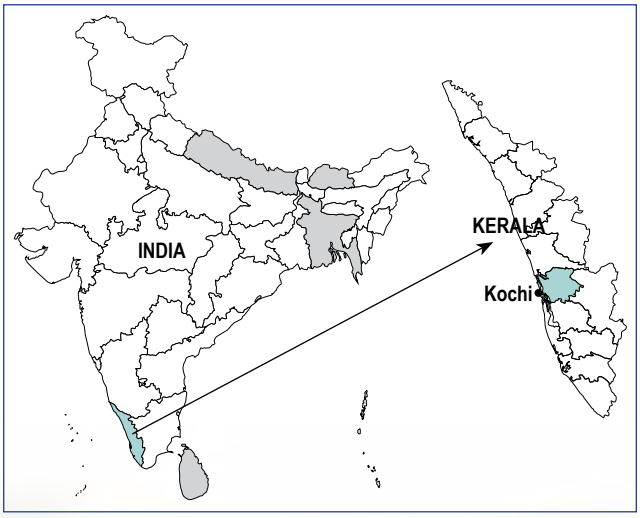
City Resilience Strategy: Kochi

The coastal city of Kochi is located in the district of Ernakulam in the state of Kerala and is spread over an area of 107.13 sq.km. It is the commercial and industrial hub as well as the second largest city in the state of Kerala. With a population of 601,574 as recorded in 2011, the city of Kochi has Kerala's highest population density with 5,620 people per km^2. The city, also known as the Queen of the Arabian Sea for its scenic beauty, is a trading port and was the spice trading centre of the world in the 14th century.

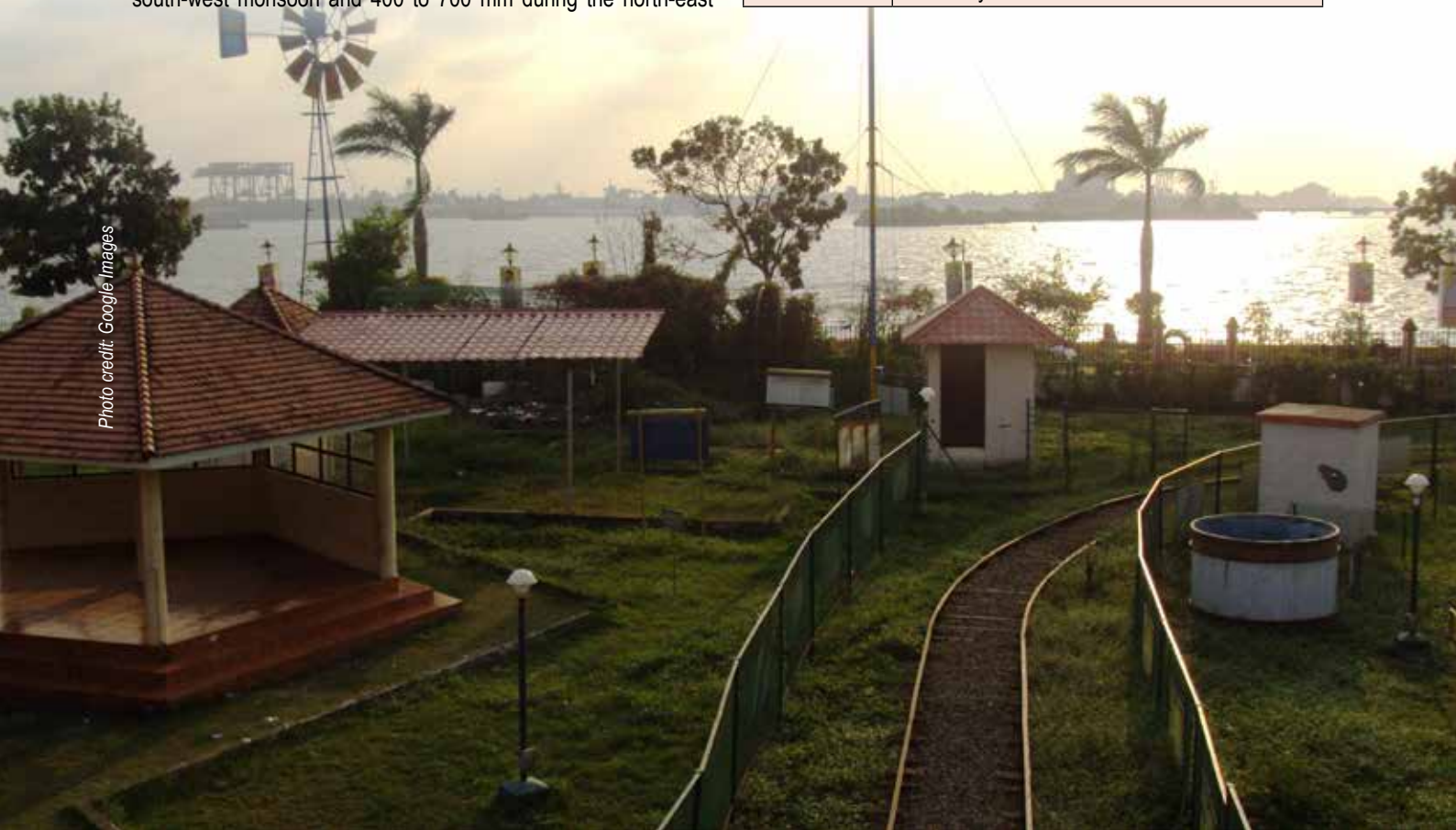


The annual variation of temperature in Kochi is between 22°C and 32°C. Rainfall varies from 1,500 mm to 2,000 mm during the south-west monsoon and 400 to 700 mm during the north-east monsoon. The maximum annual rainfall in the region is around 3,000 mm. The humidity is high round the year because of the nearness to the sea and due to the large area of backwaters in the region. Kochi corporation area being a flat land, adjacent to the coast, is subjected to floods during the monsoons affecting normal life and disrupting traffic in the city. Added to this, water logging is a major problem in Kochi. Almost every year the city gets flooded and incurs huge losses.

Climate Risks

The two climate risks identified through the ICLEI ACCCRN Process (IAP) for Kochi are:

Changing Climate Conditions	Climate Scenario Summary Statements
Increased rainfall	Projected precipitation may show a moderate increase in 2015-2044 with respect to the rainfall of 1971-1999 by 0.5 mm/day in Kochi city.
Increased temperature	Projected mean temperature may show a net increase of 0.53° C in 2015-2044 with respect to the mean temperature of 1969-2000 in Kochi city.



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Vulnerability Assessment

The fragile urban systems and their corresponding climate fragility statements for Kochi are:

Fragile Urban Systems		Climate Fragility Statements
		Can increase rates of water evaporation and demands for potable water putting stress on the system.
		Can lead to flooding and consequent contamination of the groundwater as well as salt intrusion.
		May alter waste decomposition rate and leachate production rate leading to the spread of infectious diseases.
		May have impacts on health, as stagnating sewerage, will become a conducive breeding environment for harmful pathogens.
		Will increase incidences of water logging which will affect the sewerage management system infrastructure. Furthermore, there can be instances of freshwater and rainwater mixing with sewerage and sludge, polluting limited freshwater bodies and facilitating the spread of diseases.
		Coupled with clogged drains will lead to increased incidences of water logging and flooding in the city. This will have profound impacts on the infrastructure, finance and health of Kochi city.

Through the vulnerability assessment, the adaptive capacity of the key actors identified in the IAP was scored based on three parameters: capacity to organize and respond, availability of resources, and access to information. Actors who receive a low adaptive capacity score are classified as vulnerable while those who receive medium and high scores are classified as supporting and can aid the local government in resilience building activities. The table below presents an overall analysis of actors across the different fragile urban systems.

Actor Analysis for Kochi City

Vulnerable Actors	Supporting Actors
• Citizens (includes slum dwellers) • Waste Collectors • Ward Committee • *Kudumbashree* (Women Self Help Group) • Residents Welfare Associations • Fisheries Industries / fisherman community	• Kochi Municipal Corporation • Kerala Water Authority • Greater Cochin Development Authority • Public Works Department

Kochi Municipal Corporation (KMC), the primary stakeholder, emerged as a supporting actor across all urban systems. The corporation has the means and will to build resilience and has established good relationships with other government departments. KMC however, lacks the access to finance as the work within the municipality is dependent on release of funds from the state department.

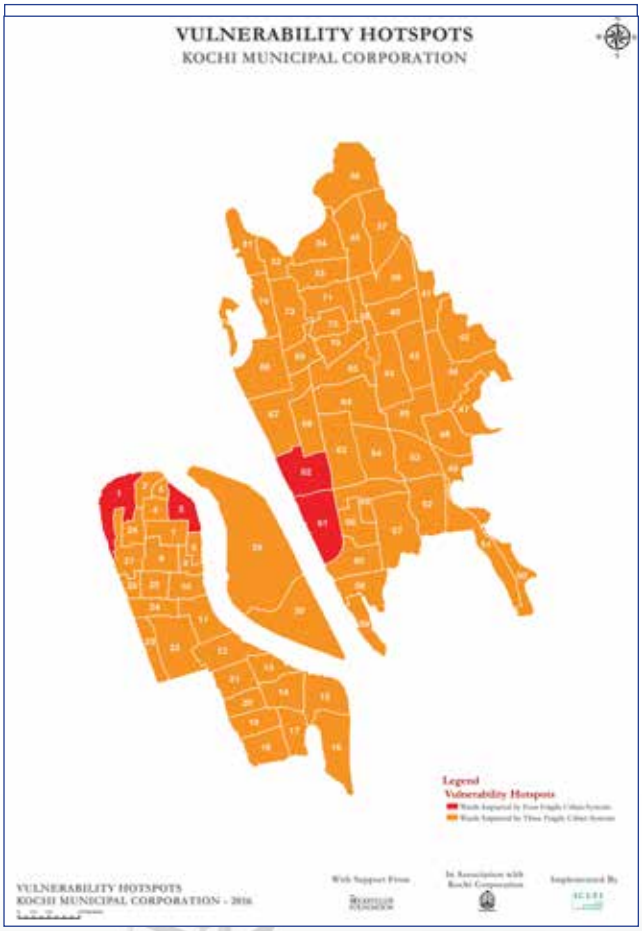
The adaptive capacities of the fragile urban systems are assessed on the basis of five broad categories – economic, technology/ infrastructure, governance, social, and ecosystem services. Each of these five categories was rated as high/medium/low and averaged across all the urban systems to generate an overall score for each parameter in the city as detailed in the following table.

Overall Adaptive Capacity of Systems in Kochi City

Adaptive Capacity Parameters	Adaptive Capacity Score		
	Low	Medium	High
Technological/ Infrastructural			
Economic			
Governance			
Societal			
Ecosystem services			

Most of city was found to be vulnerable (refer map) in the analysis of vulnerable areas. However after discussions with the core team, wards 1 (fort Kochi), 5 (Matancherry), 61 (Ravipuram), and 62 (Ernakulam South) were assessed as the most vulnerable to all fragile urban systems. It is important to note that these wards have substantial slum populations. Ward 1 has a large population of fishermen who are adversely impacted by the climate risks. Wards 61 and 62 are areas where water logging occurs regularly because of a lack of or poorly maintained infrastructure.

Among some of the soft measures identified through the IAP are included better coordination among different departments involved in the administration of relevant urban systems, development of management information systems and guidelines for management and disposal of water, solid waste, waste water as well as awareness generation activities and training for staff and public. The infrastructural measures include enhancement and upgradation of urban services, use of decentralised systems for waste management and involvement of public sector and their regulation for better and sustainable service delivery.



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Key Interventions Identified for Kochi City

Infrastructural Measures	Non-Infrastructural/ Policy Measures
Water Supply	
• Rain water harvesting structures for reuse of water especially in public buildings. **Costs associated** (Cost of structures for individual units, civil and construction work): INR 5 lakhs per unit. **Co-benefits:** Can be used for recharge if excess rainfall is there.	• Developing a management information system to monitor the water supply system. **Costs associated** (Consultant costs, cost of infrastructure): INR 50 lakhs.
Solid Waste Management	
• Decentralized solid waste management system with community level composting and processing units. Recyclables recovered at the processing units can be sent to recycling centres and non-recyclables can be used to prepare Refuse Derived Fuel (RDF). **Costs associated** (Cost of setting up of composting units, recyclable processing unit, RDF facility): Ranges from 140-370 INR per ton of waste for annual capacities of 45 MT to 500 MT. Higher the capacity lower the rate. Operation and maintenance (O&M) costs are in the range of 120 – 290 INR per ton. **Co-benefits:** Can generate income, promote resource recovery, reduce emissions.	• Training of *Kudumbashree* members on the aspects of decentralised solid waste management. **Costs associated** (Cost of training materials, venue, staff): INR 2 lakhs per training. **Co-benefits:** Create skills to enhance capacity of members.
Sewerage	
• Public Private Partnership mode of sewage treatment wherein private players collect and transport waste and the city is responsible for waste treatment. **Costs associated** (Cost of development of sewage treatment plant): INR 20 lakhs per MLD. **Co-benefits:** Can promote efficiency and good governance.	• Strict regulation of private sector sewage removal service providers. **Costs associated** (Cost of meetings, cost of developing by-laws, staff costs): INR 2.5 lakhs per year. **Co-benefits:** Can generate revenue for municipal authority.
Storm Water Drainage	
• Regular cleaning of drains especially before the monsoons. **Costs associated** (Staff costs, material costs): INR 15 lakhs per km.	• Monitoring information system that will assist in monitoring and evaluation and O&M of the drainage system. **Costs associated** (Cost of consultants and systems): INR 50 lakhs. **Co-benefits:** Good governance practices will be encouraged.

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