Water Blueprint of Meenchanda (Kozhikode Corporation, Kerala State): a contributive citizen-science initiative

Prepared by

KSCSTE- CENTRE FOR WATER RESOURCES DEVELOPMENT AND MANAGEMENT (CWRDM) KOZHIKODE, KERALA

Department of Science & Technology, Government of India

KSCSTE - CWRDM ISO 9001:2015

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Under the project

W 4 C

WATER FOR CHANGE
Integrative and fit-for-purpose
water sensitive design
for fast growing livable cities

ISBN: 978-93-342-1474-1

Suggested citation: Manoj P Samuel, K Ch. V Naga Kumar, P S Harikumar, U Surendran, A Navaneeth, T S Salumol, C Noobiya (2025) Water Blueprint of Meenchanda (Kozhikode Corporation, Kerala state): a contributive citizen-science initiative. KSCSTE - Centre for Water Resources Development and Management, Kozhikode, Kerala.

Funded by
Department of Science and Technology
Government of India

Acknowledgements :

The Water Folks initiative in the Meenchanda ward is a collaborative endeavor jointly supported by the Ramakrishna Mission School, Prithvi Roots (A dedicated NGO focused on environmental conservation) and the ASHA workers of the ward. We also extend our gratitude to the Councillor of the Meenchanda ward for the invaluable support. We sincerely acknowledge and appreciate the contributions of all the Water Folks volunteers involved in the preparation of this book.

Executive Director's Message

It is with great pleasure that I extend my commendations to the Water Folks volunteers for their exemplary efforts in preparing this comprehensive water information booklet for Meenchanda Ward as part of their citizen science initiative. Recognizing that water, as an invaluable resource, necessitates sustainable management through collective action and informed decision-making.

This booklet serves as a significant demonstration of the critical role that the community engagement plays in understanding and addressing local water-related challenges. Through the collection, analysis, and presentation of vital data, the volunteers have not only advanced water literacy but have also empowered the residents to actively participate in enhancing water governance.

At KSCSTE-CWRDM, we remain steadfast in our commitment to fostering innovative strategies and collaborative efforts that promote water conservation and sustainable development. Initiatives of this nature inspire hope and provide a model to the participation at the grassroot level that can drive a meaningful and lasting change

I offer my sincere congratulations to the entire team for this remarkable accomplishment. Let us continue to work together to ensure a sustainable and secure water future for all.

Dr. Manoj P Samuel
Executive Director
KSCSTE-CWRDM

Executive Summary

The Water Blueprint of Meenchanda is a pioneering citizen-science initiative undertaken by KSCSTE-CWRDM under the Water4Change (W4C) Program—a collaborative initiative between the Department of Science & Technology (DST), India, and the Netherlands Organization for Scientific Research (NWO). This program aims to develop an integrative, fit-for-purpose, and contextually relevant water-sensitive urban design framework to address challenges faced by rapidly growing secondary cities in India. As part of this initiative, a community-driven program named "Water Folks" was launched. It leverages the participatory approach of involving an engaged community comprising local residents, researchers, policymakers, and stakeholders. The primary objectives of the initiative include: a) mapping, and evaluating of surface and groundwater availability and their levels, b) conducting, regular analyses of drinking water sources for physical, chemical, and biological parameters to identify pollution hotspots and safeguard public health, c) reviewing the existing practices and community-level awareness and governance gaps to identify and recommend improvements for equitable and sustainable water distribution.

In addition, workshops, capacity-building programs, and participatory decision-making exercises were conducted to promote inclusivity and facilitate knowledge dissemination. The findings revealed significant seasonal variability in water availability, with a heavy reliance on groundwater sources during dry periods. Water quality assessments indicated the presence of coliforms in several areas, likely due to improper waste disposal and surface runoff. The citizen-generated data empowered the community to better understand their local water challenges and collaboratively develop sustainable management strategies. Key outcomes of the project include enhanced community awareness, data-driven decision-making by local authorities, and development of community-led initiatives to ensure long-term water security for the Meenchanda region.

By integrating local knowledge with advanced tools, t*he Water Blueprint of Meenchanda* fosters sustainable water management, enhances resilience to climate variability, and strengthens water governance frameworks. This initiative serves as a replicable model for addressing urban water challenges and has the potential to be scaled up to other urban regions facing similar issues.

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Introduction

India is rapidly evolving into an urban agglomeration, facing significant infrastructure deficits and adaptation gaps towards addressing current and future climatic, societal, and economic changes. Water stress, characterized by pressures on the quantity and quality of water resources leads to recurring challenges such as water shortages, flooding, pollution, and ecosystem damage. In fast-growing secondary cities, the impacts of water stress vary widely due to geographical and contextual factors, such as the prevalence of potentially contaminated sites and ineffective water resource management practices. This highlights the critical role that water can play as a driver of sustainable transformation in these cities. Currently, more than 300 cities in India with populations exceeding 100,000 are grappling withinfrastructure deficits and adaptation gaps in areas such as stormwater management, water supply, wastewater systems, groundwater sustainability, and flood mitigation. To provide sustained and equitable services to their citizens, these cities must undergo significant changes. India faces converging trends and risks, including natural disasters, economic crises, social inequality, climate change, and demographic shifts that demand innovative approaches and strategies for managing and utilizing environmental resources. While technological solutions exist and the key drivers of these challenges are well understood, current strategies remain insufficient to deliver the transformative changes that are necessary to proactively respond to these challenges. Water, as a fundamental necessity for life, has the potential to act as an agent and as well as the catalyst for positive change when managed equitably and in a context-sensitive manner.

Recognizing these challenges, the India and Dutch governments have introduced the **Water4Change (W4C)** Program, a collaborative initiative between the Department of Science & Technology (DST) and the Netherlands Organisation for Scientific Research (NWO). This program aims to develop an integrative, fit-for-purpose, and contextually relevant **water-sensitive urban design framework** to address the challenges that are faced by the fast-growing secondary cities in India. The research program targets the complex challenges of urban water systems and the sustainability transitions needed for short- and long-term mitigation, adaptation, and resilience. The W4C program adopts a holistic, integrative, and socio-ecological approach that addresses governance, spatial planning, technology, infrastructure design, and societal behaviours. Together, these dimensions enable to develop “equilibrium" solutions that are sensitive to socio-economic,

environmental, technical, and procedural conditions while remaining adaptable to future changes. By synergistically connecting key realms of governance, technology, infrastructure, and societal behaviour, the program co-creates and mainstreams an **integrative water-sensitive design framework** to foster livability, sustainability, and resilience in secondary cities. To develop and test this framework, three Indian cities—**Kozhikode**, **Bhuj**, and **Bhopal**—were selected as case studies. These pilot cities serve as benchmark for identifying current obstacles and devising solutions for systematically implementing water-sensitive design and resilient infrastructure. The findings and practices derived from these pilot studies aim to integrate water-sensitive principles into urban planning, governance, and regeneration of urban water systems.

A series of transition management workshops have been conducted in these three case study cities. These workshops focused on framing the challenges, envisioning a water-sensitive future, and designing pathways towards achieving water-sensitive urban transformation. The outcomes of these workshops are foundational for systematically implementing resilient and adaptive urban water management strategies that promote equality and long-term sustainability. In these cities, a series of transition management workshops were organised, involving key stakeholders such as policymakers, urban planners, engineers, researchers, and community representatives. These workshops focus on three core objectives:

1 **Framing transition challenges:** Identifying and prioritizing the most pressing water-related issues in each city.
2 **Creating a water-sensitive vision:** Developing a shared, long-term vision for sustainable urban water management.
3 **Designing water-sensitive pathways:** Co-creating actionable strategies and path ways to achieve the envisioned water-sensitive future.

Through this participatory and collaborative approach, the workshops have laid the groundwork for systematically incorporating water-sensitive design principles into urban planning, governance, and infrastructure development. Inspired by these insights' researchers from KSCSTE-CWRDM conceptualized the **'Water Folks Program',** a citizen science initiative. This program was designed to empower individuals who are passionate about water conservation and environmental stewardship to actively participate in water quality monitoring and governance. Citizen science, as a core philosophy of the Water Folks Program, serves as a powerful tool for democratizing water governance. It allows non-experts, such as

local residents and community members, to actively contribute to scientific research by collecting and analyzing water data. This participatory approach not only expands the scope of data collection but also increases public awareness of water issues, enhances accountability, and fosters a culture of shared responsibility. By involving citizens in water governance, the program builds trust, strengthens future changes. This participatory approach not only expands the scope of data collection but also increases public awareness of water issues, enhances accountability, and fosters a culture of shared responsibility. By involving citizens in water governance, the program builds trust, strengthens community resilience, and ensures that solutions are rooted in local realities.

Fig 1. Photographs showing the glimpses from series of workshop conducted in the Kozhikode city

2. Kozhikode- city profile

Kozhikode, also known as the "City of Truth", which is honored recently as an UNESCO "City of Literature," is a coastal city blended with rich cultural heritage and historical significance. Famed for its architectural splendor, diverse culinary traditions, and tranquil landscapes, it has long been a beacon of trade and cultural exchange. Historically called Calicut, the city emerged as a prominent trading hub as early as the 12 th century, attracting merchants across the globe, including Arabia, China, Portugal, the Netherlands, and Britain. As per the 2011 Census, Kozhikode has a population of about 608,255, spread across 75 administrative wards, comprising nearly 20% of the district's total population. The city spans around 118.59 square kilometers, covering approximately 5% of the total district's geographical area. Situated in the lowlands and midlands of Kerala state, Kozhikode city enjoys a climate that is characterized by seasonal variations, with temperature ranging from 17.5°C to 36.5°C, and with an average annual rainfall of 3130 mm, received over 126 rainy days which is pre-dominantly during the Southwest and Northeast monsoons. The city's development is deeply intertwine with its natural assets, including a 22-kilometer-long coastline and with the rich water resources provided by rivers such as the Korapuzha, Chaliyar, and Kallai. Kozhikode is experiencing rapid urbanization as the Economist Intelligence Unit (EIU) has ranked it as the fourth-fastest growing city in the world, highlighting its dynamic transformation with time.

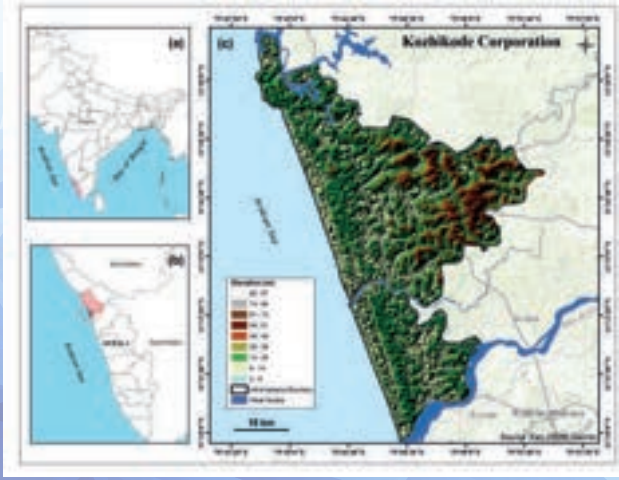


Figure 2:
(a) Map showing India with Sate boundaries and Kerala State is marked in pink color, (b)Map of Kerala State showing Kozhikode corporation incircle along with Kozhikode district marked in pink color, and (c) ALOS Palsar Digital Elevation Model (DEM) of Kozhikode corporation, Kozhikode district

3. Story of Meenchanda Ward: A Participatory Journey in Water Data Collection

The story of Meenchanda Ward is one of innovation, collaboration, and community empowerment, showcasing how collective action can address critical water management challenges. It began with the launch of the Water Folks Initiative at the Centre for Water Resources Development and Management (CWRDM), aimed at engaging local communities in sustainable water stewardship.

3.1 Launch of Water Folks program at CWRDM

Recognizing the urgent need for grassroots involvement in water conservation, CWRDM launched the Water Folks initiative on **March 20 th , 2024** under the project **Water for Change**. This ambitious program aimed to establish a knowledge platform connecting individuals passionate about water science, with a particular focus on Kozhikode Corporation. The launch event brought together **20 volunteers from diverse backgrounds**. To ensure seamless knowledge transfer and accessibility, a dedicated website and the **WATER-CAT mobile application** were introduced. The 'app' enabled real-time water quality assessments and provides a centralized platform for data sharing and the web portal aimed at showcasing major activities and outcomes of the program. The program actively sought partnerships with community groups, including NGOs, schools, and colleges. Among the early adopters, **Ramakrishna Mission School and Prithvi Roots (NGO)** in Meenchanda Ward emerged as pivotal collaborators, expressing their commitment to the initiative.

Figure 3: (a) Photograph showing the list of volunteers participated & trained during the launching events of the Water Folks program, (b) Field photograph showing the water volunteers engaged in the training with the water quality tool-kit

3.2 Involvement of Ramakrishna Mission School and Prithvi Roots

A dynamic partnership with **Ramakrishna Mission School and Prithvi Roots (NGO)** became the foundation of the Water Folks initiative in Meenchanda Ward. This collaboration not only enhanced community participation but also brought an educational and grassroots perspective to the program. A **Water Clinic** was established at the school, providing a space where residents could submit water samples for analysis. The Water Folks team, supported by CWRDM experts, analyzed these samples and uploaded the results onto the WATER-CAT mobile application. The clinic became a hub for raising awareness about water quality issues, fostering a culture of inquiry and action among students, NGO members, and local residents.

3.3 Training of Volunteers

Comprehensive training sessions were conducted to equip volunteers with the skills and confidence needed for effective water data collection. The training covered:

- **Water Sampling Techniques:** Collecting samples systematically from various sources and analyzing them using portable water testing kits.
- **Data recording and Analysis:** Utilizing the WATER-CAT mobile application to accurately record data and interpret the trends.
- **Health and Safety Protocols:** Ensuring personal safety during fieldwork and proper handling of water samples.

These sessions empowered volunteers, introducing a sense of ownership and competence that drove the initiative forward.

Figure 4: (a) Training of Water Folks volunteers (b) Water Folks volunteer analysing water samples

3.4 Data Collection Process

The data collection phase was conducted in with the Water Clinic and included a **detailed study to create a Water Information Sheet** for Meenchanda Ward. Under the leadership of Water Folks volunteers, supported by CWRDM experts, the process involved:

- **Mapping Water Sources:** Identifying and documenting wells, ponds, streams, and other water sources.
- **Assessing Water Quality:** Testing for critical parameters such as pH, TDS, Hardness, Alkalinity, Chloride and Total coliform. The tested results were uploaded in Water CAT mobile application
- **Monitoring Water challenges:** Understanding water usage patterns among households, and
- **Community Engagement:** Encouraging residents to share observations and insights about local water issues.

This participatory approach ensured that the data captured was comprehensive, accurate, and reflective of the community's lived experiences.

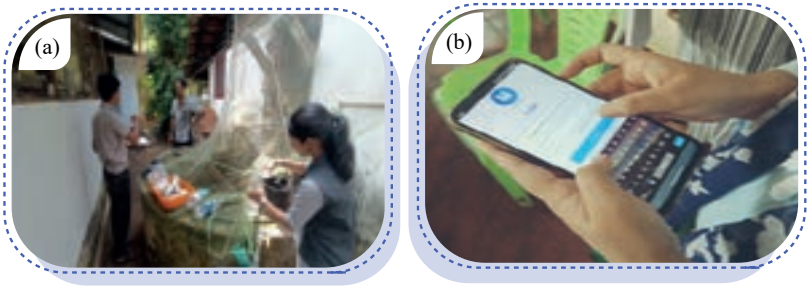


Figure 5: (a) Field photograph showing the collection of water samples, (b) Volunteers entering data in Water CAT application

3.5 Water sample collection & Analysis

Water samples were collected following standard protocols (IS 10500:2012) to ensure reliability and accuracy in testing. The analysis focused on key water quality parameters, including pH, total dissolved solids (TDS), total hardness, total alkalinity, chloride, iron, and total coliform levels. Testing was conducted using a combination of a water quality testing kit, which includes a) pH meter and b) TDS meter. Total coliform levels were assessed using H_2S vials, in accordance with established procedures.

To ensure consistent and credible results, all volunteers involved in the process received comprehensive training in water sampling and testing methodologies. This training emphasized proper sample collection techniques, adherence to standard procedures, and the accurate use of testing equipment, ensuring high-quality data for water quality assessment.

Figure 6: Field water testing kit used for the water quality analysis

3.6 Mobile application and Water Folks web portal

Figure 7: Images showing interfaces of Water CAT mobile application and Water Folks website

The WATER-CAT Mobile Application and the Water Folks-Kozhikode Web Portal are transformative tools designed to enhance water governance and foster community engagement in Kozhikode. The WATER-CAT app is a user-friendly platform that empowers citizens to assess and improve water resources through unbiased data collection and practical solutions. It features a dynamic dashboard providing real-time insights into the city's water resources and environmental conditions, along with a citizen's gateway for inputting vital data such as water quality, groundwater levels, rainfall, biodiversity, flood levels, and pollution or encroachment reports. Citizen-generated data is validated by experts to ensure accuracy and credibility, facilitating informed decision-making. In Manchanda Ward, the volunteers collected water data using the app, which was then validated by experts at CWRDM, leading to tailored-made recommendations for water management. Complementing the 'app', the Water Folks-Kozhikode web portal serves as a centralized knowledge repository, consolidating validated data from

citizens, experts, and stakeholders into a comprehensive database to promote transparency and collaboration. To amplify community participation, both platforms are integrated with social media channels such as WhatsApp, Facebook, YouTube, LinkedIn, and Instagram, where educational content, real-time updates, and interactive campaigns live Q&A sessions are shared. Together, the WATER-CAT app and Water Folks-Kozhikode web portal created a robust framework for water governance, blending technology with grassroots engagement to safeguard Kozhikode's water resources and ensure a sustainable future.

3.7 Ward-Level Workshop: Building Collective Responsibility

To consolidate findings and chart a path forward, a ward-level workshop was organized on 23rd November 2024. This interactive event served as a platform for learning, discussion, and action planning. Key highlights of the workshop included:

- **Knowledge Sharing:** Scientists from CWRDM conducted sessions on water conservation techniques and solutions to water quality challenges.
- **Presentation of Findings:** Volunteers shared the results of the data collection with residents and stakeholders.
- **Open Dialogue:** Community members participated in discussions about pressing water issues and potential solutions.
- **Formation of a Ward-Level Committee:** A committee was established comprising the ward councillor, ASHA workers, and Water Folks volunteers to oversee water management efforts in the ward.

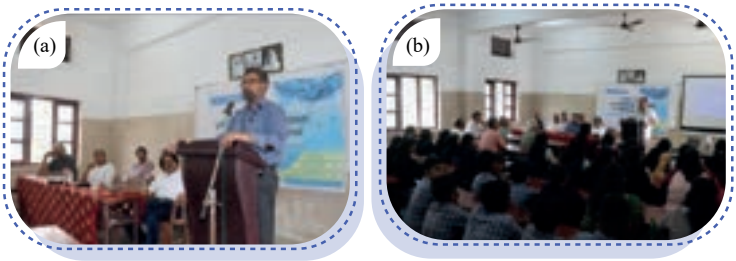


Figure 8: Photographs of Ward level workshop organised at Meenchanda ward under Water Folks initiative

The Water Information resulted from this process have been detailed out below for the Meenchanda ward. It will serve as a resource for understanding local water dynamics and showcases the success of participatory water governance. Meenchanda Ward's achievements stand as an inspiring model for other communities striving to address water challenges through collaboration, innovation, and shared responsibility.

4. Meenchanda ward, Kozhikode Corporation, Kozhikode District.

Meenchanda ward (Ward No.:38), located in Kozhikode cooperation, Kerala covers an area of 1.20 sq. km with the total population of 7247 (Census, 2011). The Meenchanda ward is mainly drained by four urban ponds, namely 1) Banglow Sree Kurumba Bhagavathi Temple Pond, 2) Thiruvichira Temple Pond, 3) Kannancheri Temple Pond and 4) Kozhipuram Temple Pond. Residents are primely relied on open wells and Kerala Water Authority (KWA) supply system as the source of freshwater.

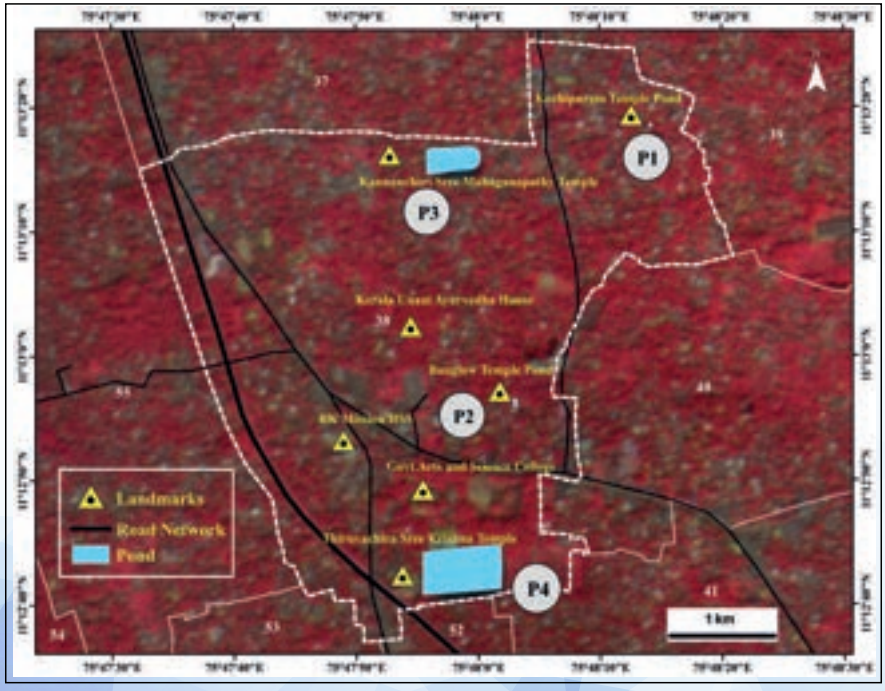


Figure 9 : LISS IV satellite image dated 04-December-2019 of Meenchanda ward, (Ward No.: 38), Kozhikode Corporation, Kozhikode District, Kerala.

4.1 Geomorphology

Meenchanda Ward typically has a relatively undulating terrain, with areas of low to moderate elevation. The region is situated close to the coastline, which impacts its drainage patterns and water systems. The prominent geographical features exhibited by the Meenchanda ward is Swale and Young coastal planes. A swale is a shady spot, or a sunken or marshy place. The term "swale" or "beach swale" is also used to describe long, narrow, usually shallow troughs between ridges or sandbars on a beach, that run parallel to the shoreline. And young coastal panes are often covered with sand dunes, beaches, or marshy areas and may include features like estuaries, lagoons, and delta formations. Formed by the deposition of sediments such as sand, silt and clay. The geomorphological modification occurred in the area is as a result of the dynamic interplay between natural processes like erosion, sedimentation, and water flow, as well as human activities that have shaped the land over time. Understanding these features is essential for managing land use, water resources, and ensuring sustainable development in the region.

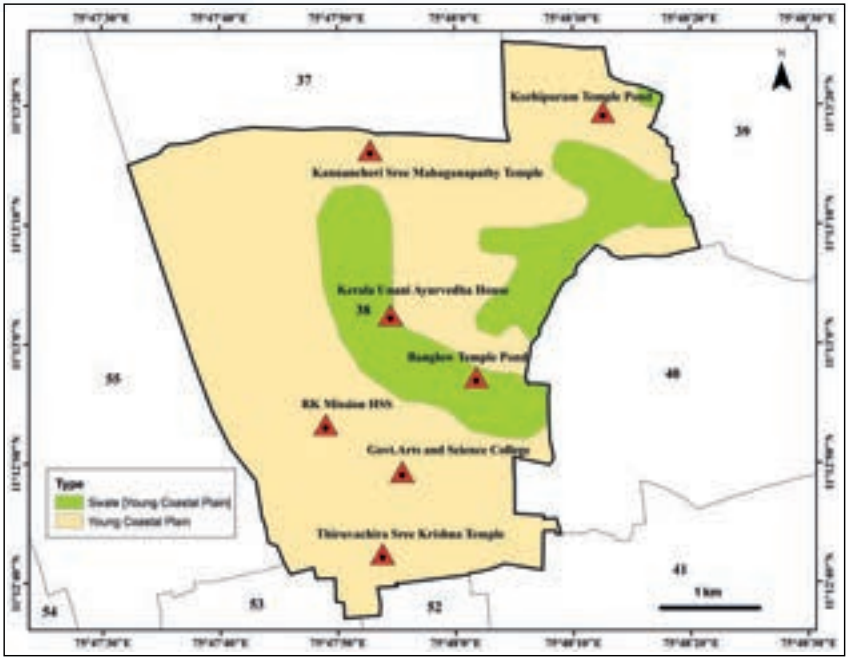


Figure 10 : Map showing the Geomorphology of Meenchanda ward, Kozhikode Corporation, Kerala

4.2 Digital Elevation Model (DEM)

Digital elevation model brings information about the topography of the location, which is beneficial in infrastructure planning, flood modelling and environmental conservation. The DEM data of Meenchanda ward shows elevation change in the North-South region, attaining a maximum elevation of 45 m, where North-East regions are showing minimum elevation change with a value of 30 m. DEM is effective for studying ecosystems and habitats. They help in understanding watershed boundaries, soil erosion, and the effects of environmental changes, such as deforestation or climate change.

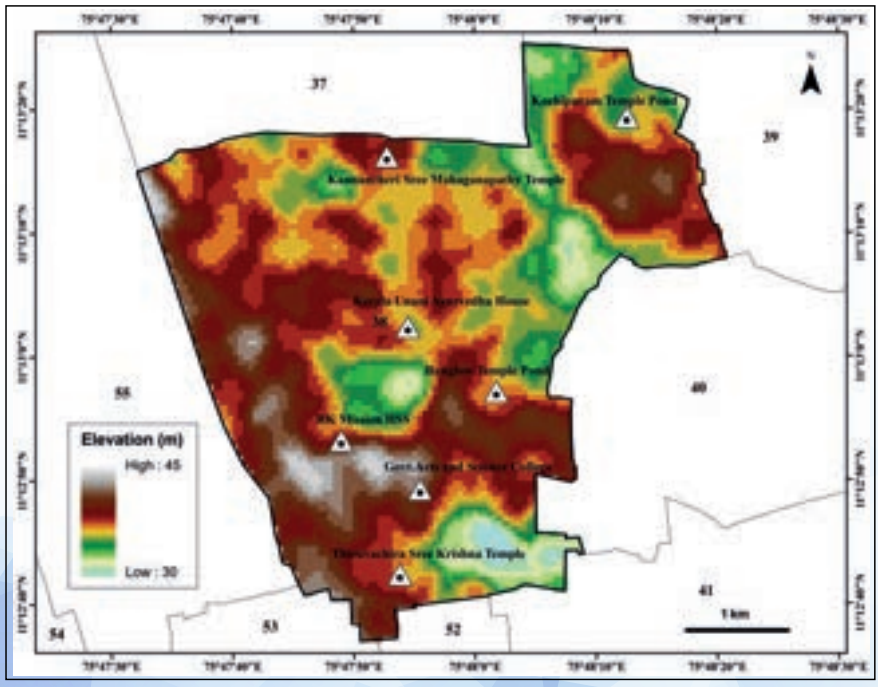


Figure 11. Map showing the digital Elevation Model (DEM) of Meenchanda ward, Kozhikode Corporation, Kerala

4.3 Landuse/ landcover

Mapping land use and land cover is essential for understanding the physical and human-driven changes on the earth's surface, supporting sustainable management, development, and conservation efforts. The rise in urbanization and industrialization is visible in the Meenchanda ward as built-up covers an area of 99.59 ha, indicating the disruption ecosystem with water bodies occupying an area of 2.09 ha, followed by vegetation (17.13 ha) and water logged / waste land (1.35 ha). The significance of timely and precise information relating to the nature and scope of land possessions and changes over time is increasing rapidly, particularly in metropolitan area.

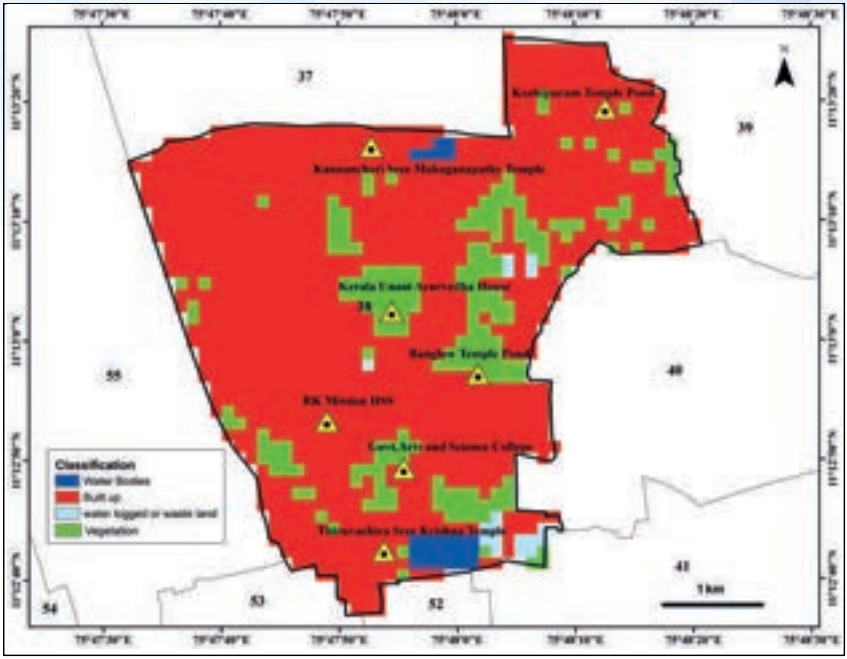


Figure 12. Map showing the landuse/ landocver (Lu/Lc) map of Meenchanda ward, Kozhikode Corporation, Kerala

4.4 Soil type

Development of urban areas has demanded rapid use of groundwater and soil resources, which requires suitable assessment and prioritization of measures for their sustainable use. The predominant soil type prevalent in the Meenchanda ward is Sandy loam, a mixture of less than 7% of clay, less than 50% of silt, and more than 43% of sand, with a good balance of water retention, aeration, and temperature regulation. It is commonly used for growing grass, as it drains well while retaining sufficient moisture for plant growth.

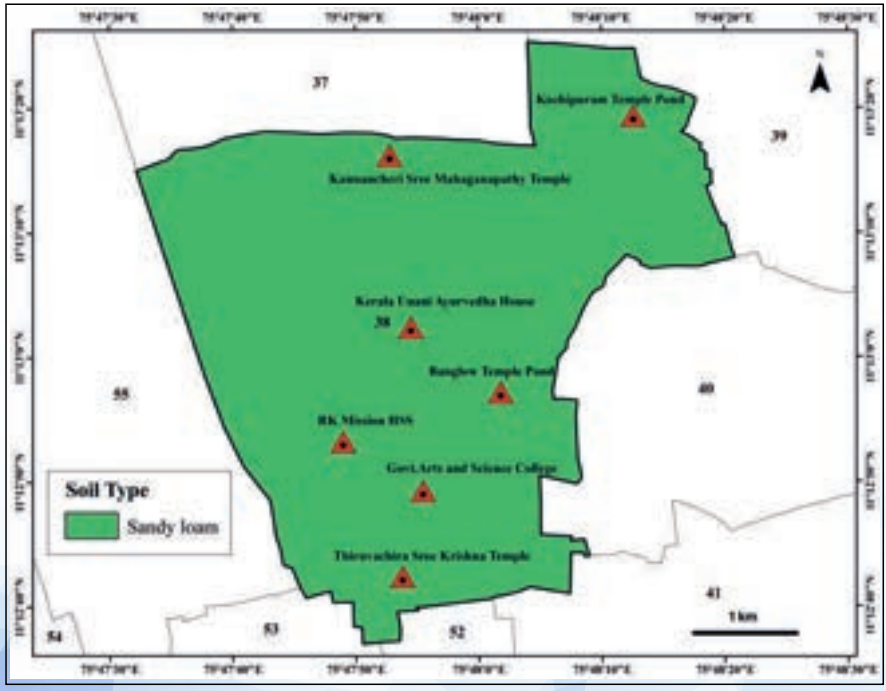


Figure 13. Map showing the soil type of Meenchanda ward, Kozhikode Corporation, Kerala

5. Surface waterbodies in Meenchanda ward

The Water Folks volunteers undertook an extensive field investigation to map the significant water bodies within Meenchanda Ward. This ward, situated between the Kallayi and Chaliyar river basins, is unique as it does not have any rivers or streams flowing through its boundaries. Despite the absence of flowing water systems, the area hosts important water bodies that play a crucial role in local water management and community usage. Through detailed fieldwork, the volunteers identified and mapped four prominent ponds within the ward. These ponds were not only geospatially recorded but also evaluated for their ecological and social importance to the community. To further understand the condition of these water bodies, the volunteers collected water samples from all four ponds. These samples were subjected to a comprehensive water quality analysis to determine key parameters that reflect their health and usability. The details of the identified ponds are as follows:

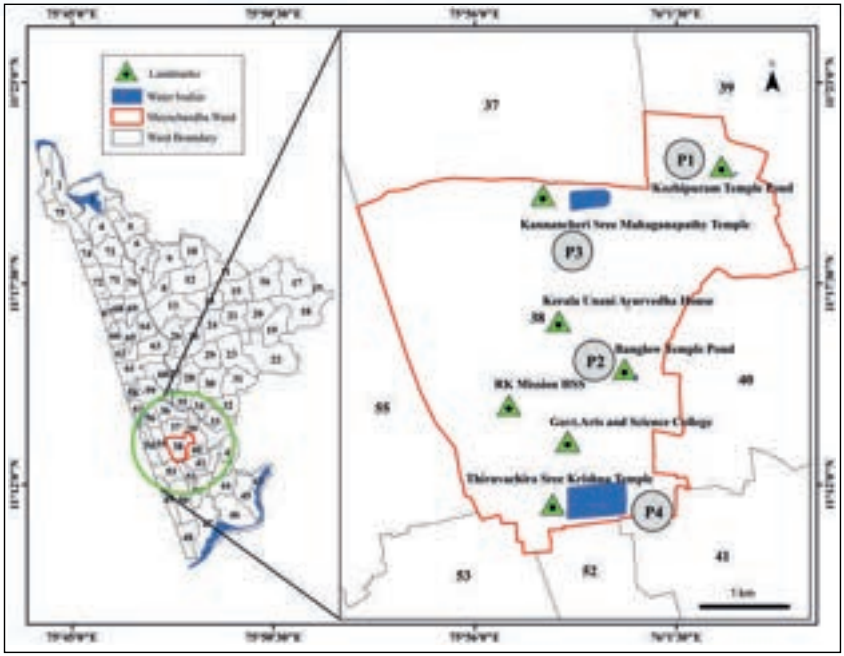


Figure 14. Map showing the surfaec wtaer bodies of Meenchanda ward, Kozhikode Corporation, Kerala

5.1 Kozhipuram Temple Pond (P1)

A pond, which spans an area of 170 sq m, is situated within the premises of the Kozhipuram Temple in Thriuvannur, Kozhikode. It is accessible to the community and is a frequent choice for bathing and swimming. The water displays a greenish hue, clearly indicating the presence of microalgae, which flourish in the nutrient-rich conditions of the water.

Figure 15. Photograph showing the kozhipuram Temple Pond, Meenchanda ward, Kozhikode Corporation, Kerala

Table 1: showing the water quality parameters of Kozhipuram Temple Pond (P1)

Parameters	Kozhipuram Temple Pond (P1)	Acceptable limit (IS10500:2012)
pH	7.3	6.5-8.5
TDS (mg/l)	159	500
Hardness (mg/l)	60	200
Fe (mg/l)	0.3	1
Chloride (mg/l)	40	250
Alkalinity (mg/l)	40	200
Total Coliform	Present	Shall not be detectable in 100 ml sample

5.2 Banglow Sree Kurumba Bhagavathi Temple Pond (P2)

A pond, covering an area of 172 km m, is situated in grounds of Banglow Sree Kurumba Bhagavathi Temple, Meenchanda, Kozhikode. Residents utilize the pond for bath and washing the clothes. The water has a dark green hue, indicating the presence of microalgal growth. One side of the pond is completely vegetated, and the overflow outlet is located near the vegetation.

Figure 16. Photograph showing the Banglow Sree Kurumba Bhagavathi Temple Pond, Meenchanda ward, Kozhikode Corporation, Kerala

Table 2: showing the water quality parameters of Banglow Sree Kurumba Bhagavathi Temple Pond (P2)

Parameters	Banglow-sree kurumba bhagavathi Temple Pond (P2)	Acceptable limit (IS 10500:2012)
pH	7.7	6.5-8.5
TDS (mg/l)	295	500
Hardness (mg/l)	110	200
Fe (mg/l)	BDL	1
Chloride (mg/l)	50	250
Alkalinity (mg/l)	70	200
Total Coliform	Present	Shall not be detectable in 100 ml sample

5.3 Kannancheri Ganapathi Temple Pond (P3)

A Pond is located within the premises of the Kannancheri Ganapathi Temple, Kannancheri, Kozhikode, is a vital water body owned by the temple authorities and situated in a densely populated area. Primarily used for bathing, the pond faces challenges such as water pollution caused by unrestricted access and activities like laundering and improper bathing practices. While protective walls have been constructed, unchecked vegetation along the edges detracts from the pond's aesthetic appeal and functionality. Furthermore, regular cleaning and maintenance are limited, exacerbating water quality concerns.

Figure 17. Photograph showing the Kannancheri Ganapathi Temple Pond, Meenchanda ward, Kozhikode Corporation, Kerala

Table 3: showing the water quality parameters of Kannancheri Ganapathi Temple Pond (P3)

Parameters	Kannancheri Ganapathi Temple Pond (P3)	Acceptable limit (IS 10500:2012)
pH	8.6	6.5 - 8.5
TDS (mg/l)	169	500
Hardness (mg/l)	50	200
Fe (mg/l)	0.3	1
Chloride (mg/l)	50	250
Alkalinity (mg/l)	80	200
Total Coliform	Present	Shall not be detectable in 100 ml sample

5.4 Thiruvachira Temple Pond (P4)

The pond is situated close to a residential area, covering an area of about 19,842 sq m and is associated with the temple grounds, primarily used for bathing. However, the pond is poorly maintained, with visible vegetation growth on its side walls. The protective walls are damaged, and there is an evidence of solid waste being dumped around the near surroundings. The presence of large number of invasive fish species like African Catfish is reported by local residents.

Figure 18. Photograph showing the Thiruvichira Temple Pond, Meenchanda ward, Kozhikode Corporation, Kerala

Table 4: showing the water quality parameters of Thiruvachira Temple Pond

Parameters	Thiruvachira Temple pond (P4)	Acceptable limit (IS 10500:2012)
pH	8.10	6.5-8.5
TDS (mg/l)	204	500
Hardness (mg/l)	80	200
Fe (mg/l)	0.3	1
Chloride (mg/l)	40	250
Alkalinity (mg/l)	80	200
Total Coliform	Present	Shall not be detectable in 100 ml sample

Figure 19. Photograph of Waterfolks volunteers collecting water samples from urban ponds.

Acceleration of urbanization and increasing waste discharge drastically influenced the groundwater quality and became a global issue owing to its widespread distribution and its potential consequences to human health. As large number of population is concentrated in the cities, groundwater is bound to be polluted by frequent and intensive human activities. The analysis of the physico-chemical characteristics of the ponds provided valuable insights into their ecological health and the extent of contamination from various sources, including wastewater discharge, surface runoff, solid waste disposal, and local human activities such as bathing and laundry. The pH values of the ponds were generally observed to be close to neutral and above, indicating slightly alkaline conditions. However, private ponds exhibited a broader range of pH values, reflecting variability in water quality. This variation is primarily attributed to activities like bathing and laundry, which introduce detergents and organic matter, influencing the water's pH.

Parameters such as Total Dissolved Solids (TDS), hardness, alkalinity, chloride, Iron in the samples collected from urban ponds were found to be within acceptable limits. (Table 1, 2, 3, & 4). However, the microbiological analysis revealed significant microbial contamination in all the water samples from the pond. According to the BIS (IS 10500:2012) standards, the water from these urban ponds is unsuitable for consumption without proper treatment. The elevated bacterial load observed can be linked to surface runoff during the rainy season, which carries animal waste, inadequately managed sewage, and domestic waste into the ponds. Additionally, these ponds are often located in densely populated areas, increasing their proximity to septic tanks and public sewage systems. Human activities such as washing and bathing near private ponds further exacerbate pollution levels, contributing to microbial contamination and posing risks to water quality.

6. Groundwater quality assessment of Meenchanda ward, Kozhikode Corporation.

The assessment of groundwater quality is crucial since it is associated with public health, ecosystem stability and agriculture. In Kozhikode city majority of the population rely on open wells as the primary source of freshwater. A total number of 25 groundwater samples were collected across the Meenchanda ward and analysed in accordance with measuring the concentration of physical and chemical parameters namely, pH, TDS, Total Hardness, Iron and Total Alkalinity using water quality testing kit. Assessment of water quality is beneficial in implementing better water management practices, optimized sanitation practices and urban developments.

6.1 Potential of Hydrogen (pH)

Examining pH levels is essential because it directly influences the chemical and biological processes within various environments. In water quality, constrains analysis of pH is crucial in determining water quality and the safety of the water for various uses, including drinking, irrigation, and industrial applications. The lowest pH value observed in the area is 5.96 with a maximum value of 6.89 indicating Acidic nature of water resources.

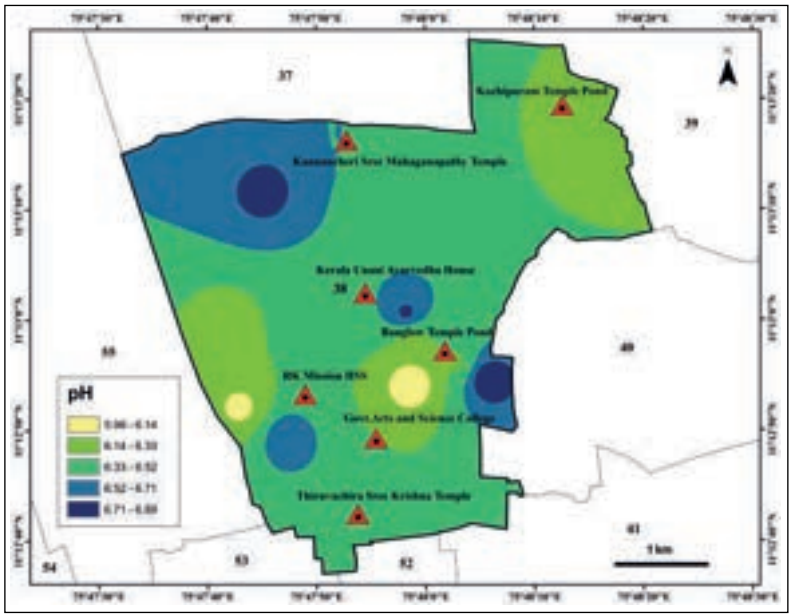


Figure 19. Image showing the pH distribution in Meenchanda ward, Kozhikode Coporation

6.2 Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) refer to the concentration of the total dissolved minerals, salts, and metals in water. Various physical and chemical processes can alter the chemical composition of groundwater and influence their concentrations over time. In case of groundwater samples collected from Meenchanda ward, the TDS concentrations range from 165.25 mg/L to 740.48 mg/L. The majority of the samples fall within the acceptable limits as per the BIS (2016) guidelines, although a few samples exceeded the recommended threshold. Elevated TDS levels can affect water bodies' ability to serve their intended purposes, such as drinking, supporting biodiversity, and providing ecosystem services. While TDS itself is not considered a primary water pollutant, it serves as a significant indicator of water quality. High TDS concentrations are often linked to anthropogenic activities and can have direct and indirect effects on human health, particularly in urban areas with contaminated water sources

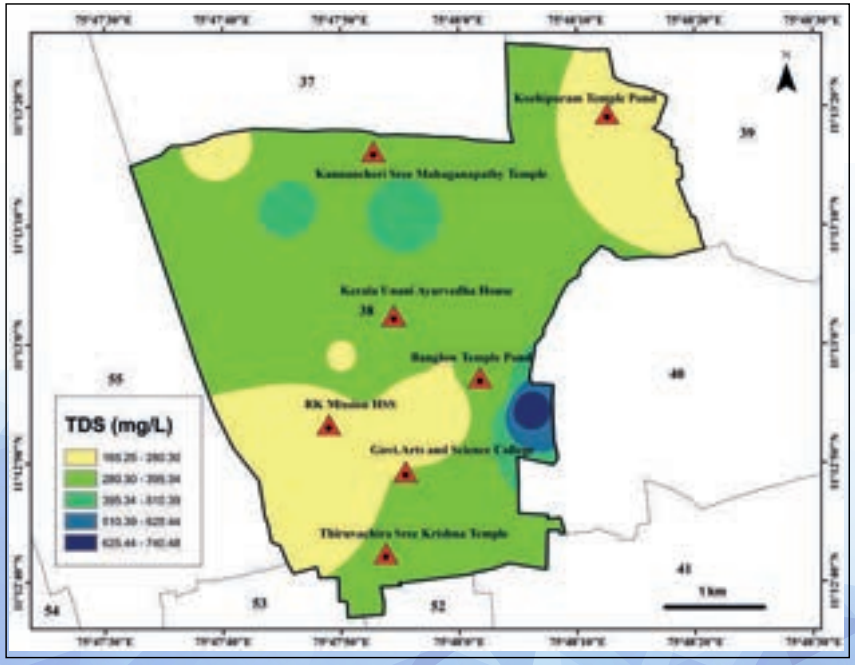


Figure 20. Image showing the Total Dissolved Solids (TDS) distribution in Meenchanda Ward, Kozhikode Corporation.

6.3 Total Hardness

Total hardness in water is primarily caused by the presence of divalent cations such as calcium, magnesium, strontium, ferrous iron, and manganese. In the Meenchanda ward, the total hardness values range from a minimum of 70.04 mg/L to a maximum of 269.82 mg/L. The majority of the samples fall within the acceptable limits as per the BIS guidelines. However, a few samples exceeded the recommended threshold, indicating potential areas for further monitoring and management.

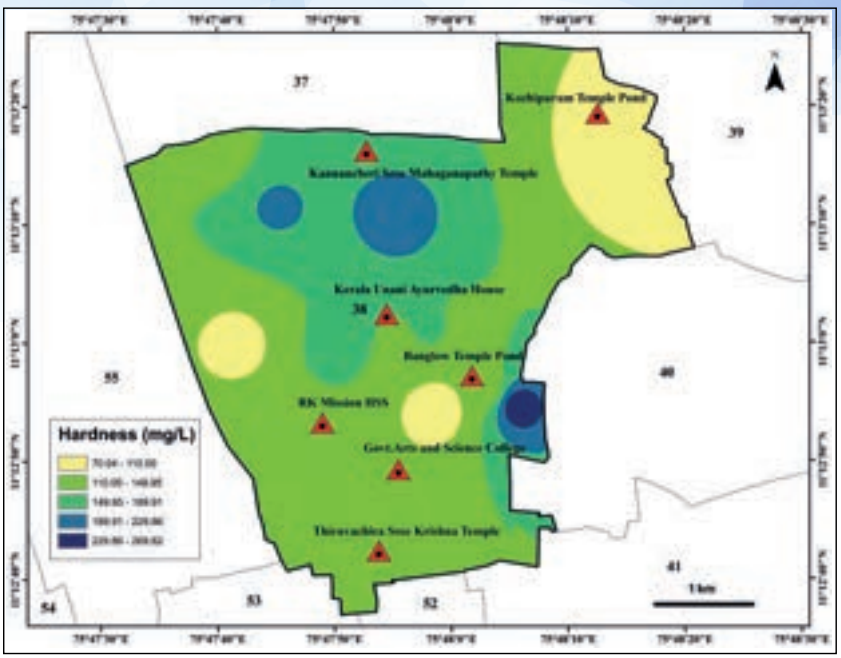


Figure 21. Image showing the Total Hardness distribution in Meenchanda Ward, Kozhikode Corporation.

Alkalinity, chloride, and iron levels were also analyzed in the groundwater samples. The alkalinity values ranged from 40 to 180 mg/L, while chloride concentrations varied between 30 and 90 mg/L, both of which fall within the acceptable limits. Iron was detected in certain samples, with concentrations ranging from below detection Limit (BDL) to 1.5 mg/L. While the majority of the samples were within the acceptable limit, a few exceeded the threshold for iron, highlighting areas that may require further attention and monitoring.

6.4 Bacterial contamination

Total coliform bacteria are a group of microorganisms commonly found in the environment, including soil, vegetation, and the intestines of warm-blooded animals. Their presence in water serves as an indicator of potential contamination by harmful pathogens. In the case of the 25 water samples collected from Meenchanda Ward, 19 samples tested positive for total coliform bacteria, suggesting significant contamination. These waterborne infections are primarily a result of pollution in water sources, driven by anthropogenic influences, rapid population growth, and urbanization. Pollution fosters the proliferation of pathogenic microorganisms, reflecting the poor water quality and lack of effective water management systems. Key factors contributing to the occurrence of total coliform bacteria include contamination from human and animal feces, improper waste management, and inadequate sanitation and hygiene practices. High population density, the proximity of wells to septic tanks, and wastewater discharge near wells are significant contributing factors to this contamination.

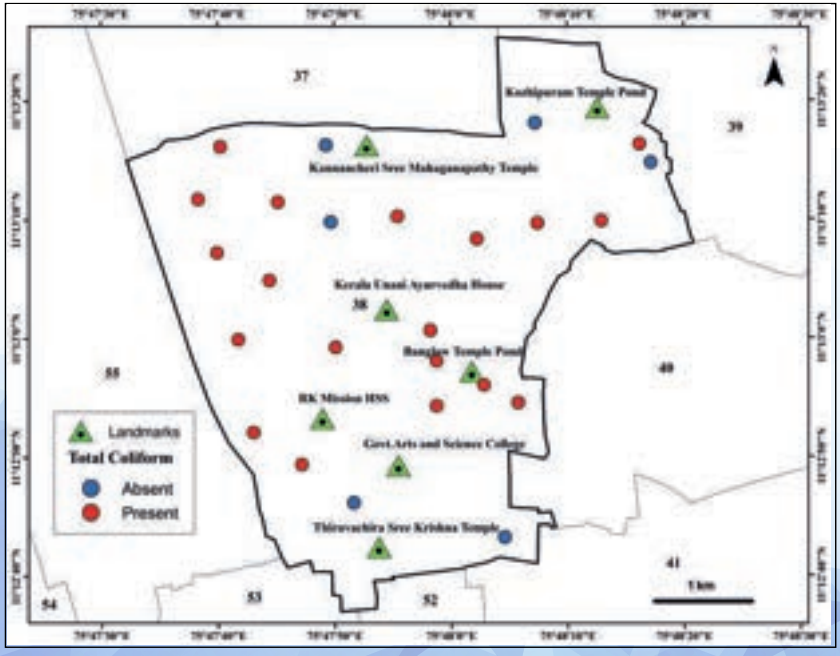


Figure 22. Image showing the Total Coliform bacterial contamination in Meenchanda Ward, Kozhikode Corporation.

6.5 Groundwater level in the Meenchanda ward

Generally, water levels in aquifers follow a natural cyclic pattern of seasonal fluctuation, typically rising during the winter and spring due to greater precipitation and recharge, then declining during the summer and fall owing to less recharge and greater evapotranspiration. Water levels inspected from the Meenchanda ward is varying from a range of 0.30-3.19 and form the questionnaire survey, as stated by the locals, they have not experienced a completed depletion of water levels even in the summer season. The magnitude of fluctuations in water levels can vary greatly from season to season and from year to year in response to varying climatic conditions. Changes in ground-water recharge and storage caused by climatic variability commonly occur over decades, and water levels in aquifers generally have a delayed response to the cumulative effects of drought.

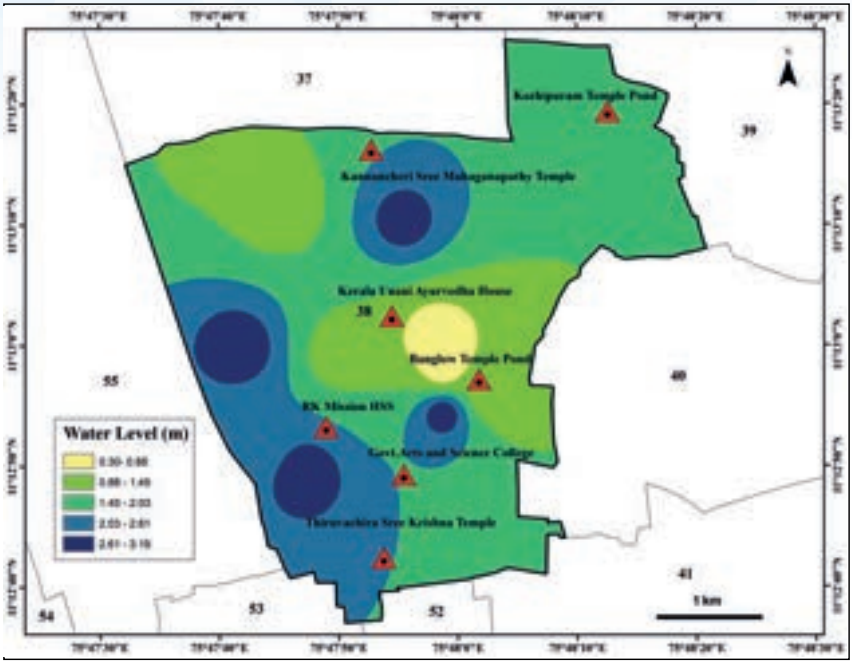


Figure 23. Image showing the Groundwater level in Meenchanda Ward, Kozhikode Corporation.

6.6 Occurrence of Microplastics in water resources.

Microplastics, defined as plastic particles with diameters of less than 5 mm, can be classified into two types based on their origin: primary and secondary microplastics. Primary microplastics are intentionally manufactured at small sizes, whereas secondary microplastics result from the breakdown of larger plastic debris. Together, they pose significant threats to the environment, including groundwater resources. An extensive study on microplastic contamination in groundwater resources within Kozhikode Corporation was conducted by the Water for Change research team at CWRDM. Water samples were collected from two open wells in a selected ward. The analysis revealed the presence of approximately 20 microplastic particles in each well. The majority of these were identified as polypropylene, followed by high-density polyethylene (HDPE) and low-density polyethylene (LDPE). The presence of microplastics in groundwater was primarily attributed to the degradation of plastic coir ropes used for drawing water and the breakdown of plastic nets. Other contributing factors include poor maintenance of wells and atmospheric deposition of microplastic particles. These findings highlight the urgent need for improved well management practices and measures to reduce plastic waste to safeguard groundwater resources.

Figure 24. Photographs showing open wells covered with plastic net and coir in Meenchanda Ward, Kozhikode Corporation.

7 Citizen Perceptions

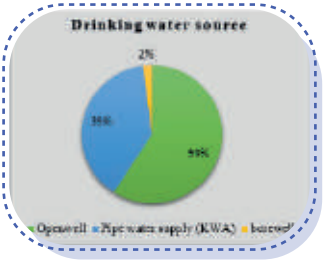
Surveys are an effective tool for understanding trends and tracking water-related challenges over time, enabling policymakers to identify patterns and make informed decisions. To understand citizen perceptions on various aspects of water across the ward, a comprehensive survey was conducted by Water Folks volunteers. A total of 103 households actively participated in the questionnaire survey, providing valuable insights into local water issues and concerns.

7.1 Source and availability of Drinking water

In Meenchanda ward, the primary drinking water sources are open wells, followed by piped water supplied by the Kerala Water Authority (KWA). According to the survey, 58.6% of respondents rely on open wells as their main freshwater source, while 38.4% depend on the KWA water supply. A small minority (2%) use borewells as their primary water source. The survey also revealed that 83.8% of respondents reported having an adequate water supply throughout the year for all household purposes. However, 16.2% expressed concerns about an insufficient supply at certain intervals.

Water scarcity in the region is attributed to several factors, with climate change and urbanization being the most significant. While 27.3% of residents reported experiencing water scarcity, 72.7%

stated they had no such issues throughout the year. Those who experienced shortages identified the peak months of March and April as the most problematic. This seasonal water scarcity is likely driven by a combination of factors, including shifting weather patterns, risingtemperatures, and reduced rainfall during the dry months.



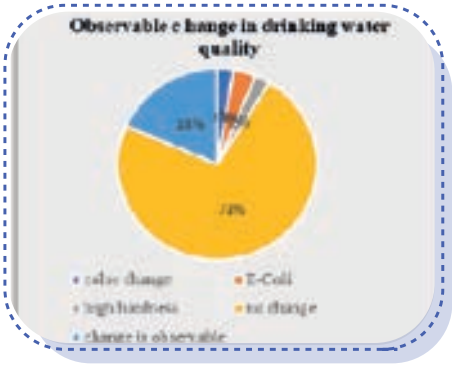
7.2 Water quality and Sanitation

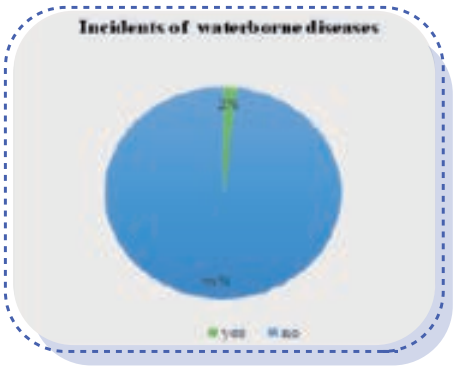
Most of the residents stated that there is no observable change in the water quality (72.89%) but at certain locations change in colour, texture and hardness has been reported. 18.51% of peoples reported having issue with observable change in the water quality. Color change, increase in the hardness of the water and presence of total coliform bacteria are the major issues found in the Meenchanda ward. The pungent odor and change in the colour of water indicate the presence of bacterial contamination, pollution and lack of proper waste management. Around 2.64% of residents in the area mentioned experiencing difficulties with yellowish tint of the water. Presence of Total Coliform bacteria is mentioned by 3.7% of the locals and they are said to be using water purifiers for domestic needs. As per the concentration of major ions present in the water body variation in hardness is conventional yet bring difficulties in performing daily routines. The change in texture and difficulties with lathering the soap is mentioned by 2.46% of locals. Conducting water quality test at respective intervals is beneficial for the public health protection, environmental protection and community awareness. Unfortunately, most of the peoples are not committing to any kinds of water quality test as per the survey. More than half of population of Meenchanda ward (56%) is not performed any type of water quality test for the past years. Moreover, only 44% percentage of peoples shown interest in water quality test.

Proper waste management in households plays a crucial role in maintaining a healthy, sustainable, and environmentally-friendly living environment. Effective waste management practices not only reduce the amount of waste that ends up in landfills but also minimize environmental degradation, pollution, and the depletion of natural resources. In the Meenchanda ward, it was observed that the collection of plastic waste at the household level by *Harithakarmasena* is relatively efficient, with the majority of households relying on their services. However, despite these efforts, the dumping of plastic waste in public areas remains a concern, highlighting gaps in waste disposal practices and public awareness. For biodegradable waste management, some households have adopted biogas plants, which serve as an effective and sustainable method of converting organic waste into energy. Additionally, many households still follow traditional methods of waste disposal, where solid waste and biogenic waste are separated and decomposed in designated dumping sites near their homes. While this approach has been practiced for generations, it may require modernization to ensure environmental safety andefficiency. Field visits also revealed concerns regarding kitchen wastewater management. In most cases, wastewater is either treated using soak pits or simply

drained into the surroundings. Improper drainage can pose a significant risk to water quality, especially for open wells located nearby, as untreated or poorly managed wastewater can lead to contamination. Waterborne illnesses are caused by consuming or coming into contact with contaminated water, often due to the presence of harmful microorganisms. These illnesses can lead to severe diseases such as Cholera, Typhoid, and Hepatitis. According to survey findings, 98% of residents in Meenchanda ward reported not experiencing any waterborne diseases. However, 2% of respondents stated that they had suffered from illnesses like Typhoid and Jaundice. The presence of waterborne diseases in the ward can be linked to several contributing factors, including unhygienic water bodies, improper waste management practices, and limited awareness about the importance of protecting water resources. Notably, instances of Escherichia coli (E. coli) contamination have been detected in local water sources, further highlighting the unsanitary conditions and the need for improved water quality management.

These findings underscore the importance of implementing robust water safety measures, promoting community awareness about the risks of contaminated water, and ensuring proper waste disposal to protect water sources.





7.3 Vulnerability towards urban flooding

The response of residents regarding flood experiences in Meenchanda ward was analyzed as part of the study. The findings revealed that 98.2% of respondents reported that they are not experiencing flood-related issues in the ward, while 2% stated that they had faced flood-related challenges.

Although the majority of the population is not directly affected by flooding, certain areas within the ward experience waterlogging during heavy rainfall, which remains a concern. This localized waterlogging can disrupt daily life and highlight the need for improved drainage infrastructure and urban planning measures to mitigate the impact of heavy rainfall events.

7.4 Citizen motivation in water conservation

Public willingness towards water conservation is a critical factor in determining the effective management and sustainable use of water resources in any area. Active participation and engagement of the community in conservation initiatives can significantly reduce water wastage, enhance resource efficiency, and contribute to environmental sustainability. Survey revealed that while 65.3% of residents are willing to participate in water conservation efforts, 34.7% remain uninterested due to factors such as limited awareness, insufficient access to resources, and a lack of institutional support. Field visits further highlighted that water-saving practices, such as rainwater harvesting, have been adopted by only a small number of households, reflecting the need for targeted interventions to promote conservation on a larger scale.

Recommendation for the ward

The efforts of Water Folks volunteers have played a crucial role in revealing critical insights into the water situation and its current scenario in Meenchanda ward. Their dedicated activities have provided a clear understanding of local water-related issues, making it evident that further engagement is needed. More volunteer participation will be instrumental in gathering additional insights and contributing to the development of sustainable water management practices in the region. Below are some key aspects that Meenchanda should focus on for improved water management

- Conduct regular water testing for key parameters (pH, Total Dissolved Solids (TDS) Total Hardness, Iron (Fe), Alkalinity and Total Coliform Bacteria) in local water sources (ponds, wells).
- Promote awareness about necessity of water purification methods like chlorination and filtration in households.
- Improve waste management practices around water bodies to reduce waste dumping.
- Strict enforcement to implement rainwater harvesting systems in homes and public institutions as per the government guidelines.
- Construct groundwater recharge pits in low water table areas to restore natural groundwater levels.
- Regular maintenance of ponds: de-silt, remove invasive species, and install biofilters for better water quality.
- Establish ecological buffer zones around ponds to prevent contamination and improve biodiversity. Strictly ban on use of soap and detergents in ponds. Monitor and control algae and invasive species
- Improve waste and sewage management around water bodies through decentralized treatment systems.
- Organising regular public awareness campaigns and clean up campaigns to educate residents on water body cleanliness and contamination risks.
- Regular maintenance of stormwater drainage including de-siltation for avoiding water logging issues

Suggestions for upscaling

The *Water Folks* initiative stands out as a transformative citizen science program, fostering community-driven solutions for urban water challenges, which we have observed in Meenchanda. By actively involving local residents, researchers, and policymakers, it bridges the gap between science and society, creating a sense of shared responsibility for water resources. Through real-time data collection and collaborative analysis, *Water Folks* empowers communities to understand water availability, quality, and governance issues, enabling data-informed decision-making. It serves as a platform for inclusive participation, knowledge exchange, and capacity building, driving sustainable and resilient water management. Key outcomes of the project include enhanced community awareness, data-driven decision-making by local authorities, and the development of community-led initiatives to ensure long-term water security for the Meenchanda region.

To upscale the **Water Folks** initiative, it is essential to build on its strengths while incorporating advanced technologies and broader community engagement. Expanding citizen participation can be achieved by involving diverse groups such as schools, universities, and local organizations while incentivizing contributions through recognition programs and gamification of data collection. Integrating advanced tools like IoT-based sensors and AI-driven analytics can enhance the accuracy and efficiency of real-time data collection and interpretation, while data visualization dashboards can make insights accessible to both policymakers and the public. Partnerships with government bodies, academia, and industries under CSR initiatives can provide the technical and financial support needed to scale the program. Pilot projects in other urban regions facing similar challenges can refine the model further, supported by guidelines and toolkits to enable easy replication. Leveraging social media for awareness campaigns and interactive content, alongside training programs for volunteers, can boost participation and knowledge-sharing efforts. Institutionalizing the initiative by advocating for its integration into urban water governance policies and securing financial and legal support is vital for its sustainability. Regular impact assessments and feedback mechanisms can ensure continuous improvement, making the initiative a replicable and transformative model for addressing urban water challenges.

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