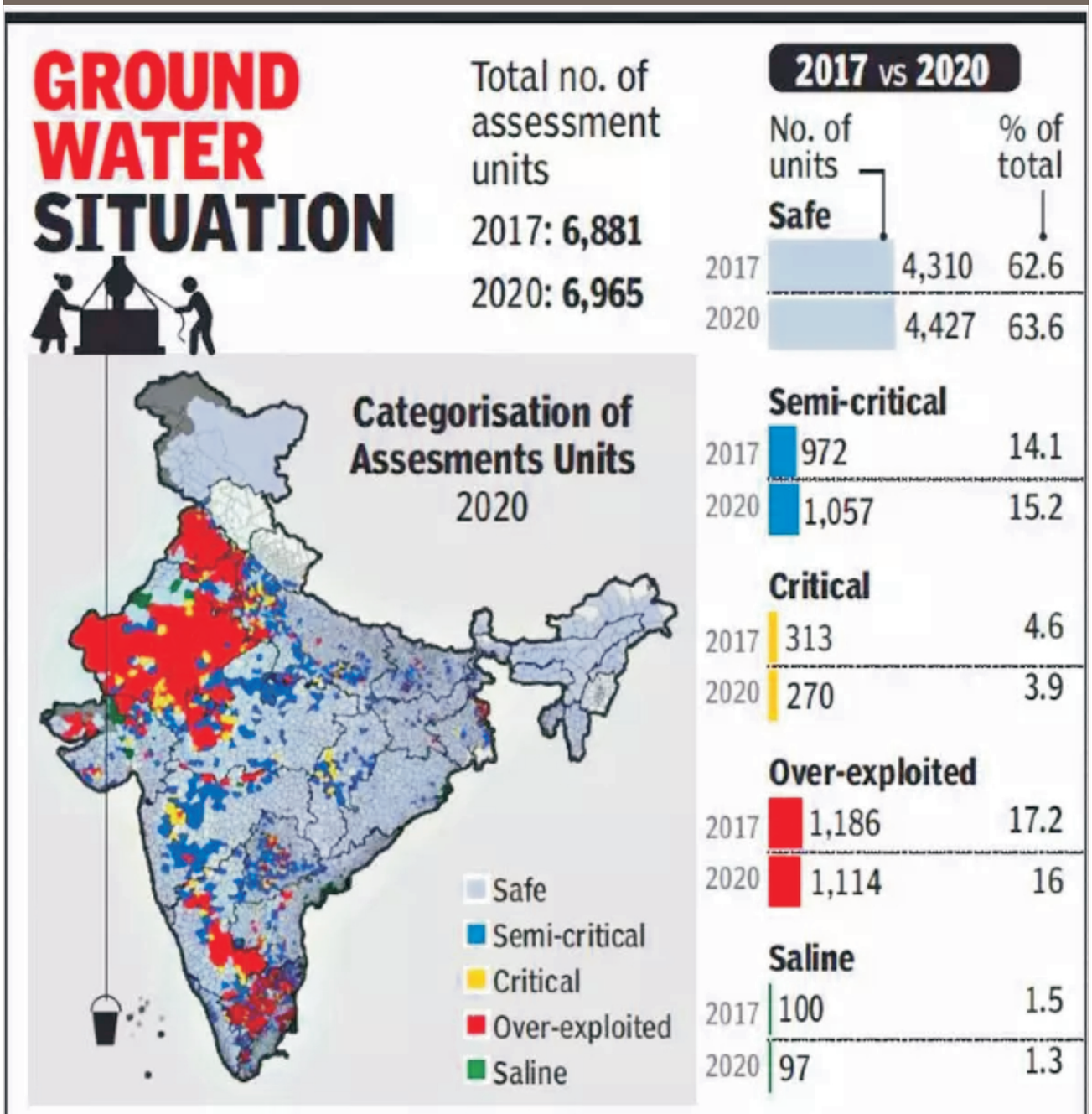
METHODOLOGY

The case study is based on a secondary review of data available through journal articles, research papers, reports, newspaper reports as well as government records. Keywords will be identified to ensure a comprehensive literature review from the period extending from 2015 onwards.

Newspaper, reports, and published journal articles focusing on water scarcity issues in the cities of Delhi and Chennai, for the period between 2015-2021 have been referred to analyze the water crisis in both cities.

GROUNDWATER SCENARIO IN INDIA

FACT SHEET



(Source: Central Ground Water Board, 2020)

WATER AVAILABILITY

- Yearly India receives about 4000 billion cubic metre (BCM) of precipitation.
- Annual utilizable surface and ground water resources in the country are estimated to be 690 BCM and 431 BCM, respectively.
- Per capita water availability in the country has declined by almost 20% in the last two decades and is likely to decline by another 20% by 2050, making India a water- scarce country.
- Largest user of groundwater in the world.

WATER CONSUMPTION

- Direct drinking water consumption is limited to 2–4 litres per capita per day (lpcd).
- Per capita daily water footprint is estimated to be 1.24 million lpcd5
- Agriculture Sector utilises almost 85% of total water (freshwater) usage.
- Water required for cooking food per day constitutes 6–8% of the total water demand.
- India's water demand would be twice the available supply by 2030.
- 83% of electricity production is based on the utilization of water.

WATER AND DISASTERS

- India is one of the most disaster-prone countries in the world.
- Hydrological (water-related) disasters are among the most frequent and have high mortality and damage costs.
- 9 out of 10 disasters are water-related.
- By 2100, extreme rainfall events are very likely in three major river basins, viz. Krishna, Godavari, and Ganga.

GROUND WATER

- 80% of the water supply in rural and urban areas utilise groundwater.
- Punjab, Haryana, Rajasthan, and Delhi have overexploited their groundwater with more than 100% extraction.

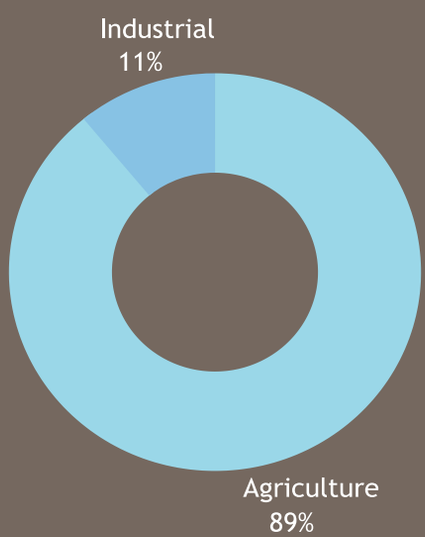


Figure1: Ground Water Distribution

(Source: TERI, 2022)

CASE STUDY: WATER CRISIS IN DELHI, 2021

Describing the Delhi Water Crisis

The existing water policy of Delhi led to a major water crisis in 2021 during the scorching heat and peak of COVID 19. More than 15 areas in East, West, and Central Delhi were affected for over 2 months. This also affected the supply of water to the hospitals within those areas. This is a recurrent situation in Delhi and various steps have been taken by Delhi Jal Board (DJB) to mitigate the issue but nothing seems to meet the targets set by them. Factors leading to the water crisis in Delhi are given below:

- **Reduction in release of water in Yamuna river by Haryana:** The reduced quantity of released water in Yamuna river affected the water supply in Delhi. The water level in the Wazirabad pond reduced from 674.5 feet to 667.6 feet (Aijaz, 2020).
- **Repair work:** The 232 million gallons per day of water coming from Beas was stopped by the centre because of repair work which led to the closure of the Nangal hydel channel, accounting for the stoppage of 25% of the water supply in Delhi (Aijaz, 2020).
- **Overpopulation:** The infrastructure and services of Delhi are burdened due to overpopulation and ever-growing demands. It is surrounded by populated cities like Faridabad, Ghaziabad, Gurugram, and Noida because of which it faces a massive movement of the population daily for work. The development of Delhi has also been irregular, and the informal growth of built structures has been extensive. People live in different types of areas, authorized and unauthorized, planned colonies, resettlement colonies, unplanned colonies built without authorization, urban villages, slums in inhabitable areas, colonies infringe/peri-urban areas, and villages and hence meeting the demand of such a populous city becomes a challenge for the service providers as well (Aijaz, 2020).
- **Gaps in production of water and treatment of wastewater:** For the city having a population of 21 million, the projected demand for water for the year 2019 was 1260 mgd. The city was able to produce 74% of its demand and 66% of the wastewater, so produced was treated (Aijaz,2020)

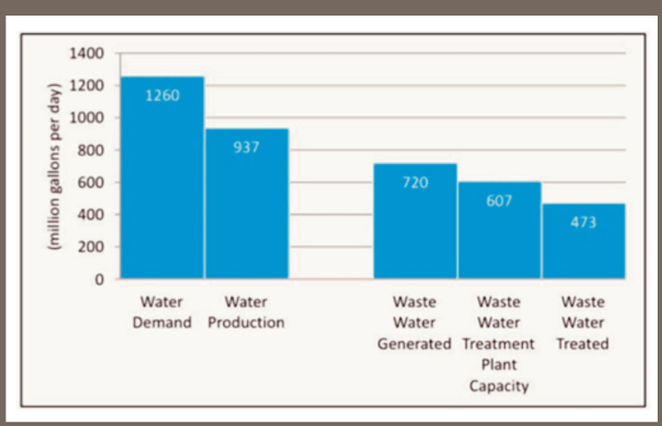


Figure 2: Gaps in production of water & treatment of wastewater
(Source: Planning Department, Economic Survey of Delhi 2019-20)

- **Insufficient Raw Water:** The quantity of surface raw water received from its neighboring states was very low, which even reduces more during summer as the states have their requirements to be met. As per the data available, there is a gap of 323 mgd in demand and supply. The availability of surface raw water has been greatly impacted due to unregulated and unrestricted extraction, leading to depletion of its groundwater table (Aijaz, 2020).
- **Low Groundwater Table:** Groundwater has been the constant source of water on the lawns of the areas situated in peri-urban parts of the city. The water table has also been depleted due to concretization and unauthorized construction of the built structures which disturbs the natural flow of water and prevents adequate recharge of the aquifers (Aijaz, 2020), can also mention the conversion of natural wetlands into cemented/ concretized wetlands- restricting the permeability (Aijaz, 2020).
- **Poor Quality:** The quality of surface raw water provided is poor. It was found that most of the industrial units in Haryana discharge untreated effluents into the Yamuna river. Several drains in Delhi too do the same practice. This has led to water pollution in the river and an increase in the levels of ammonia. There is a practice of dumping waste in the river water by the people living in authorized households and slums which further impacts the quality of water. The pipelines, especially the ones which run parallel to the sewerage lines often suffer from leakages leading to penetration of the contaminated substances (Aijaz, 2020).
- **Wastewater handling irregularities:** Although there have been many steps taken by DJB for the introduction of mechanized sewer cleaning machines, there have been many reported cases of injuries and death of the workers during the cleaning of sewer lines. Apart from this, many areas in Delhi still lack sewer connections. The present sewerage network of Delhi (over 8,400 km long) covers all planned colonies, 557 unauthorized regularised colonies, 384 unauthorized colonies, 130 urban villages, 54 rural villages, and 44 resettlement colonies (Aijaz, 2020). This number still is able to cover only around 78 percent of the city's population. There are 35 wastewater treatment plants at 20 different locations in the city, having an operational capacity of 607 mgd. However, it can be seen from the figure below that only 473 mgd of 720 mgd of wastewater generated is actually treated. Thus, there is a huge gap in the treatment and generation of wastewater, leading to the discharge of effluents and untreated water in the Yamuna river (Aijaz, 2020).

- **Inequitable distribution:** There is an inequitable distribution of water in Delhi not only in the unplanned colonies but also in the planned colonies as well. Because of the high tap-to-user ratio, not all households have 24 hours access to water. This irregularity in the supply of water makes it more susceptible to contamination (Aijaz, 2020).
- **Wastage:** There is around up to 40% distribution loss in total water supplied. A significant percentage of water is wasted and lost during its transmission and due to leaks in pipelines. Illegal tapping of water from the pipelines is also an issue. Along with this, the water gets misused by the tanker mafias who sell water to earn money and do not deliver it to the colonies (Aijaz, 2020).

CASE STUDY: WATER CRISIS IN DELHI, 2021

Impact of Water Crisis

The inadequacy in the distribution of water had already worsened the condition in Delhi. The frequent selling of water by tanker mafias has created damage to the social and physical fabric of the city where the people who do not have any formal access to water are deprived of their legal rights due to this activity, despite several additional tankers put in place for them. Besides this, the private tankers charged a huge amount for the water which further lead to extortion of the poor and underserved communities in which they must pay high prices for unreliable services (Stewart, 2020). Due to the gendered role of women in the maintenance of the household by cooking, cleaning, and sanitation, the additional burden of acquiring water falls disproportionately on them. During the crisis, many women were seen standing in long queues and on the footpath with their vessels in South Delhi's Chanakyapuri area waiting for the water tanker to arrive. Some of them even climbed on the tanker to ensure that they get water, flouting the COVID-19 social distancing norms (ABP News, 2021). The women sacrificed their health and hygiene to keep the house running during the COVID times.

The existing water policy in Delhi compelled the peripheral bodies and other marginalized communities, specifically women, to burden themselves socially and physically (Stewart, 2020). There was also a cut down on the water that was being provided to the hospitals in Central Delhi, North Delhi, South Delhi, and West Delhi due to decreasing water levels in the river (Business Today, 2021). Hence, the national capital struggled for lifesaving gas and other resources such as water, whose demand was manifold due to COVID prevention measures and ways (Business Today, 2021).

Steps Undertaken for Crisis Management

CASE STUDY: WATER CRISIS IN DELHI, 2021

Water Crisis Management

- Central Public Health and Environmental Engineering Organisation (CPHEEO) – Developed the norms and fixed the total quantity of 274 lpcd water for commercial and non-commercial uses.
- Setting up water treatment and recycling plants for producing clean water obtained from various surface sources.
- Memorandum of Understanding, 12 May 1994: The majority of raw water enters the Yamuna from five riparian states namely - Delhi, Haryana, Himachal Pradesh, Rajasthan, and Uttar Pradesh. Hence, an MoU was signed between them. MoU for other sources of water situated outside the administrative unit of the city - Bhakra storage (Himachal Pradesh), upper Ganga canal (Uttar Pradesh), and Munak canal (Haryana) was also signed.
- Water Tariff for Domestic Consumers: The domestic water consumers who already have the functional meters installed at their places are not required to pay any charges until 20 kilolitres (kl) per month. However, any consumption beyond this quantity is chargeable. An average of 10 kl per month for the unmetered connections and 25kl from the villages is assumed and is not charged.
- An agreement with some river-basin states for constructing three upstream storage dams i.e. Renuka in Himachal Pradesh, and Kishau and Lakhwar Vyasi in Uttarakhand—on the river Yamuna have been signed to augment the water supply.
- Levying Environmental compensation charges, ranging between Rs 10,000 and Rs 100,000 is proposed to regulate the commission of tubewells in the city.
- Rainwater Harvesting – Rainwater harvesting had been mandatory for private buildings having an area of 100 sq m and above. They are also eligible for a 10% rebate on their total billing amount while the ones which don't install the system will be given the penalty of enhanced tariff by 1.5 times.
- Over 2000 flow meters have been installed by 2019 for auditing purposes generating revenue and improving the quality of distribution services.

CASE STUDY: WATER CRISIS IN DELHI, 2021

Water Crisis Management

Steps Undertaken for Crisis Management

- An ongoing initiative is an Indo-Dutch collaborative project named Local Treatment of Urban Sewage Streams for Healthy Reuse (LOTUS-HR). Once the project is operational, it is anticipated that 10,000 liters of sewage will be treated every day for reuse (Aijaz, 2020).
- Quality control wing-9 plant laboratories have been established and 8 zonal laboratories have been established to monitor the quality of the samples of the treated water before it is supplied to the consumers for use.

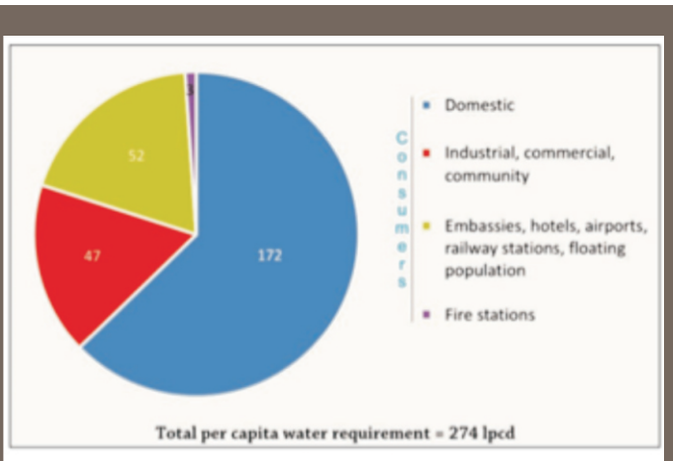


Figure 3: Per Capita Water Requirement in Delhi
(Source: Planning Department, Economic Survey of Delhi 2019-2020)

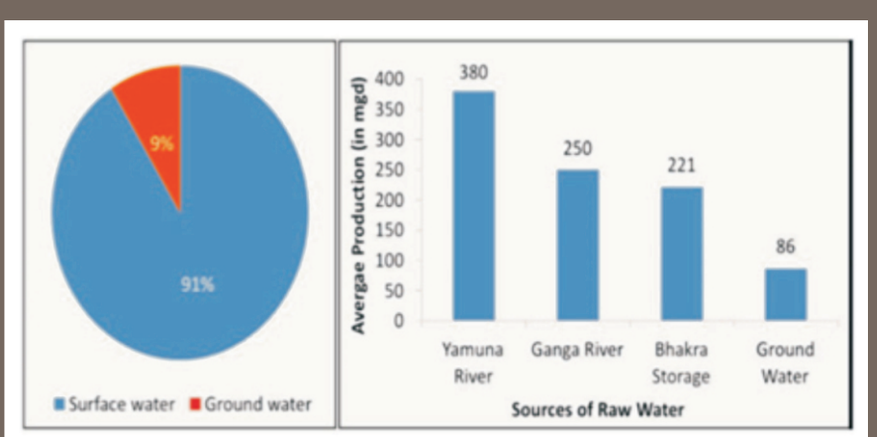


Figure 4: Sources of Raw Water
(Source: Planning Department, Economic Survey of Delhi 2019-2020)

ROLE OF STAKEHOLDERS



CASE STUDY: WATER CRISIS IN DELHI, 2021

The following steps were taken by DJB before the crisis- laying down new pipelines in the unauthorized colonies and replacing the old ones with the new ones, constructing new underground reservoirs, constructing wastewater treatment plants and rehabilitation the older ones, and providing water ATMs to 60 different public place locations, provision of packaged drinking water under the "JAL" scheme, GPS installation in the water tankers and increase in their total numbers, collaborating with the private companies and international experts.

(Planning Department, Economic Survey of Delhi 2019-20; Delhi Jal Board, Budget 2019-20)

CASE STUDY: WATER CRISIS IN CHENNAI, 2019

Describing Chennai Water Crisis, 2019

It was less than four years ago that Chennai faced devastating floods, taking away 422 lives and caused damage of up to $14 billion, that the city faced an acute water crisis in 2019. Because of excessive attention paid to mitigate floods in the city, Chennai has lost most of its rainwater to parched groundwater reserves.

The data published by the World Resources Institute also indicated that approximately 10 million people in Chennai faced an imminent water crisis. NITI Aayog, an Indian government think tank also has predicted that 21 Indian cities would run out of groundwater in 2020 (Aspinwall, 2019).

- **Dependence on tankers:** The groundwater supply by the tankers coming from outside of the city is its lifeline. 9000 public tankers deliver water to the residents on daily basis even during normal conditions. Some of the affluent residents who can hire private tankers get 5000 tankers more. Also, during the last summer crisis, a greater number of tankers were required to fulfil the daily water demand of the residents. The tankers often get filled up from the farms, mines, and unregulated sources of water. The additional task of filling water from the tankers comes to women wherein they must spend hours filling their utensils. Perennially water- starved southern districts like Pudukkottai, Ramanathapuram, Sivagangai, Madurai, Dindigul, and Virudhunagar people spend day and night collecting water from whatever sources are available. Sadly, a serving ladle (agappai) – is used to fetch water from the temporary dug wells. While they help to extract water in the rivers like Vaipar in Tuticorin and Gundar in Sivagangai districts at times they become death traps to children and animals. Some people moving in a hurry became victims of pits laid down for new pipelines in Kumbakonam and Pudukkottai towns. This also demonstrates inequity in the city where the rich can afford an immediate solution to fulfil their needs while the poor had to wait for hours for the tankers to be sent by the government. For many of them, every day is Day Zero (Trivedi, 2019).
- **Empty reservoirs:** Poondi, Cholavaram, Redh, ills, and Chembarambakkam are the four major reservoirs present in Chennai city. They get filled up at the end of the monsoon (Oct-Nov) and can supply about 200 MLD of water. However, the monsoon season after 2015-2016 had been deficit and the reservoirs were not filled upbringing their combined storage to almost zero (Guntoju, 2019).

CASE STUDY: WATER CRISIS IN CHENNAI, 2019

Describing Chennai Water Crisis, 2019

- **More and more bore wells:** The people who cannot afford to pay huge prices, dig bore wells. Those who cannot afford to drill, have had their taps run dry. This has also caused conflict with the neighboring areas. Various protests erupted as the availability of water became scarce.
- **Chennai's vanishing groundwater:** There has been extensive extraction of groundwater in Chennai by the public and private water tankers, from within as well as from outside of the city to meet the daily water demands of the city. Within city limits, groundwater extraction takes place from about 0.42 million private groundwater wells, with 66 percent of households having their private wells (Sengupta, 2019). The limited period of groundwater recharge and long-term extraction of groundwater in an indiscriminate manner results in overexploitation requiring well deepening or the search for wells further away from the city (Guntoju. 2019).
- **No flow zones:** As Chembarambakkam Lake is a large special economic zone. The development near it is intense. There is an automobile plan for Hyundai at Irungattukottai, an area that is a part of the lake's catchment area. The factory uses rain and groundwater — for cooling machinery, washing vehicles, and mixing with paint that would have otherwise flowed into the reservoir (Guntoju, 2019).
- **Urban spread:** The other side of the Chembarambakkam Lake, called Senneer Kuppam, meaning "place with pure water" used to be a farming area. The areas were believed to have grown only eggplants and sunflowers for generations and we're used to be irrigated with plentiful water from an insubstantial well, dug by hand. But as the city expanded beyond its limits and a superhighway was built through a once-sleepy village, the farmers began to sell their land for development or became water merchants during the crisis.

CASE STUDY: WATER CRISIS IN CHENNAI, 2019

Impact of Water Crisis

1. The impact of the water crisis was disproportionately felt by the poor families which were to spend hefty amounts charged by the private companies for something available at a much lesser price anyways. For example, for a tanker of 900 liters, a private company charged somewhere between 4000-5000 rupees which otherwise from CMWSSB costs only Rs 800-900 but had a waiting period of 15-20 days. This high price was due to the short obtainability of the public tankers made it high-priced for the poor (Guntoju, 2019).

2. The farmers abandoned their jobs amidst acute water scarcity, uprooted themselves, and started searching for something else. The production of food in the outskirts of the city was falling, no agriculture was left and food prices shoot up. The farming communities which used to grow water-intensive crops such as sugarcane and rice protested against water tankers for taking water from the farmers' dwindling supply (Trivedi, 2019).

3. The service sector establishments in Chennai were in distress. There was no potable water in about 5000 hotels, hospitals, and educational institutions and the water available from the bore wells was unfit for drinking purposes due to high salinity. Some of the hotels in the busy areas of the city like Nungambakkam were closed while some opted for partial cancellation of their services because of unbearable price and erratic supply of water. In most of the shopping malls in Chennai, there were only some of the floors had operational restrooms. (Pathak, 2019).

4. The students were asked to bring their oater for toilet purposes. Many government schools and hospitals locked their toilets due to scarcity of water. Some of the private schools started conducting the classes during morning hours only. The highly subsidized Amma canteens run by the state were also severely affected. Many IT companies asked their employees to work from home while some advised them to migrate to Bangalore and Hyderabad. Even many residents in Chennai started migrating to their hometowns owing to the water crisis. The sudden stoppage of construction work left thousands of unskilled cost construction (Pathak, 2019).

CASE STUDY: WATER CRISIS IN CHENNAI, 2019

Water Crisis Management

Steps Undertaken for Crisis Management

- Tamil Nadu Groundwater Development Management Act, 2003 - For regulating the number, as well as the locations of borewells, dig. It also required the landowners to get permission before digging a borewell, making rainwater harvesting mandatory in all private buildings and homes.
- Chennai Rain Centre – It is a non-profit organization to teach people about harvesting rainwater. "Catch rain. It's free! That's our slogan," said Sekhar Raghavan, founder, and director of the Rain Centre (Akash Ganga Trust, raincentre.net)
- At the peak time of the crisis, more than 9000 tankers were dispatched each day by the city to ship water from its outskirts to drought-stricken neighborhoods. But even that could not suffice the complexity of the situation. Hence, the private firms stepped in for providing another 5,000 trucks and Chennai continued to rely on distant water sources.
- Senior officers from govt. the authorizer is put in charge of each zone to identify gaps in supply and ensure that water is provided in those spots. The government set up a price for the tankers. A special train for transporting 10 million liters of water per day – that's about 2.6 million gallons — to Chennai from another part of the state was set up. After initially turning down donations, Tamil Nadu accepted an offer of the aid of 2 million liters of drinking water from a neighboring state, Kerala.

ROLE OF STAKEHOLDERS

Before the crisis, the supply of water through 556 combined water supply schemes (CWSS) for 24 districts was being done by Tamil Nadu Water Supply and Drainage Board (TWAD) to solve the problems of drinking water in rural areas. The schemes ensure liters of water per head along with the supply available from the bore wells in the village. Bigger CWSS provides 90% distribution through Cauvery supply.

KEY GAPS AND CHALLENGES

There are no tracking systems and MIS systems in place yet to assess the requirement, production, and distribution of water (CAG, 2013: 96). Around 93% of the households have access to piped water connections but the information on hours and quantum of water supplied to them is not available.

The distribution of water is inequitable even in some of the affluent areas of the capital (Grover, 2021). There is a paucity of funds at DJB in terms of income generated from water and the amount required for its maintenance because of which most of the targets are not getting achieved. The issues of conflict of interests arise in the crisis because Haryana was told by the top court to supply an adequate quantity of water to Delhi such that there is no shortage of water in the city. Even DJB alleged Haryana for withholding 120 MGD of water but on the other hand, Haryana doesn't consider itself to be responsible for the crisis at all which was later clarified in the 52nd and 54th meetings of the upper Yamuna board.

The building of extensive drainage networks in the city to mitigate floods has led to the loss of freshwater and made the city more susceptible to drought than a flood-prone one (Tim Ha, 2020). Variation in monsoon induced by climate change, sustained population growth, increase in the water demand, absence of planning to include long-term measures, inadequacy in the storage and dilapidated infrastructure facilities, leakages, dearth of knowledge among residents on water paucity and its improper management together contributed to the severe water crisis in Tamil Nadu.

KEY GAPS AND CHALLENGES

There have been accusations that the state had given more importance to the urbanite areas in Chennai alone while the other areas in the state have been rather given a step-motherly attitude. The same situation of water scarcity prevails all over Tamil Nadu (Tim Ha, 2020).

The scarcity of water is vivacious and an emergent problem in India. The cities are facing immeasurable tests and trials for supplying drinkable water to their populations. As per a report by Niti Aayog, 70% of its water is contaminated. Domestic sewage, lack of wastewater treatment facilities, weak enforcement of the policies, and unregulated practices for extraction of water are some of the key drivers of water scarcity. Because of this, the number of critically polluted rivers in India has also increased from 32 to 45 in the period span of just 3 years, putting excessive stress on groundwater by which most of the water demands in Delhi are met. The river Yamuna also considered a holy river of India is now completely dead in New Delhi. As soon as it enters the city, the city extracts 229 million gallons of water for the supply of potable water to its residents. With this, the river also carries more than 800 million gallons the sewer with it every day and has been considered unfit for drinking and bathing purposes since 2014. The city of Chennai is sprawling over the peri-urban areas and is dependent on only a few water bodies to meet its water demands. Due to uncontrolled urban sprawl, there has been a weighty transformation in the way lands are being put to use & land covered because of which the water bodies have shrunk (Ghosh, 2021).

NATURE BASED SOLUTIONS FOR WATER SECURITY

Nature-based Solutions are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature (IUCN, 2020).

Working with nature to improve the management of water resources, achieve water security for all, and contribute to core aspects of sustainable development

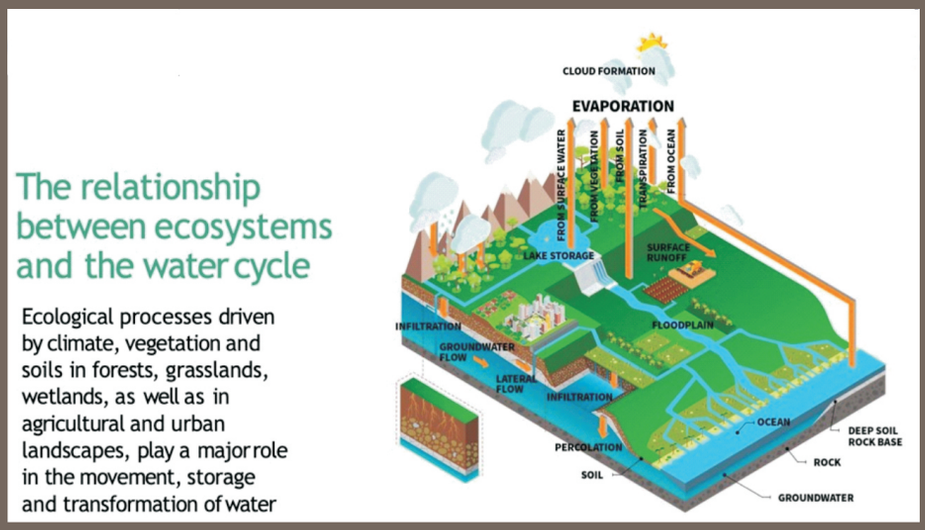


Figure 5: Relationship between Ecosystems and Water Cycle
(Source: Food and Agriculture Organization of the United Nations, 2018)

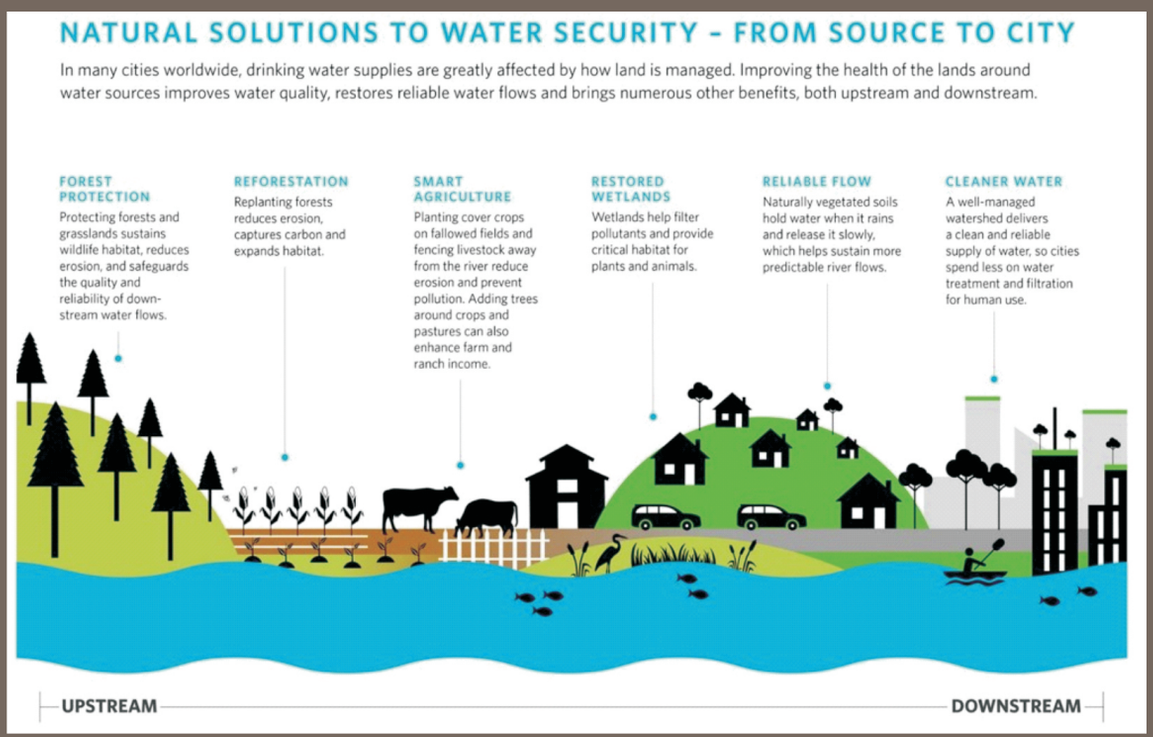


Figure 6: Nature-based Solutions (NbS) for Water Security.
(Source: The Nature Conservancy, 2019)

RECOMMENDATIONS

The study suggests preventive, mitigatory, and preparedness measures for proactive urban management. Overcoming the challenges faced in managing water effectively, there is a need to adopt proactive measures for long-term sustainability and resilience- building along with the promotion of social behavior change communication campaigns and capacity-building programs among stakeholders and citizens for the effective management of the risk.

1. Effective water management strategies: Rainwater harvesting is the easiest way of enforcing the existing laws in the cities of Delhi and Chennai. Besides the installation of RWH systems in private buildings and housing societies, efforts should be made to explore the installation of the system in the potential areas of the city such as on roads, flyovers, waterlogged areas, and open spaces.

2. Nature-based solutions: The corporates can explore the possibility of funding (under their Corporate Social Responsibility arm), the nature based solutions such as having green spaces and the wetlands that are capable of absorbing the standing water on the roads which in turn would increase the level of groundwater recharge.

3. Wastewater treatment capacity-In Chennai, a huge amount of sewage is carried into the sea every day by Cooum and Adyar rivers and by the Yamuna river in Delhi. The paucity of land is an issue for both cities hence steps can be taken to combine the sewage at the apartment level with the small level sewage treatment plants without utilizing more land augmenting the capacity of sewage water treatment plants. While the deficiencies of severed connections need urgent attention in Delhi (Palanichamy, 2019).

4. 3 R's of Reduce, Reuse, and Recycle wastewater: Numerous lakes in the city have been badly affected due to disposal of untreated waste. Hence, a combination of two separate treatment plants i.e. the small ones combined with the sewage treatment plants at the apartment levels can actually help in treating the sewage without having the need of occupying new land (Palanichamy, 2019).

5. Conserve natural sources of water: The master plans of the cities must incorporate the steps for the protection of lakes, rivers, and flood plains and should work on improving the capacities of the natural water sources. Steps should be taken to regulate the use of groundwater and stop the construction over the floodplains and consider the provisions of incentives for prioritizing developments over ridges. Demolition of the existing illegally built structures to improve the runoff at the surface level (Palanichamy, 2019).

6. Effective water governance: The strategies for promoting green infrastructure such as establishing rooftop gardens should be done. It would also ensure that the rainwater is well captured and is not left to waste. Support to the rural areas can be given via farm-to-table interventions. It would enable the farmers not to deal with the voracious middlemen anymore. This would assist the families to have improved sources of income while ensuring that they do not fall prey to the water traders. Cooperation over shared water with neighbouring states should be established for the effective use and management of water.

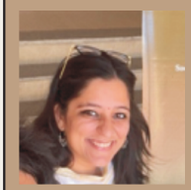
7. Anti-pollution measures – Steps should be taken to prevent illicit dumping of waste in the river water. Various other reasons for contamination of water sources such as unfitting discard of sewage which is not treated, discharge of runoffs from the industries, and leakages in the pipelines should be addressed with the help of improved technologies to prevent the loss of clean drinking water, and legal action should be taken against the polluters (Palanichamy, 2019).

The study suggests that preventive and preparedness steps should be undertaken, and efforts should be made to mitigate its impact. It should be followed up by a culture of proactiveness, such as purchasing the riparian rights, promoting of acts, and guidelines addressing the demand for water before the crisis hit. The study highlights the importance of strict law enforcement, the building of long-term resilience models with the support of local people, and highly recommends promotion of the public information and awareness campaigns for people, conducting capacity-development programs, and innovative management programs, for managing the risks effectively (Palanichamy, 2019).

REFERENCES

1. K. Sivasubramaniyan, and S. Rajendran. (2019). Mitigating drinking water crisis in Tamil Nadu. International Journal of Research - Granthaalayah, 7(8), 301-317. https://doi.org/10.29121/granthaalayah.v7.i8.2019.673.
2. Economic Survey of Delhi. (2019-20); Planning Department, Delhi: Government of NCT of Delhi.
3. Delhi Jal Board, Budget. (2019-20). Delhi: Government of NCT of Delhi.
4. Aijaz, R. (2020). Water Supply in Delhi: Five Key Issues. ORF Occasional Paper No. 252.
5. Stewart, M. (2020). Delhi Water Politics: How Institutionalized Ways of Knowing Disenfranchise Marginalized Communities. Journal of the Asia-Pacific World, 3(1). https://doi.org/10.33137/relocations.v3i1.33507
6. Comptroller and Auditor General of India (CAG). (2013). Government of Delhi, Report of the Comptroller and Auditor General of India on Social Sector.
7. Yaffa (2018). Negotiating states of water: Producing illegibility, bureaucratic arbitrariness, and distributive injustices in Delhi. Environment and Planning D: Society and Space.
8. Ghosh, P. (2021). Water stress and water crisis in large cities of India.
9. Planichamy, R. (2019). How does a flood-prone city run out of water? Inside Chennai's "Day Zero" crisis.
10. Tim Ha. (2020). One year after the drought: Has Chennai learned from its water crisis?
11. Grover, S. (2021). Not only oxygen, but Delhi is also struggling for water too. Covid is making it worse.
12. Pathak, S. (2019). No drips, no drops: A city of 10 million is running out of water.
13. Guntoju, S. (2019). Chennai water crisis: A wake-up call for Indian cities.
14. Trivedi, A. (2019). Responding to day zero equitably: Water crisis lessons from Cape Town and Chennai.
15. Sengupta, S. (2019). Chennai's water wars.
16. Aspinwall, N. (2019). Chennai's Man-Made Water Crisis.
17. ABP (2021). Delhi water crisis: Women climb atop water tanker; citizens put the onus on Kejriwal Government.
18. Business Today. (2021). Delhi hospitals face imminent water crisis amid COVID-19 surge

About the Authors

Overall Supervision:			
	Prof Anil K Gupta, Professor and Head ECDRM Division, National Institute of Disaster Management (NIDM), Delhi		
Contributing Authors:			
	Dr Aditi Madan Associate Fellow, Institute of Human Development (IHD), New Delhi		Ms Pritha Acharya Research Associate, CAP-RES, National Institute of Disaster Management (NIDM), Delhi

Cover Photo & Design Credit:
Pritha Acharya, Research Associate, CAP-RES, NIDM

About CECR and CAP-RES Project

About CECR

The National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament with a vision to play the role of a premier institute for capacity development in India and the region. Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management.

NIDM has a dedicated division for Environment, Climate and Disaster Risk Management (ECDRM) which has been designated as a Centre of Excellence on Climate Resilience (CECR) under the National Action Plan for Climate Change and Human Health (NAPCCHH). The CECR is implementing six research projects namely Climate Adaptive Planning for Resilience and Sustainable Development in Multi-hazard Environment (CAP-RES) with support of DST-Govt of India, National Agriculture Disaster Management Plan (NADMP) funded by the Ministry of Agriculture & Farmers Welfare, Health Resilience and Capacity Building (HER- CAP) with WHO, Crisis Management Plan for dealing with Contamination of Water Bodies (CMP-WB) funded by CPCB, Disaster Management Plan for Ministry of Environment, Forest and Climate Change (NEFC-DMP) with the support of MoEFCC and Disaster Management Plan for the Dept. of Chemicals and Petrochemicals (NCPC-DMP) supported by DCPC, MoC&F. It also collaborates with a number of international and national organizations working in the areas of climate change adaptation, resilience, disaster management and disaster risk reduction.

About CAP-RES Project

“Climate Adaptive Planning for Resilience and Sustainable Development in Multi-Hazard Environment (CAP-RES)” aims at developing and implementing capacity building including a knowledge and training support system for wider use by related institutions and training centres across sectors and regions. The CAP-RES focuses on three specific regional contexts,i.e. Indian Himalaya Region (special reference to North East), Coastal region and Central- western region. Region-specific climate-related hazard complex, including flood, drought, water scarcity, forest fire, cyclone/storm surge, coastal erosion, slope erosion/landslide, windstorms, heat wave, disease epidemics, industrial/chemical risks, etc.

The proposal of NIDM aims at value-addition to programme sub-areas of the NKMCC by engaging with the institutions/research centres and network of experts, researchers and practitioners, across the following 5 key sub-sets of the project focus:

- Green Growth and Disaster Risk Reduction
- Resilient Agriculture Systems
- Public Health Resilience
- Climate Proofing Disaster Relief and Recovery
- Environmental Policy Instrument in Disaster Risk Reduction

Other publications under CAP-RES



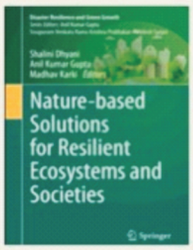




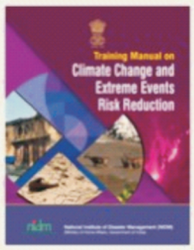


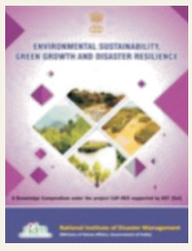


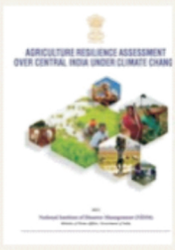


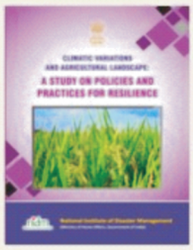








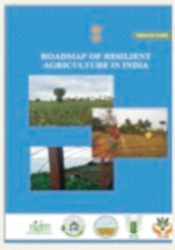


















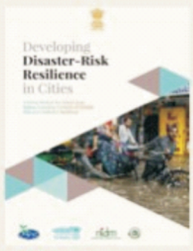












Notes

Notes

Notes

Resilient India - Disaster Free India

National Institute of Disaster Management
(Ministry of Home Affairs, Government of India)
Plot No.15, Pocket 3, Block-B, Sector-29, Rohini, Delhi-110042
Email: ed.nidm@nic.in | Website: https://nidm.gov.in

ISBN No.: 9788195796533