



RESILIENT INDIA THROUGH INTEGRATED CLIMATE POLICY

Madhav Pai

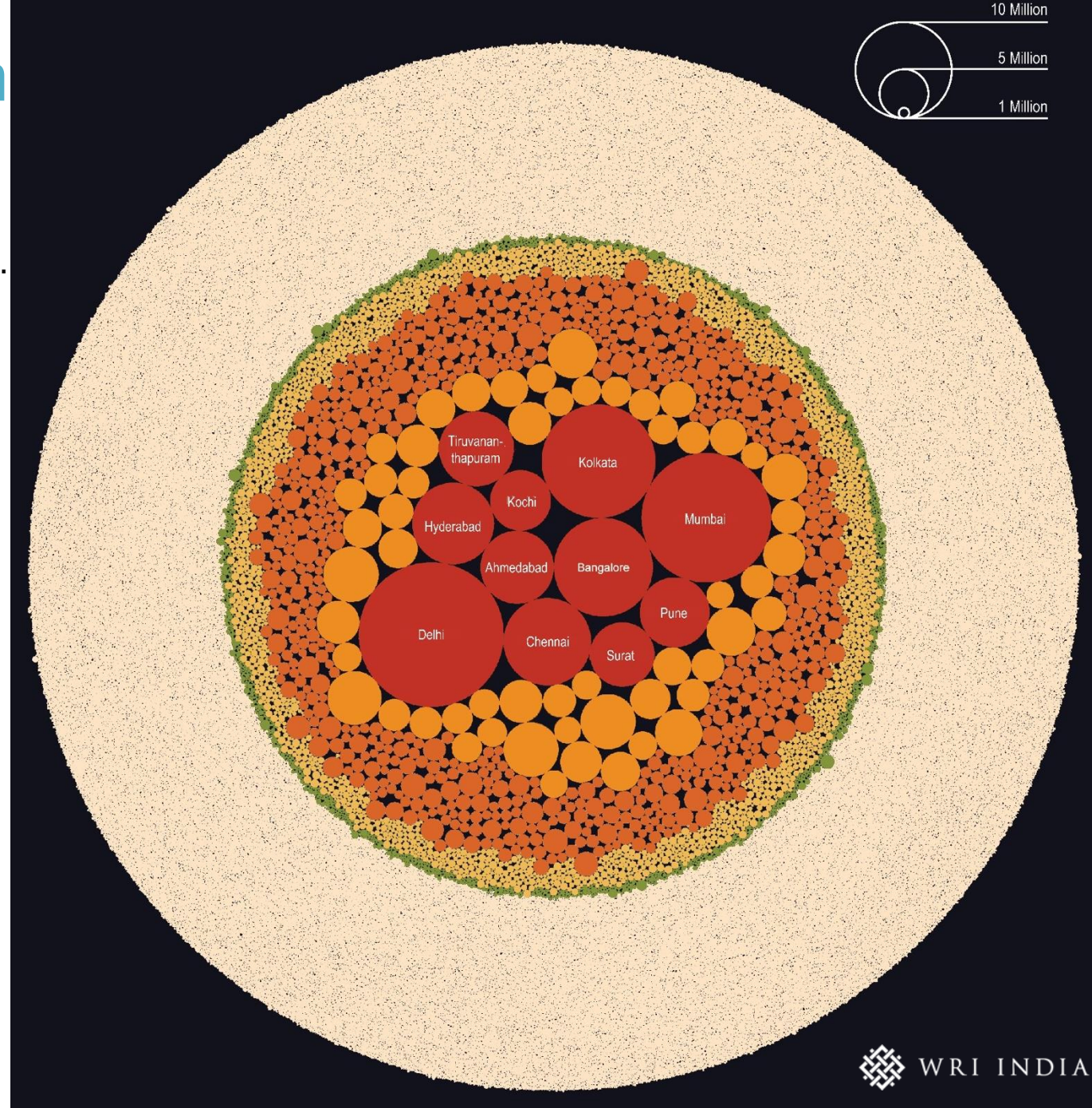
DECEMBER 2025

India's true agglomerations in 2020

Delhi's agglomeration is set to overtake Tokyo to become world's largest.

From unprecedented giant agglomerations, contiguous urban stretches, to tiny villages turning urban, India may take principles and learnings from the global north but can no longer borrow planning/ development/ governance templates and must create its own.

- Megacities (Population >5 million) (11 in number, Total population: 140 million)
- Large cities (Population range: 1 to 5 million) (55 in number, Total population :110 million)
- Medium cities (Population range: 0.1 to 1million) (710 in number, Total population: 180 million)
- Small cities (Population < 0.1 million) (7437 in number, Total population : 82 million)
- Census towns outside CBUA (1985 in number, Total population: 71 million)

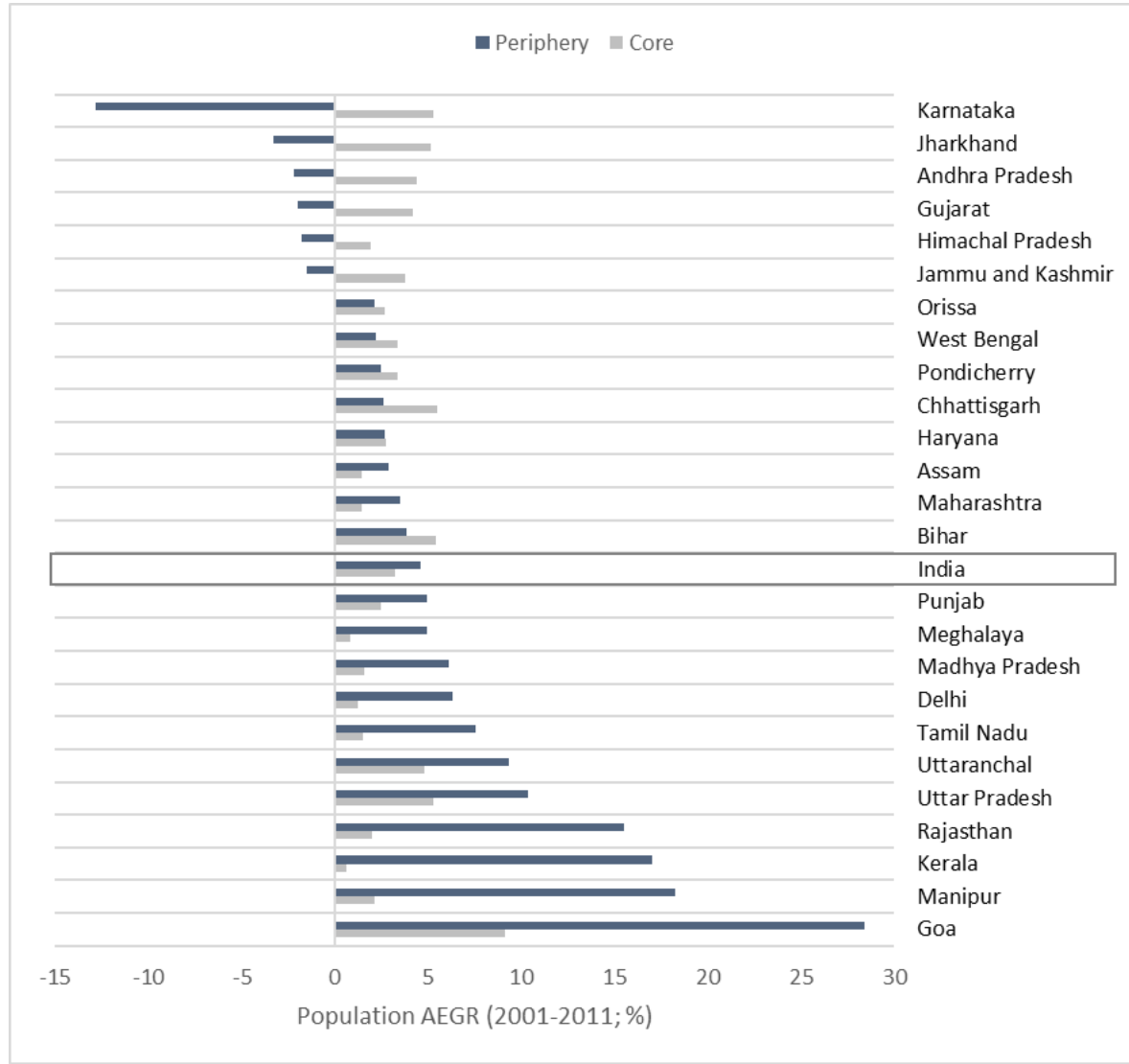


66% OF URBAN BUILT-UP BETWEEN 1990 & 2020 WAS OUTSIDE PRIMATE CITIES

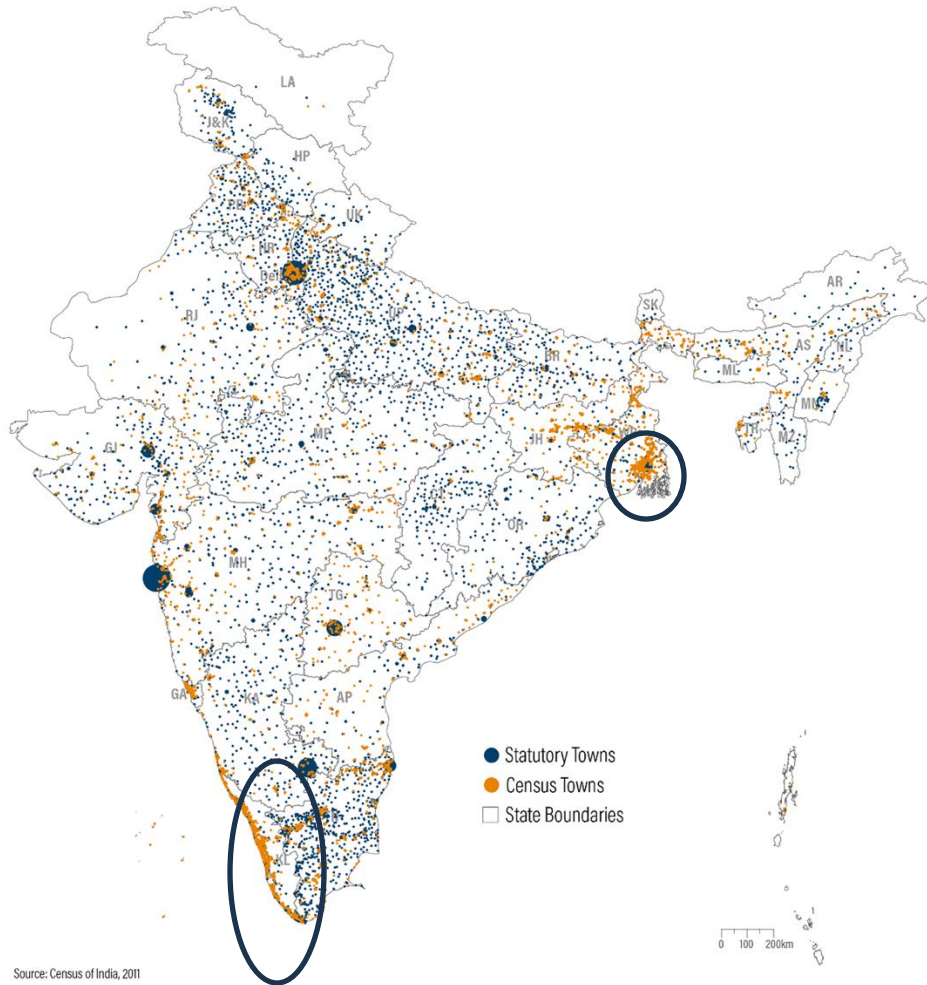
Population growth is higher outside municipal limits



■ Builtup in 1990
 ■ Builtup added by 1995
 ■ Builtup added by 2000
 ■ Builtup added by 2005
■ Builtup added by 2010
■ Builtup added by 2015
■ Builtup added by 2020



PLANETARY URBANIZATION- EXPANSION BEYOND MAJOR CITIES INTO REMOTE AND NON-CITY SPACES WITH NO GOVERNANCE STRUCTURES FOR MANAGING GROWTH



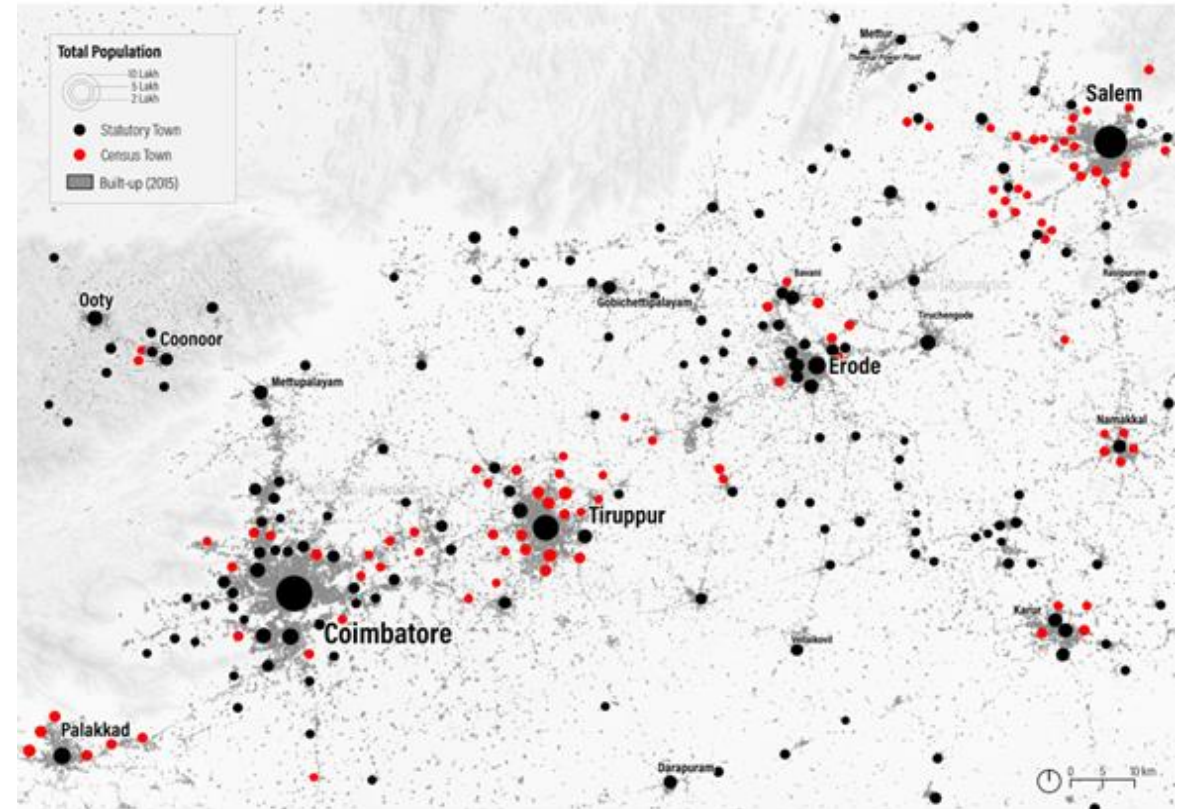
Source: Census of India, 2011

Note: 1. Size of the bubble is proportional to the population of city/town.
 2. Map is spatialization of Census 2011 data on Statutory Towns and Census Towns.

Analysis and Visualisation by Vinamra Bharadwaj and Nileena S/WRI India

DISCLAIMER: This map is for illustrative purpose and does not imply the expression of any opinion on the part of WRI India, concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries

Statutory and Census Towns in Western Tamil Nadu



Data and Methods: Visualization shows the population and the locations of statutory towns and census towns recorded in Census 2011

Analysis and Visualization: Kowsalya G. Jyoti, Raj Bhagat P, Nileena S (WRI India GeoAnalytics)

More than 40% percent of new development in top 10 cities is located in zones with high and very high water recharge potential

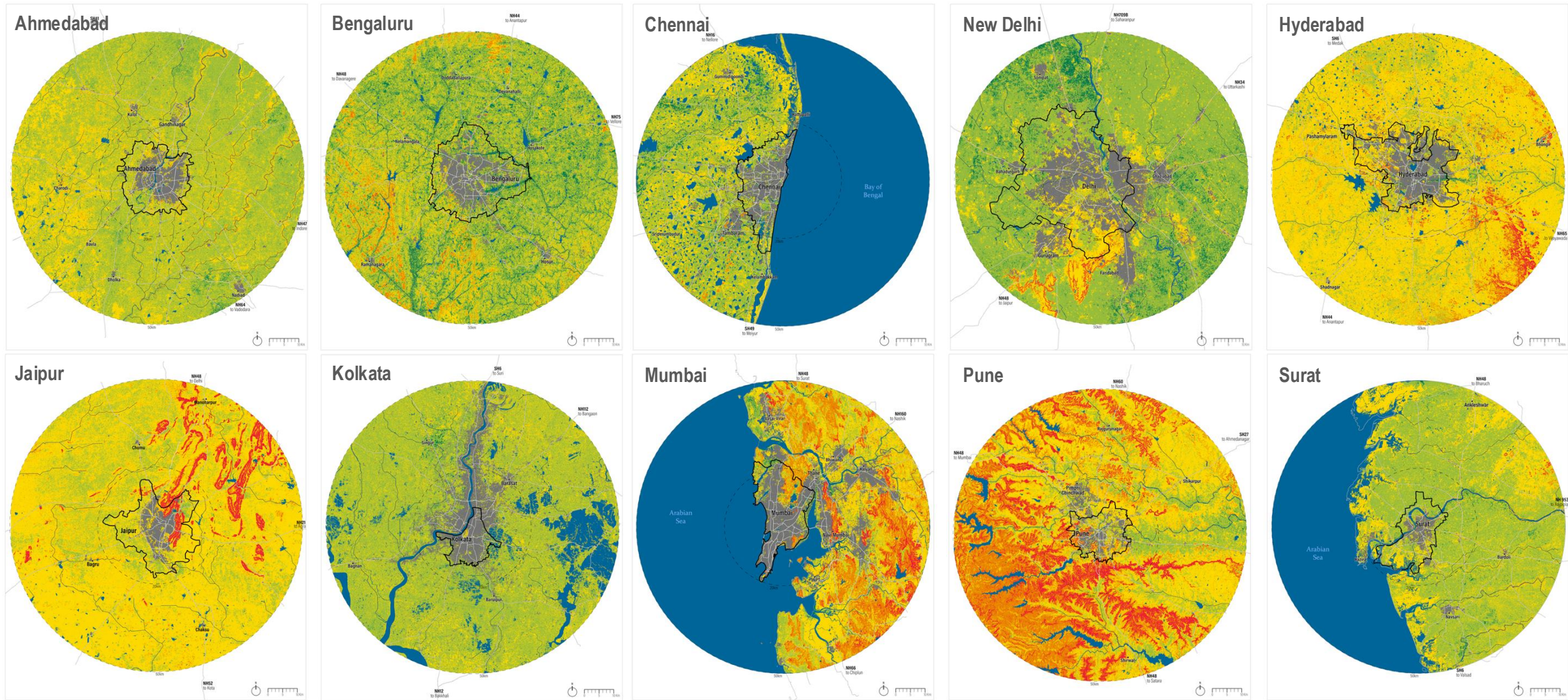
UNCHECKED URBAN GROWTH DEPLETES NATURAL INFRASTRUCTURE & ECO-SENSITIVE ZONES CRITICAL FOR RESILIENCE AND SUSTAINABILITY



HYDERABAD



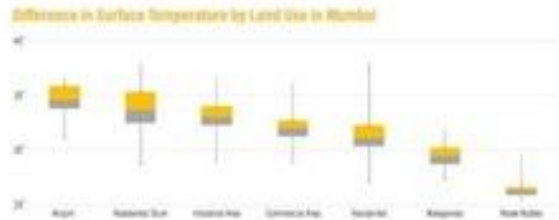
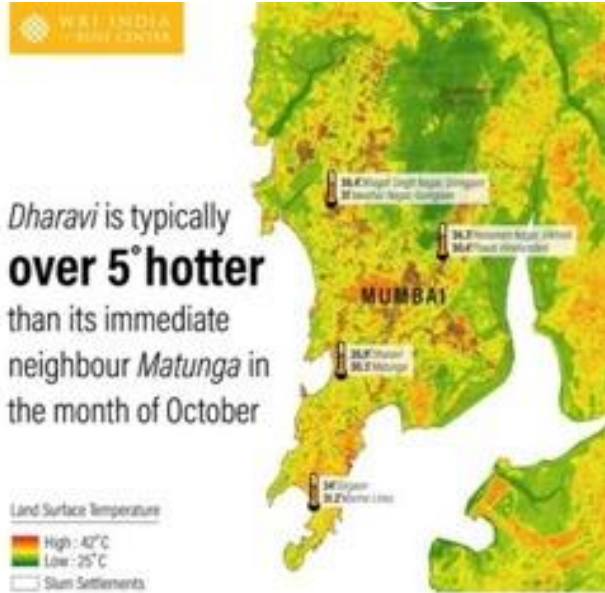
Rapid urbanization with shrinking blue green cover



Municipal Boundary
 Urban Extent till year 2000
 Highways
 Distance from city center
 Maximum Surface Water (1984 - 2018)
 River Network
Recharge Potential:
 Very Low
 Medium
 Very High
 Low
 High

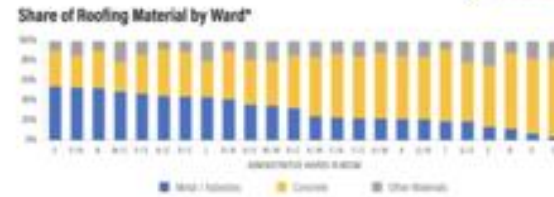
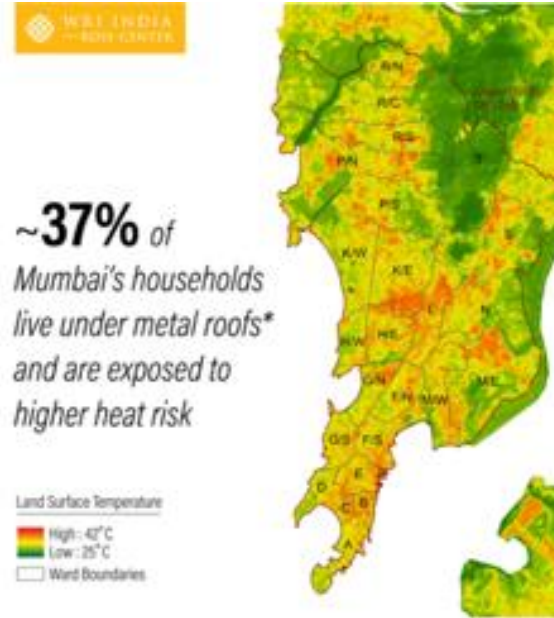
Source: Recharge Potential - Landsat 5 TM collection (USGS), SRTM Data; Urban extent - EC IRC; Maximum Surface water- IRC Global Surface Water; River Network- FAO River Network

TO INFORM, PRIORITIZE, AND TAKE ACTION



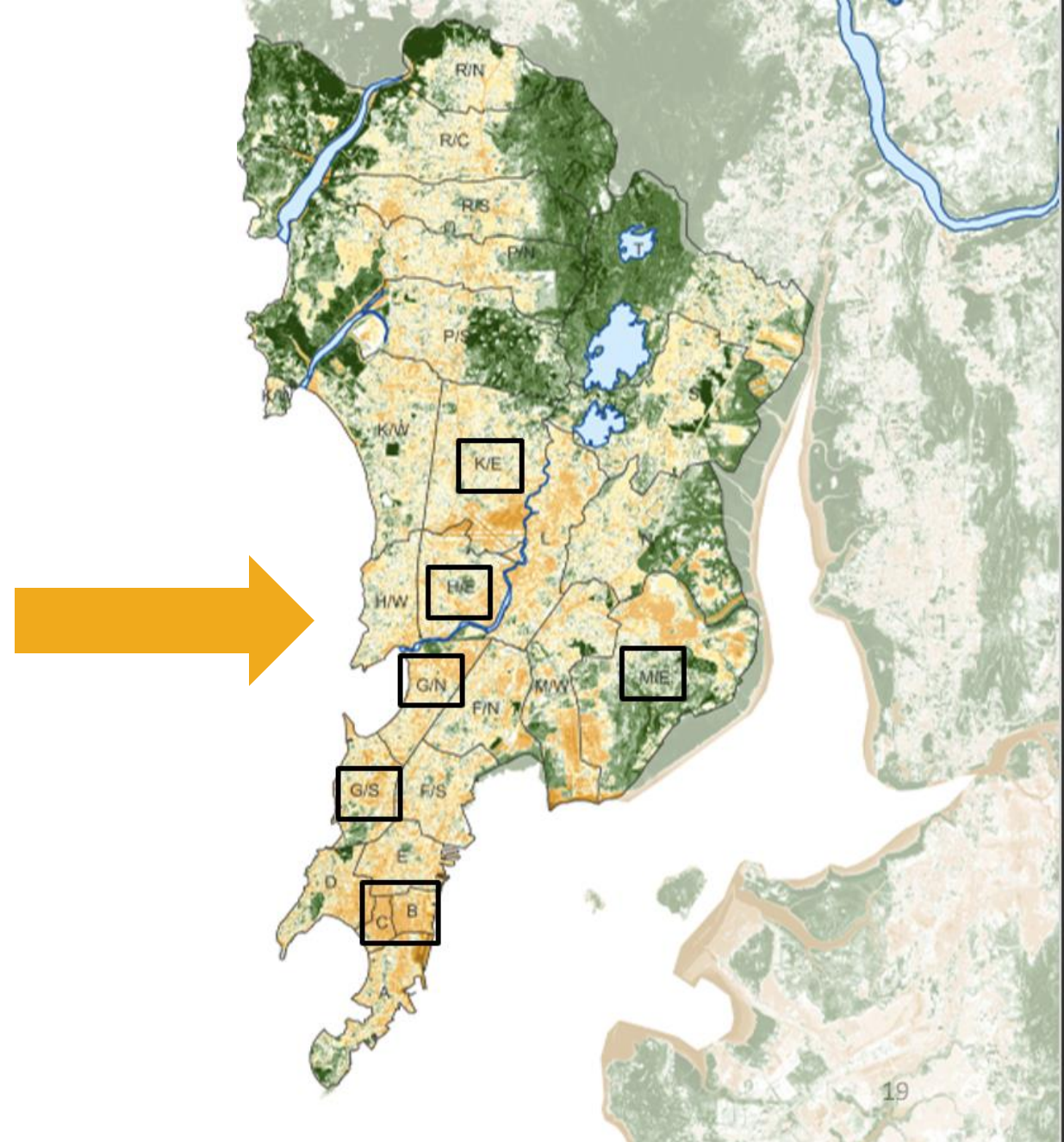
The average surface temperatures for the month of October, in Mumbai, over the past three years present a stark difference in heat exposure in poorer communities. This is a function of building material, compromised ventilation and green cover, and limited access to open space within these neighbourhoods. Industrial and commercial land use with large built-up footprints like the airport, industrial estates, malls have a significantly higher surface temperature than green and blue areas (parks, urban, mangroves). The city will need to adopt heat mitigation measures to reduce the ambient temperature and protect people's health, lives and livelihoods.

Source: WRI India using LandSat 8 (2010)
Mean surface temperature of 27.83°C in October (2017-2019)



Roofs are the most exposed surfaces of a building to solar radiation, and hence play a key role in determining indoor thermal comfort and reflected heat in the outdoor environment. This map shows that the difference in surface temperature of settlements with concrete or metal roofs can be as high as 5 degrees. Metal roofs are poor insulators and good conductors, resulting in increased indoor temperatures. On the other hand, materials such as concrete transfer heat at a slower rate, resulting in increased nighttime temperatures. To help maintain livable microclimates in the outdoors and reduce heat vulnerability in low-income, high density settlements, cities can explore passive cooling techniques like white and green roofing solutions, pockets of green cover in dense neighbourhoods and larger open spaces as large for the city, increasing green cover in the city is an effective and sustainable way of minimizing heat stress.

Source: WRI India using LandSat 8 (2010) in October 2017-2019
*Data from Census of India, 2011



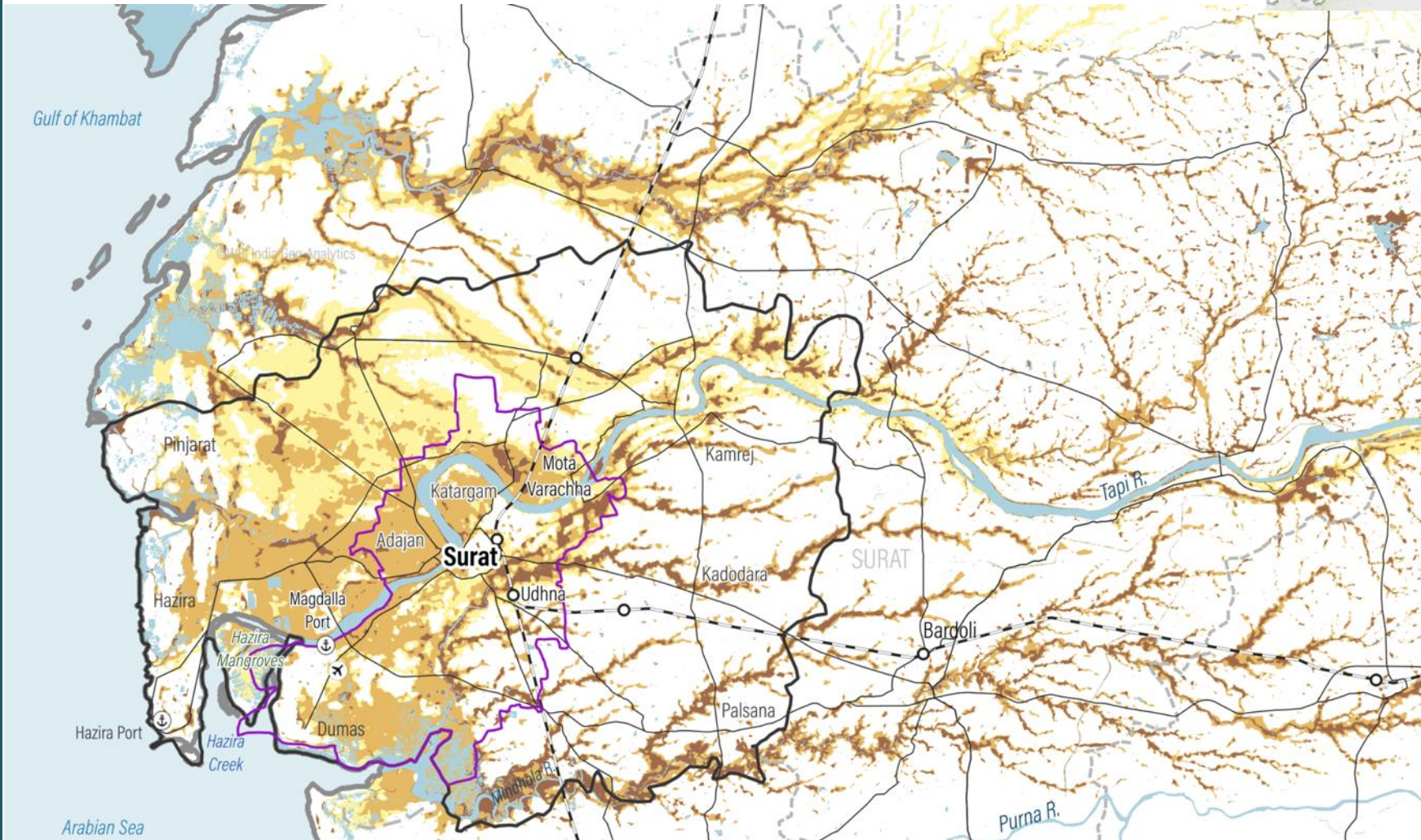
SER vulnerable to multiple environment and climate hazards

Flood risk in Surat

33% of SUDA under moderate to high risk

Severe floods in 2006 inundated ~75% of Surat's total area, 150 people died, and led to losses of US\$ 3.5 billion

Flood Risk in and around the Surat city



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Source: Processed by WRI India using IMD, CWC, WRIS, SRTM, ESA World Cover and multiple sources; Flood-induced economic loss and damage to the textile industry in Surat City, India, Asian Cities Climate Resilience, Working Paper 2015

CLIMATE HAZARDS AND VULNERABILITY ASSESSMENT (CHVA)



Why do cities *need* to conduct vulnerability assessments to inform resilience planning?

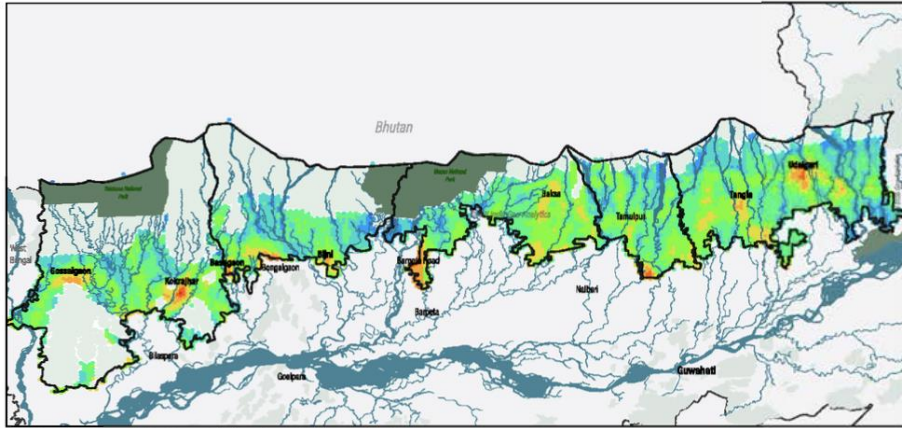
How can cities *assess and visualize* these differential vulnerabilities and in turn impact resilience capacities?

And how can cities *conduct and integrate* the findings from a vulnerability assessment into plans, projects, and strategies?

Integrating risk-based and vulnerability-based approach to measure and assess urban risks

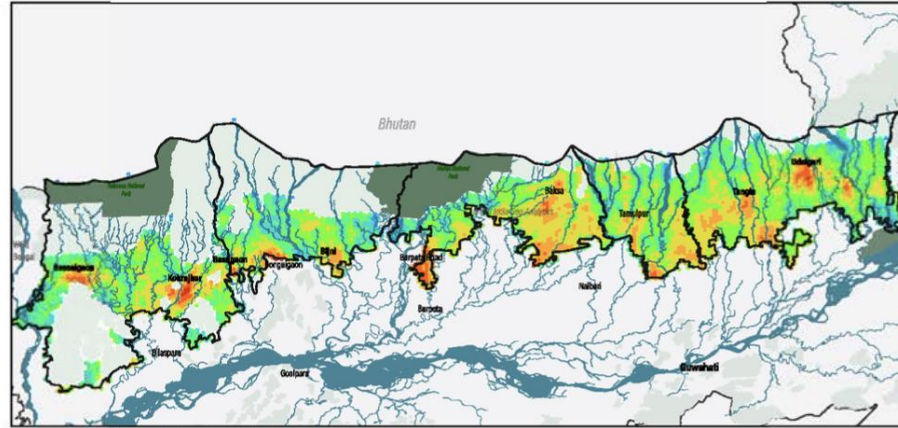
Land Suitability Scenarios

Scenario 1



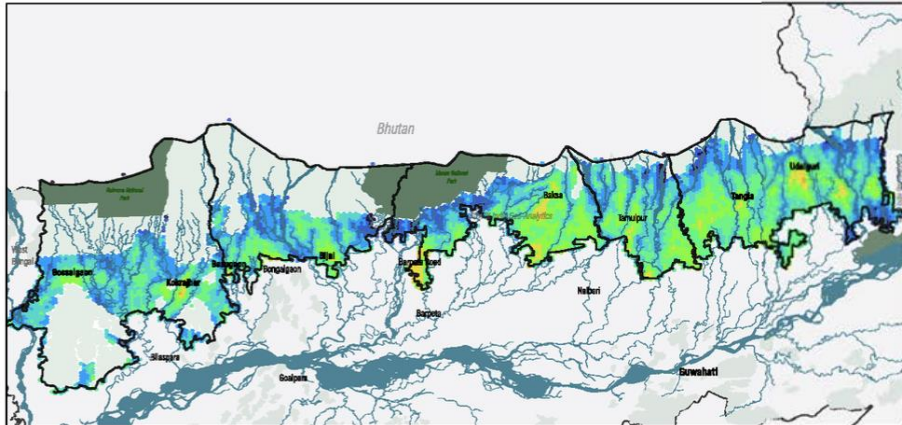
Regional connectivity thematic is given highest priority.

Scenario 2



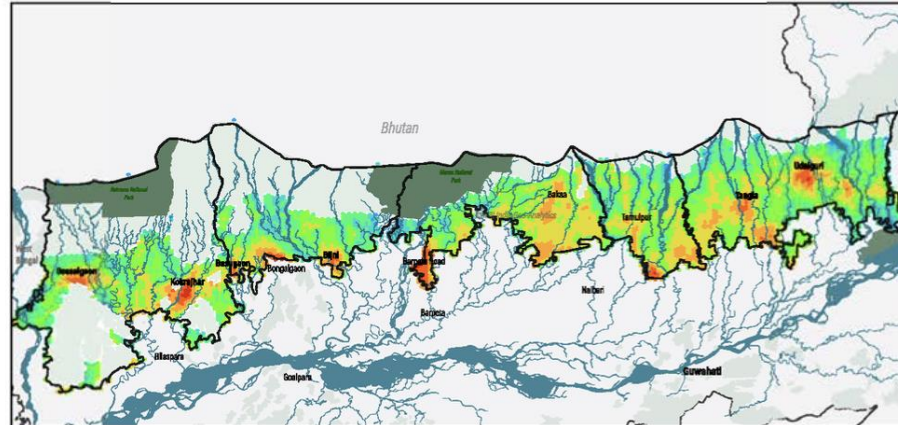
Demography thematic is given highest priority.

Scenario 3



Environment thematic is given highest priority.

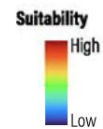
Scenario 4



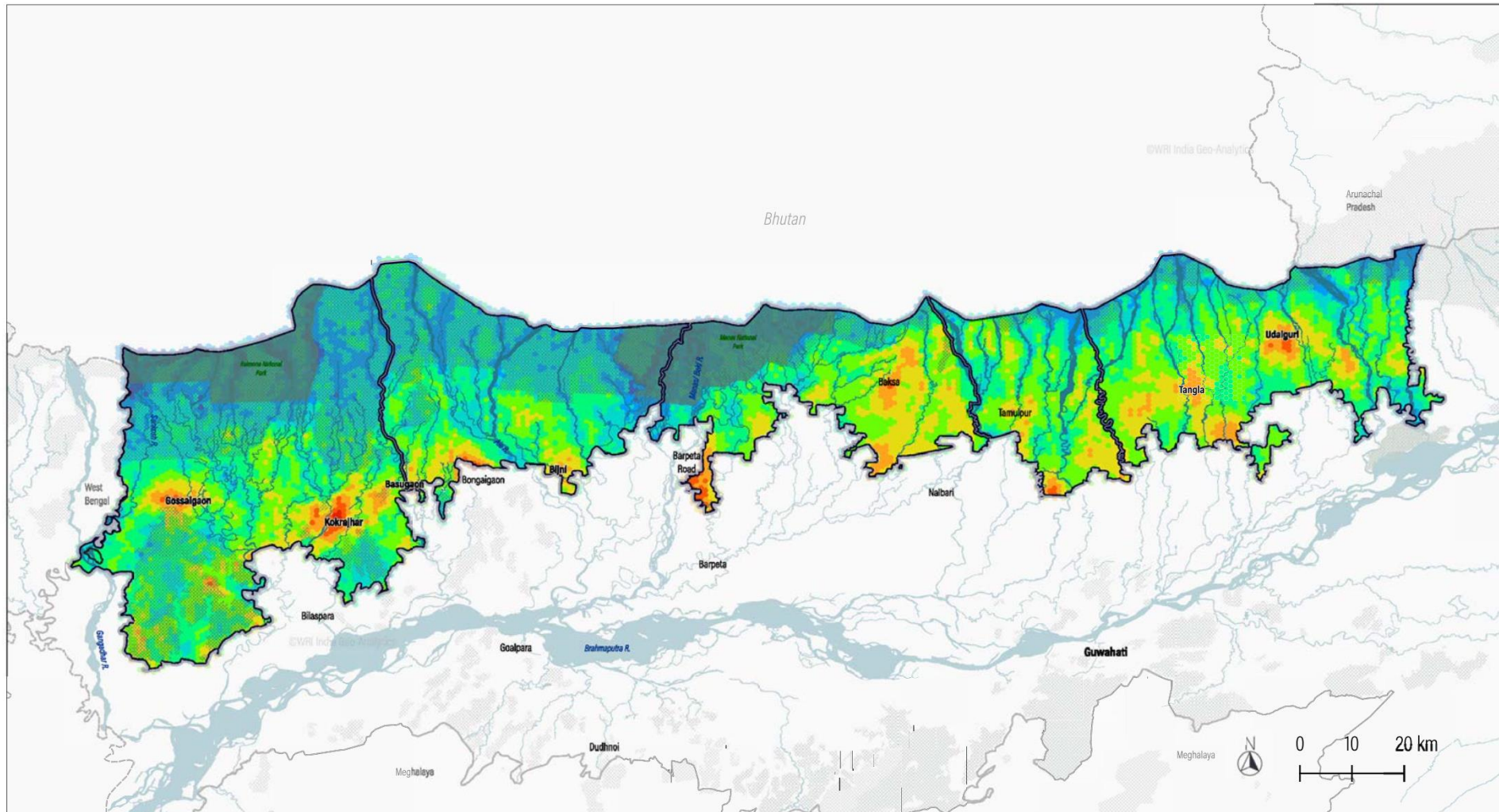
All thematics are given equal weightage

Legend

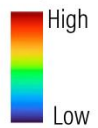
BTR District Boundary
 State Boundary
 National Park
 Reserve Forest
 River



Land Suitability Analysis - equal weightage scenario



Suitability

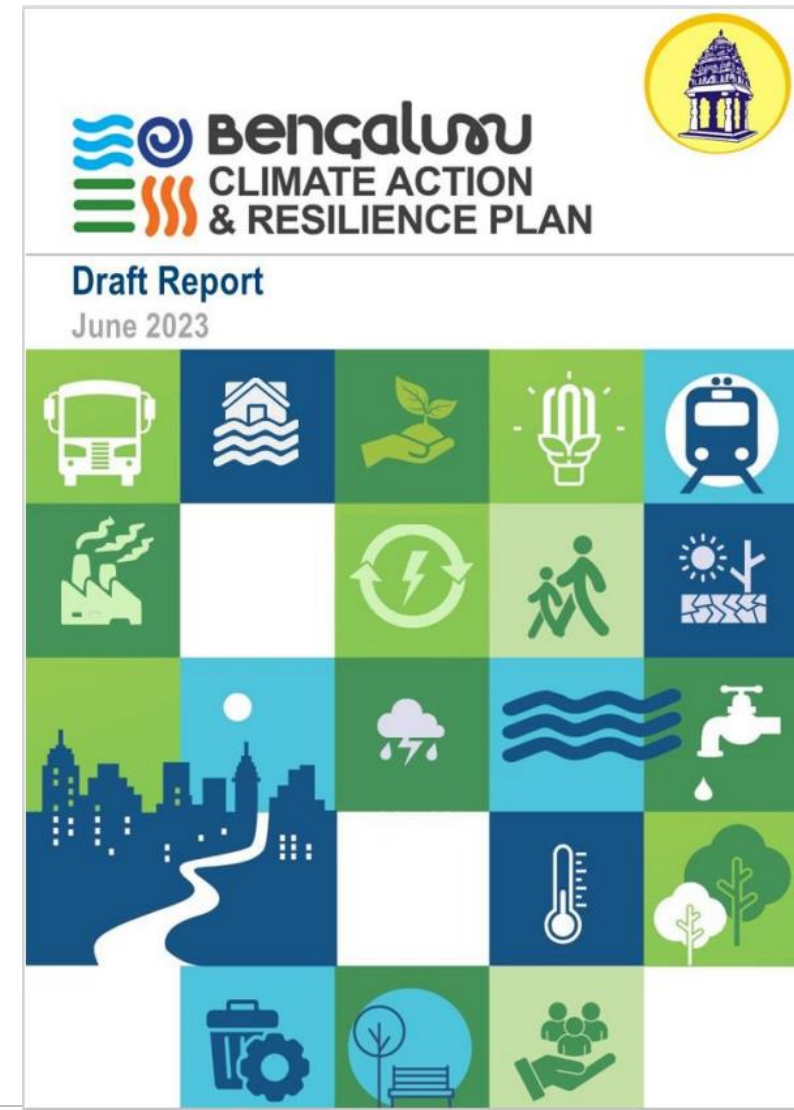
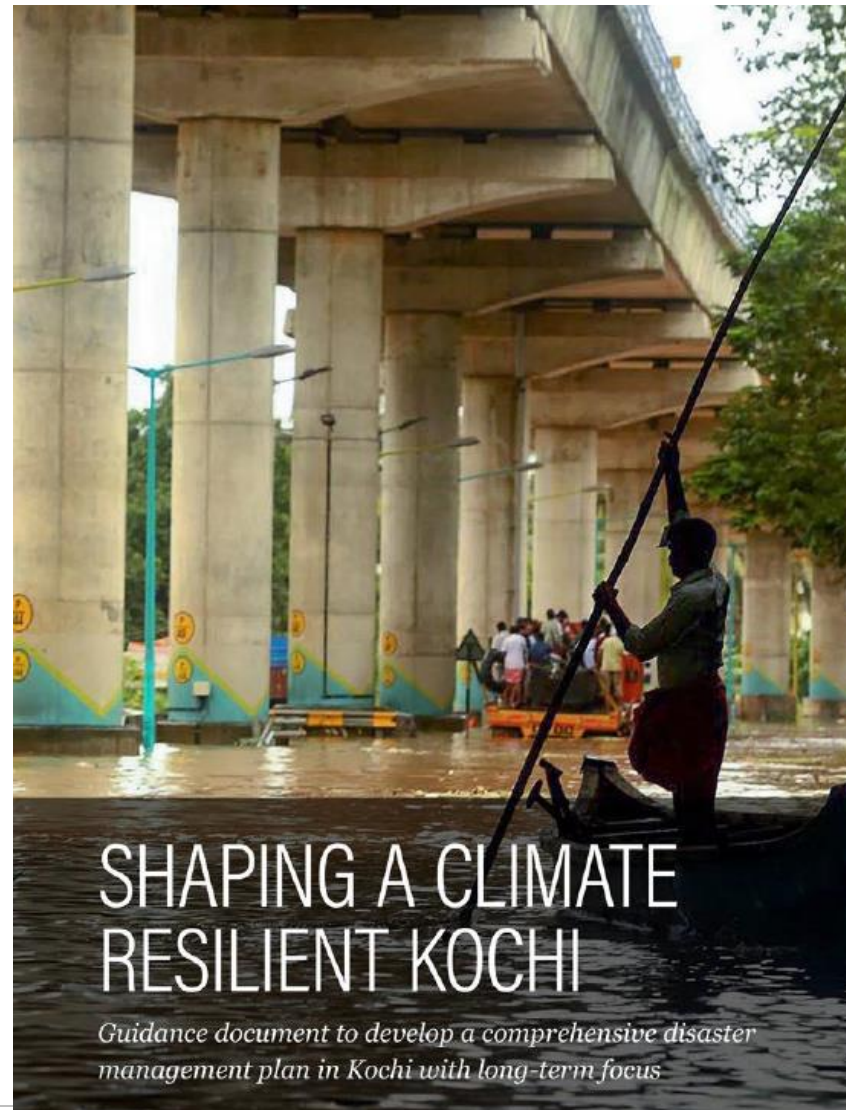
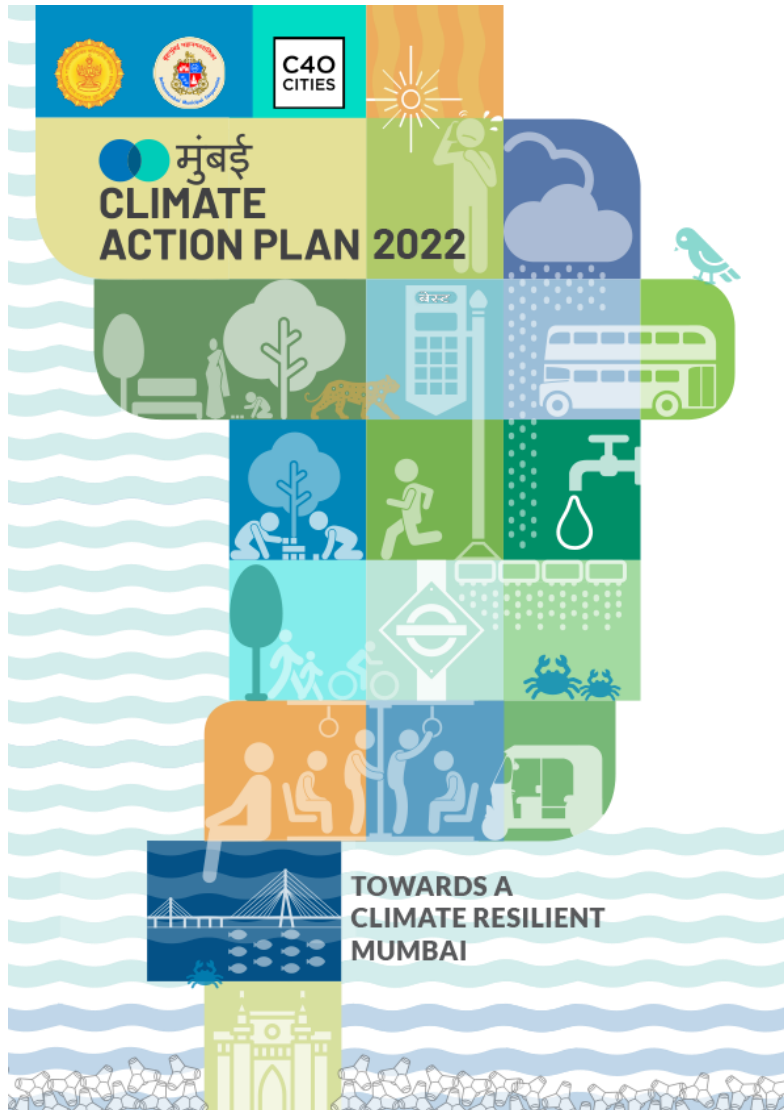


- BTR Districts
- State Boundary
- National Park
- Reserve Forest
- River

Source: Analysis by WRI India

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Long-term Strategy Planning based on Data-based Assessments



COOL CITIES LAB



Evaluate intervention scenario



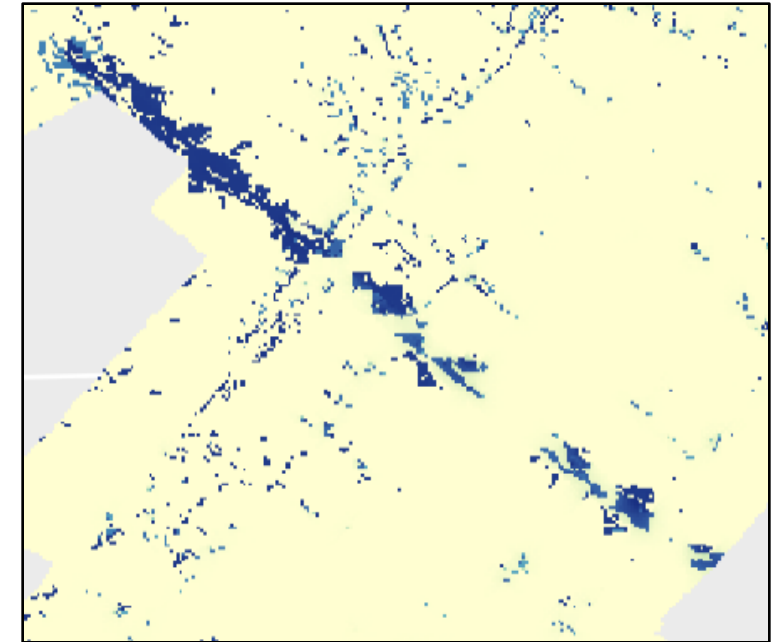
Model infrastructure and heat changes



Map scenario cooling potential

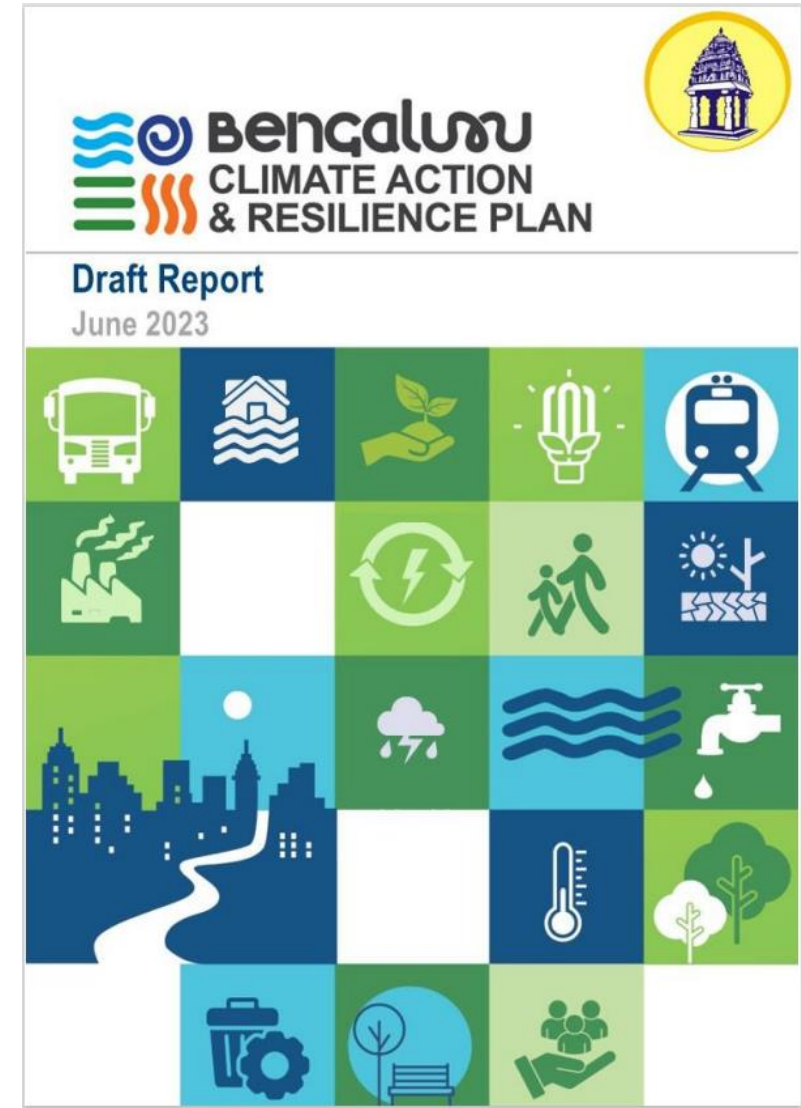
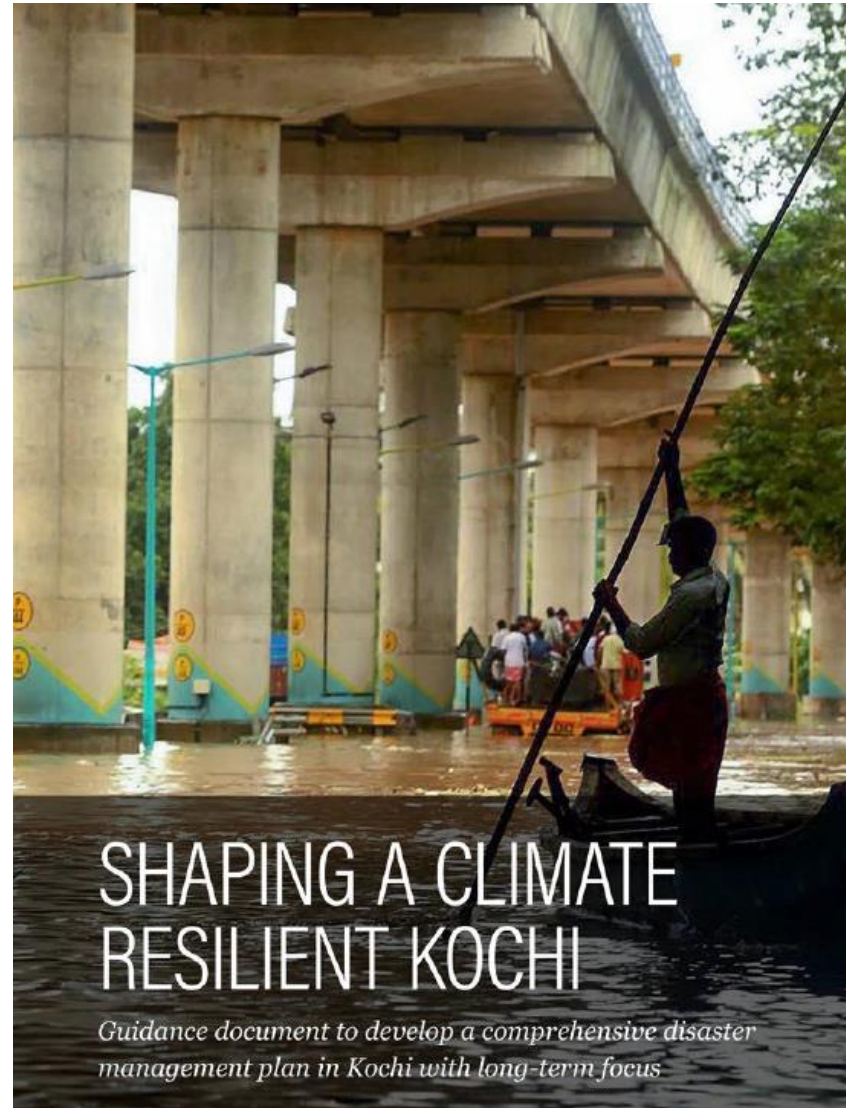
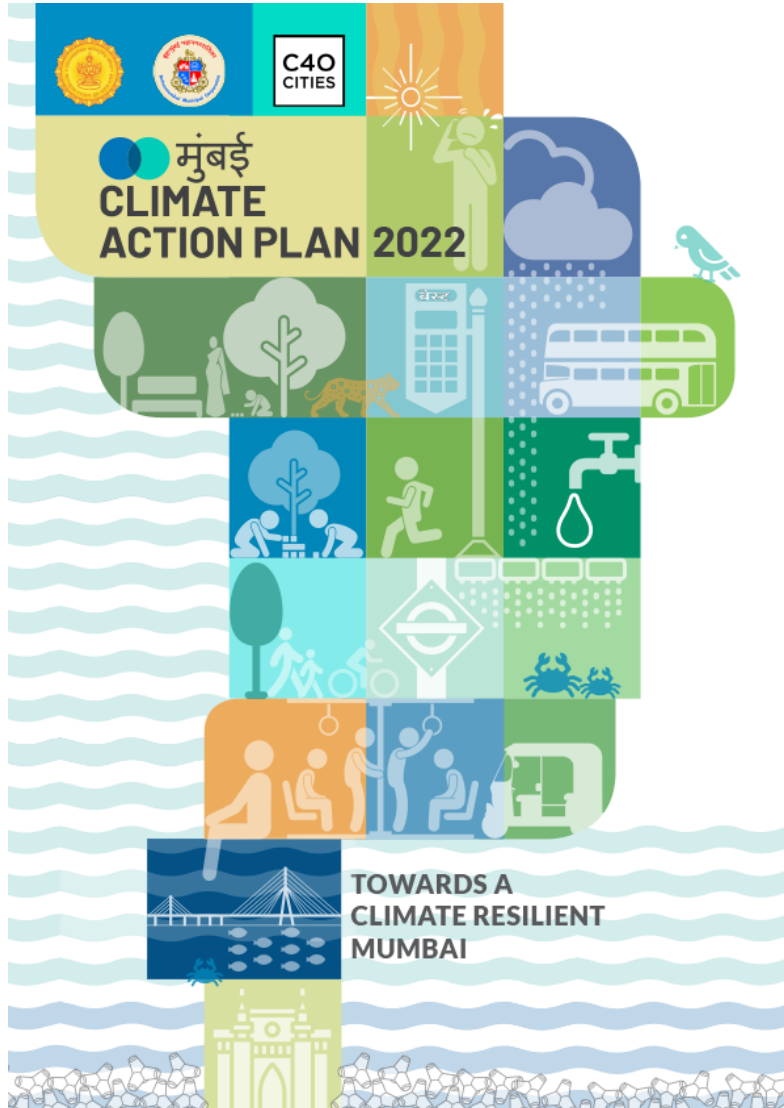


- Road
- Existing trees
- Street tree potential

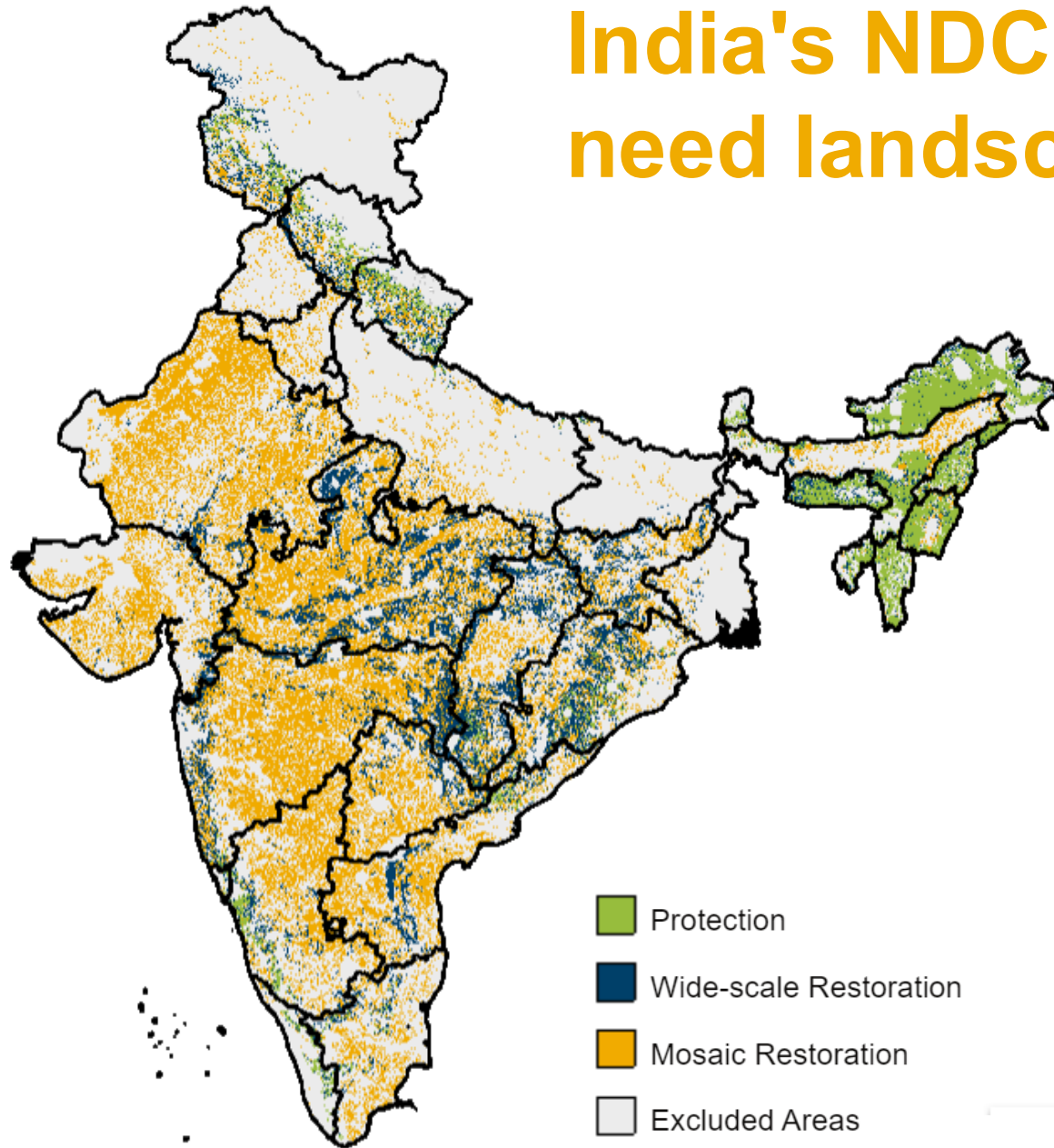


Change in UTCI (C)
-13 0

Long-term Strategies based on Data-based Assessments

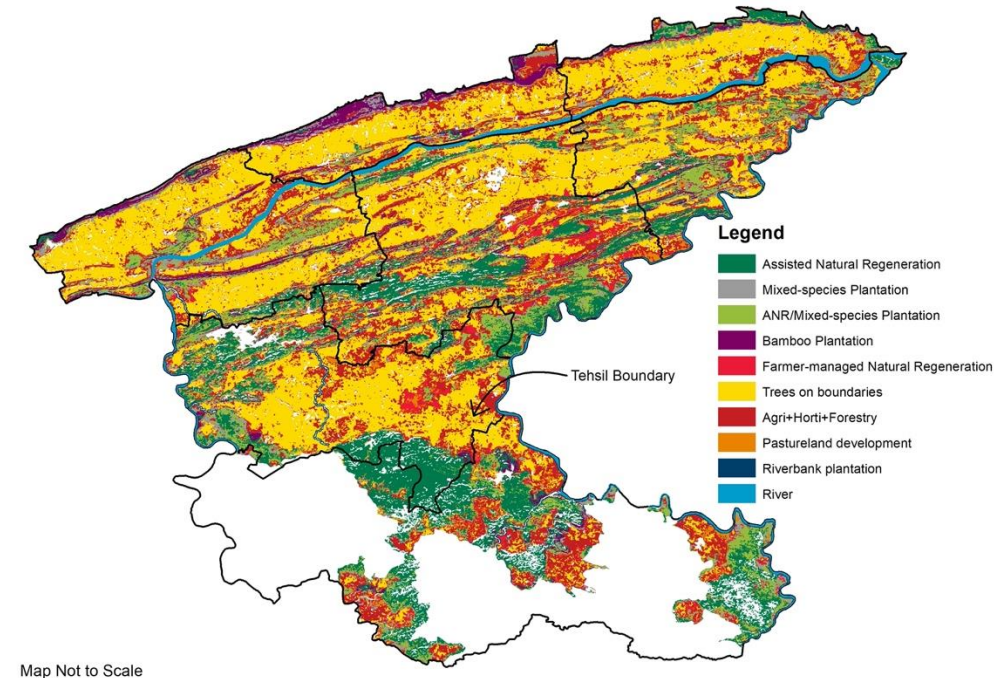
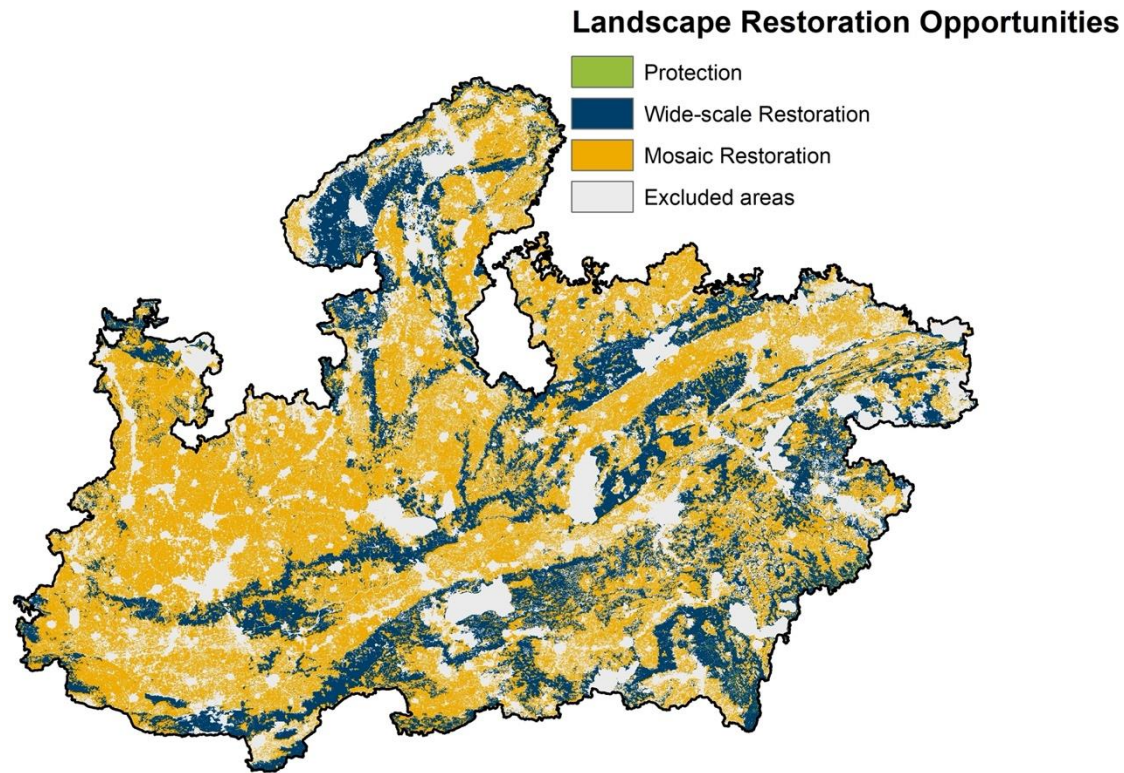


India's NDC & Bonn Challenge targets need landscape restoration



- 250 million, mostly tribal and indigenous communities, women, and marginal farmers, need forests for fuelwood, animal fodder, food security and income.
- But forests are at risk from climate change and large industry & infrastructure projects.
- Restoring 140 million hectares of land can sequester 3-4.5 billion tons of carbon by 2040. Of this, 87 million hectares lies outside forests.

POTENTIAL OF LANDSCAPE RESTORATION IN MADHYA PRADESH



Sidhi District

- Madhya Pradesh highest potential for widescale restoration
- Widescale restoration potential where forest is the land use is 7Mha while mosaic restoration potential (outside forest areas) is 13Mha
- Potential for sequestration of **548 - 709 MT** of above-ground **CARBON** by 2040

MAPPING CROWDS IN VARANASI'S OLD CITY

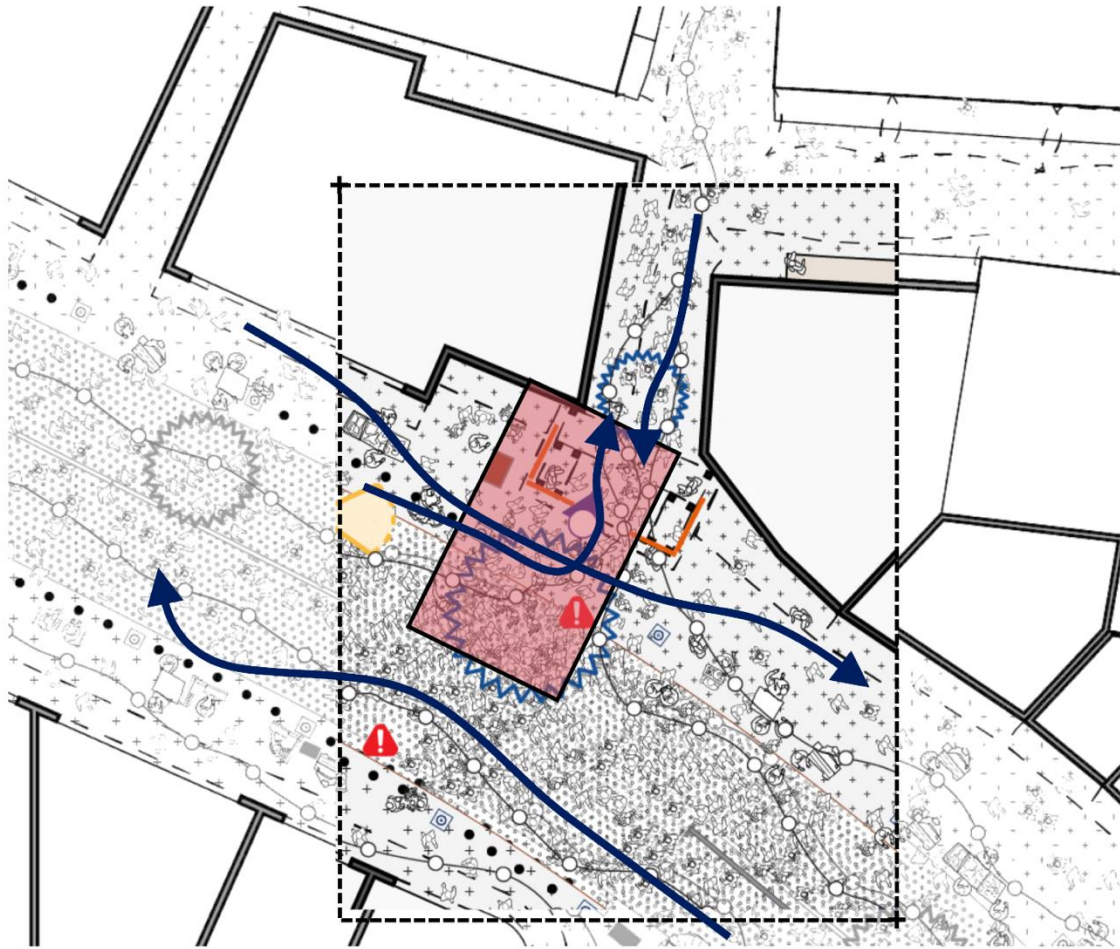
In late 2024, WRI India and The Urban Lab undertook a detailed crowd mapping study that aimed to:

- Understand Spatial and temporal movement of crowds
- Capture how different citizen groups experience crowding
- Quantify densities during one of the most overcrowded event in the world – Dev Diwali.

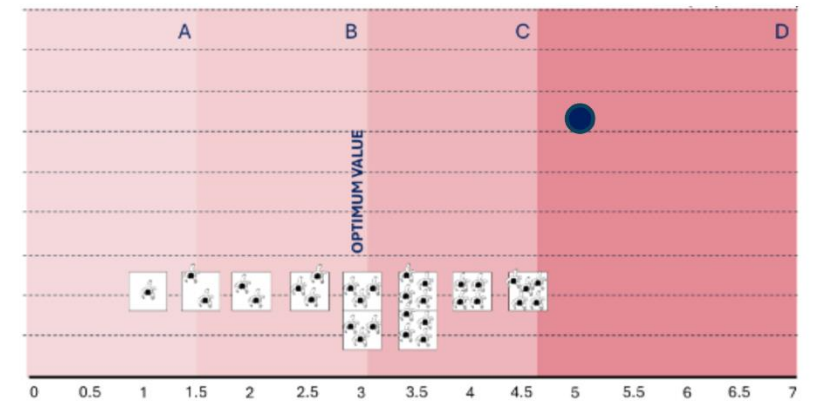


Spot Density (Super Crowding Event Scenario)

Entry gate from Dashashwamedh Street



III.MICRO LEVEL ANALYSIS



Source: Primary Surveys and Primary Perception Data

66 move in and out the Entry gate to Kashi from Dashashwamedh Street at a point in time

Density is **5.0 ped/m²**

C

BEFORE



AFTER



**BEHAVIOURAL
NUDGES**

