

Climate Resilient WASH Infrastructure A Case of Kochi

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Global South Academic Conclave on WASH and Climate linkages

2nd - 4th February 2024, Ahmedabad

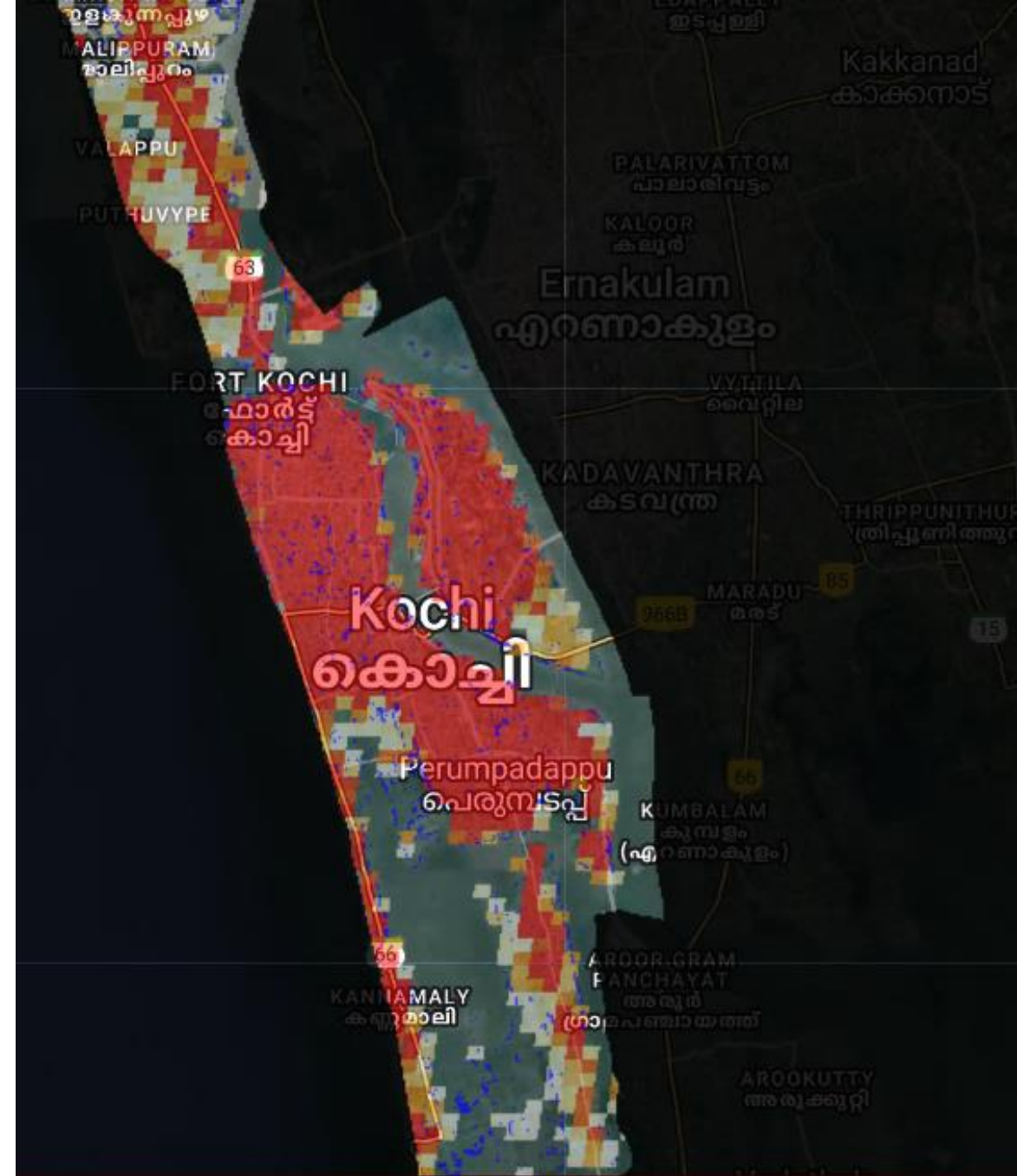
CWAS CENTER
FOR WATER
AND SANITATION
CRDF CEPT
UNIVERSITY

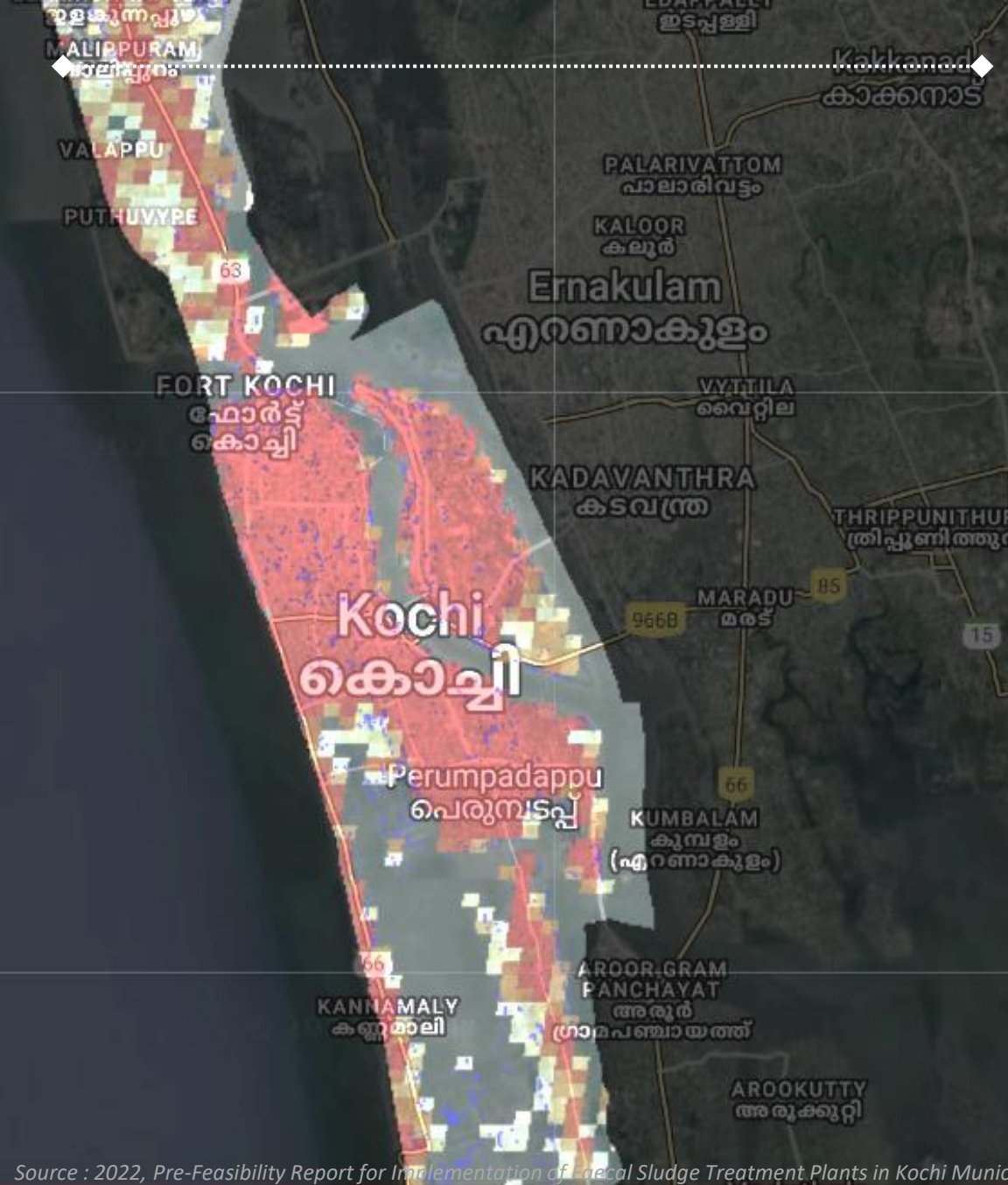
BILL & MELINDA
GATES foundation



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Specifying the Topic

Climate Resilient

Ability to cope with the impacts of climate change.



WASH infrastructure

Ability to adapt and to cope with the impacts of climate change on WASH systems, while maintaining their reliability and functionality.



“Climate Resilient WASH infrastructure in Indian cities using Kochi City as a case study”

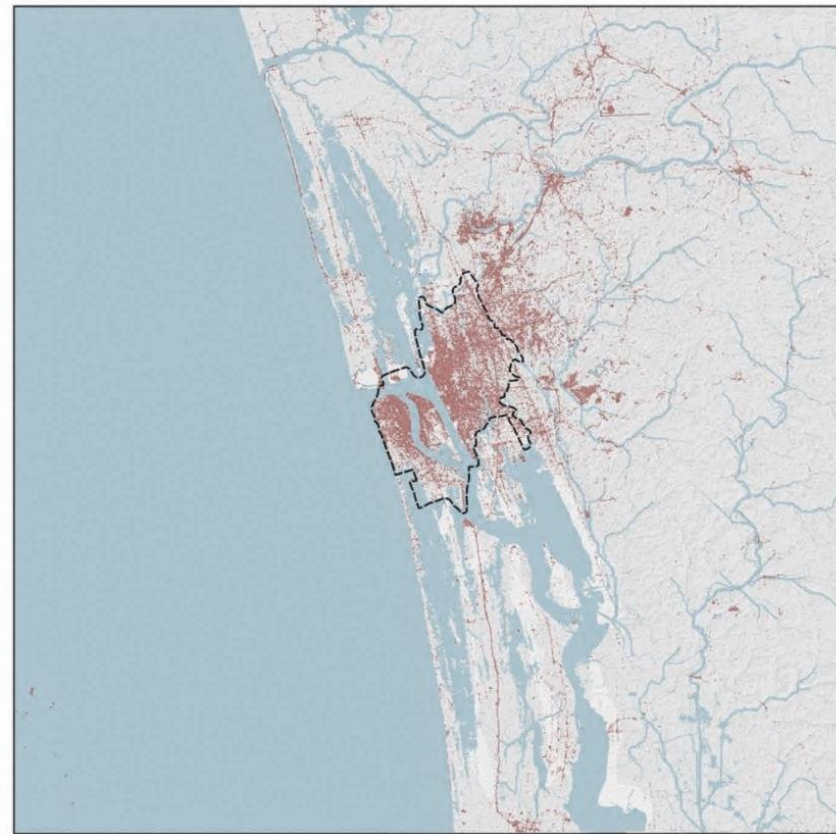
Kochi City

Its impacts on climate change, particularly through sea-level rise and increased frequency and intensity of extreme weather events.



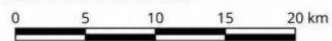
Climate-resilient WASH infrastructure in Indian cities such as Kochi is a critical step towards building a more sustainable and resilient future in the face of a changing climate.

Source : 2022, Pre-Feasibility Report for Implementation of Faecal Sludge Treatment Plants in Kochi Municipal Corporation by AMRUT and CDD, Bangalore.



■ Built - up ■ Water — Natural Drainage □ Boundary

Datum: WGS 84: EPSG 4326



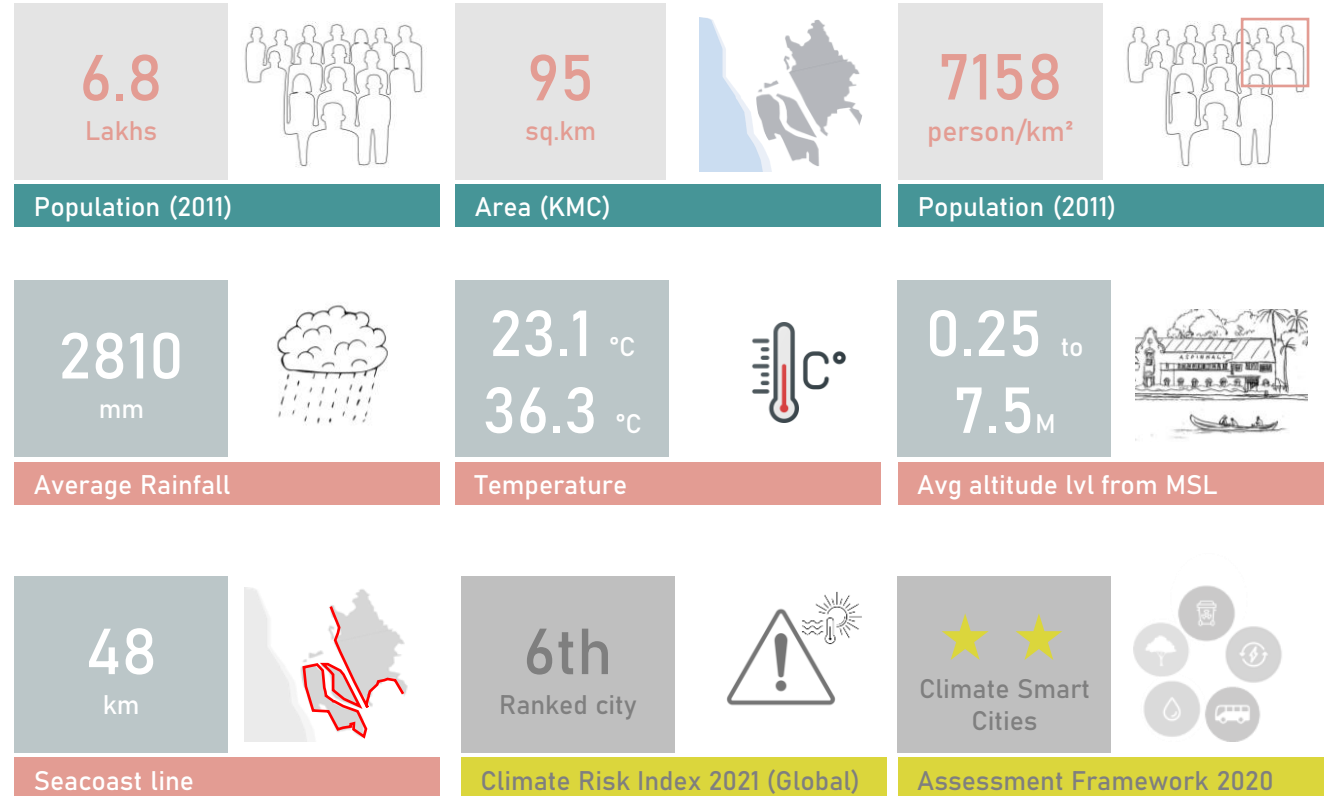
Data Source(s): IIHS Analysis, 2017; USGS; Survey of India(1999).
Boundary: <https://cochinmunicipalcorporation.kerala.gov.in>

Note: Misclassification due to cloud cover, Spectral mixing and seasonal variation is possible



City Profile- Kochi City

“Financial and commercial Capital of Kerala”



Kochi is located in the Ernakulam district of Kerala and is governed by the Kochi Municipal Corporation. The city is divided into seven zones for administrative purposes. The KMC is responsible for providing essential services such as water supply, waste management, and sanitation to the city's residents.

Source : September 2019, Mapping how growth in Kochi, Mumbai and Chennai made them flood and drought-prone. The News Minute. 2022, <https://kochicorporation.lsgkerala.gov.in/en/>

Location Justification

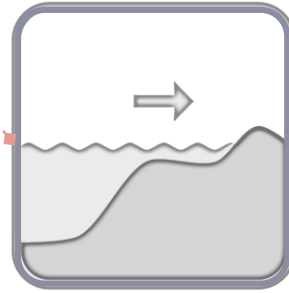
Risk Clusters of Kochi



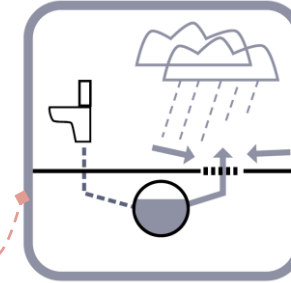
Reclaimed land



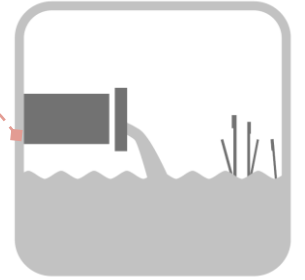
Unexpected precipitation



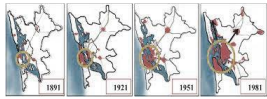
Sea level rise



Deficient urban drainage system



Discharging of used water into water body



Estuarine city

Intensity <---> Frequency <---> Irreversibility

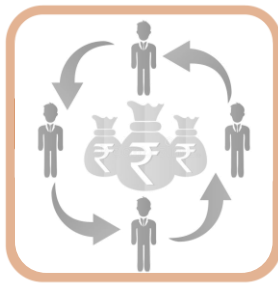
Climate change impacts

Susceptibility <---> Exposure <---> Adaptive capacity

Vulnerability of Kochi



People



Economy



Environment

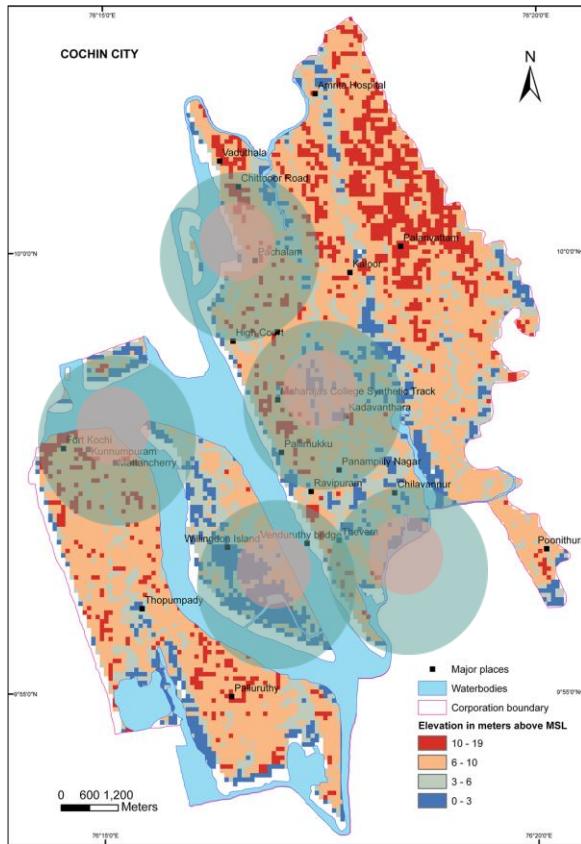


Existing Infrastructure

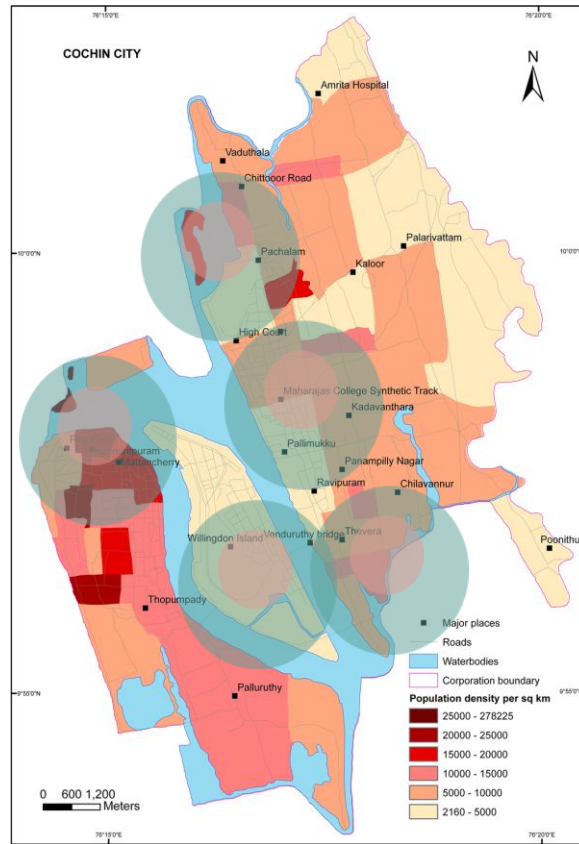


Source : 2021, City Lab Kochi, India climate risk and Resilience Assessment - MGI-iki.com.

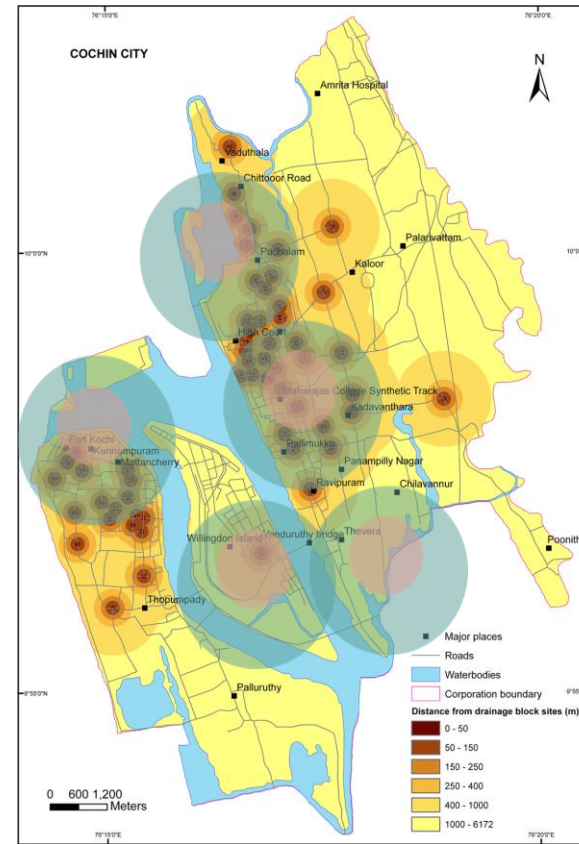
Understanding through maps



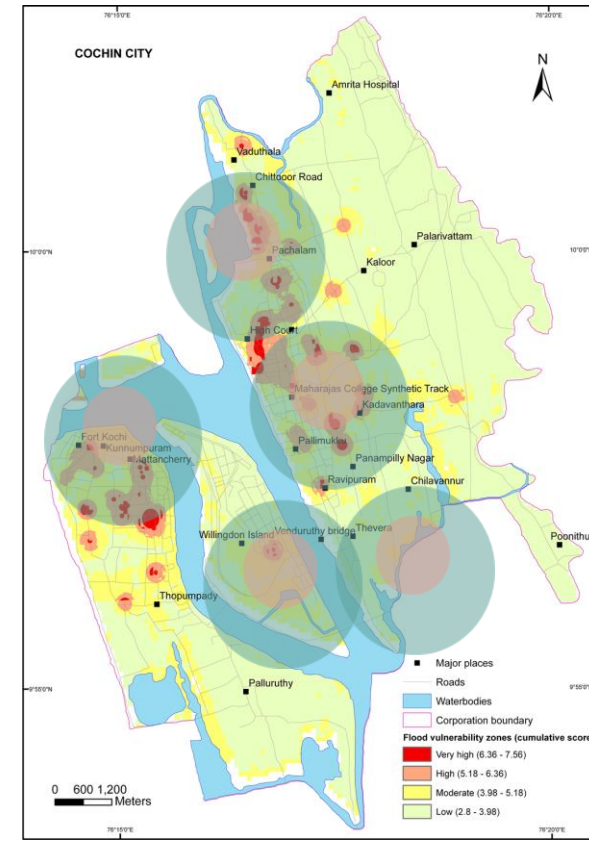
Spatial distribution of the contributing factor—elevation in m above MSL factor



Spatial distribution of the contributing factor—population density per sq km



Spatial distribution of the contributing factor—distance from drainage block sites in meters



The urban flood vulnerability zones identified in Kochi City Corporation area

24.13 % of Corporation area lies in the moderately vulnerable to urban flood zone. Major part of the Cochin City Corporation area (67.14 %) is identified as low vulnerable and is safer compared with other locations

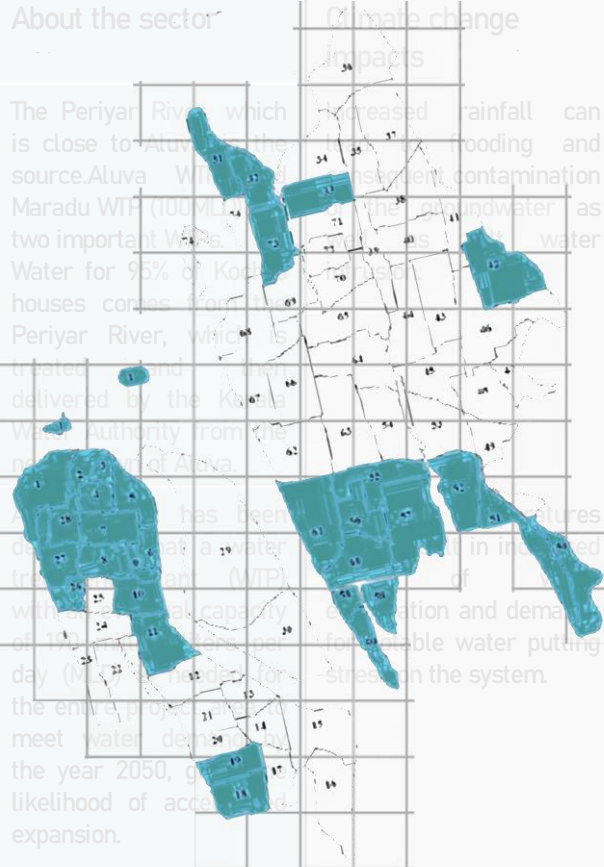
Source : 2014, Urban flood vulnerability zoning of Cochin City, Southwest coast of India, using remote sensing and GIS. Authors : K. Sowmya • C. M. John • N.

K. Shrivasthava

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Water Supply

About the sector
 The Periyar River, which is close to Aluva, is the source. Aluva WTP and Maradu WTP (100MLD) are two important WTPs. Water for 95% of Kochi houses comes from the Periyar River, which is treated and delivered by the KWA. The capacity of the WTPs is not sufficient to meet the demand. The city has been facing water stress in several wards. The water supply system is under stress due to increased demand and limited capacity. The city is facing water stress in several wards. The water supply system is under stress due to increased demand and limited capacity.



Critical wards facing water supply issues.

Sanitation

About the sector
 About 80% of the water usage is discharged as waste water, leading to significant strain on the city's water resources. The total water demand for the city can be brought down. Sanitation is a major challenge in Kochi. The city's water resources are being depleted due to the high volume of wastewater being discharged. This is leading to a significant strain on the city's water resources. The total water demand for the city can be brought down. Sanitation is a major challenge in Kochi. The city's water resources are being depleted due to the high volume of wastewater being discharged. This is leading to a significant strain on the city's water resources. The total water demand for the city can be brought down.



Critical wards facing Sanitations issues.

Solid Waste Management

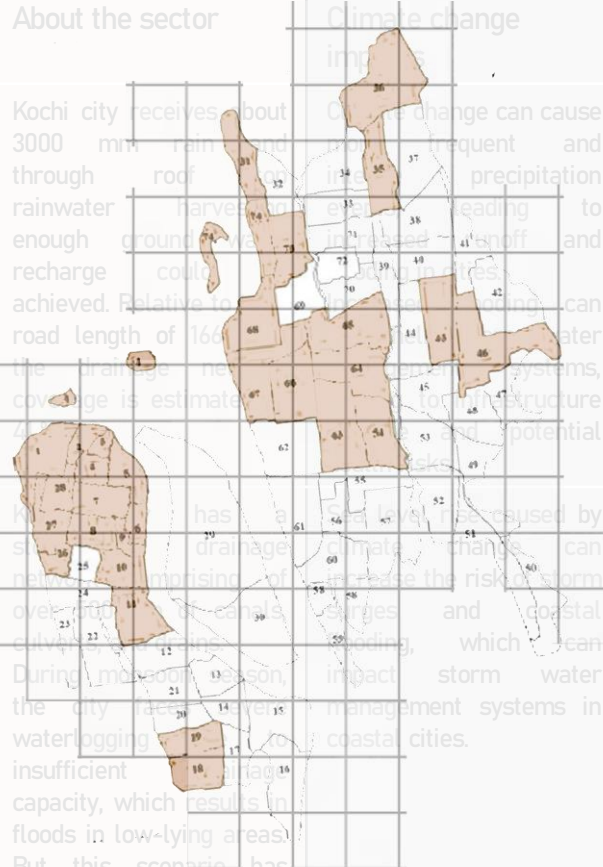
About the sector
 KSUDP data shows an average of 707 g of solid waste per capita per day. While the levels are satisfactory with collection efficiency at 96%, segregation at 86%, and recovery at 10%. The city is facing solid waste management issues. The city's solid waste management system is under stress due to increased demand and limited capacity. The city is facing solid waste management issues. The city's solid waste management system is under stress due to increased demand and limited capacity.



Critical wards facing Solid waste issues.

Stormwater Management

About the sector
 Kochi city receives about 3000 mm of rain annually through roof harvesting. The city is facing stormwater management issues. The city's stormwater management system is under stress due to increased demand and limited capacity. The city is facing stormwater management issues. The city's stormwater management system is under stress due to increased demand and limited capacity.



Critical wards facing Storm water/flooding issues.

Sanitation must be prioritized as a crucial component of **WaSH infrastructure in Kochi**, as it is currently in a significantly poor state compared to other sectors and is most affected by environmental challenges.

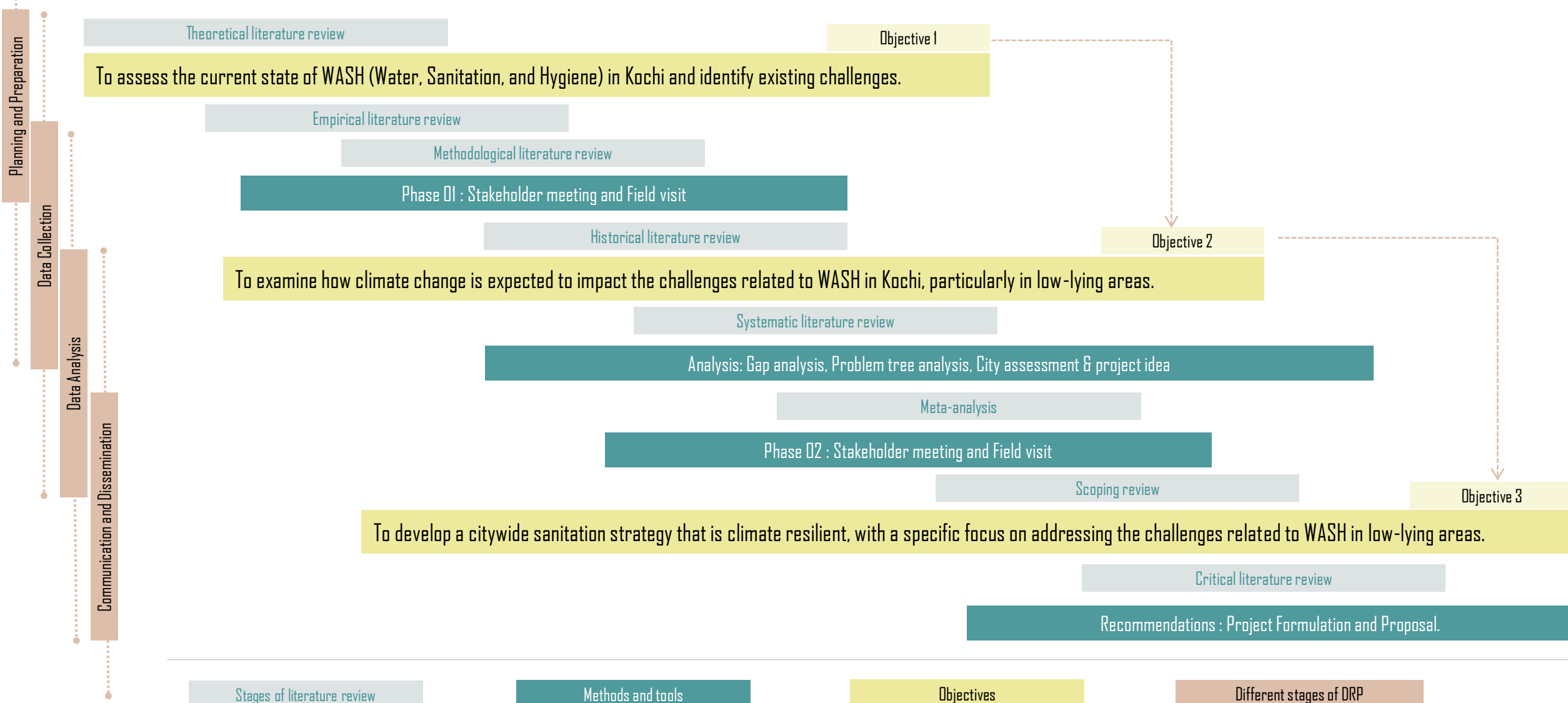
Source : 2022, Climate Action Plan for Kochi City- Preliminary Assessment, GIZ.








Water Supply
Sanitation
Solid Waste
Stormwater

Source : 2020, Untreated wastewater has choked the Thevara-Perandoor canal in the city. | Photo Credit: H. VIBHU

Literature Review







Insights from Key Stakeholders

Name of the organization	Key informant	Suggestions/inferences
 <p>1. Kochi Municipal Corporation (KMC) 1.1 Engineering Department 1.2 Health Department 1.3 AMRUT Department 1.4 Centre for Heritage, Environment and Development</p>	1.a. Mayor of KMC 1.b. Municipal Secretary of KMC 1.1. Environmental Engineer 1.2.a. Health Supervisor 1.2.b. Health Inspector-SBMin charge 1.3.a. Urban Planner 1.4.a. Director	<ul style="list-style-type: none"> □ With the support of a few experts including GIZ, ICLEI, WRI, and others, the city is currently working on climate resilience. □ Mixed terrain, high groundwater table, cases of inundation, connected canals (visually polluted- 90% water bodies are polluted) which is initially designed for desalination also transportation and rapidly developing unplanned settlements □ Limited sewerage network (less than 10%) and 95% of the households rely on on-site sanitation systems □ The Municipal Corporation presently does not own any desludging vehicles and the desludging operations are carried out by licensed private operators.
 <p>2. Greater Cochin Development Authority</p>	2.a. Town Planning Officer 2.b. Town Planning Officer	<ul style="list-style-type: none"> □ This city should be focusing on the 3 nodes from main land Kochi to Keezhmad region, Puthenkurishu region and Mulanthuruthi region. □ GCDA also manages 2 STPs currently and also there are 2 STPs and 1 ETP proposed in the city
 <p>3. Kerala Water Authority - Water supply and Waste water management, GoK authority.</p>	3.a. Assistant Engineer	<ul style="list-style-type: none"> □ The newly constructed largest STP under AMRUT will be handled by KWA (5MLD at Elamakulan)- this will make the cities total sewerage network from 5% to 8% coverage. □ The entire city has been divided into 12 zones and integrated sewerage masterplan of Kochi has been under progress. □ Both KMRL and KWA are working on this masterplan which is proposed for 2055.
 <p>4. Suchitwa Mission - Technical Support Group (TSG), LS GD, GoK</p>	4.a. District Coordinator	<ul style="list-style-type: none"> □ From the report of Clean Aquifer campaign in 2021- it was clear that the water bodies and all other natural resources are polluted, also there is a 95% faecal contamination in water bodies.
 <p>5. Cochin Smart Mission Limited - SPV to rejuvenate the prevailing urban ecosystem by ABD strategies.</p>	5.a. Deputy General Manager	<ul style="list-style-type: none"> □ The Kochi area's largest proposed STP project was dropped as a result of public outrage. □ There are other climate resilient proposals by CSML on WASH and other infrastructures at AED area.

Source : 2022, Author.

Insights from Key Stakeholders

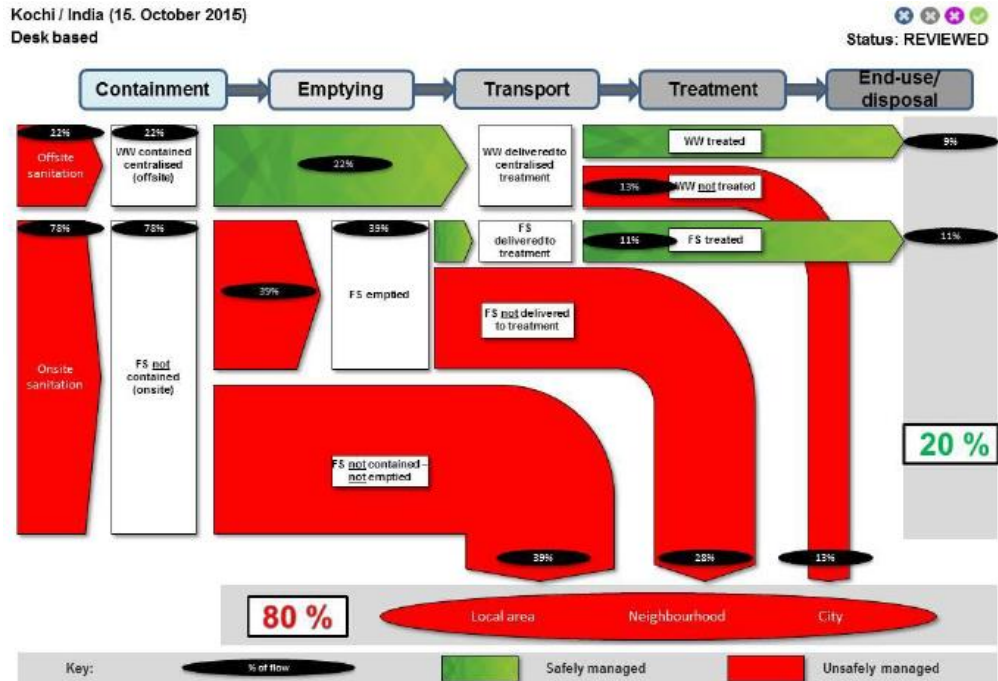
Name of the organization	Key informant	Suggestions/inferences
 <p>6. Kochi Metro Rail Limited (KMRL)</p>	6.a. Asst. General Manager	<ul style="list-style-type: none"> Engaged in Cleaning of water bodies and canals STPs proposed at 5 zones of KWA/KMRL/CSIND (Department of Coastal Shipping and Inland Navigation) /KIFB (Kerala Infrastructure Investment Fund Board) integrated masterplan will be covering the major part of KMC – 77MLD
 <p>7. Kerala Institute of Local Administration - An autonomous training, research and consultancy organization constituted under LSGD, GoK</p>	7.a. Urban Chair Professor 7.b. Senior Urban Fellow	<ul style="list-style-type: none"> Climate resilience should focus on the upcoming areas and the critical locations should have risk management alternatives. Decentralized Water and Used water management will have better impact. Protection of local natural resource could make lesser climate impacts. Technologies like alternative building technology to make biogas from septage by COSTFORD (Centre of Science and Technology for Rural Development) should be promoted.
 <p>8. World Resources Institute India - global research non-profit organization</p>	8.a. Program Manager – Urban Planning And Disaster Resilience	<ul style="list-style-type: none"> The city has been under water stress since it was an organically planned city. Since the city has been reclaimed with construction debris, it has its own issues. City has its own geographical challenges and its focusing on Nature based solutions
 <p>9. GIZ India - German Agency for International Cooperation</p>	9.a. Tec.Expert at GIZ- India	<ul style="list-style-type: none"> All urban services are getting effected by climate change and its high time for Climate resilience approach in these sectors Climate Change Database for Impact Assessment and Development: Adaptation and Mtigation Options for Kerala- A Multi disciplinary simulation and modeling should be established.

Source : 2022, Author.

Stakeholder Meetings: Key Takeaways

SLB - indicators	SLB	Current
Coverage of Toilets	100%	100%
Coverage of sewerage network services	100%	6%
Collection efficiency of the sewerage network	100%	100%
Adequacy of sewerage treatment capacity	100%	6%
Reuse and recycling	20%	-
Quality of sewerage treatment	100%	100%
Cost recovery	100%	-

Kochi / India (15. October 2015)
Desk based



5% - 8%
STP
coverage
within
KMC limits

200KLD
FSTP- two
100KLD
plants

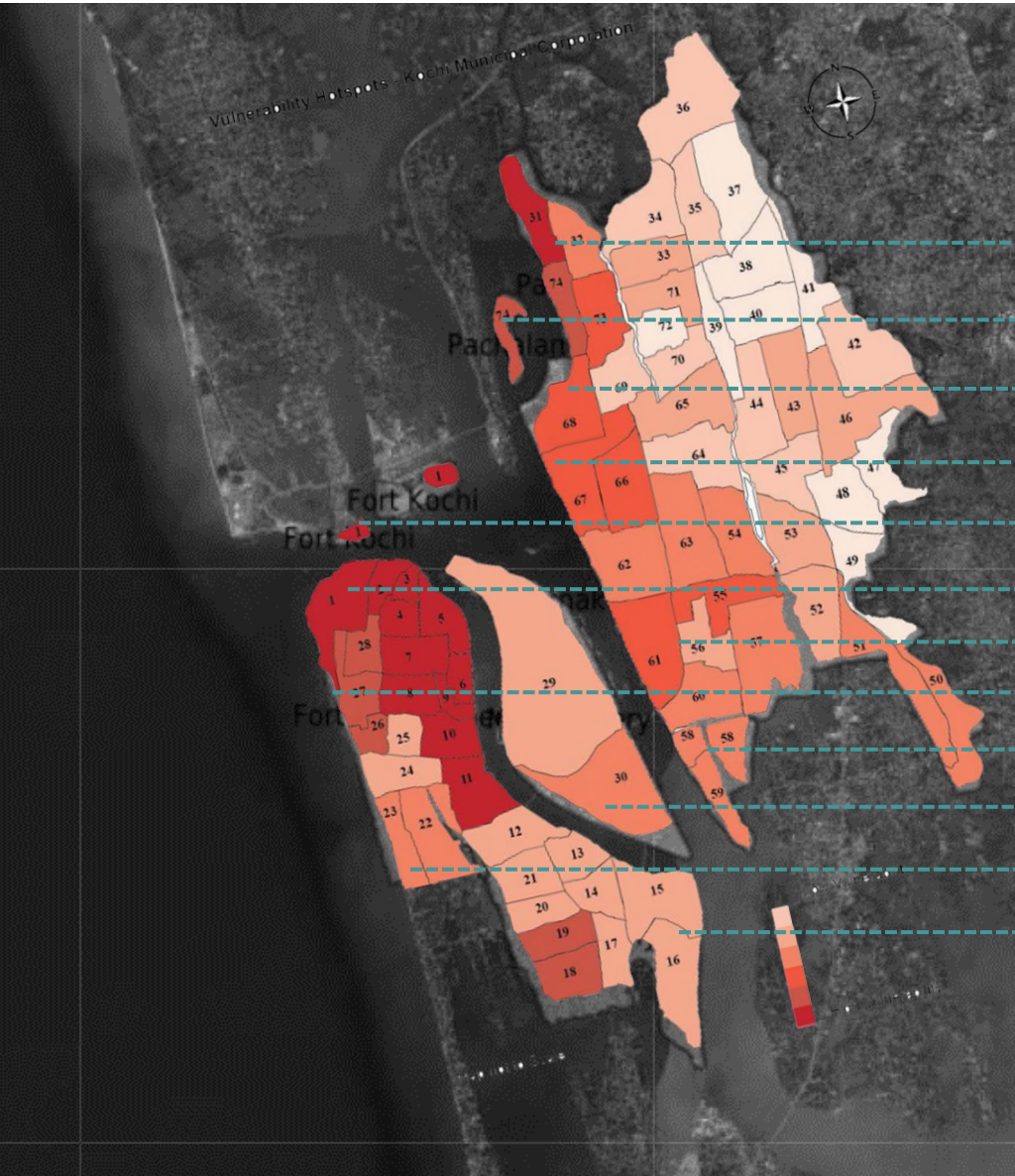
95% onsite
sanitation

1. The city is characterized by mixed terrain, high groundwater table, cases of inundation, connected canals (visually polluted-90% water bodies are polluted) which is initially designed for desalination and rapidly developing unplanned settlements.
2. The city has limited sewerage network and 95% of the households rely on on-site sanitation systems like septic tanks and pits whose overflow is connected to stormwater drain.
3. Due to the high groundwater table, the frequency of desludging these systems is high and hence the quality is close to high strength wastewater rather than faecal sludge.
4. The Municipal Corporation presently does not own any desludging vehicles and the desludging operations are carried out by licensed private operators.
5. The city lacks systems for proper monitoring of desludging activities and hence is victim to indiscriminate dumping of FS.

The city's current FS treatment capacity is insufficient to meet the treatment needs of future wastewater generation.

Source : 2022, Pre-Feasibility Report for Implementation of Faecal Sludge Treatment Plants in Kochi Municipal Corporation by AMRUT and CDD, Bangalore.

An Analysis of Specific Areas



Climate risks considered

Tidal effect

Urban heat island

Sea Level Rise

Flooding

Perandoor

Thanthonni Thururth

Mangalavanam - Buffer Zone

Mullassery Canal- Mainland Kochi

Fort Kochi- Vipin area

Fort Kochi Main

Panampilly Nagar

Nazreth Beach - Rameshwaram Colony

Thevara- TP Canal

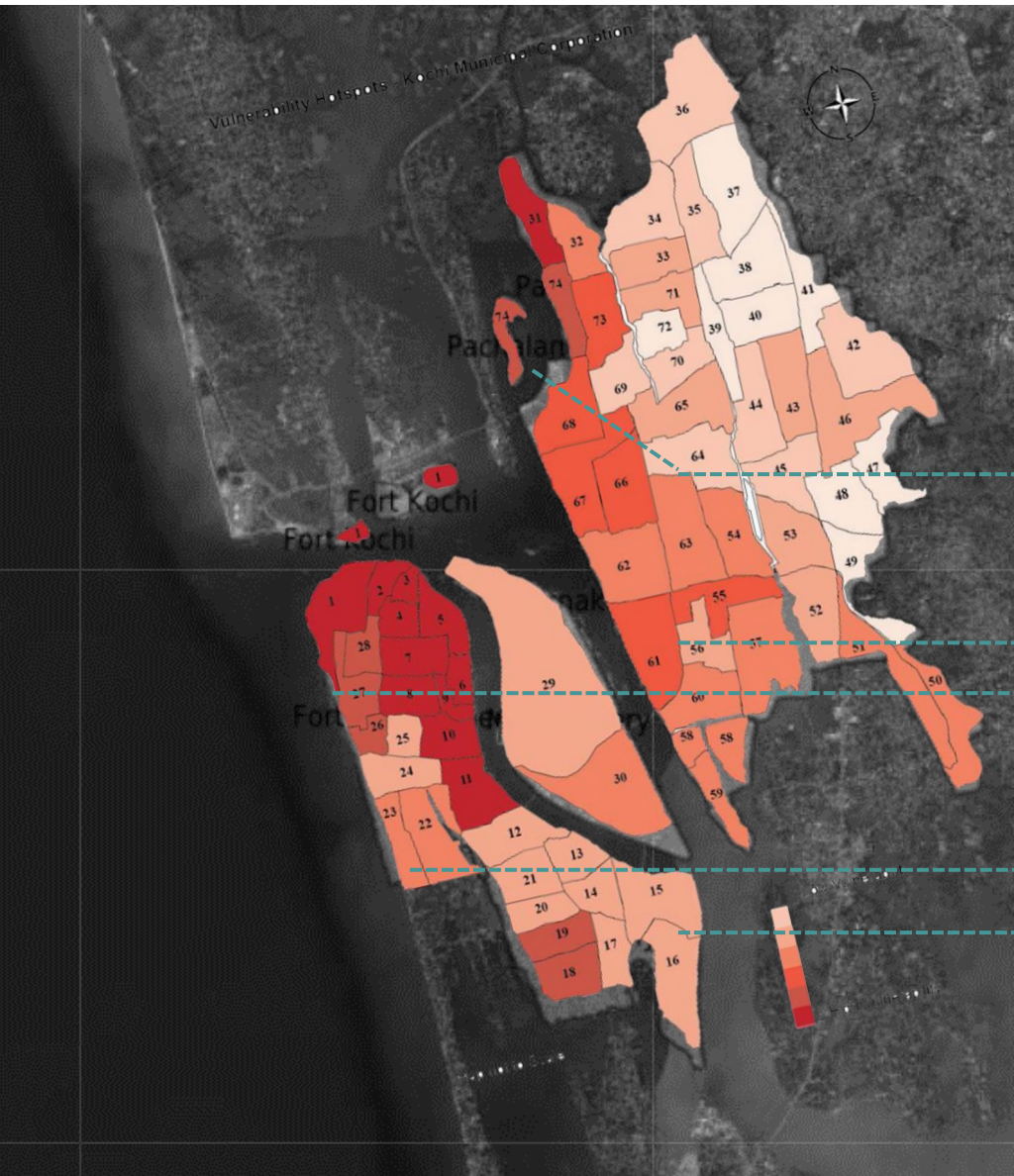
Vathuruthy Colony- Wellington island

Saudi colony- Thoppumpady

Eda Kochi

As a result, the study focused on areas that were affected by three or more climate change impacts, including Thanthonni Thuruthu, Rameshwaram Colony, Panampilly nagar, Saudi colony, and Eda Kochi, to conduct a more in-depth analysis.

Source : 2022, Climate Action Plan for Kochi City- Preliminary Assessment, GIZ and 2023, Author.



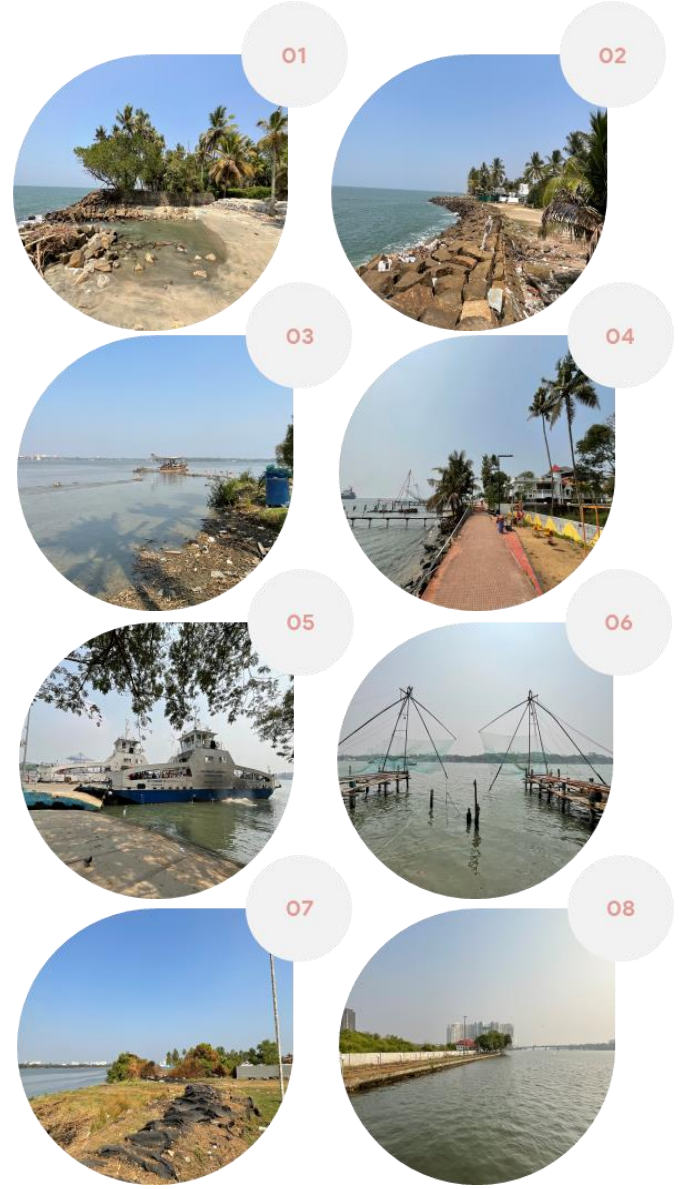
Thanthoni Thururth

Panampilly Nagar

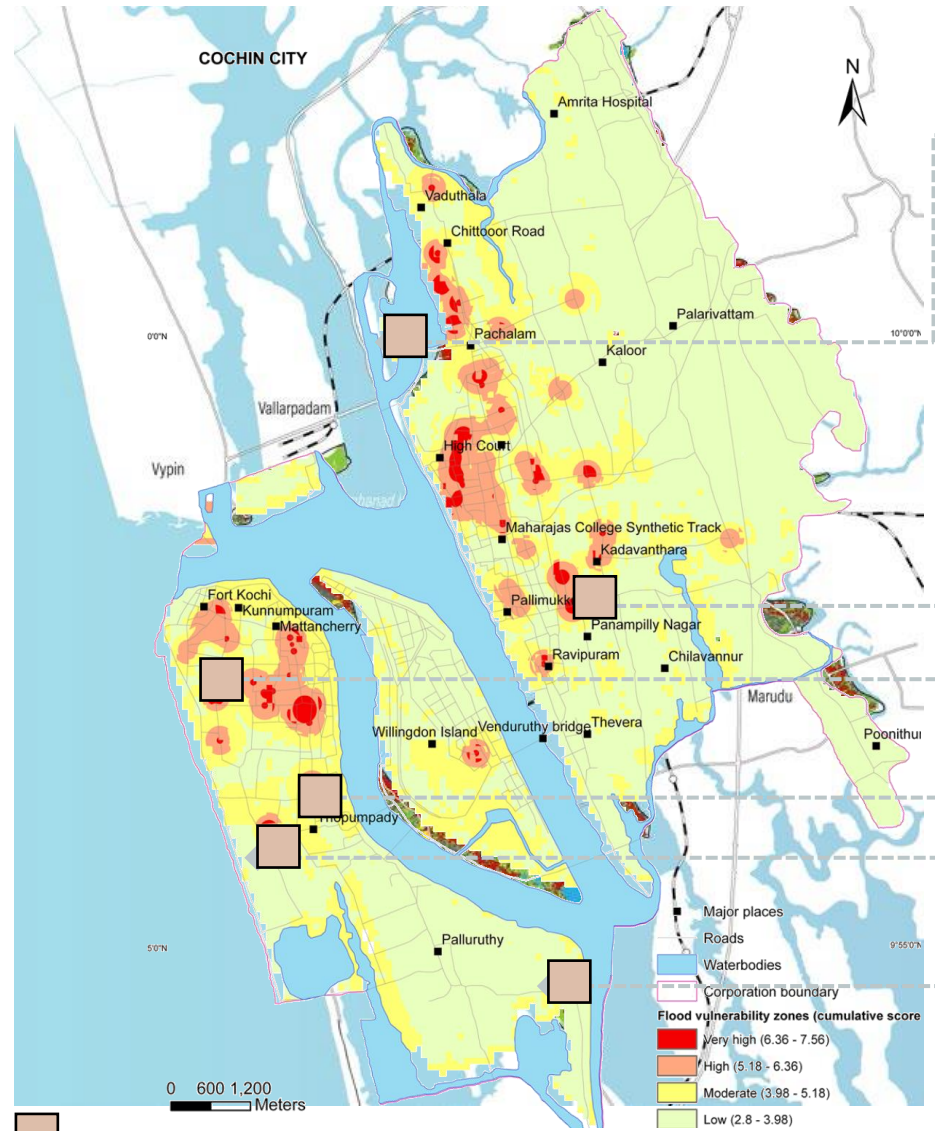
Nazreth Beach - Rameshwaram Colony

Saudi colony- Thoppumpady

Eda Kochi



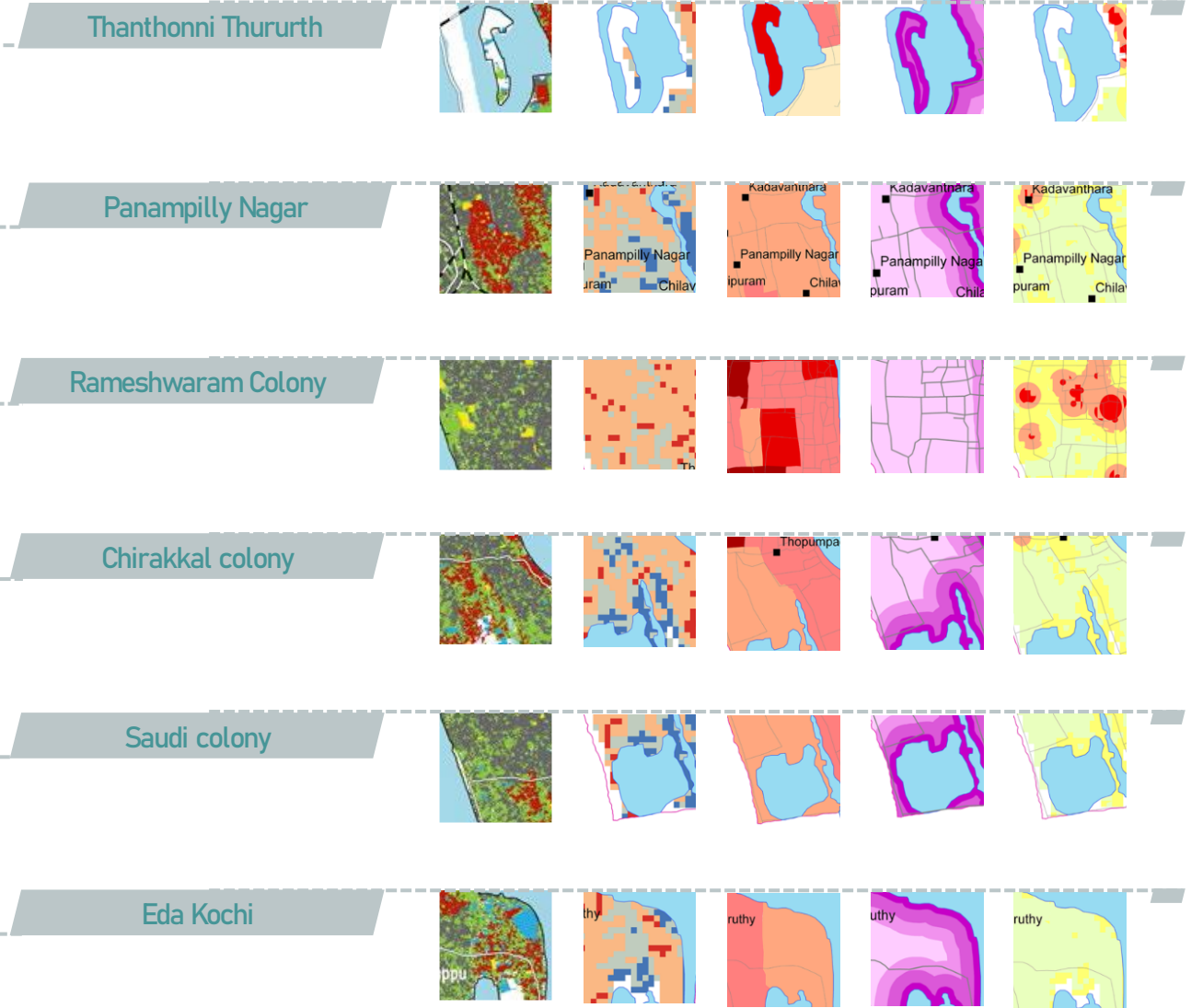
Urban Flood vulnerability zones in Kochi



Critical – survey locations identified

Source: WRI India 2021; NCESS 2010; Sentinel ESA

Selected cluster- analyzing through map

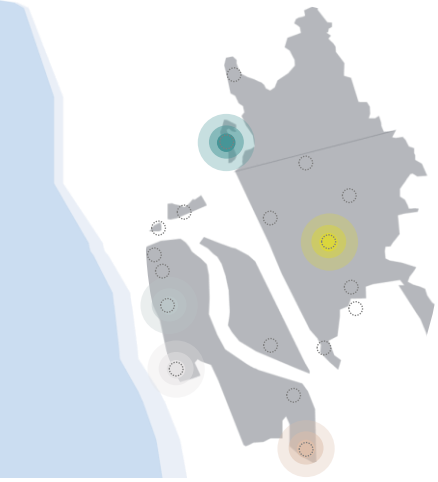


“Zooming in: Understanding Local Perspectives through Questionnaires”

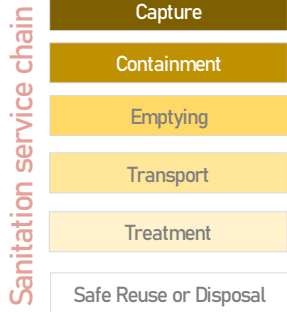
Voices from the city : key takeaways

Understanding the sanitation situations at the selected locations

Total surveys : 77



Critical Locations	Thanthonni Thuruth	Panampilly Nagar	Rameshwaram Colony	Eda Kochi	Saudi Colony
	<p>Climate risks considered :</p> <p>Tidal effect - Sea Level Rise</p> <p>Precipitation fluctuation</p> <p>Flooding</p> <p>Urban heat island</p>				
<p>Icons representing climate risks: Tidal effect, Precipitation, Flooding, Urban heat island.</p>					
LIG/MIG/HIG	LIG	MIG and HIG	LIG	MIG	LIG
Sanitation Service Chain:					
Access to toilet - Capture					
Onsite/Offsite - Containment (Septic tank - ST, Soak Pit- SP)					
Emptying - Avg. year					
Treatment - Location	NIL - Not Accessible for tankers	Aware of disposal - any 3 FSTPs	Aware of disposal - Willington Island Plant	Aware of disposal - Willington Island Plant	Aware of disposal - Willington Island Plant
Safe Disposal/Reuse					



Source : 2023, Author

Sanitation Service Chain of Kochi

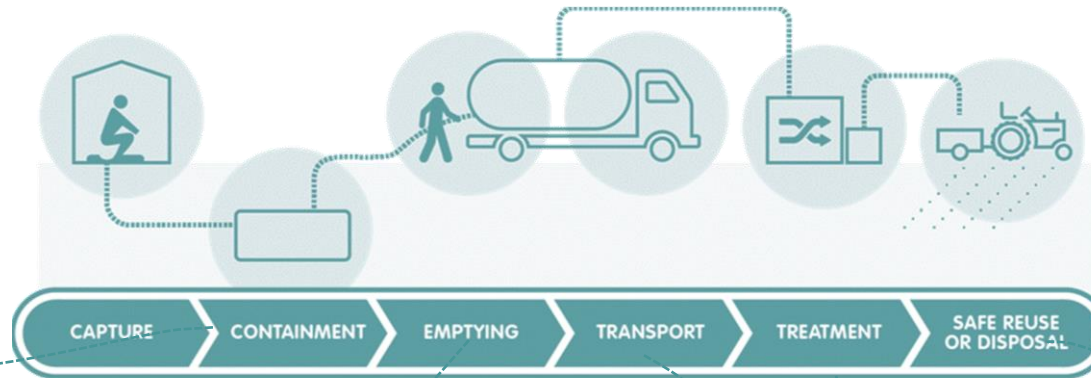
95% - Onsite and 5% - Offsite

Sanitation types in HH
(Census 2011)



- Flush - connected to sewer
- Flush - connected to septic tank
- Flush - connected to open drain
- Pit latrines

The most common **containment** technologies in Kochi are the septic tank, followed by pit latrines, and centralized sewer and open defecation. Surveys show that many septic tanks do not comply with location, design and construction guidelines



End-use / Disposal: As there is no designated disposal site in the city either, the faecal sludge is illegally and irregularly dumped on open ground or directly in water bodies. The treated wastewater is disposed to the nearby river.



Emptying is not monitored by the authorities but managed by private run businesses. Desludging is done on request of the residents when a septic tank is overflowing. Due to high groundwater tables, infiltration of onsite technologies has to be considered as unsafe disposal and can cause ground water contamination.

2021, Clean Aquifer campaign report

95% of water bodies

Transport: The properties of the influent entering the WWTP suggest considerable dilution of the sewage by groundwater. Transport of faecal sludge is conducted via faecal sludge trucks.



X 40 loads (per day)

No Monitoring = e.g.

Tanker spills septic waste on Kerala's Atlantis-Maharaja's College stretch

The incident came to light after a youth recorded a video of the tanker lorry (KL-41-B-2055) — permit number 07SW025 — spilling the septic waste by keeping its tank valve open.

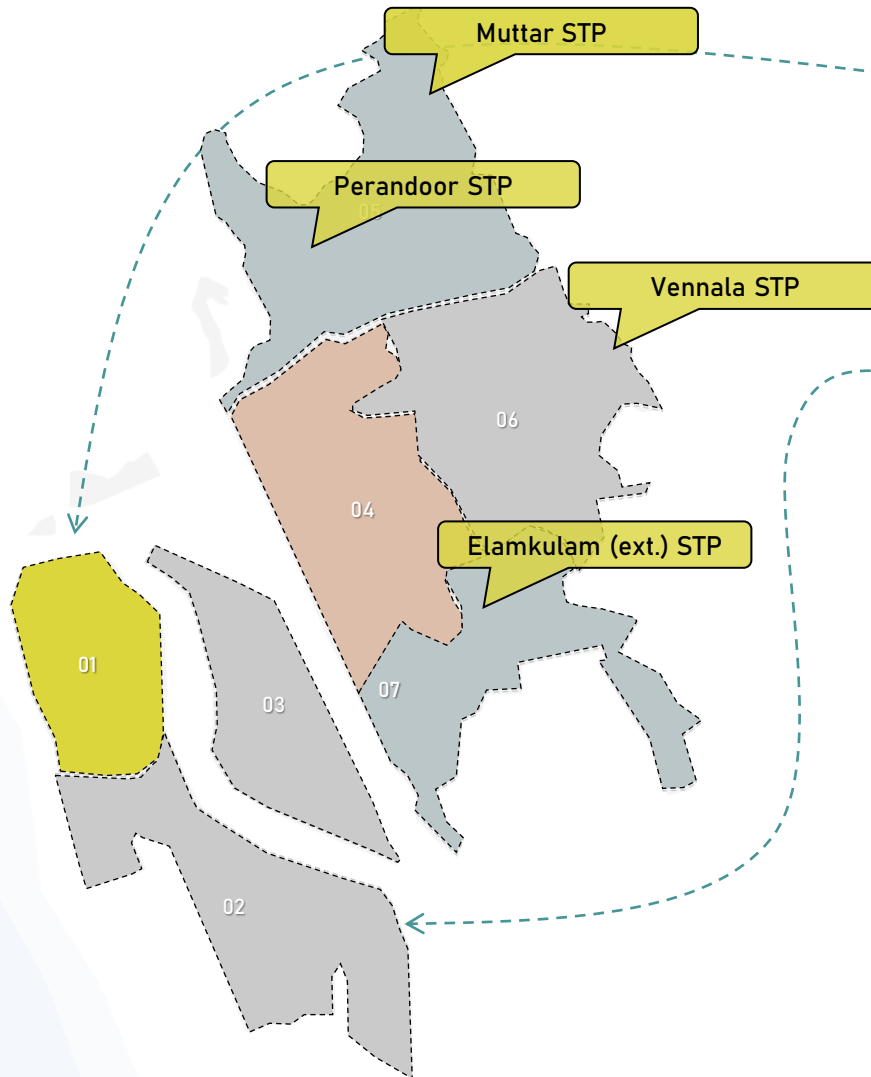
Published: 09th August 2022 09:23 AM | Last Updated: 09th August 2022 09:23 AM

Treatment: The sewage is conveyed to the WWTP in Elankulam and treated in an activated sludge process. Effluent data suggest an adequate treatment performance. A new Septage! Treatment Plant (STP) was constructed recently at Brahmapuram east of the city center with a capacity of 100 m³ daily and the similar set up is at Willington island.

STP/FS TP	Owned	Location	Capacity (MLD)
STP	KWA	Elankulam	4.5
STP	GCDA	Marine Drive	0.9
FSTP	KMC	Willington Island	0.1
FSTP	KMC	Bhramapuram	0.1

Source : 2016, SFD Promotion Initiative Kochi- GIZ and 2011, city sanitation plan, Kochi-KSUDP, 2021- The New Indian Express.

Proposed System Of Liquid Waste Treatment



Projected wastewater to be collected by 2041

Zone 1 comprising the northern side of West Kochi area has **21%** of the Sewage load concentrated in **10%** of the land area.

8.16 sq. km – 1.2lk population

CSML project proposed : 10MLD (2041 – 21MLD)

Gap of 11MLD

Zone 2 comprising the Eda Kochi area has **20%** of the Sewage load concentrated in this area.

1.2lk population

AMRUT project proposed : 16MLD (2041 – 22MLD)

Gap of 6MLD

Zone 3 -Willingdon Island : current is **0.1MLD**, proposed will be **1MLD**

Zone 4 –Central Kochi : current is **0.1MLD**, proposed will be **1MLD**

92500 population

Project proposed : 11MLD (Requires 12MLD)

Gap of 1MLD

Zone 5,6 and 7 – not proposed any WWTP- will require in future

Nearly 4lk population

Gap of 49MLD

The total liquid waste generation in Kochi, for future is estimated to be 105.11 MLD.

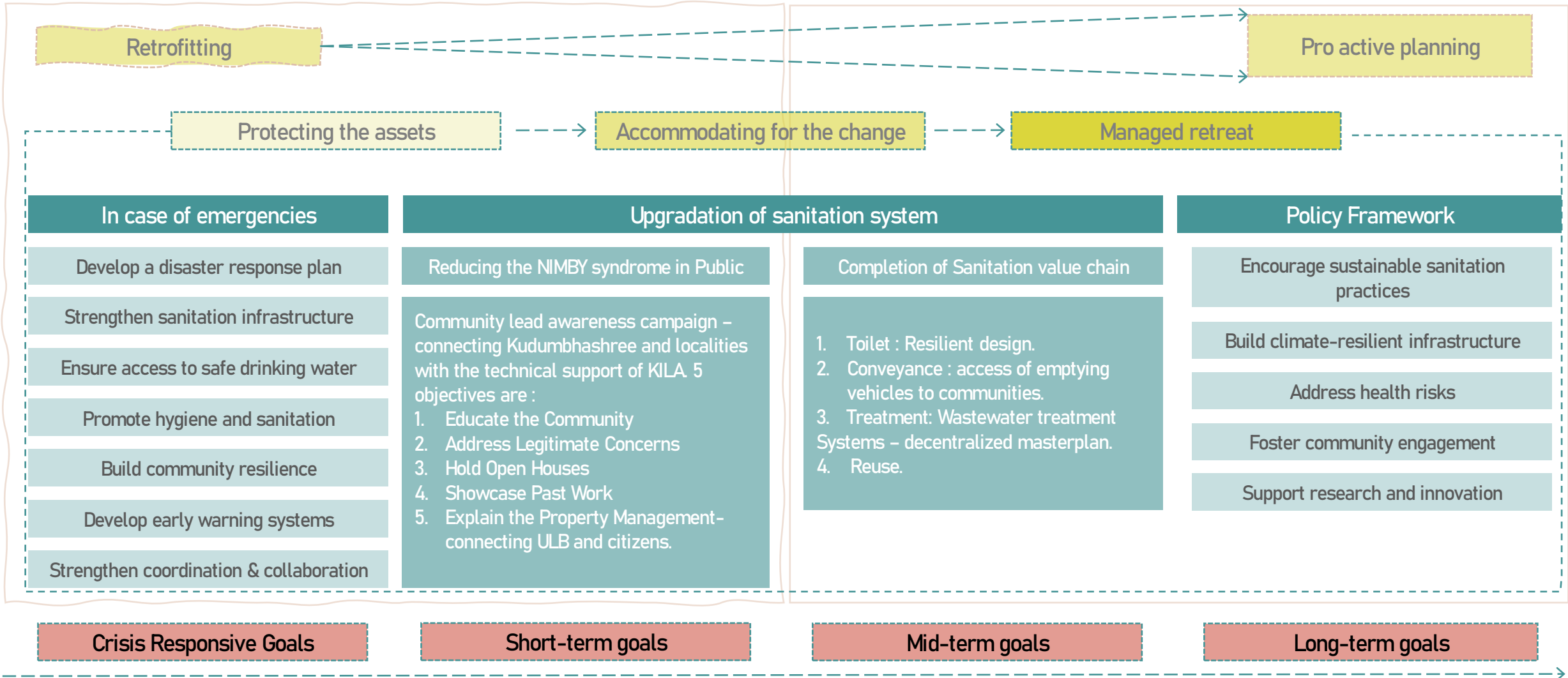
The present treatment capacity of the Sewage Treatment Plants is 5.6 MLD.

So, presently there is a gap of 100 MLD.

Source : 2022, Pre-Feasibility Report for Implementation of Faecal Sludge Treatment Plants in Kochi Municipal Corporation by AMRUT and CDD, Bangalore.

Recommendations

Climate Resilient Urban Sanitation - " Sanitation Value Chain towards Climate Resilience "



Source : Author.

"Not In My Backyard, Not In Anybody's Backyard:
Join the Fight Against NIMBY Syndrome"

Recommendations

Upgradation of sanitation system

Project **SIMBY** : "Sanitation In My Backyard" development **Sensibly In My Backyard**.
Promoting on-site and decentralized sanitation

Reducing the NIMBY syndrome in Public
Community lead awareness campaign –
5 objectives are :



Educate the Community

Address Legitimate Concerns

Hold Open Houses

Showcase Past Work

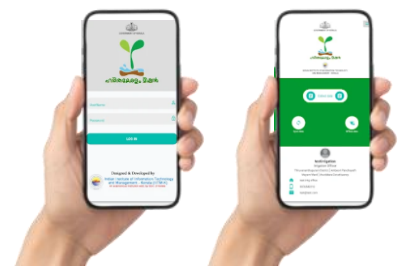


1 Haritha Karma Sena (HKS)= 250 houses

Project SIMBY requires 1000 HKS

Data collection through Haritha Keralam Mission App
Data required : locations, sizes/ capacity of Septic tank, avg HH, previous desludging date

"Malambhootham FSM IEC Campaign Suchitwa Mission Kerala SBM Sanitation"



Existing mission : Haritha Kerala Mission



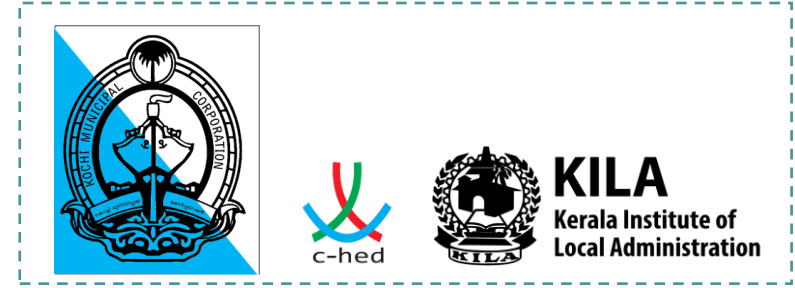
Stakeholders involved



Training and capacity building programs



Supported by



Source : Author.

Conceptualizing of Sanitation Value Chain for Kochi

01

Access to toilet in emergency cases/ islands

02

Floating containment

03 a

Desludging through Floating Honey suckers



Water ways like **Water Metro** or existing **Ferry** can be used for an integration desludging

Separate toilets

Floating containment

HDPE floating bridge



03 b

Different Types of Floating Digesters

a

Composting - Charcoal, sand, coconut husks, humus soil, and wood chips break down waste with the presence of air.

b

Hybrid - Container 1 with pipe uses air to break down waste while container 2 decomposes waste without air.

c

Anaerobic - The container is partially submerged under water. It decomposes waste without air

d

Anaerobic Twin - The containers are connected in a series and they decompose waste without air.

Stakeholders involved

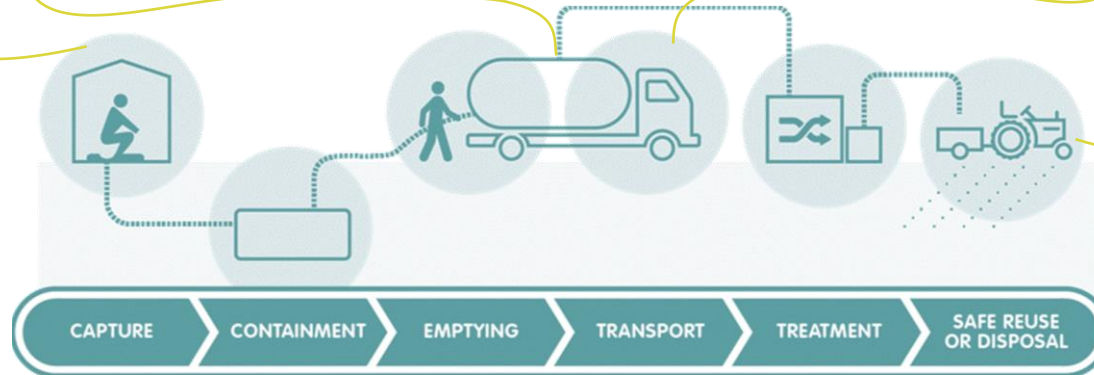
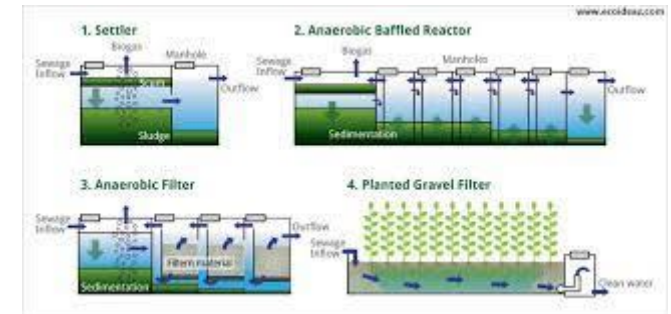
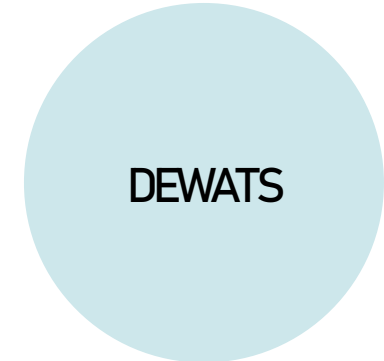
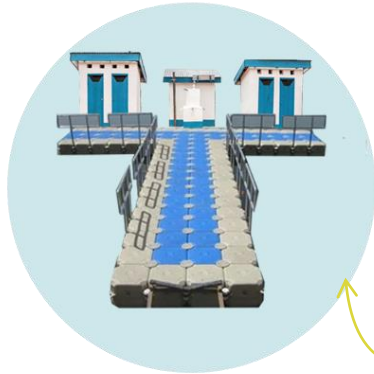


Source : Author.

Conceptualizing of Sanitation Value Chain for Kochi

Climate Resilient Urban Sanitation - "Sanitation Value Chain towards Climate Resilience"

Floating Toilet for islands & other vulnerable points



Decentralised Wastewater Treatment System

Source : Author.

Thank You

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