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WRI INDIA

Building Capacity to Assess Urban Climate Hazards and Tackle Heat and Flooding in Cities

Nature-based Solutions to Tackle Urban Heat in Cities

5 March 2025

9:30-10:45 GMT / 10:30-11:45 CEST / 12:30-13:45 EAT / 15:00-16:15 IST / 16:30-17:15 WIB

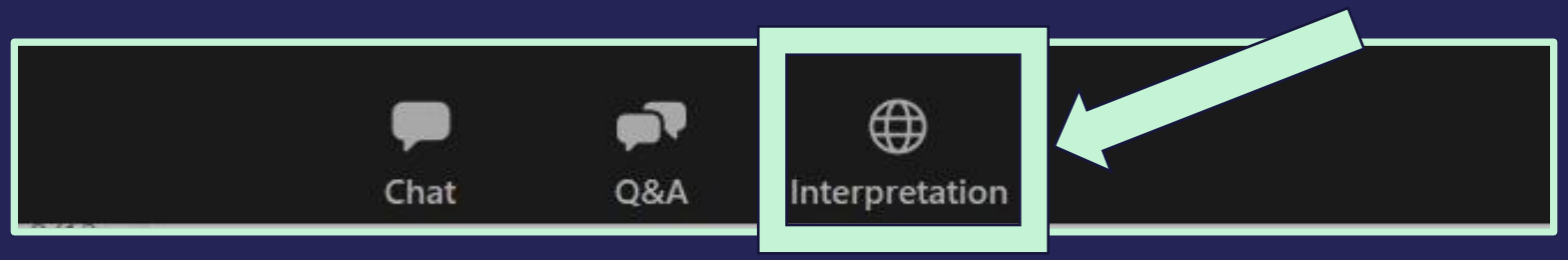
Part 2 of a 3-part capacity building webinar series on measuring and mitigating urban climate risks

Live Interpretation

ENGLISH: We have simultaneous interpretation in English, French, and Bahasa Indonesia! Click on the "interpretation" icon at the bottom of your screen to listen to the event in your preferred language.

FRENCH: Nous disposons d'une interprétation simultanée en anglais, en français et en bahasa indonesia ! Cliquez sur l'icône « interprétation » en bas de votre écran pour écouter l'événement dans la langue de votre choix.

BAHASA INDONESIA: Kami memiliki interpretasi simultan dalam bahasa Inggris, Prancis, dan Indonesia! Klik ikon “interpretasi” di bagian bawah layar Anda untuk mendengarkan acara dalam bahasa pilihan Anda.



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Welcome Remarks

Hellen Njoki Wanjohi-Opil, Climate and Engagement Lead, Cities Program, WRI Africa

Building Capacity to Assess Urban Climate Hazards and Tackle Heat and Flooding in Cities

A Three-part Capacity Building Webinar Series

Webinar 1: Introducing the Climate Hazard Vulnerability Assessment Framework (5 Feb 2025)

***Webinar 2:* Urban Heat & Greening (Today)**

Webinar 3: Urban Flooding & Nature-based Solutions (Wednesday 26 March)

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SUPPORTED BY: LED BY:

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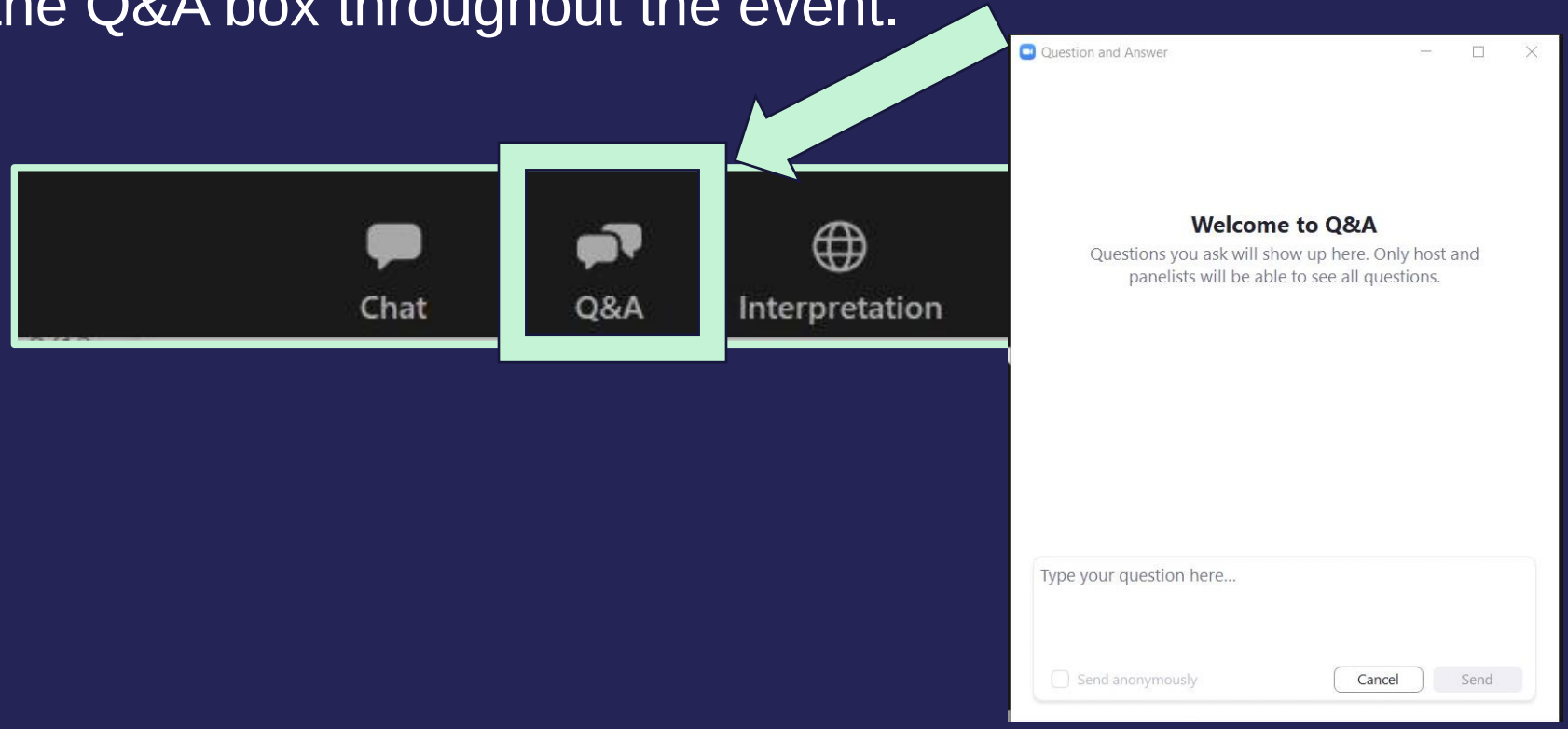
WORLD RESOURCES INSTITUTE | C40 CITIES | ICLEI Local Governments for Sustainability | UNDP | THE WORLD BANK | ADB

Audience Questions

If you have any questions about the presentations during the event, feel free to enter them into the question and answer box. We have a dedicated Audience Q&A session after the main presentation, and will respond to other questions entered into the Q&A box throughout the event.



URBAN SHIFT

AGENDA

- **Welcome and Housekeeping**: Hellen Njoki Wanjohi-Opil, WRI Africa
- **Introductory Remarks:** Lubaina Rangwala, WRI India
- **Keynote Presentation**: The Challenge of and Opportunities to Overcome Urban Heat in Tshwane, South Africa: Lutkse Newton, City of Tshwane
- **Training Presentation**: Deepti Talpade, WRI India
- **Live Audience Q&A**
  - Moderator: Hellen Wanjohi-Opil
- **Closing remarks**: Lubaina Rangwala

Introductory Remarks

Lubaina Rangwala, Program Head, Urban Development, Cities Program, WRI India

Keynote Presentation

Lutske Newton, Director of Climate Change Adaptation and Resilience, City of Tshwane, South Africa

INSERT LUTSKE'S SLIDES HERE

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Training Presentation: Capacity Building for Urban Greening and Heat Resilience

Deepti Talpade, Program Lead, Urban Development and Resilience, WRI India

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Capacity Building Module on Nature Based Solutions to Tacke Urban Heat in Cities

Photo credit: Shutterstock

Contents

Video: Tackling Urban Heat in Mumbai

The video shows how geospatial tools can be used to understand high heat risk zones in a city. This helps in strategizing where to prioritize greening activities

Source: GoogleEarthEngine, YoutTube, 2022

How to Define Urban Heat?

Land Surface Temperature (LST)

- **Land surface temperature** is how hot the “surface” of the Earth would feel to the touch in a particular location. From a satellite’s point of view, the “surface” is whatever it sees when it looks through the atmosphere to the ground.
- It could be snow and ice, the grass on a lawn, the roof of a building, or the leaves in the canopy of a forest.
- Rise in surface temperatures causes increased indoor and outdoor experienced temperatures.

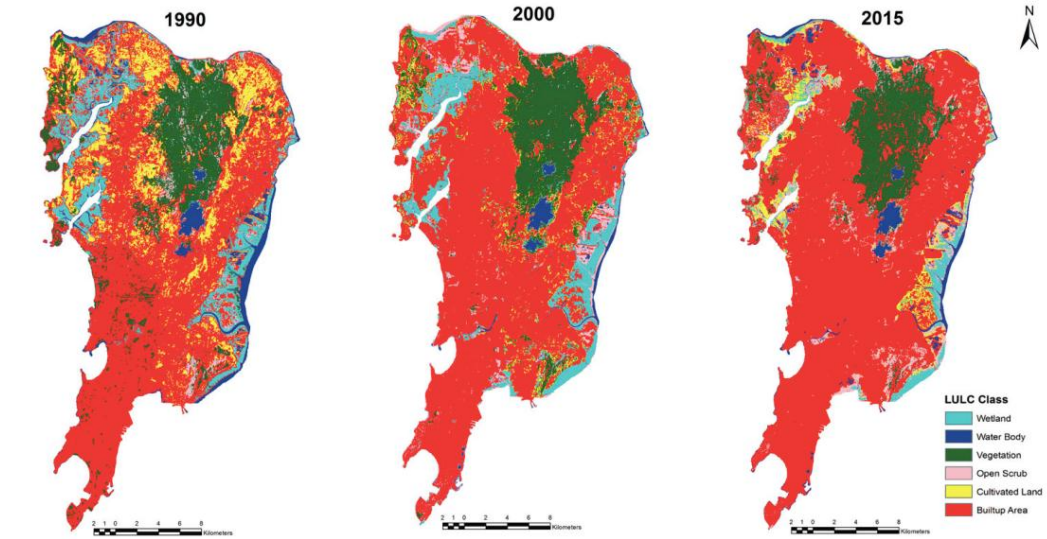


Figure 2. Land use/land cover map of Mumbai in 1990, 2000 and 2015.

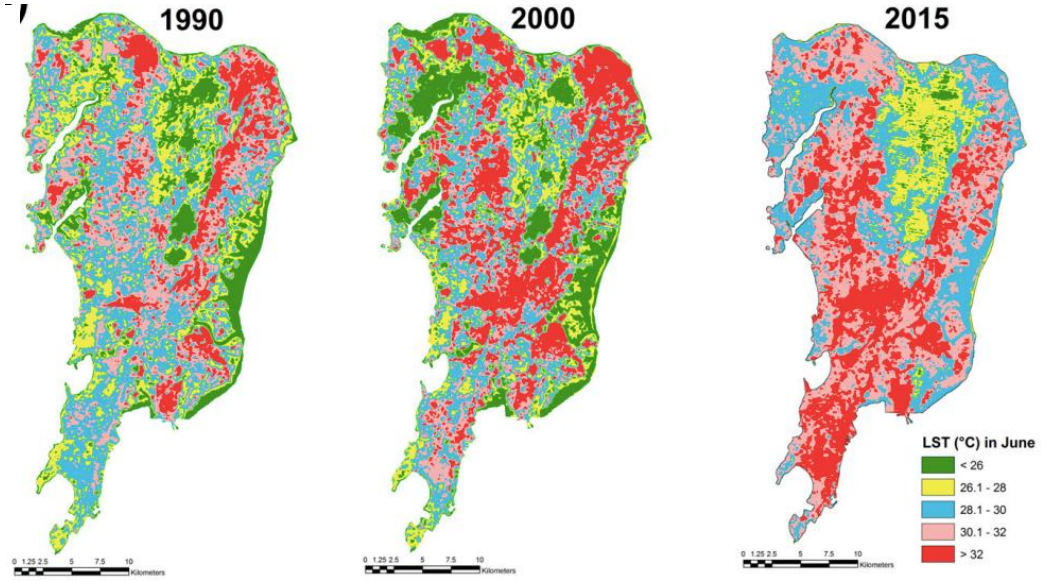
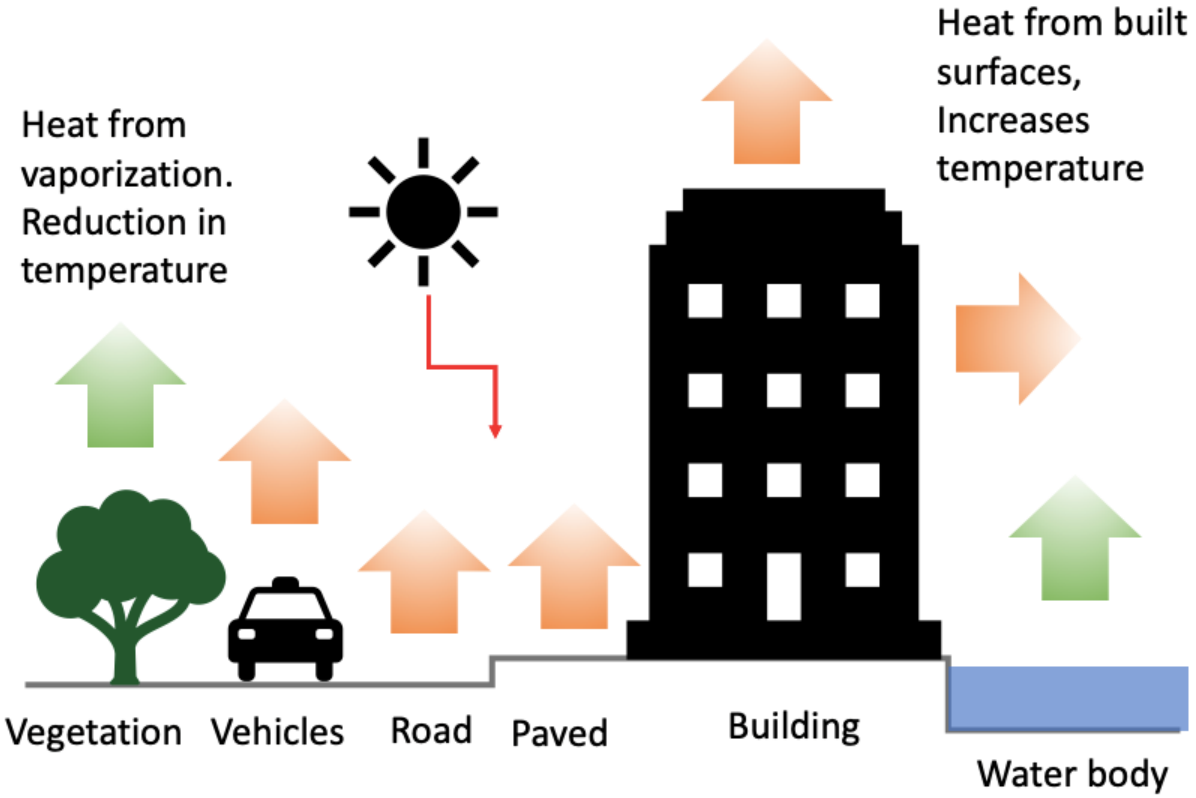


Figure 3. Land surface temperature in Mumbai city (1990–2015): (A) January, (B) June and (C) October.

Source: *Text:* NASA Earth observations; Image: *International Journal of Urban Sciences · June 2018*

Causes of LST

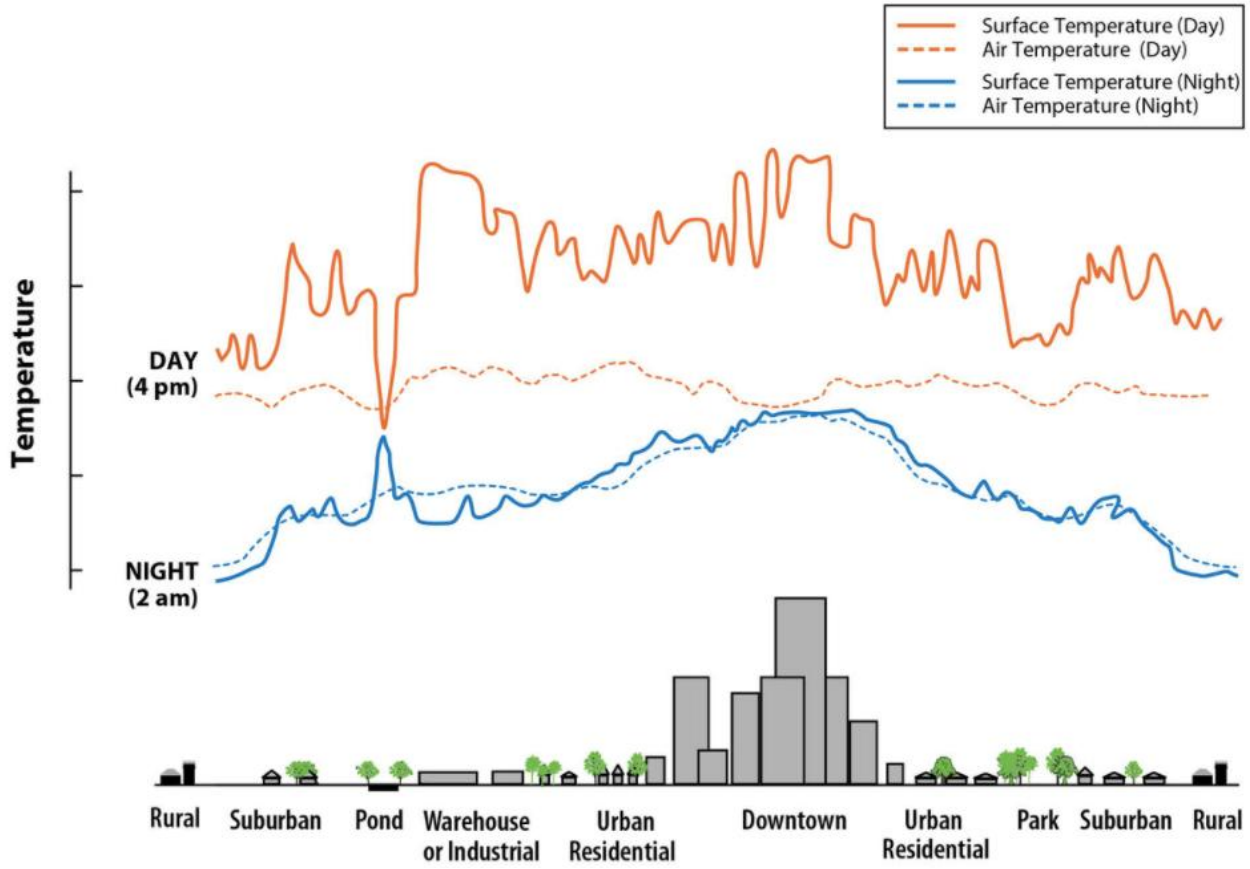
- Global warming increases overall heat.
- Vegetation is being replaced by asphalt and concrete (impervious surfaces) for roads, buildings and paved public places. These surfaces absorb—rather than reflect—the sun's **heat**, causing surface temperatures and overall ambient temperatures to rise.
- Exposed bare soil – dried agricultural land or open plots show high LST
- Large scale infrastructure projects contribute to high heat zones.



Urban Heat Islands

An **urban heat island** (UHI) is a phenomenon where **urban** area is significantly warmer than its surrounding rural areas due to intense human activities.

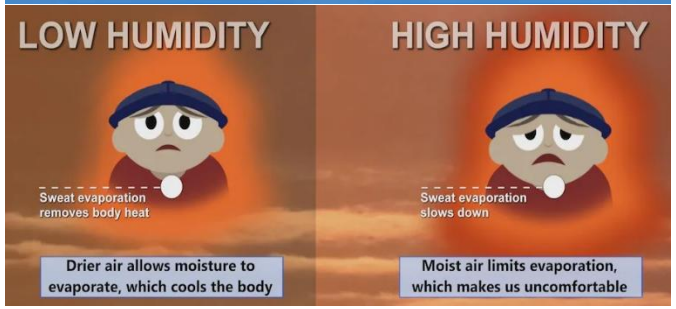
Land surface temperature and Air temperature at various spots has to be recorded to calculate UHI.



Source: *U.S. Environmental Protection Agency*

Impact on health

Humidity makes us feel even hotter



WARNING	HEAT INDEX	HEALTH IMPACT
Safe	< 26	No adverse effects expected due to heat
Caution	27- 32	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	33 - 40	Heat stroke, heat cramps or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	41 - 51	Heat cramps or heat exhaustion likely and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	52 - 92	Heat stroke highly likely
Beyond human threshold*	<93	Values beyond human resistance to heat

HEAT INDEX CHART

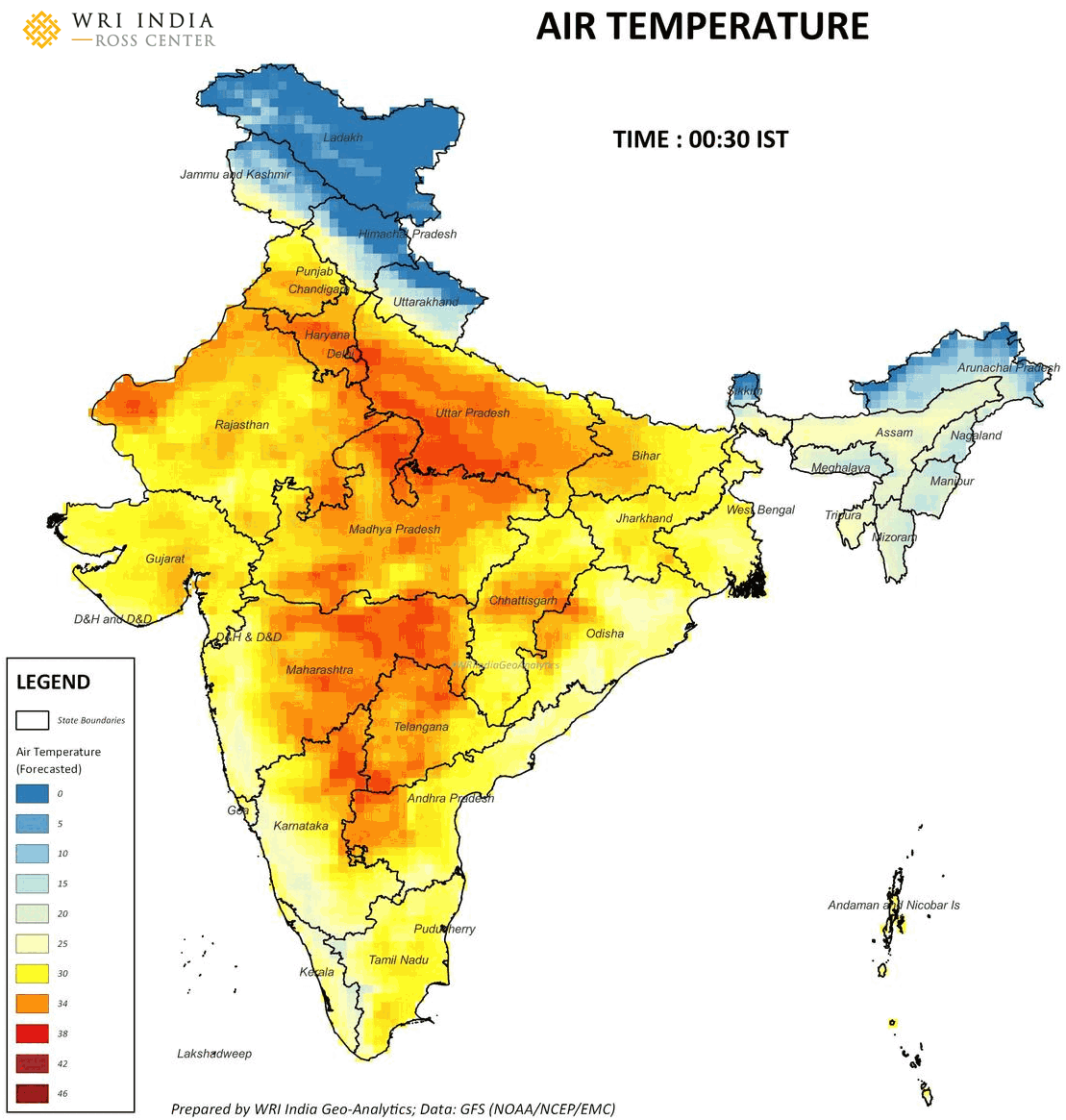
AIR TEMPERATURE (CELSIUS) \ RELATIVE HUMIDITY (%)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15
20	21	21	20	20	20	20	20	20	20	20	19	19	19	19	19	19	19	18
22	23	23	23	22	22	22	22	22	22	22	22	21	21	21	21	21	21	21
24	25	25	25	25	25	24	24	24	24	24	24	24	24	23	23	23	23	23
26	28	28	28	28	28	28	27	27	27	26	26	26	26	26	25	25	25	25
28	36	35	34	33	32	31	31	30	29	29	28	28	28	27	27	27	27	27
30	44	43	41	39	38	36	35	34	33	32	31	30	30	29	29	28	28	28
32	54	52	49	47	44	42	40	39	37	36	34	33	32	31	31	30	30	30
34	66	62	58	55	52	49	47	44	42	40	38	37	35	34	33	33	32	32
36	78	74	69	65	61	58	54	51	48	46	43	41	39	38	36	35	34	34
38	92	87	81	76	71	67	63	59	55	52	49	46	43	41	39	38	37	36
40	108	101	95	88	83	77	72	67	63	59	55	51	48	46	43	41	39	38
42	125	117	109	102	95	88	82	77	71	66	62	58	54	50	47	45	42	41
44	143	134	125	116	108	101	94	87	81	75	69	64	60	56	52	48	46	43
46	163	152	142	132	123	114	106	98	91	84	78	72	66	61	57	53	49	46
48	184	172	160	149	139	129	119	111	102	94	87	80	73	67	62	57	53	49
50	206	193	180	168	156	145	134	124	114	105	96	88	81	74	68	62	57	52

	Less than 29	*No discomfort*
	30 - 39	*Some discomfort*
	40 - 45	*Great discomfort*
	45 - 54	*Dangerous*
	Above 54	*Heat stroke imminent*

Note: The above chart is based on shady conditions, light winds and no physical activity. In direct sunlight the index can go up by almost 10 degrees Celsius, even more with added factors like physical activity, air speed, etc.

Heat Waves

- Heatwave is a prolonged period of much-warmer-than-average weather of that region. They are caused due to high pressure zones and trapping heat.
- Climate change is a significant factor contributing to increasing frequency and intensity of heatwaves.
- Greenhouse gas emissions, heat-absorbing surfaces in cities, contribute further by trapping heat for longer.



Source: WRI India blog on 'Measuring and Mapping a Heatwave', 2022 (Author: Raj Bhagat Palanichamy)

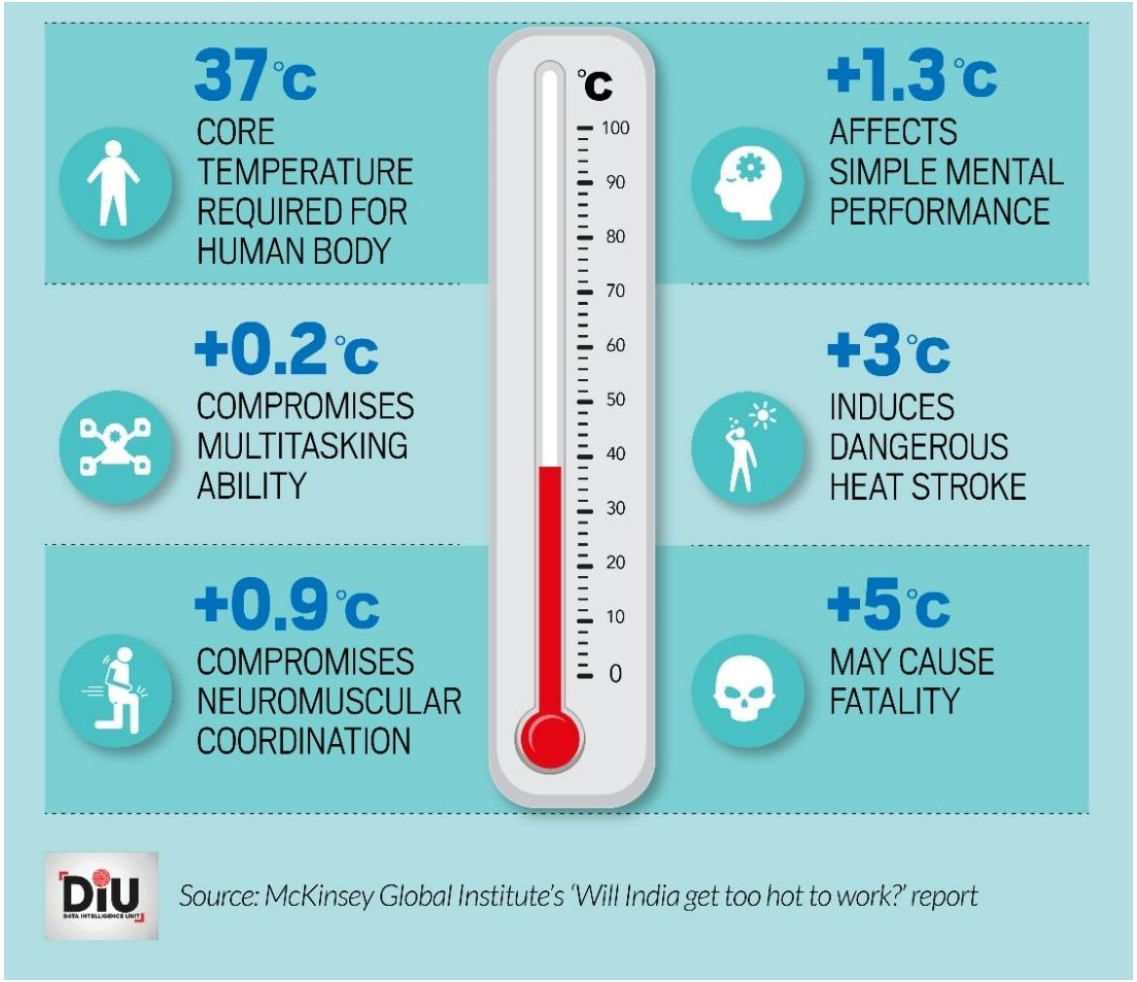
How does urban heat impact health?

Temperature extremes

1. Comprises the body's ability to regulate its internal temperature.

2. Loss of internal temperature control leads to
- heat cramps,
- heat exhaustion,
- heatstroke.

3. It also worsen chronic conditions such as cardiovascular disease, respiratory disease, cerebrovascular disease, and diabetes-related condition.



Source: *Capacity Building on Climate Change in Mumbai*, co-developed with BMC's EHO dept

Who are the most vulnerable groups?

Physiological factors

Older people and persons with disabilities

Persons with existing health conditions

Pregnant people

Infants and children

Exposure factors

Outdoor labour and manual workers

People living in sub-par housing conditions

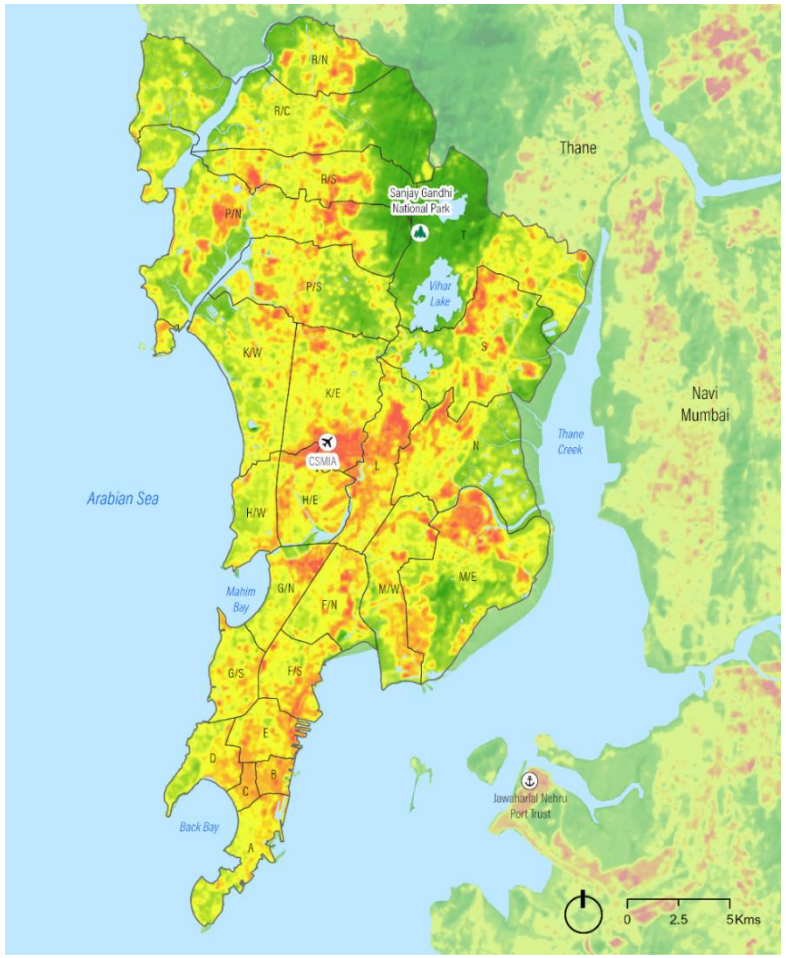
People who are poor, displaced or homeless

Attendees of outdoor events & work

Adapted from WHO's Main Heat Vulnerability Factors

WRI INDIA

Correlation: LST & Green Cover



With reduction in a city's green cover there is a rise in land surface temperature. The LST map and green cover map can be created to observe this correlation over the years.

Source: MCAP, 2021

Minimizing Local Temperatures

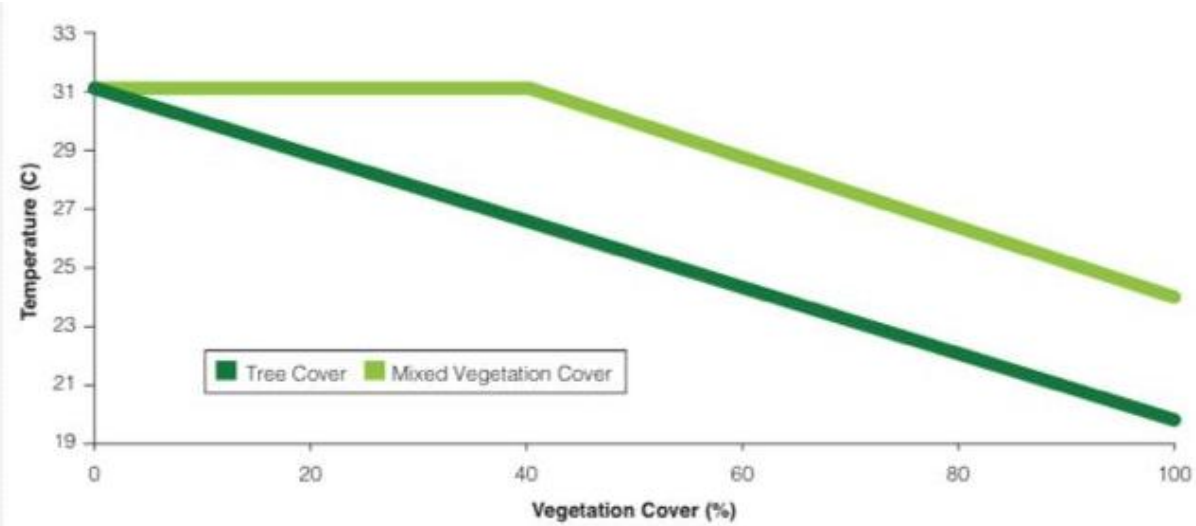
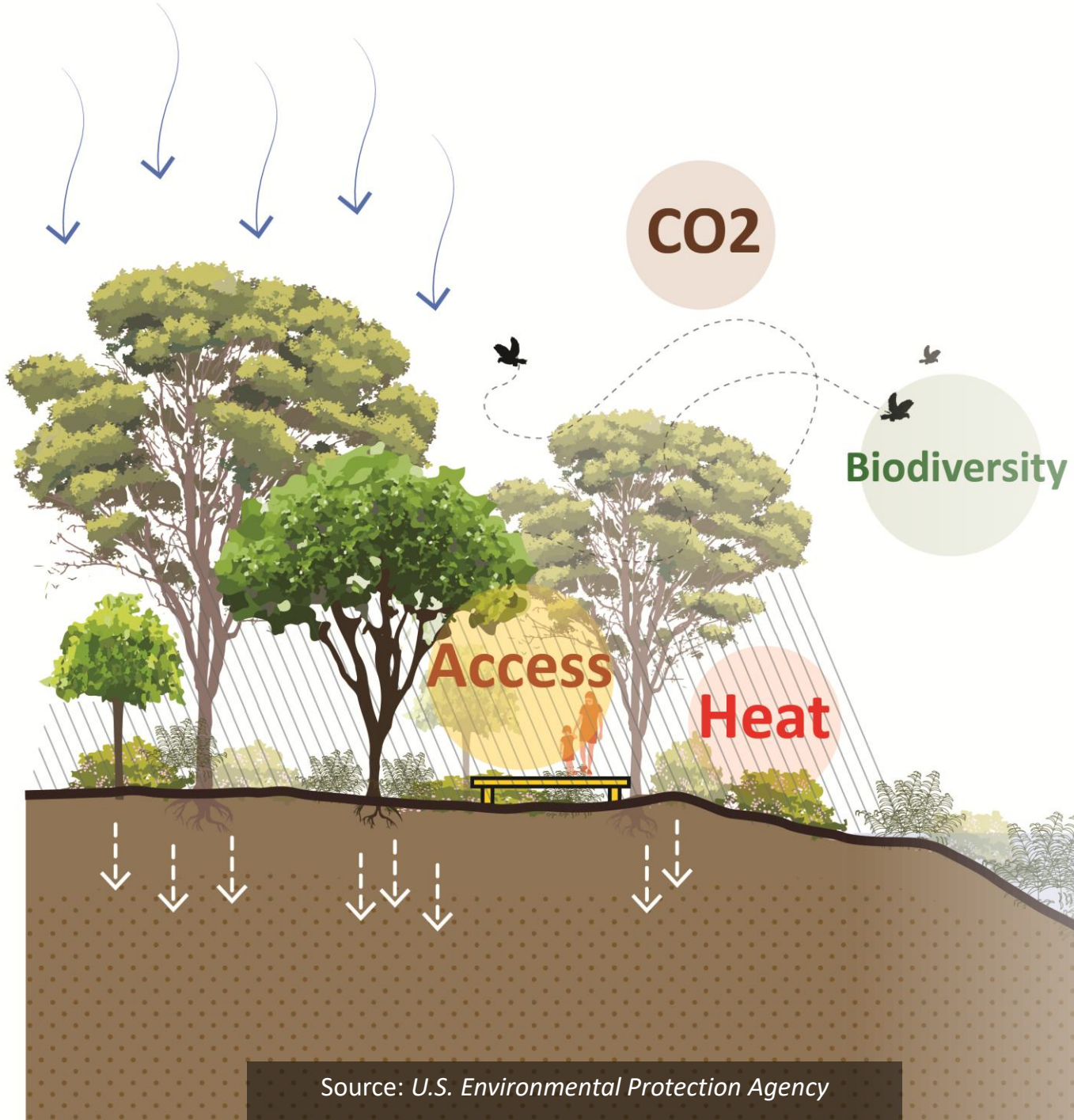


Figure 1: The modelled relationship between vegetation cover and land surface temperature

"When vegetation cover is greater than 40% of a total area, a 10% increase in vegetation leads to a reduction in LST of more than 1C. However, when mixed vegetation cover is less than 40%, there is no reduction in LST."

Source: NSW Office of Environment



Source: *U.S. Environmental Protection Agency*

Co-benefits of Urban Greening

- Increase shade
- Enhances biodiversity
- Reduces soil erosion
- Reduces flooding/waterlogging
- Increases mental and physical well-being

NATURE BASED SOLUTIONS

- Ecosystem Benefits and Ecological Integrity
- Community Resilience and Social Benefits
- Livelihoods and Economic Benefits

Examples: Urban forests, river and stream 'renaturalization', green building solutions- green roofs, open green spaces, permeable surfaces, tree planting, green corridors, urban farming, bioretention areas, rain gardens, natural inland wetlands, constructed inland wetlands, river floodplains, rejuvenation of water bodies (lakes, ponds), mangrove forests, coastal habitats, etc.

Scientific Approach to Greening

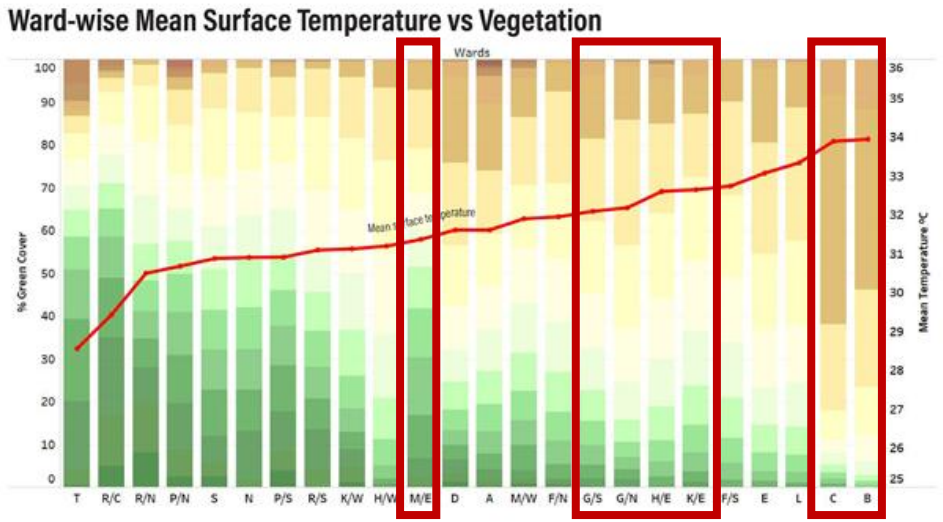
Source: WRI India

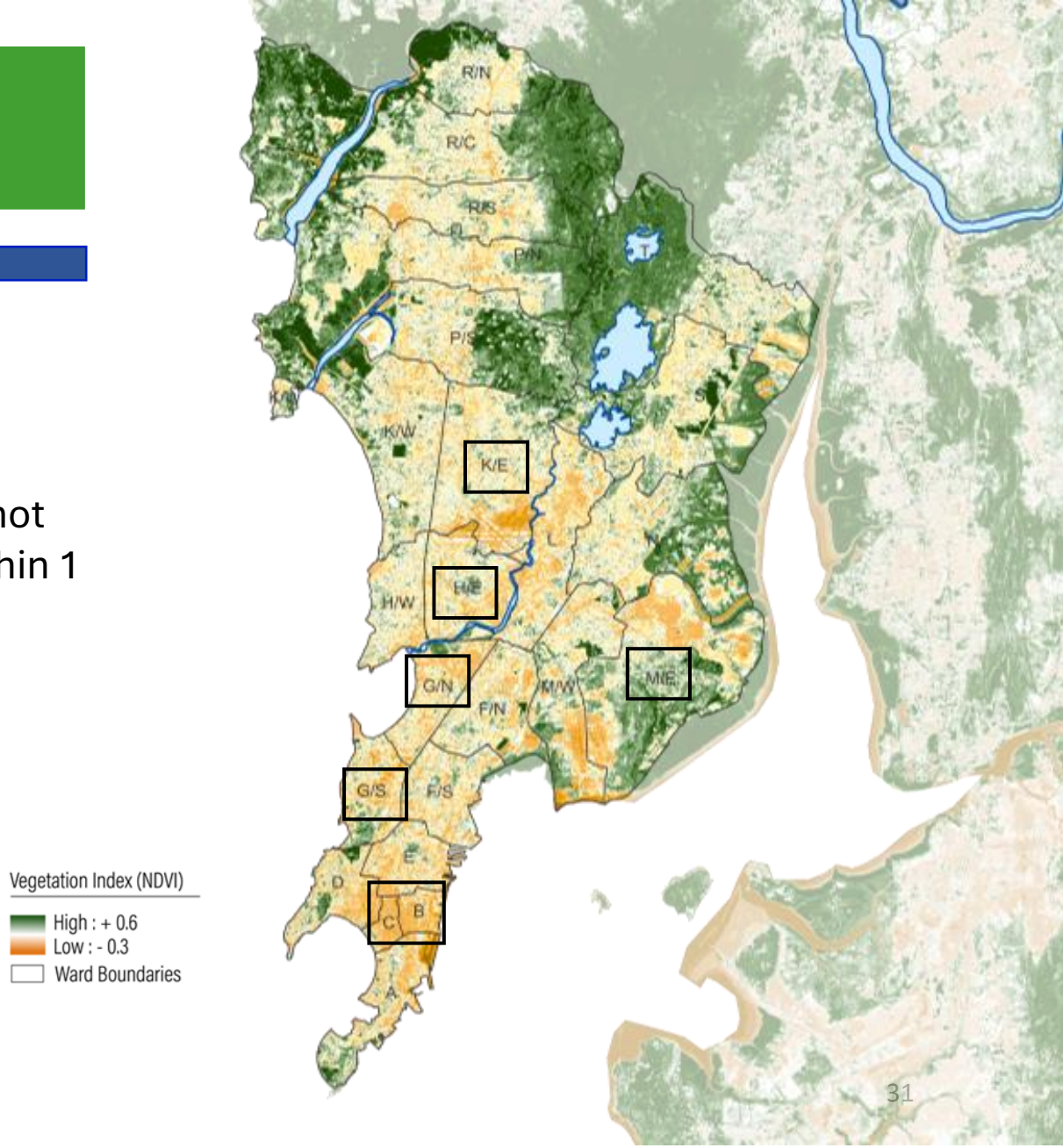
5 Key Steps for Scientific Greening

- Prioritize high-risk areas
- Ecosystems approach
- Adopt water-positive planting
- Engage with local communities
- Maintenance plan

1. Prioritize Sites

- C, B, G/S, G/N, H/E, K/E wards with lesser vegetation experience higher surface temperature.
- M/E ward has 20.1% population (highest in Mumbai) not having access to daily urban recreational spaces (within 1 km) and exposed to high heat stress.





Source: MCAP, 2021

2. Ecosystem Approach

Baseline survey

Testing for site suitability, baseline biodiversity, hydrogeological survey

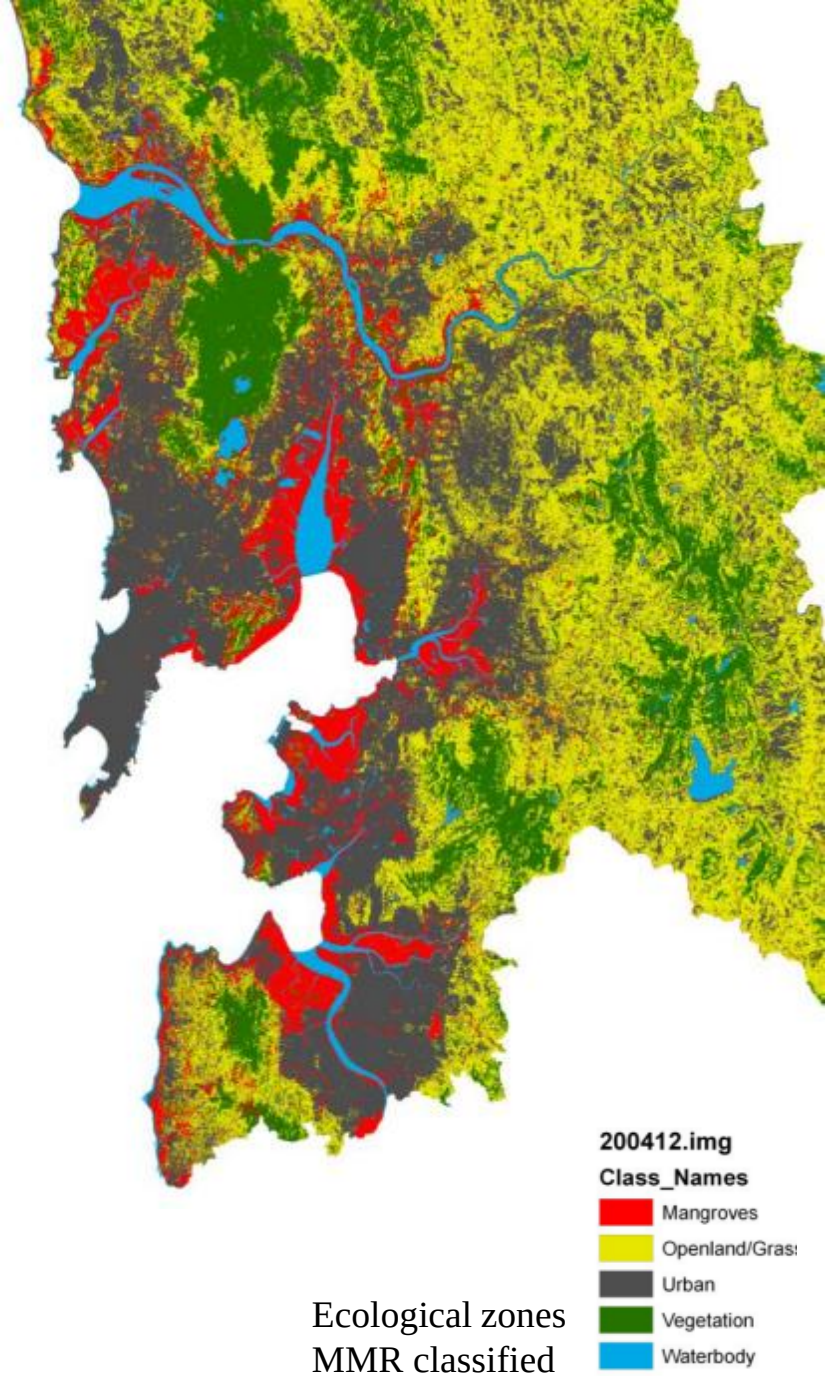
Planting design

Selection of native species, multi-layered planting as per nearest ecosystem

Ground preparation

Restore soil in urban areas to make it suitable for planting.

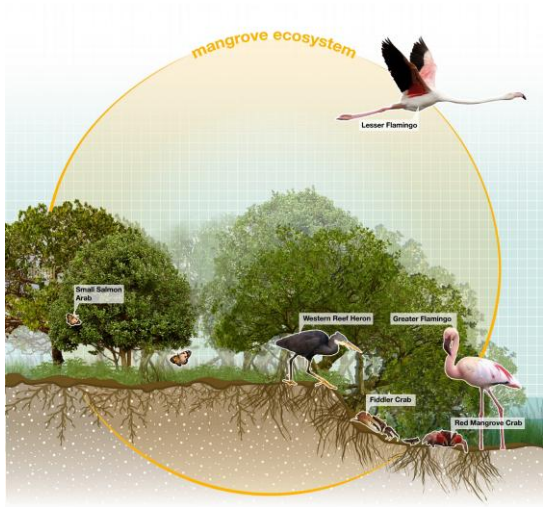
A city has various natural habitats and biodiverse ecosystems, like shown in the map of Mumbai, India. Before planting 3 steps need to be followed as shown above.



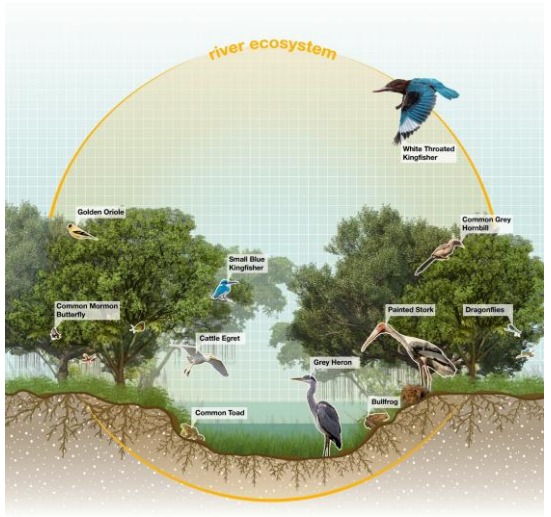
Ecological zones
MMR classified

Source: MMR Biodiversity project, Yuhina EcoMedia, Commissioned by MMR-EIS, MMRDA

2. Ecosystem Approach

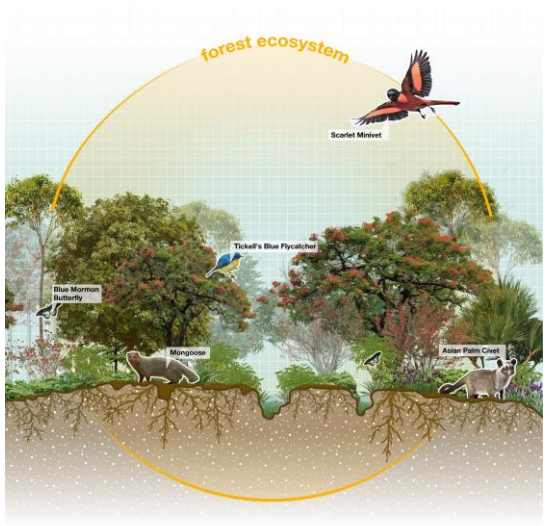


Mangroves



Riparian along water bodies

Urban parks



Forest

Be cognizant of the broader natural habitat and ecosystem along which the site is located to decide the species. These are some broader ecosystems observed in the case of Mumbai, India.

Source: Greening Mumbai: Handbook for scientific greening on small balconies to large plots, BMC, 2023

3. Water Requirement Considerations

Source: Eco-STP**(recycles sewage water of 42,000 litres/per day)**, Marol Urban Forest, WRI India

Installing water recycling units like Eco-STP or other DEWATS (Decentralised Waste-Water Systems) to reduce dependance on fresh water for irrigation

Installing Rain-Water Harvesting systems

Being mindful of water requirements for ‘Miyawaki’ type of plantation which is water-intensive. Hence, avoid planting in dry/arid regions.

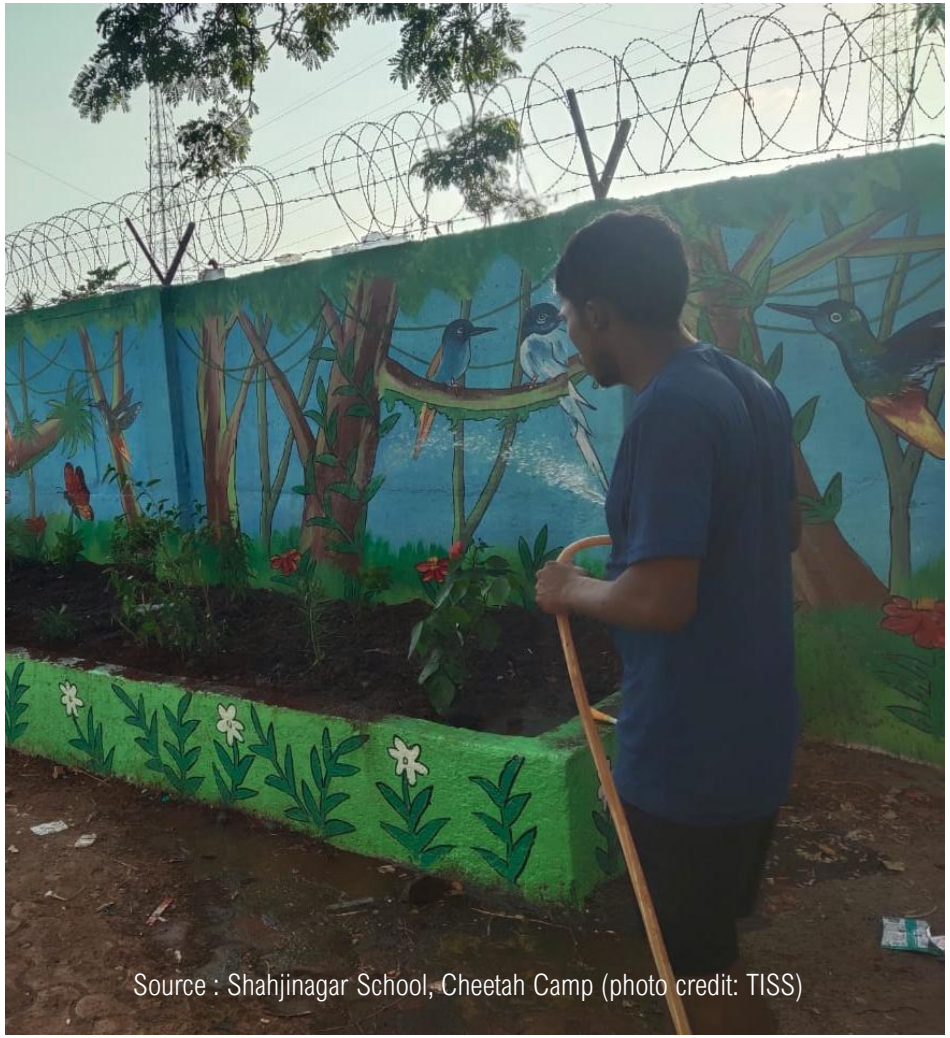
4. Engage Communities

Source Deen Dayal Maidan, Cheetah camp (photo credit: TISS)

Participatory approach towards greening by adopting engaging practices at all stages:

- Site selection
- Baseline assessment, community knowledge
- Training, capacity building on scientific greening
- Planting activity
- Maintenance mechanism

5. Maintenance

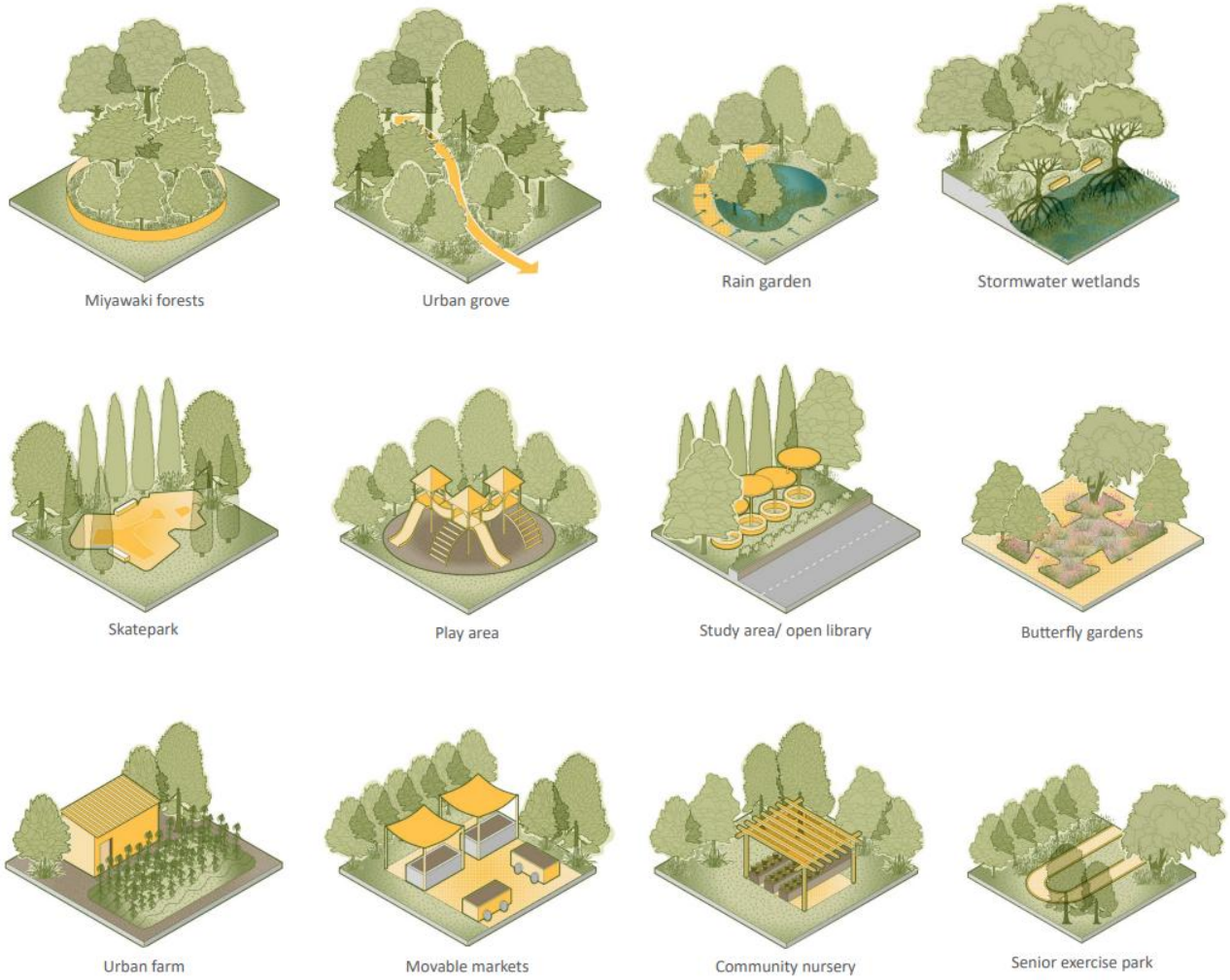


Source : Shahjinagar School, Cheetah Camp (photo credit: TISS)

- Creating charter and capacity building of stakeholders for maintenance of NBS
- Financial model for long-term sustenance to be created before implementation
- Building ownership of greening solutions in community-led projects, identifying associated community organizations

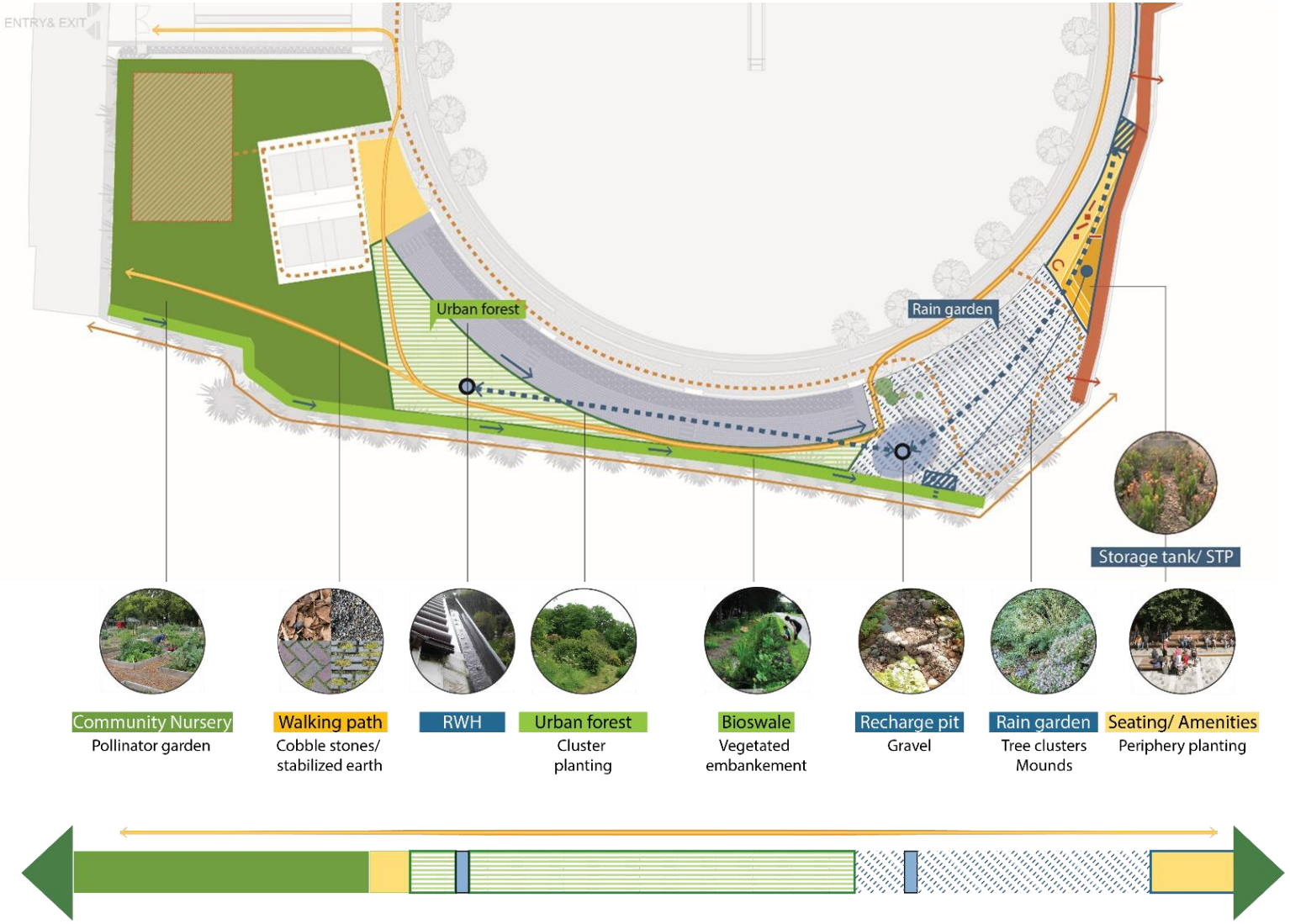
Greening Across Urban Forms

Open Spaces & Natural Areas



- Enhancement, conservation of natural areas like mangroves, forests, rivers need to be adopted.
- Open spaces act as important sites to adopt various greening approaches suitable to the needs of the community, as shown in the adjacent diagram.

Climate Sensitive Design Principles



Climate Sensitive Design Principles

Area of plot: 3000 sq.m.
No. of trees planted and conserved: 2000 | No. of shrubs: 4000

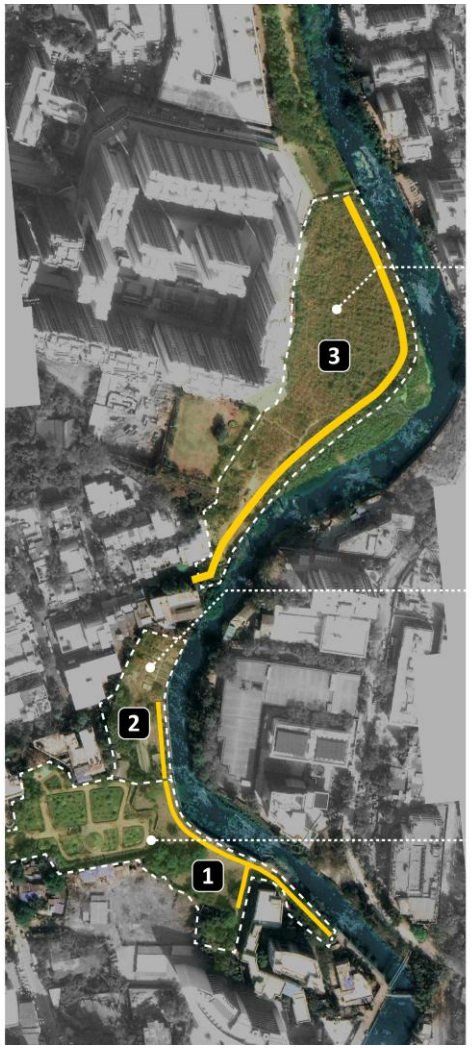
- Collaborative processes for site identification; communications and awareness strategy for biodiversity awareness and citizen support for volunteering; co-development of site program
- Funding through CSR channels facilitated by the ULB and Residents' welfare associations.

Marol, Mumbai – Water Sensitive Urban Forest

Overview

- Approximately **9 acres of land parcel**(phase 1,2 nd 3) spanning across **about a kilometre of length along Mithi river in Mumbai**
- **Multi-departmental involvement** due to varying set of requirements

Phase 1 layout - Marol Urban Forest



PHASE 3

CTS 443/13, 657, 658 - 5 acres
DP reservations - ROS 1.1

Stakeholders:
MIE, Gardens Dept., SWD Dept., DP Dept.

PHASE 2

Crematorium
CTS 655
DP reservations - DSA 4.1

Stakeholders:
HIC, Gardens Dept., SWD Dept., DP Dept.

PHASE 1

CTS 443/14 - 1.8 acres (7533 sqmt)
DP reservations - ROS 1.1, DPU 5.2

Stakeholders:
MIE, ADANI, Gardens Dept., SWD Dept., DP Dept.

Objectives

- Increase **the green cover** within one of the heat-stressed areas of Mumbai,
- **Enhance biodiversity** by incorporating native plant species,
- **Maximize permeability, improve soil health, and recharge groundwater.**
- Develop an accessible open space and riverfront for the citizens,
- Integrate nature-based solutions along the buffer zones of river

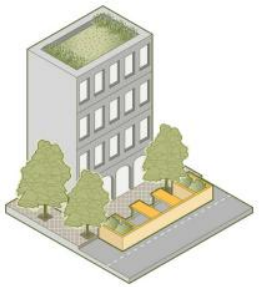
Marol, Mumbai – Water Sensitive Urban Forest

Source: Urban Forest- Marol (Photo credit: WRI India)

- Retention ponds in the project act as sponges to slow down surface water run-off as well as to enhance biodiversity.
- Elevated boardwalk is created to allow for biodiversity corridors under the structure and increase water permeability.

Buildings

Green roof



Parklets

Home balcony

Greening strategies on buildings and within building compounds include

- Roof-top greening, green terraces, urban farming
- Vertical greening in balconies
- On-plot peripheral greening, parklets

Rooftop Farming: Chennai Resilience Centre

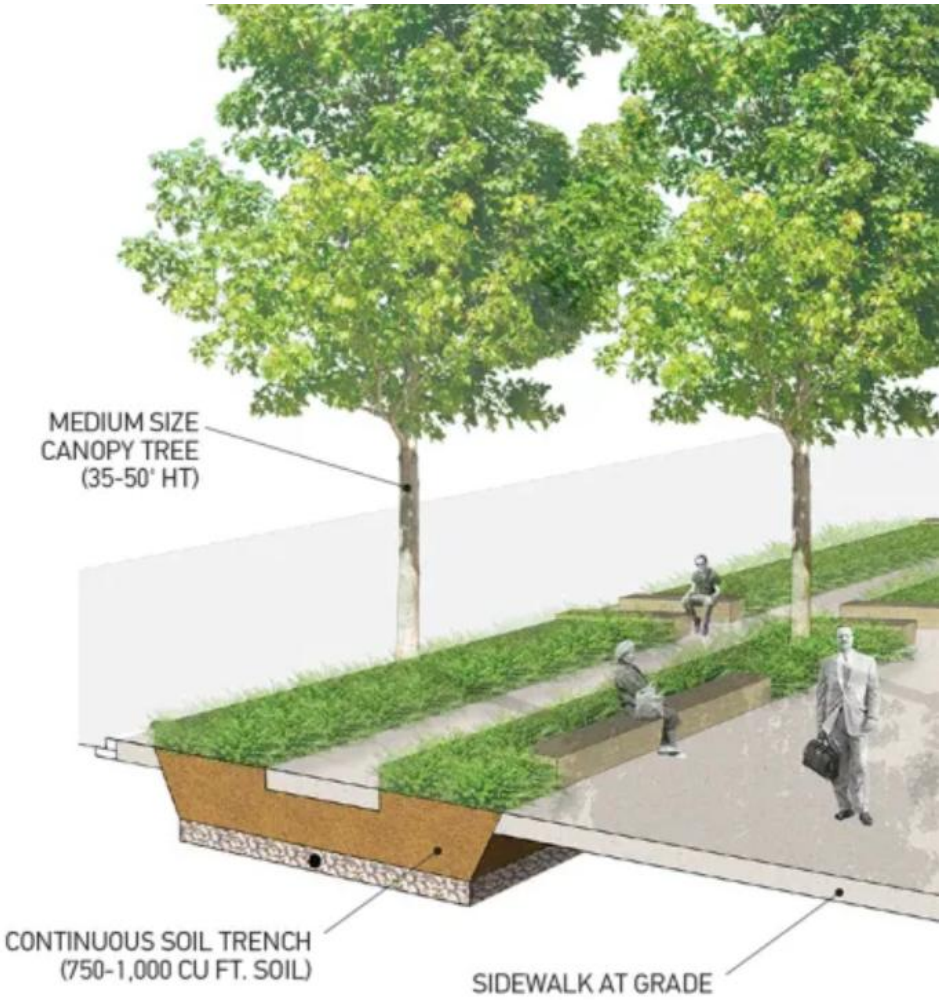
Urban Heat Mitigation via Flora-Based Roof Insulation

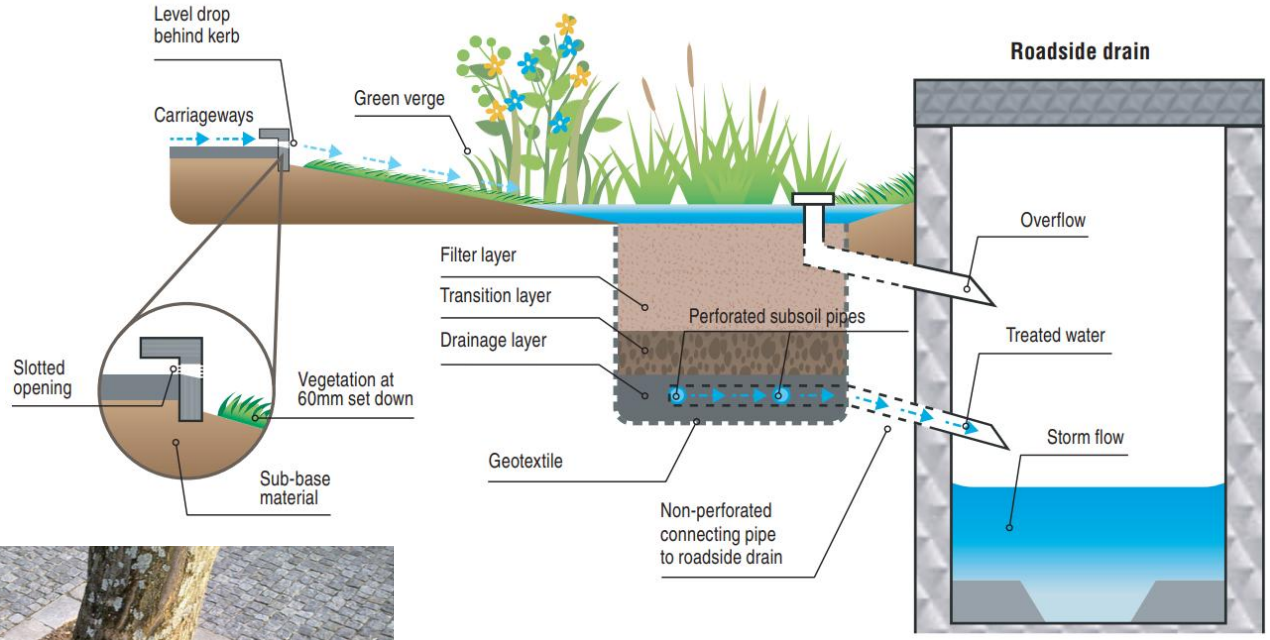
- *On an average, temperature in the garden region is 1.5°C lesser than the reported temperature for the locality.*
- *The room under plantation is on an average 2-3°C cooler than the exposed room.*
- *During a peak summer day, the room below the garden is significantly cooler (2 to 7°C lower in temperature) than the exposed room.*

EARTHONOMIC ENGINEERS

Source: https://urbanthottam.com, Chennai Resilience Centre @Integrated Child Development Centre, Chennai

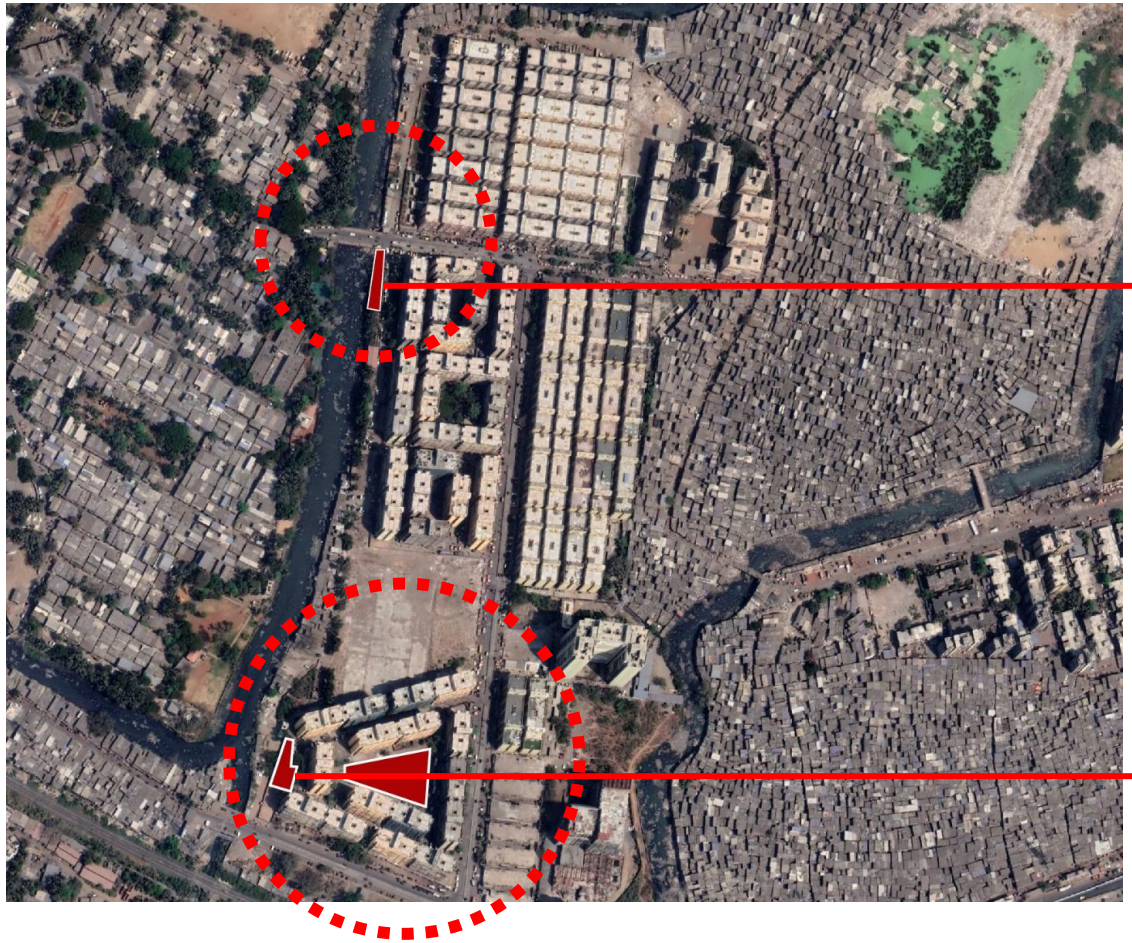
Streetscapes





Design to allow greening along roadsides, to increase permeability and shade

Local area improvement: Lallubhai compound



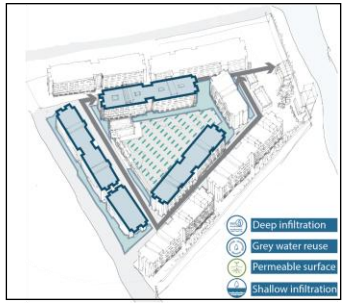
- Lallubhai Compound is a Rehabilitation and Resettlement colony located in Mankhurd.
- Holistic solutions for greening were proposed and carried out in two plots

Lal Maidan as ‘Sponge infrastructure’

Landscape Master Plan with context of Nala Scale 1:250

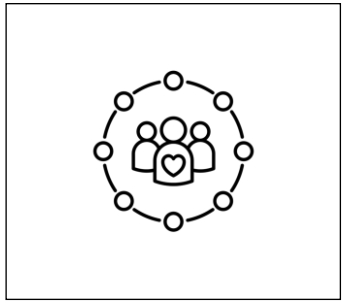
- Biodiversity restoration & enhancement
- Eco-STP
- Bioswales
- Community spaces for recreation
- Waste management plan

BIODIVERSITY RESTORATION



WATER MANAGEMENT

WASTE MANAGEMENT



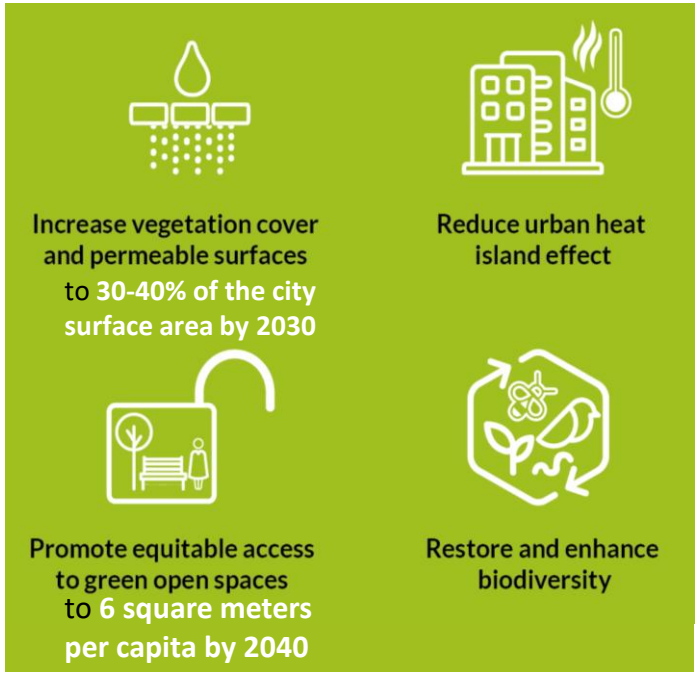
PEOPLE CENTRIC APPROACH

Long-term policies and strategic actions

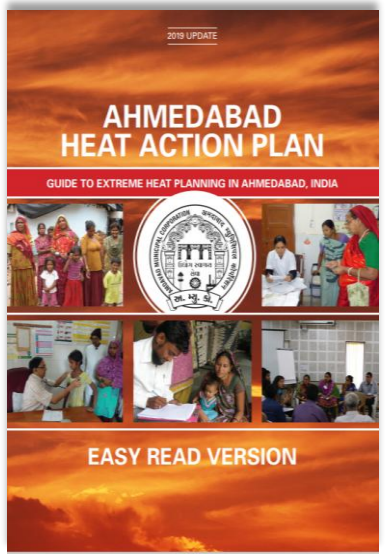
Developing city-level strategies for heat resilience needs concerted policy level effort. Some examples include creating:

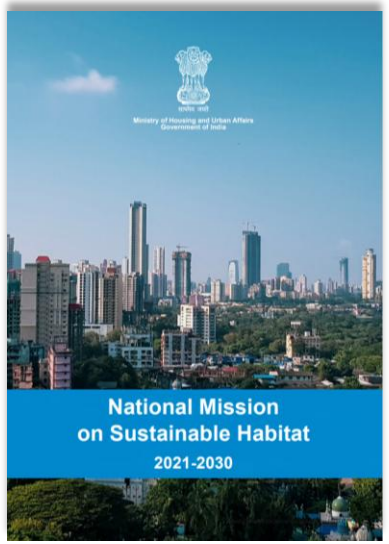
- Climate Action Plans with blue-green goals
- Heat Actions plans with long-term preparedness for cooling
- Greening manual for encouraging locally-led efforts
- Tree-census
- Landscape plans
- Mapathons for identifying derelict, unused areas for greening, creating shade.

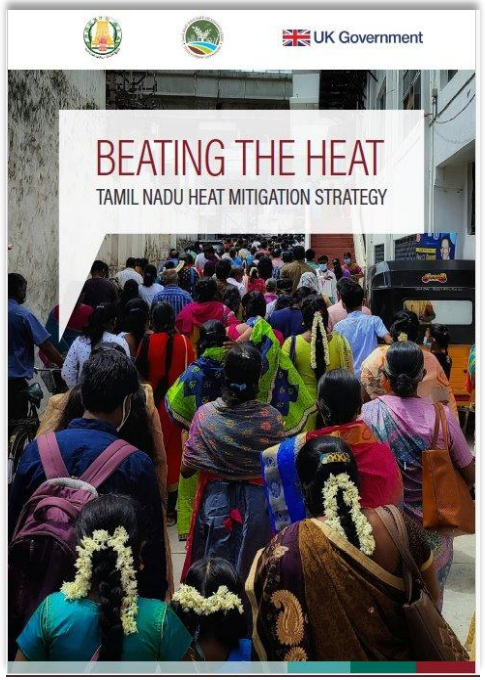
Climate Action Plans & Heat Action Strategies



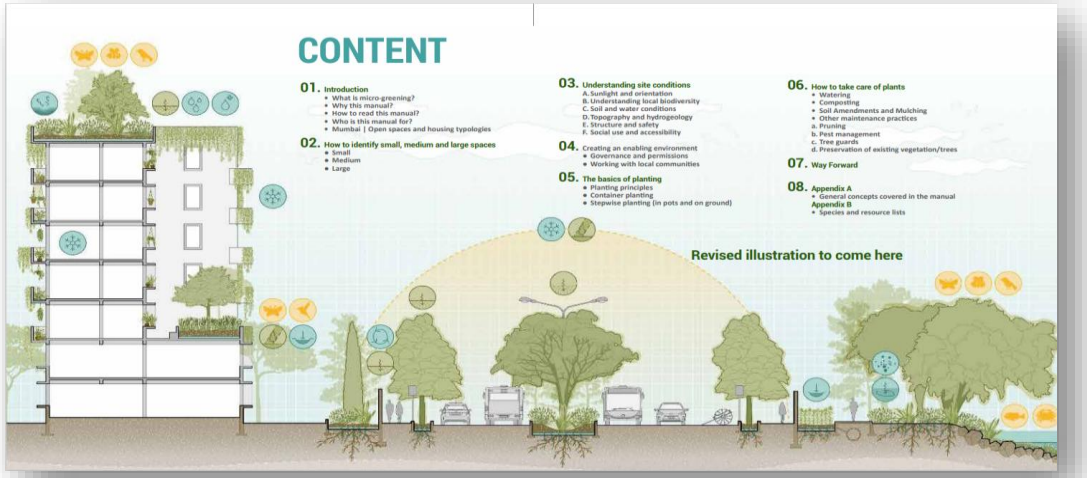
Urban Greening and Biodiversity goals

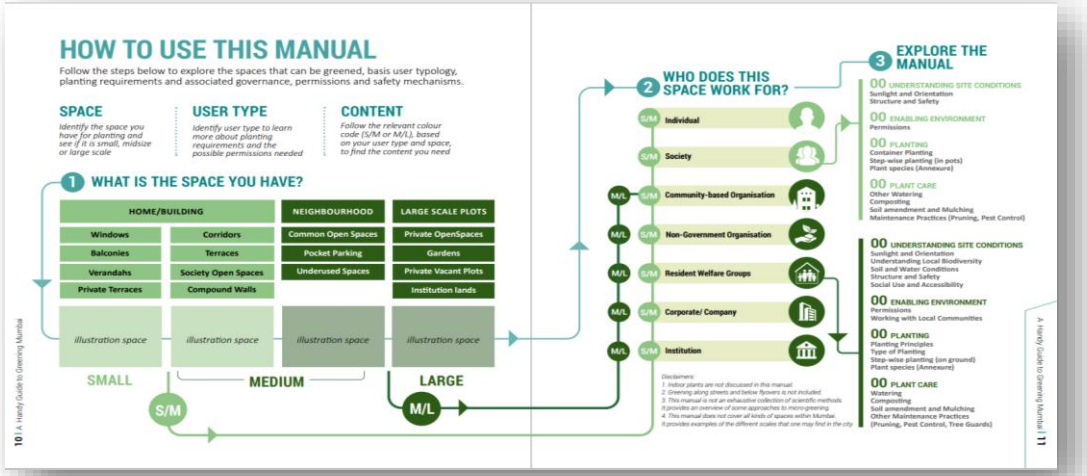


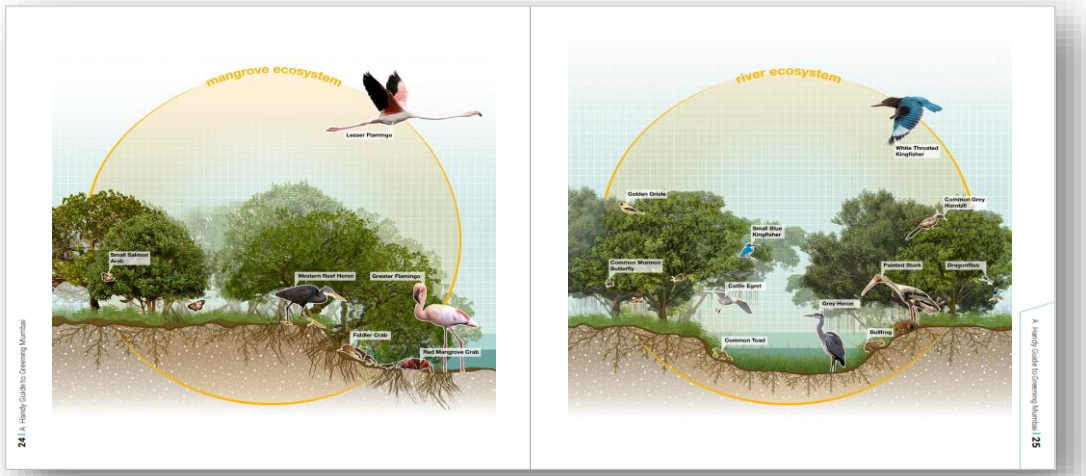




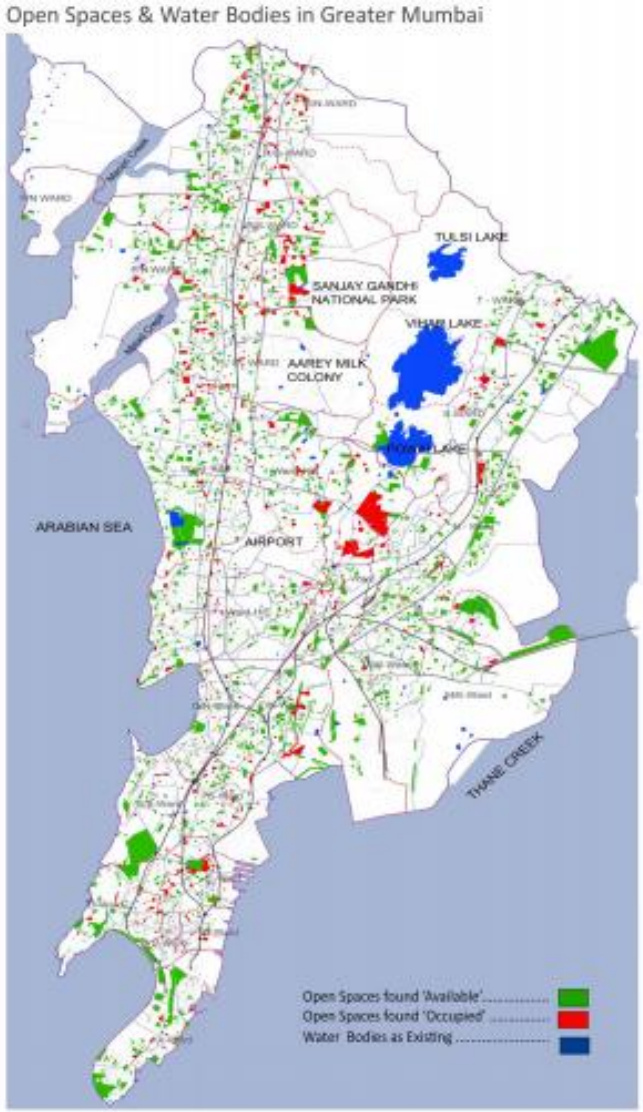
MUMBAI: Greening manual for citizens



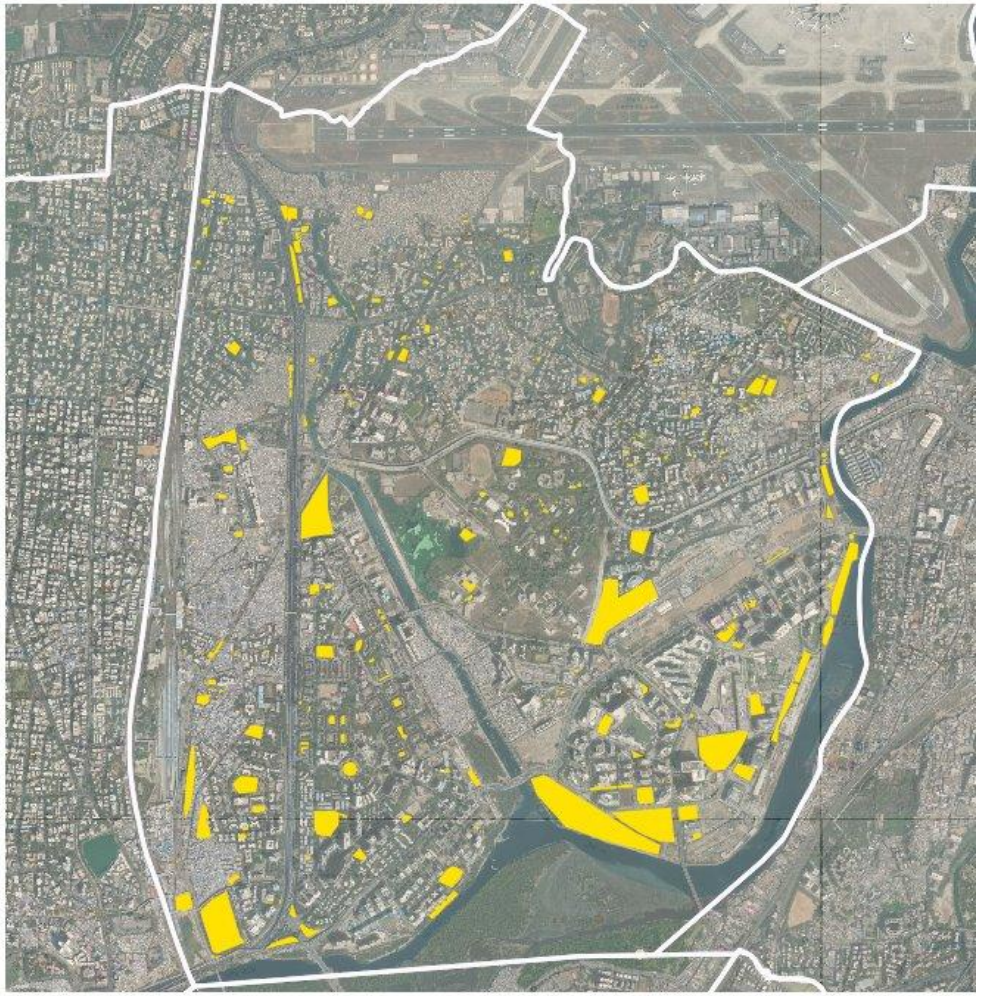




Inventory of open spaces



Mapathon: Participatory data collection



Source: *(Left)* Adarkar Associates and MMR-EIS (Mumbai Metropolitan Region – Environment Improvement Society). 2015. Inventorisation of Open Spaces & Water Bodies in Greater Mumbai.
(Right) WRI India

Tree Census, Public Biodiversity Register

Tree Census Format

No on Tree	Name of Tree	Location of tree	Girth in Cms	Height In feet	On the Tree					Health of the tree					Ground condn	Open Soil	Other comments
					FL	FR	P	N	B	DS	HLP	NL	TG C	HT H	OS/T/ C/CS	A/B/C /D/E	

Legend for Tree Census

On the Tree	Mention **FL** for flowers , **FR** for fruits, **P** for Pods, **N** for nest, **B** for burrows
Health of Tree	Mention **DS** for diseased, **HTH** for healthy, **HLP** for Heavily lopped, **NL** If you find nails, If Tree guard choking mention **TGC**
Ground condition	Mention **OS** for Open Soil, **T** for tiled, **C** for cemented, **CS** for compressed mud
How much of Open soil around trunk	Write **A** if space is Nil, **B** for 0-2 ft, **C** for 2ft>4ft, **D** for 4ft>6ft, **E** for 6 feet and more.

- Tree Census needs to be conducted in a city at least once in 5 years as per the Maharashtra (Urban Areas) Protection and Preservation of Trees Act, 1975, India.
- The only way to increase and conserve green cover in your locality is to first take stock of existing trees and their conditions.
- A participatory approach to count, identify, classify, and monitor trees in each ward, can be a very effective way of bringing innovation, accountability and transparency in the act of tree conservation.
- Tree census can provide a lot of information for further action, in terms of health of trees, types of natives in specific areas, canopy cover, etc. This information can be used towards multiple actions including calculating carbon sequestration potentials, reduction in air pollution, restoring green cover or to plan connected shaded walkable areas.


Thank you

AUDIENCE Q&A

Lubaina Rangwala

Lutske Newton

Deepti Talpade

[Moderator] Hellen Njoki Wanjohi-Opil

Closing Remarks

Lubaina Rangwala

- *Webinar 3 reminder*
  - Nature-based Solutions to Mitigate Flooding and Stormwater Risks in Cities *(Wednesday 26 March)*

URBAN SH/FT

Thank you!

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URBAN SH/FT

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