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WRI INDIA

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

Nature-based Solutions to Mitigate Flooding and Stormwater Risks in Cities

26 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

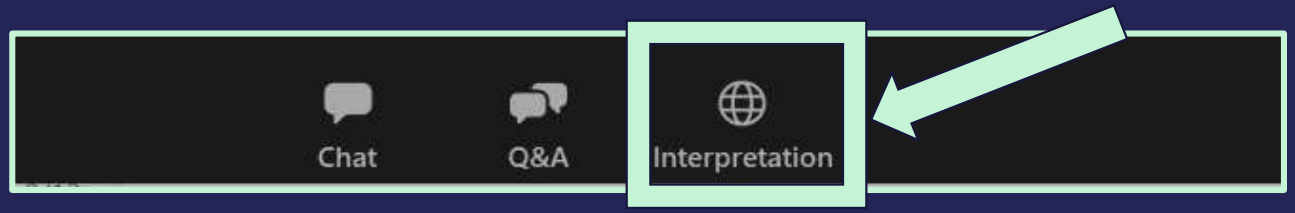
Part 3 of a 3-part capacity building webinar series on measuring and mitigating urban climate risks

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

Dr Priya Narayanan, Senior Program Manager, Urban Development, WRI India

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 February 2025)
- ✓ *Webinar 2: Nature-based Solutions to Tackle Urban Heat in Cities* (5 March 2025)
- 📣 ***Webinar 3:*** **Urban Flooding & Nature-based Solutions (Today)**

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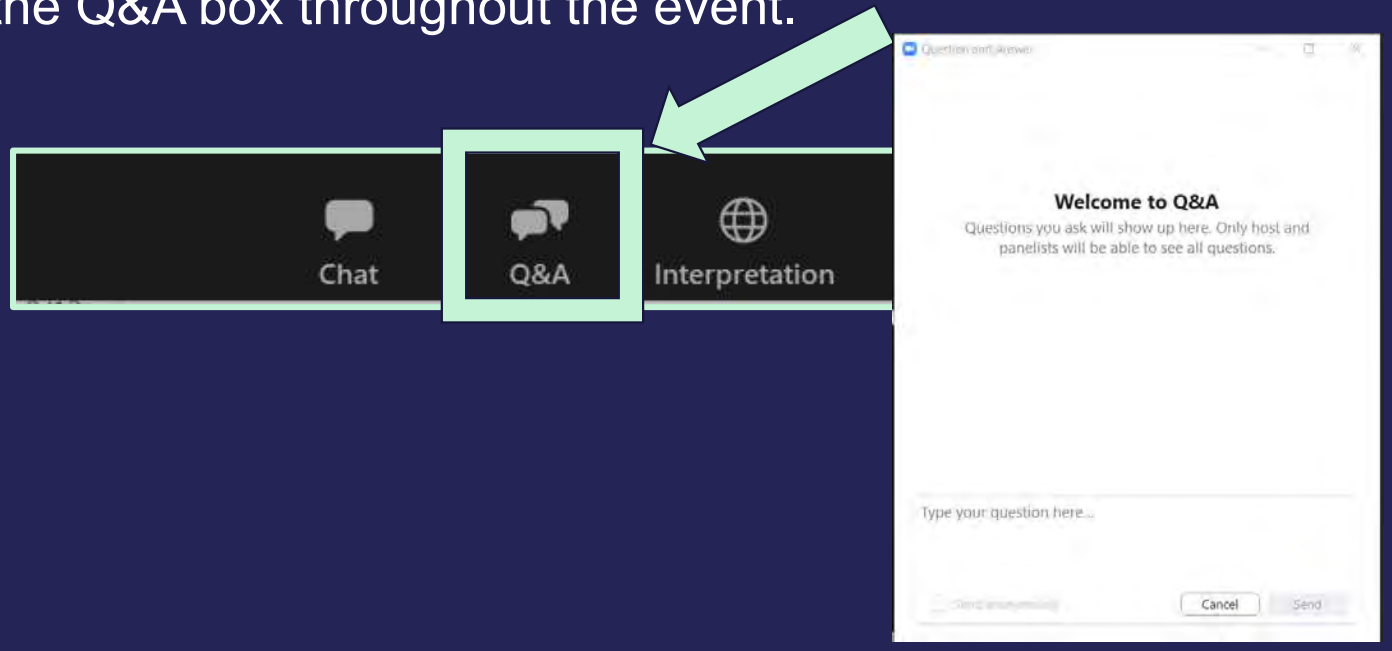
IN PARTNERSHIP WITH:

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.



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AGENDA

- **Welcome and Housekeeping**: Priya Narayanan, WRI India
- **Introductory Remarks:** Mukta Salunkhe, WRI India
- **Training Presentation**: Sahana Goswami, WRI India
- **Panel Discussion**:
  - Moderator: Dr Priya Narayanan
  - Dr Nisha Priya Mani, Sustainable Cities Specialist, Greater Chennai Corporation/Asian Development Bank
  - Mesalin Maimbu, Jayapura Environmental Agency, Indonesia
  - Hadibandhu Behera, Orissa Water Supply & Sewerage Board, India
  - Natasha Naidu, Manager: Regional Stormwater Planning, Johannesburg Roads Agency, City of Johannesburg, South Africa
- **Closing remarks**: Mukta Salunkhe

Introductory Remarks

Mukta Salunkhe
Senior Program Associate,
Urban Development, WRI India

Slide 9

0 [@Mukta Salunkhe] Could you please share a higher-resolution headshot? Thanks!
Urvi Patel, 2025-03-21T19:36:52.361

J(0 0 [@Mukta Salunkhe] / [@Deepti Talpade] pls action here...
John-Rob Pool (He/Him/His), 2025-03-24T10:43:32.571

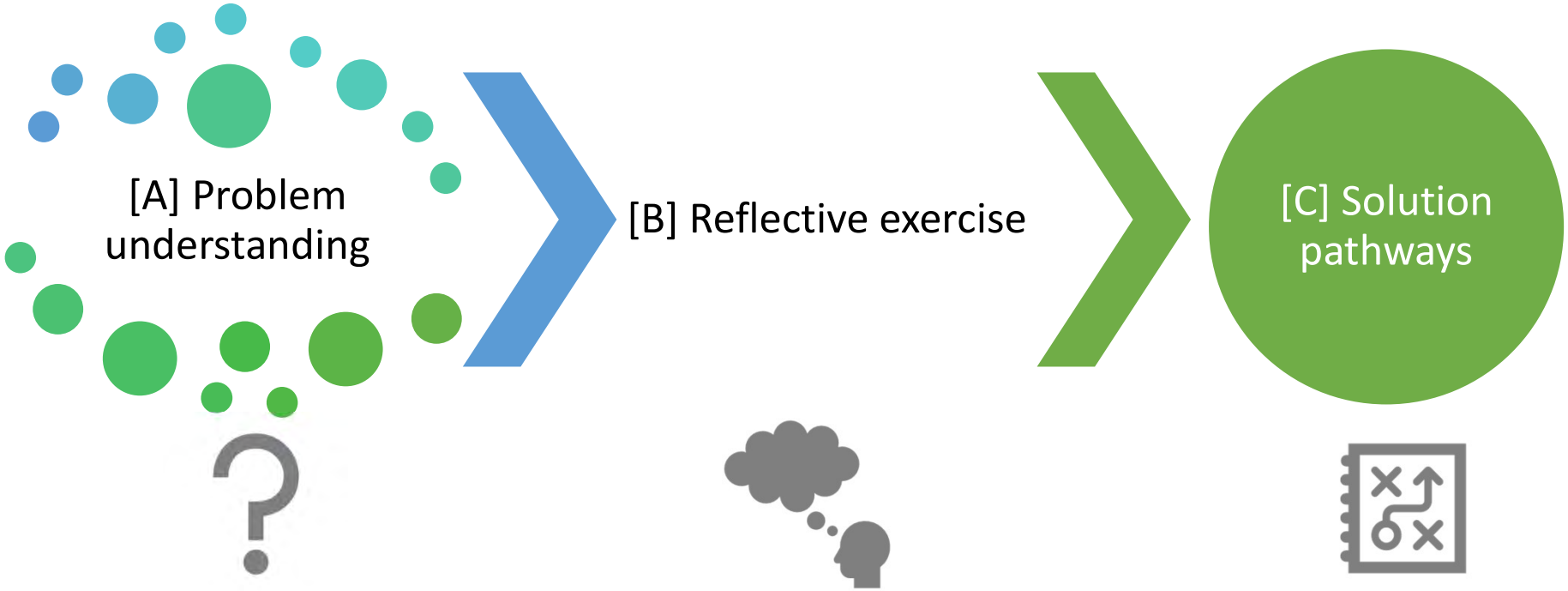
Training Presentation

Sahana Goswami
Senior Program Manager,
Urban Water Resilience, WRI
India

Capacity Building Webinar on Nature-Based Solutions to Mitigate Flooding and Stormwater Risks in Cities

Flood Pains in Growing Cities

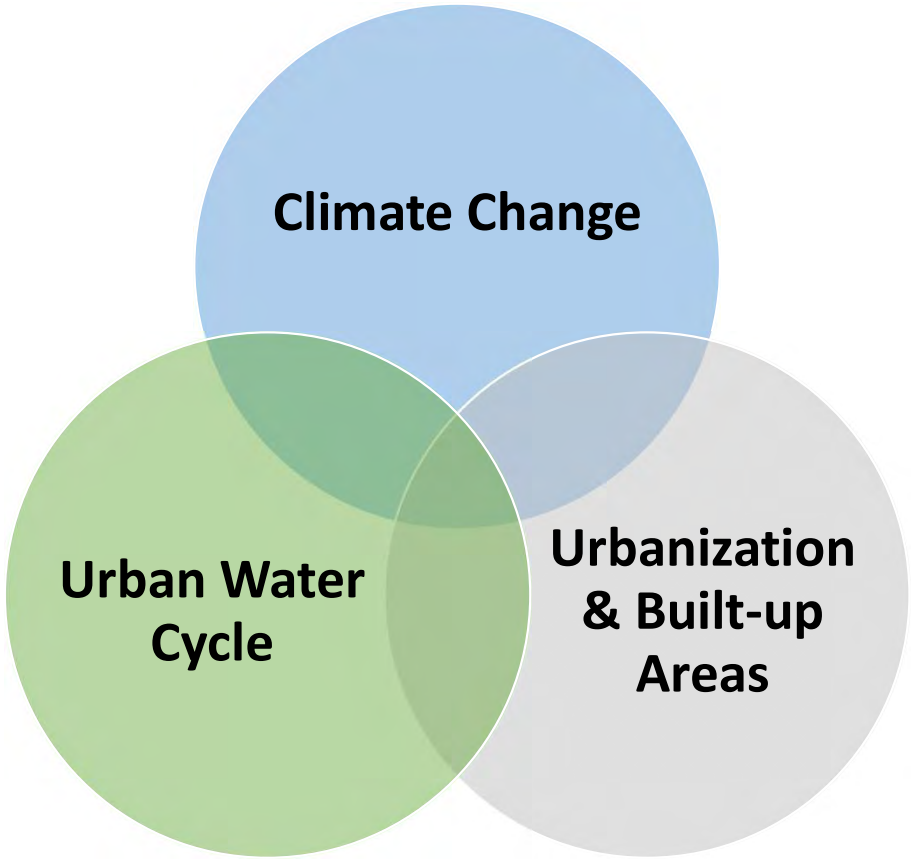
Session Structure



Understanding the Climate-Water-Urban Nexus

MS0

Climate-Water-Urban Nexus



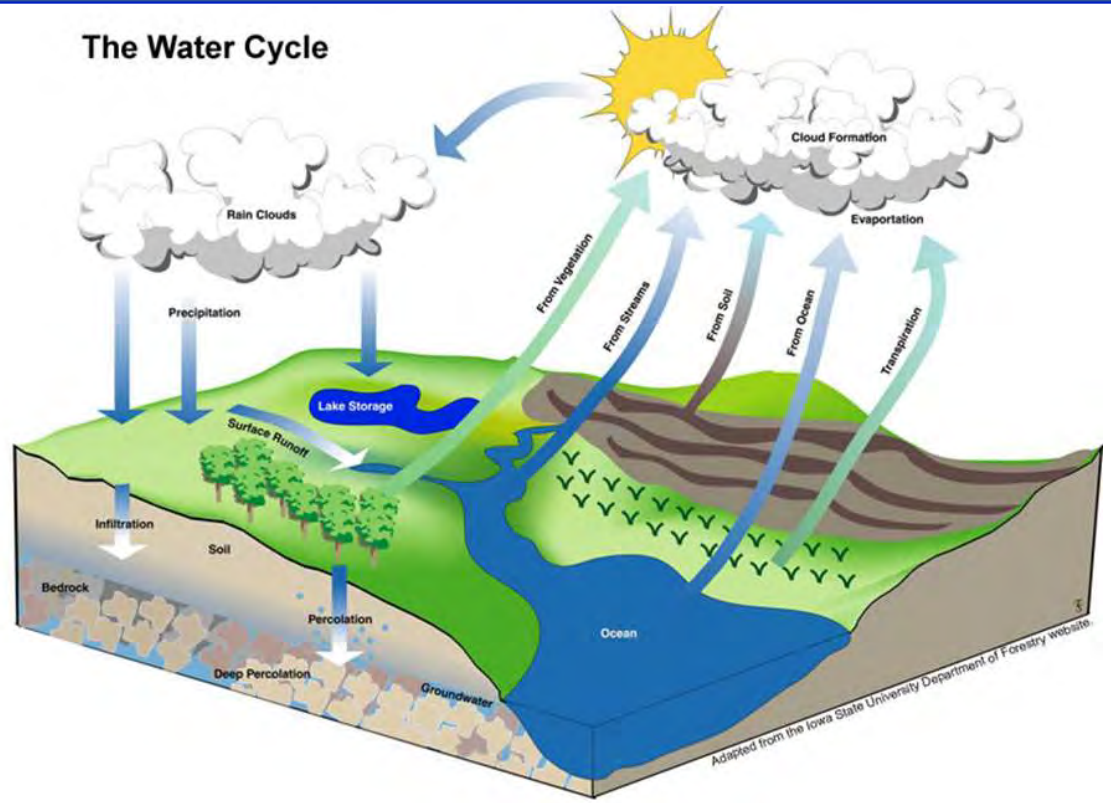
Slide 14

MS0 Animate this slide + beautify a bit [@Hammad Zubair]
Mukta Salunkhe, 2025-03-10T06:20:33.967

Climate-Water-Urban Nexus
A. Climate Uncertainty Regarding Rainfall

In the context of urban flooding, climate uncertainty limits our ability to forecast accurately when and how much rainfall will occur at a specific location

Climate-Water-Urban Nexus
B. Intensifying Hydrological Cycle



Source: https://scied.ucar.edu/learning-zone/climate-change-impacts/water-cycle-climate-change | https://www.pettitpastures.com/water-cycle-affects-weather/

Climate change affects evaporation and precipitation

A warmer climate draws more moisture from land and water bodies and holds more water vapour in the atmosphere.

- More rain and flooding
- More extreme drought
- Stronger hurricanes
- Heat waves

Climate-Water-Urban Nexus
C. Expanding Urban Footprint

Source: Johnny Miller/Unequal Scenes

- High-density urban populations are more vulnerable to extreme events.
- More buildings mean less permeable ground, causing excessive runoff that causes floods.

Why do Cities Face Flooding?

Why Do Cities Face Flooding?
A. Urban Impermeability and Runoff

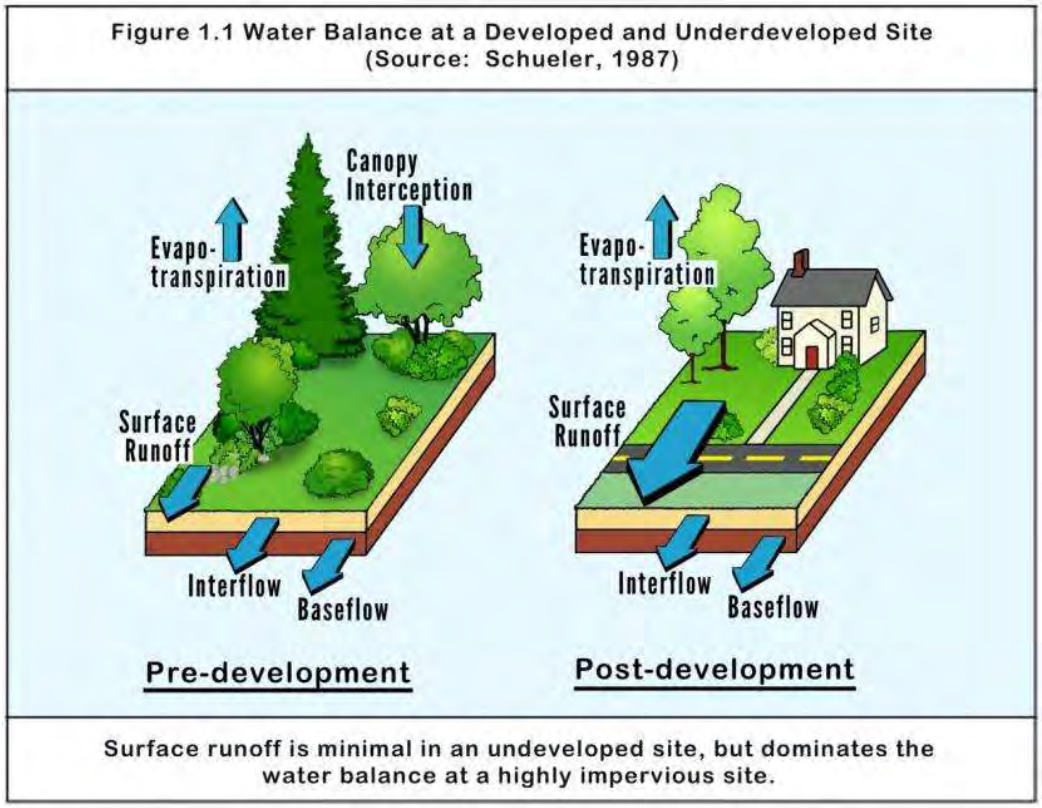
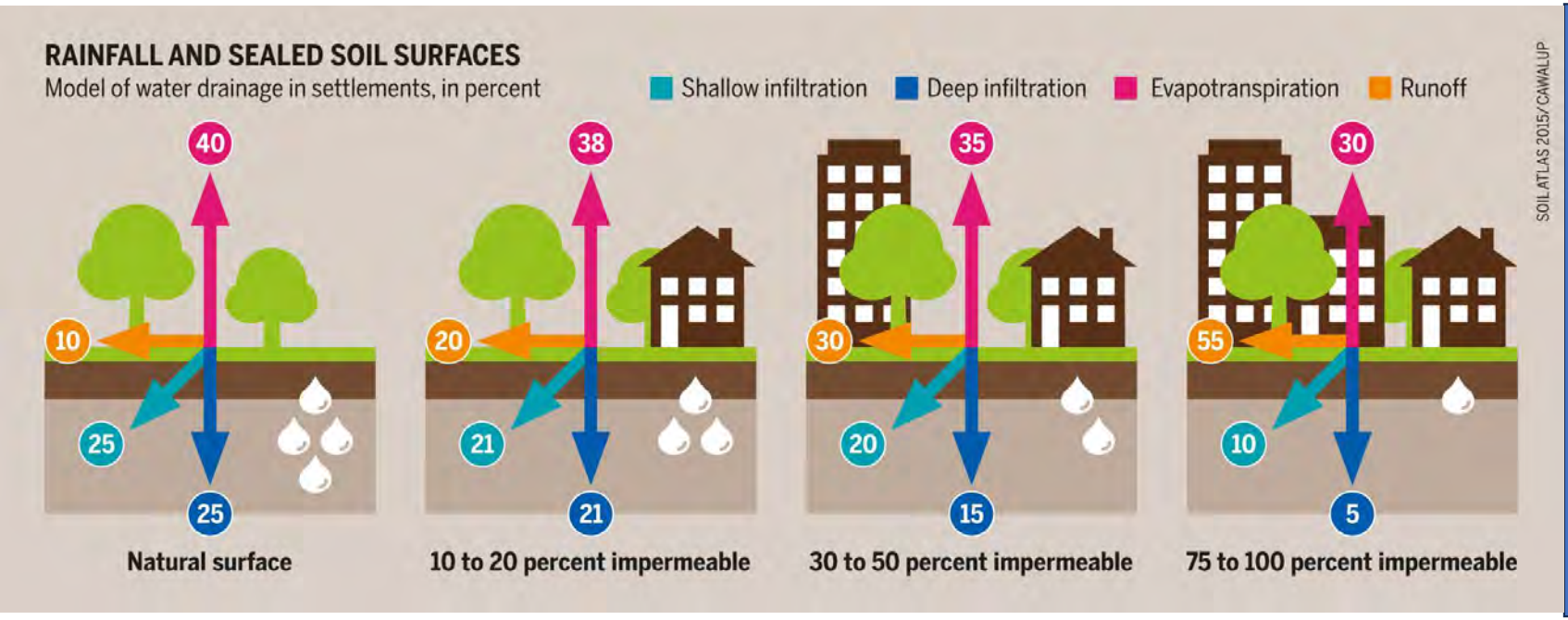


Image: City of Norman, OK | *https://www.normanok.gov/your-government/departments/public-works/stormwater-maintenance-division*

- Methods to estimate stormwater runoff in relation to urbanized footprint have been available for around 4 decades.
- The greater the extent of urbanized, impermeable area, the higher the volume of runoff that will be present at the location.

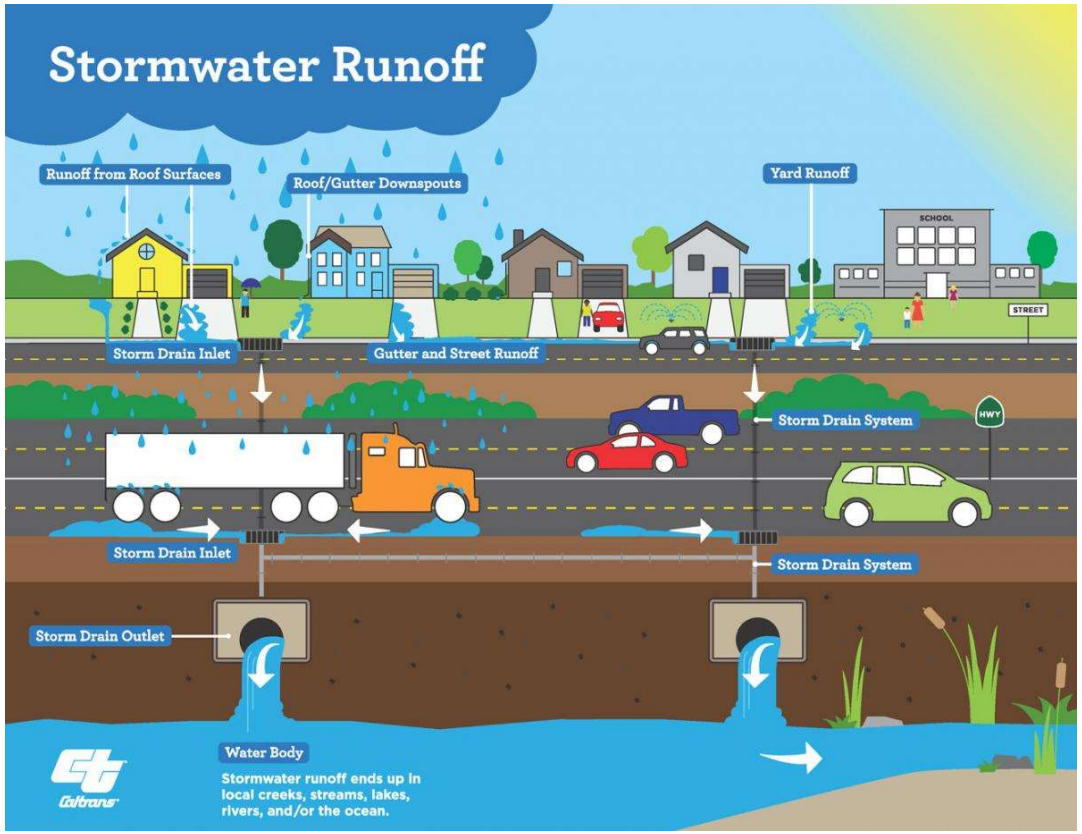
Why Do Cities Face Flooding?
A. Urban Impermeability and Runoff

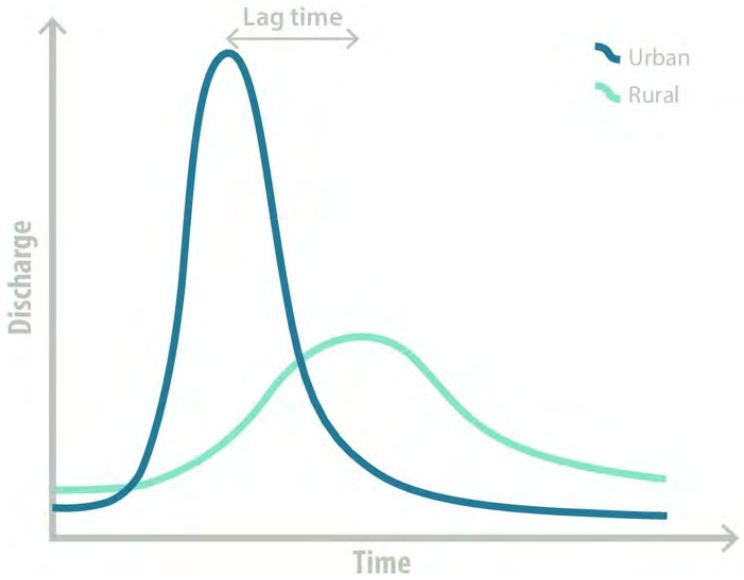


- Not just highly concertized or tarred surfaces, but compacted, bare earth (after clear-cutting of woodlands or in preparation for construction) have high runoff coefficients.

Source: Bartz/Stockmar, Flickr (CC.3.0) | *International Journal of Urban Sciences · June 2018* | https://beckleysanitaryboard.org/impervious-surface/

Why do Cities Face Flooding?
B. Rainfall Volumes and Peak Flows



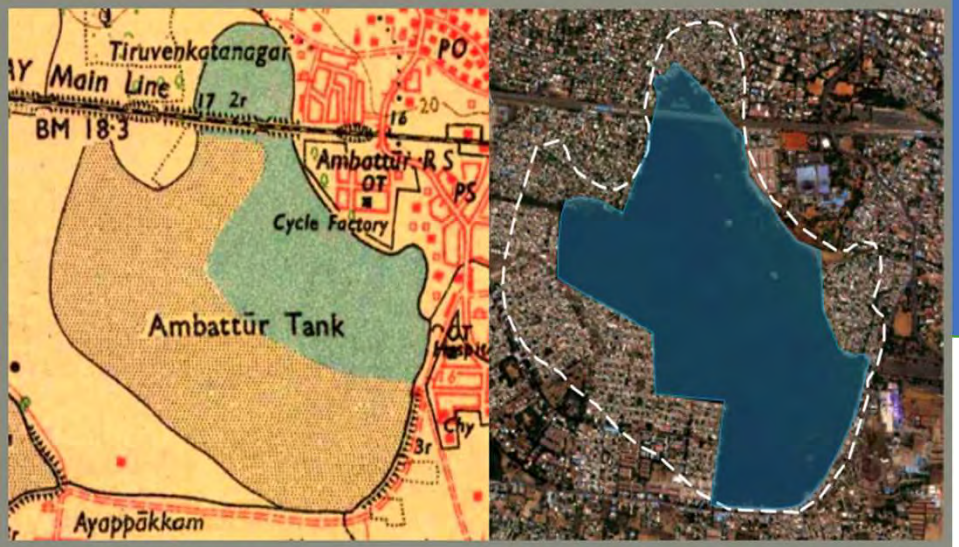


- Peak flows in highly concretised watersheds

Source: Designing Effective Stormwater Management Policies, Lefranciose 2015; Image by Caltrans, California

Why do Cities Face Flooding?
C. Building on Flood Pathways

A- Kolathur Lake



B- Ambattur Lake

- Urban development degrades natural flood defenses like upstream woodlands and wetlands.
- Water flows into former water bodies and low-lying areas even if they are built over.
- Infrastructure like roads disrupts natural water flows and drainage, exacerbating floods.

Source: Goswami, S., S. Basak, A. Malik, R.B. Palanichamy. 2023. “Urban Blue-Green Conundrum: A 10-City Study on the Impacts of Urbanization on Natural Infrastructure in India.” Working Paper. WRI India.

How are people and infrastructure impacted?

How are People and Infrastructure Impacted?
A. Property Loss and Damage

Source: Pushkar V/ Flickr

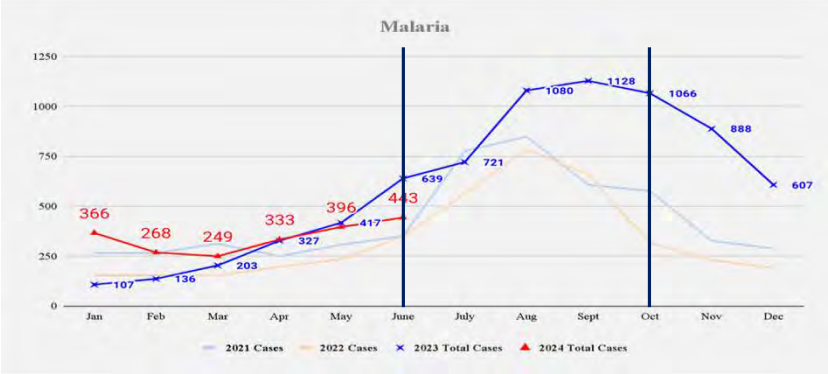
- Flooding disrupts urban life in complex and interconnected ways affecting livelihoods, education, (physical and mental) health and more

How are People and Infrastructure Impacted?
B. Pollution

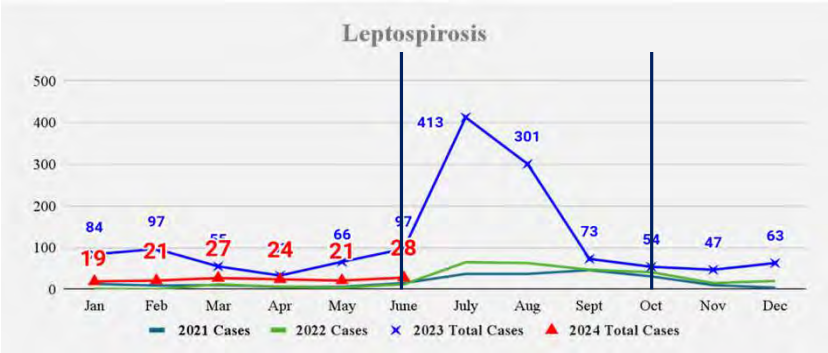
Source: Images left: Bangalore, Borgen Magazine, 2020 ; middle: Mumbai, Times of India, 2022; right: Hyderabad, Sahana Goswami, WRI India

- Larger storm drains often become dumping grounds for solid waste
- Stormwater systems when not separated and protected from sewer inflows carry large volumes of sewage and biological wastes and deliver them to downstream water bodies like lakes and rivers
- Large variety of contaminants (chemicals, vehicle fuels) are carried as street runoff into storm drains and water bodies

How are People and Infrastructure Impacted?
C. Health Impacts



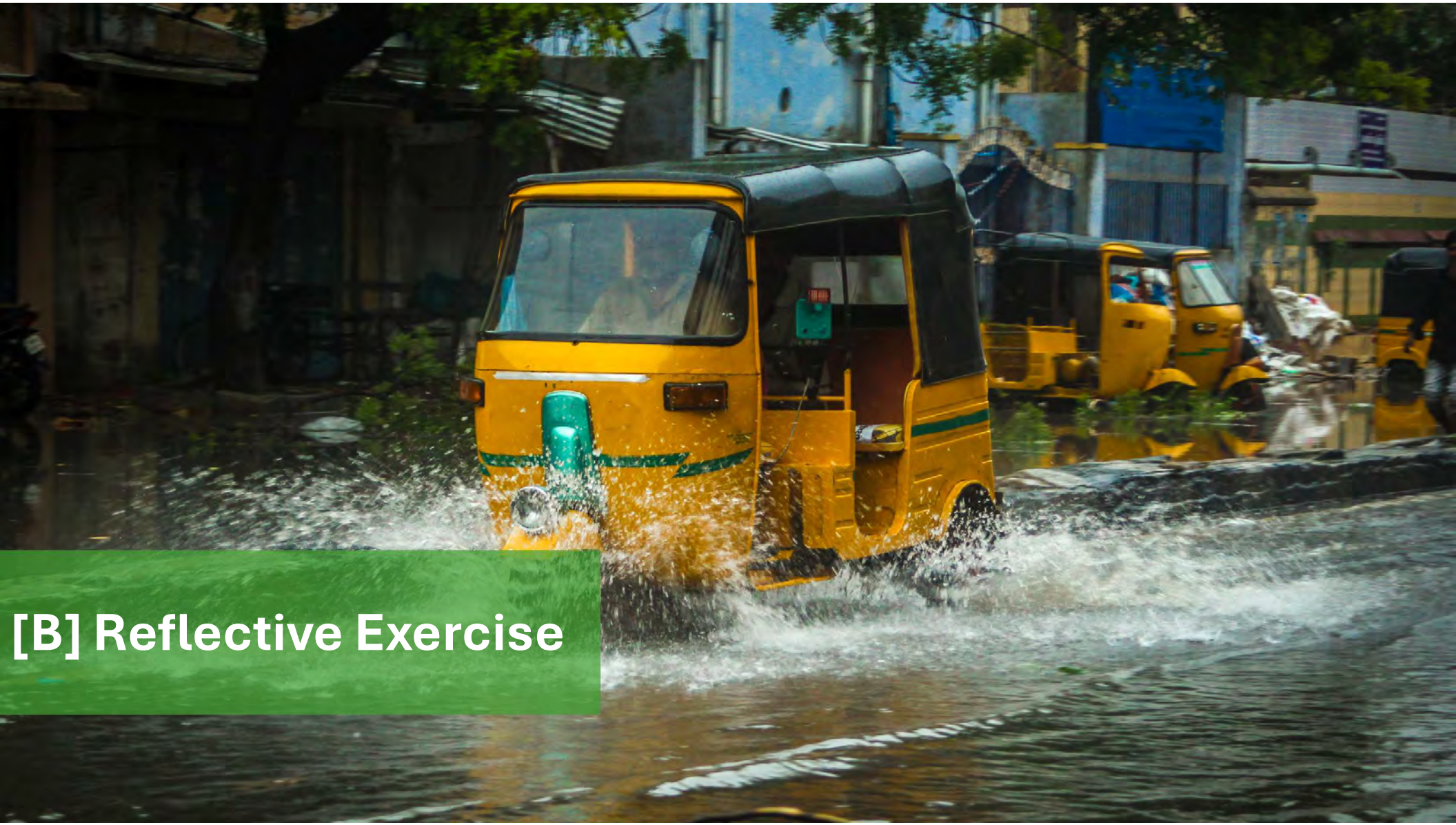
Compared to 2022, during monsoon months- July to October 2023 saw an **approx. 1.5 times increase** in number of cases of Malaria (Mumbai)



Compared to 2022, during monsoon months- July to October 2023 saw an **approx. 4 times increase** in number of cases of Leptospirosis (Mumbai)

- Increase in humidity and heat is conducive to mosquito incubation period resulting in increased breeding. Thereby, accelerating the transmission cycle.
- Irregular rainfall with pressing need for water storage also result in increasing breeding grounds.
- Similarly, higher annual mean temperature along with humidity enhance the growth and activity of bacteria called Leptospira spp. causing Leptospirosis.
- Heavy rainfall, storms, and associated waterlogging and flooding events increase human exposure to contaminated water.

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



[B] Reflective Exercise

Flooding event in 2022 | Bengaluru, India

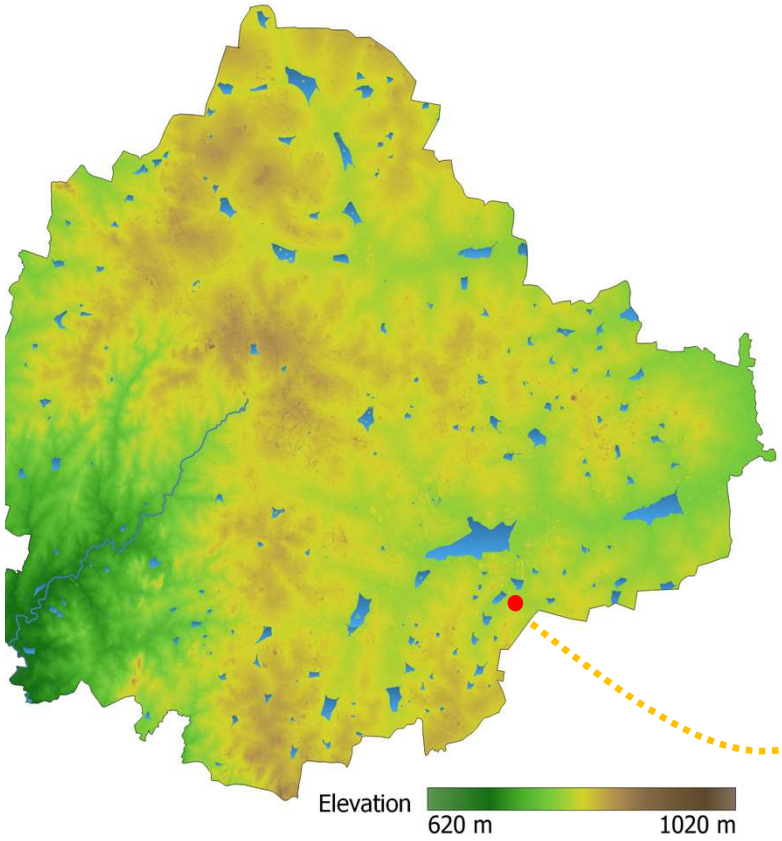
Parts of East, Southeast Bengaluru bear the brunt of overnight heavy downpour

Published - August 30, 2022 08:30 pm IST - Bengaluru

DARSHAN DEVAIAH B.P.

Firefighters and Civil Defence personnel evacuating a patient from the waterlogged **Rainbow Drive Layout.** | Photo Credit: PTI

Flooding event in 2022 | Bengaluru, India

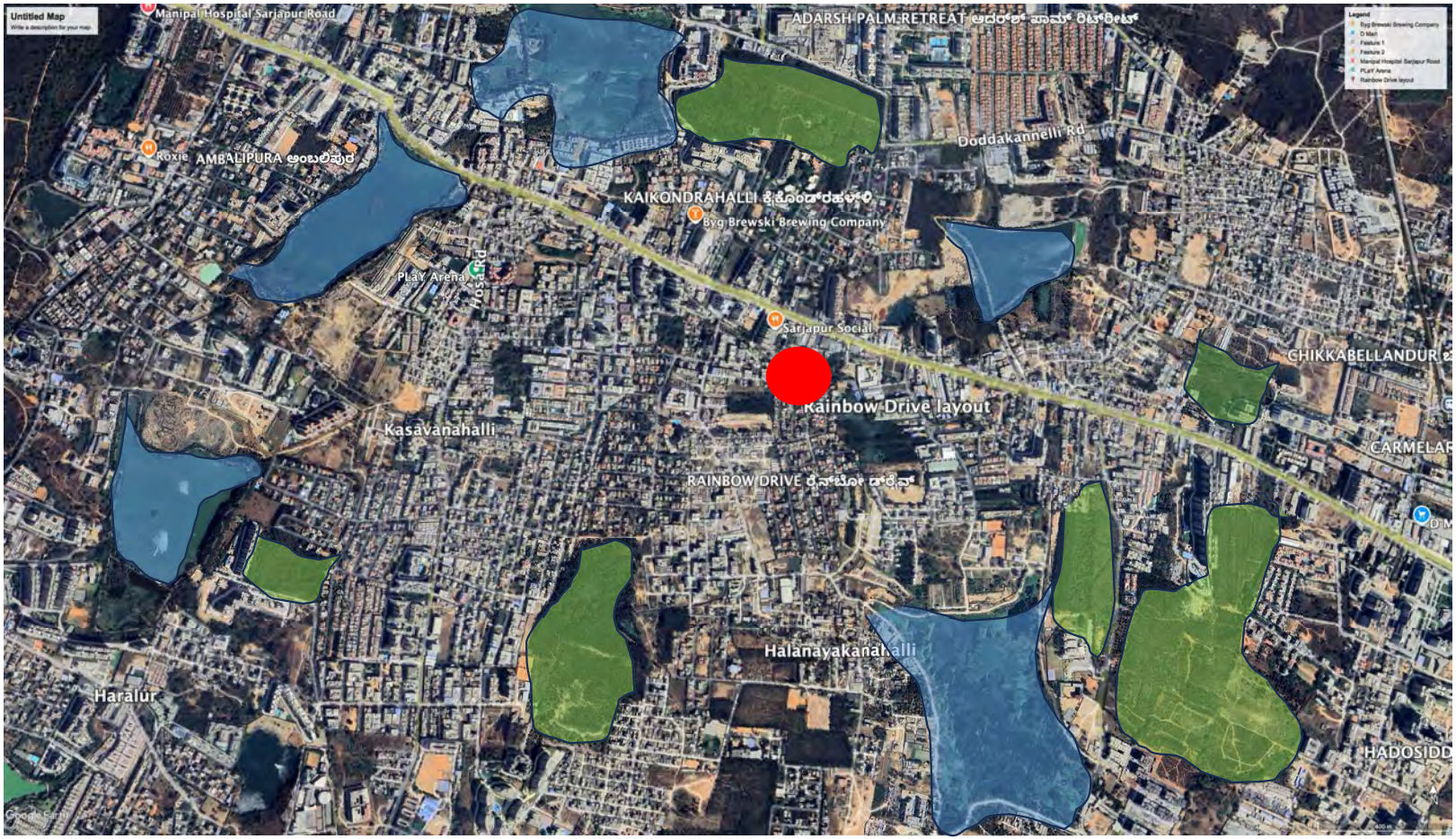


Study the address below on Google Earth Pro to view historical images of the area and understand the changing urban footprint

A **Rainbow Drive layout**
Sarjapur - Marathahalli Rd,
Rainbow Drive,
Halanayakanahalli, Bengaluru,
Karnataka 560035

Source: *India Map, WRI India | Bangalore elevation map with lakes and Vrishabhavathi River, Wikimedia Commons*

Satellite View of the Region in 2025

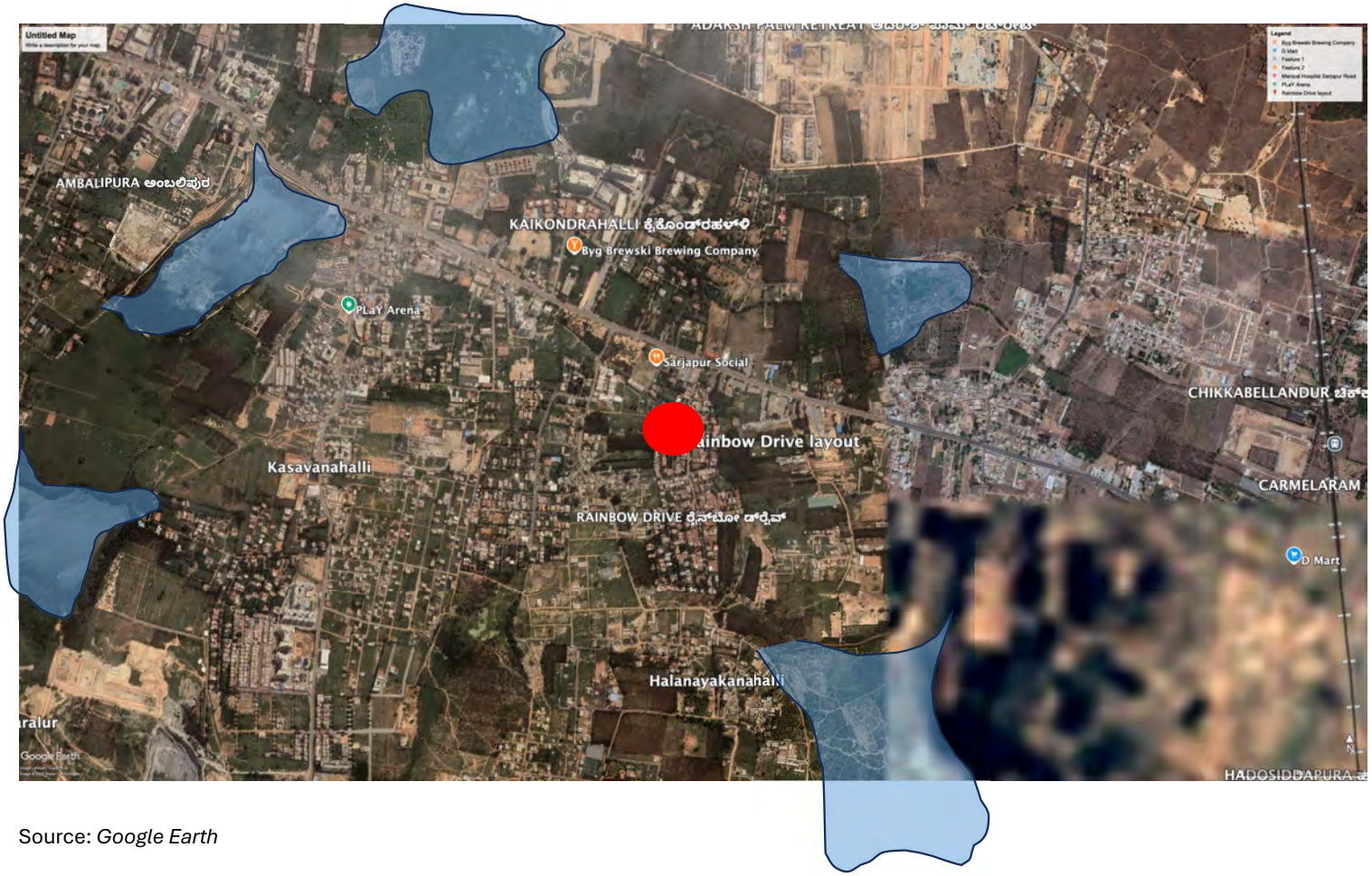


LEGEND

- Flood affected area
- Water bodies
- Open spaces

Source: *Google Earth*

Satellite View of the Region in 2011



LEGEND

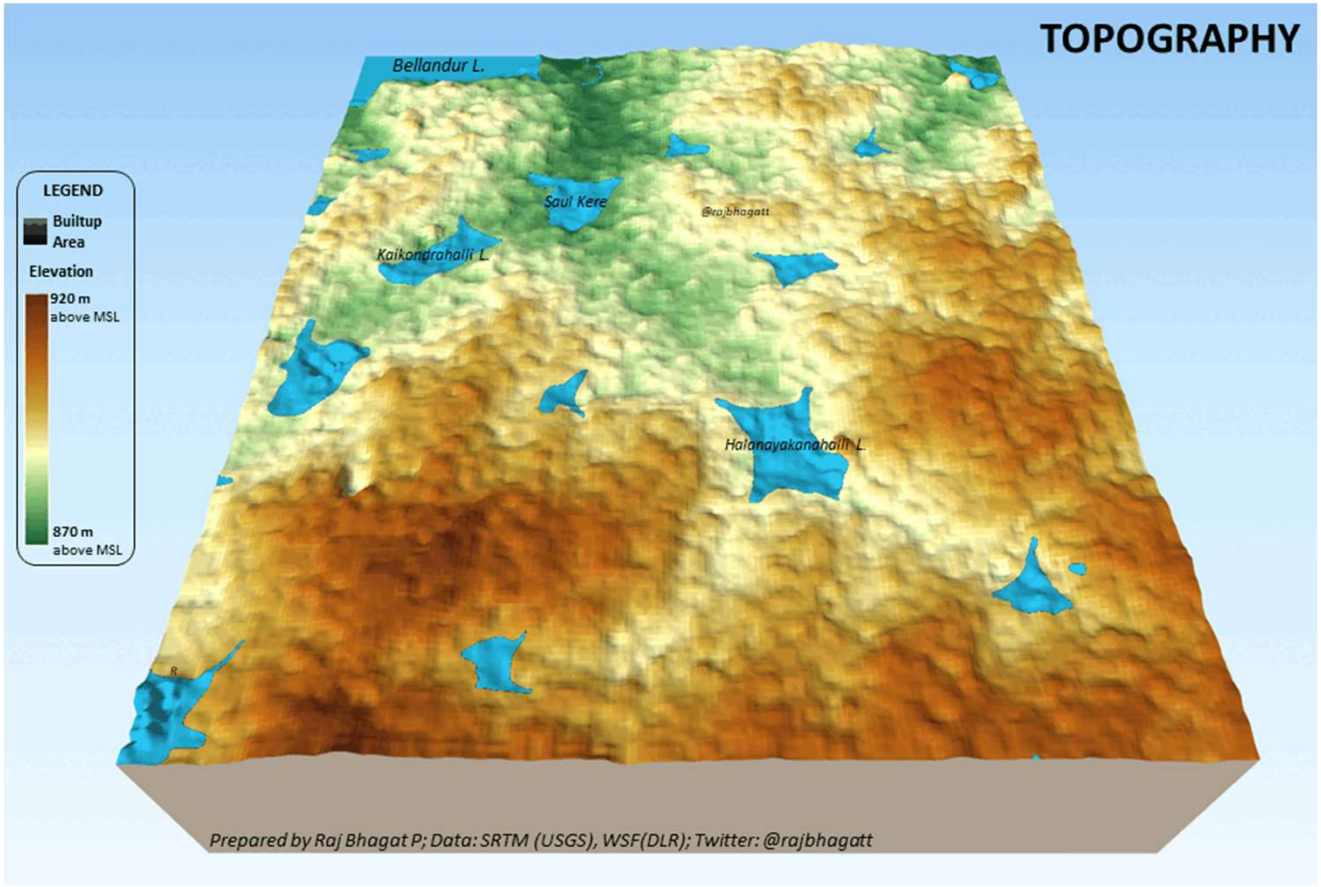
Flood affected area

Water bodies

Source: *Google Earth*

MS0

Changes to Landscape from Natural to Urban and Disruptions to Natural water flows



LEGEND

GREEN LOW ELEVATION

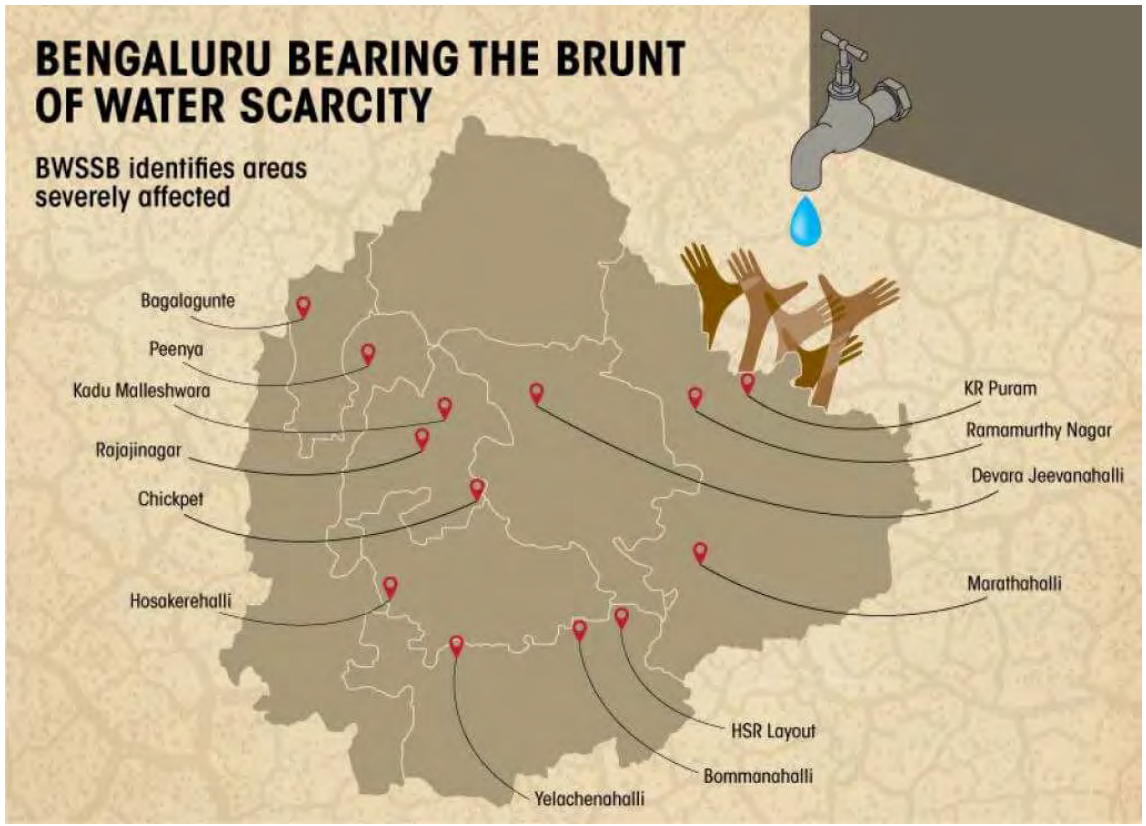
BROWN HIGH ELEVATION

Slide 32

MS0 For the webinar version this is fine, for the self study module we'll take screenshots of this graphic and add text as an explanation. [@Sahana Goswami] can you add the explainer in the notes for the self study module?

Mukta Salunkhe, 2025-03-10T12:40:37.478

When not Underwater, Bengaluru is Struggling with Water Scarcity



Groundwater levels in Bengaluru set to plummet, especially in outer zones

BWSSB appeals to residents to take Cauvery water supply connection

Updated - January 25, 2025 11:11 pm IST - Bengaluru

THE HINDU BUREAU

Source: Down To Earth | *https://www.downtoearth.org.in/water/bengaluru-water-crisis-bwssb-announces-20-water-cut-to-bulk-consumers-identifies-areas-bearing-the-brunt-94973*


A moment of reflection


Too many of the places that face urban floods also face water shortages during dry seasons and hot months

Is stormwater then only a nuisance to be removed? Or a resource to preserve for dry days?

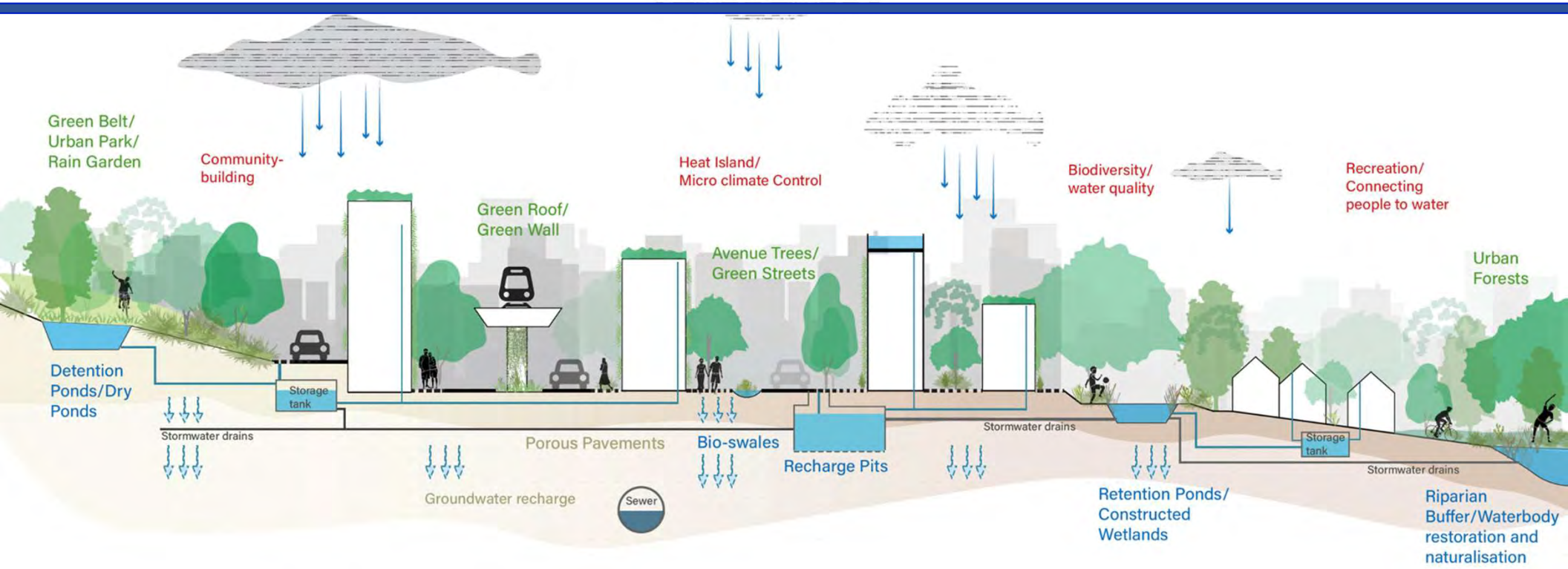
[C] Solution Pathways

Re-Thinking Stormwater Management Approaches

What if we could think of a variety of measures to manage stormwater

so that its harmful impacts are reduced and it can also be conserved for the dry days to follow?

Re-Thinking Stormwater Management Approaches



SLOW	DETAIN	RETAIN	TREAT	RECHARGE	RELEASE
Reduce runoff speed	Hold stormwater temporarily	Store stormwater for use	Improve runoff quality	Replenish aquifers and water bodies	Allow only excess water downstream

Alternative Stormwater Management Approaches

Alternative Stormwater Management Approaches: Sponge Cities

- Sponge cities are urban areas that absorb, store, and slowly release rainwater to reduce flooding.
- They are designed to be more permeable and have more open spaces to store rainwater.

DT0

Case Example: Sponge Cities China

Qnuli Stormwater Park, China

Haikou Meishe River - before and after shots of the 'sponge city' hotspot

Tianjin Wetland Park, China

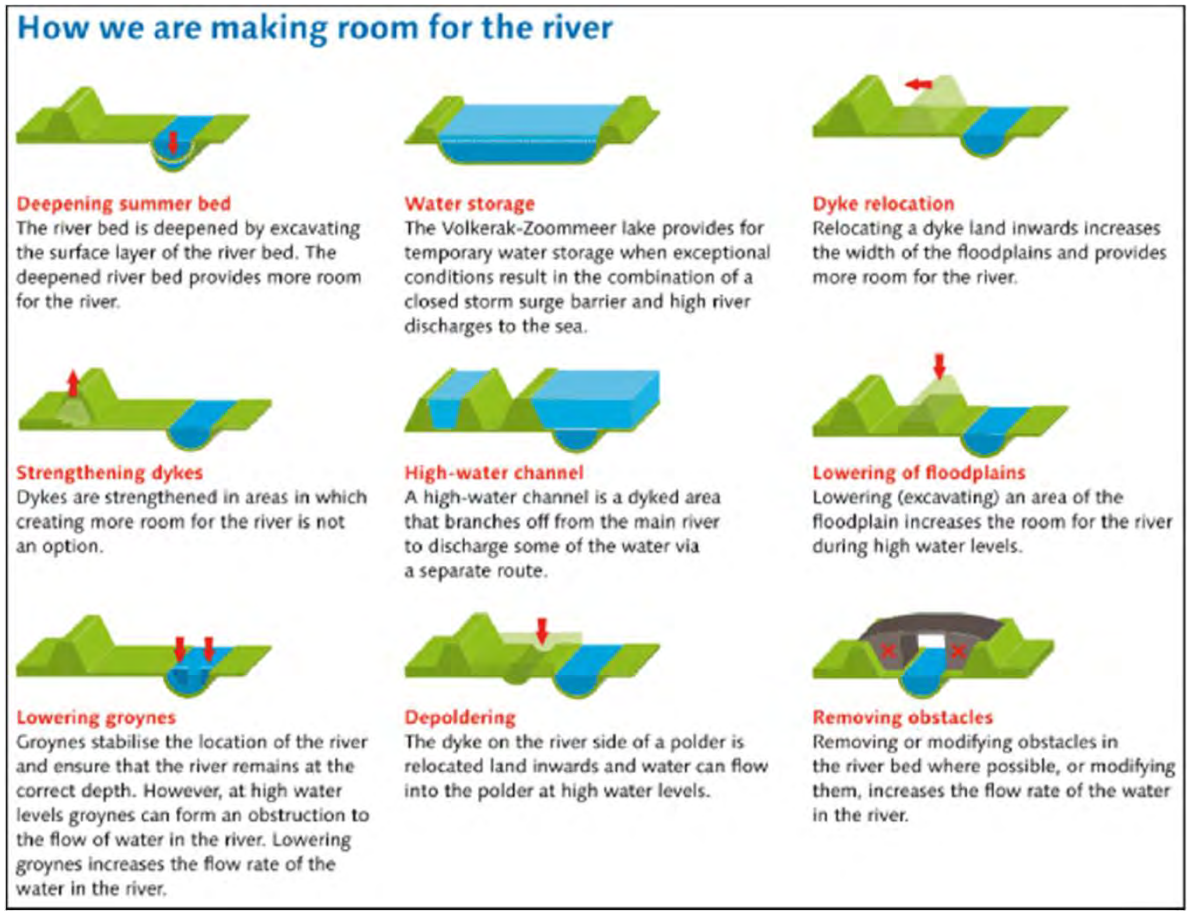
- By 2030, China aims for 80% of urban areas to absorb and reuse at least 70% of rainwater
- Over 30 cities, including Beijing, Shanghai, and Wuhan, have adopted sponge city strategies

Source: *https://www.euronews.com/green/2022/10/22/china-s-sponge-cities-are-a-revolutionary-rethink-to-prevent-flooding*

Slide 42

DT0 can it be in Urban flooding ppt?
Deepti Talpade, 2024-10-24T08:56:07.435

Alternative Stormwater Management Approaches: Room for Rivers



Source: https://www.forestandbird.org.nz/campaigns/room-rivers

- Making room for rivers allows the land adjacent to rivers to flood safely, while providing for a whole range of other benefits such as riparian planting, wetland restoration and carbon sequestration, increased groundwater recharge, river habitat restoration for native fish and birds, and more recreation opportunities for people.

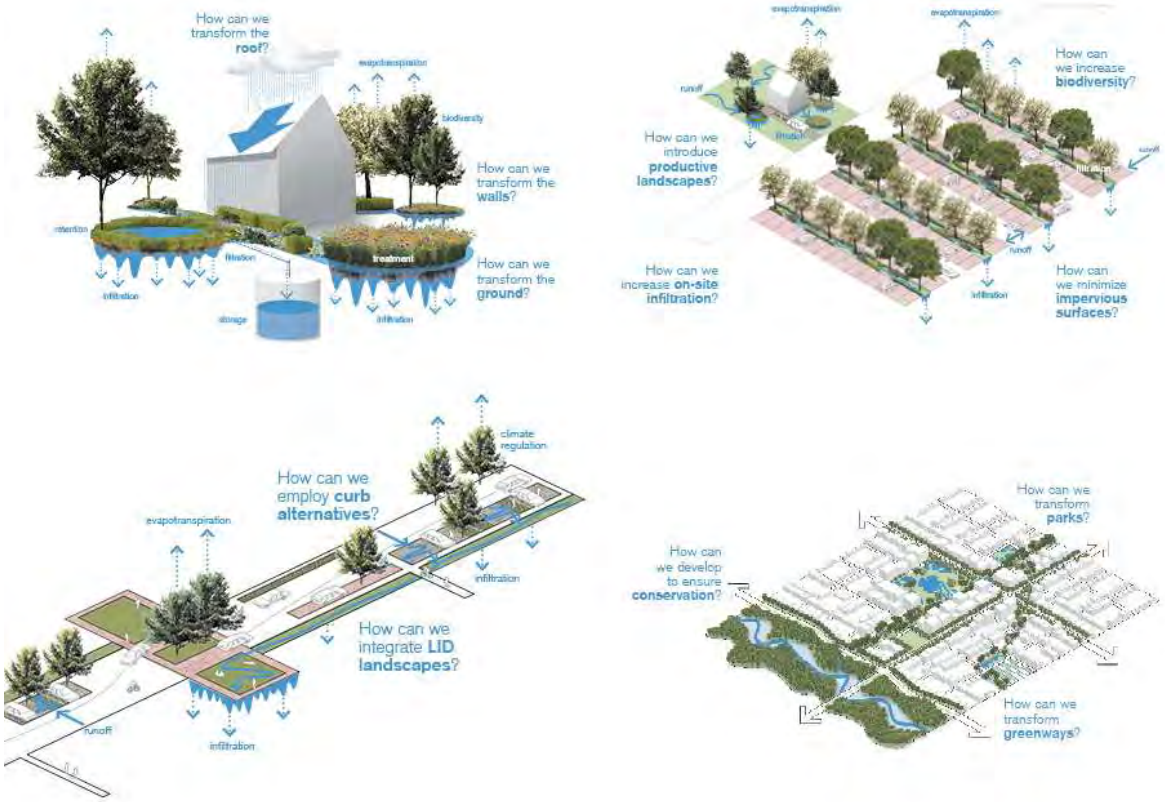
Case example: Making Room for the Mithi River, Mumbai, India

Space for the river to swell

A maidaan for holding stormwater

- The Mithi is an urban river in Mumbai which is heavily altered.
- A reimagined vision for the river finds spaces where the river can "swell" during heavy rainfall and recreational lands, such as a *maidaan* (playground), can detain excess stormwater when a river levels rise rapidly.

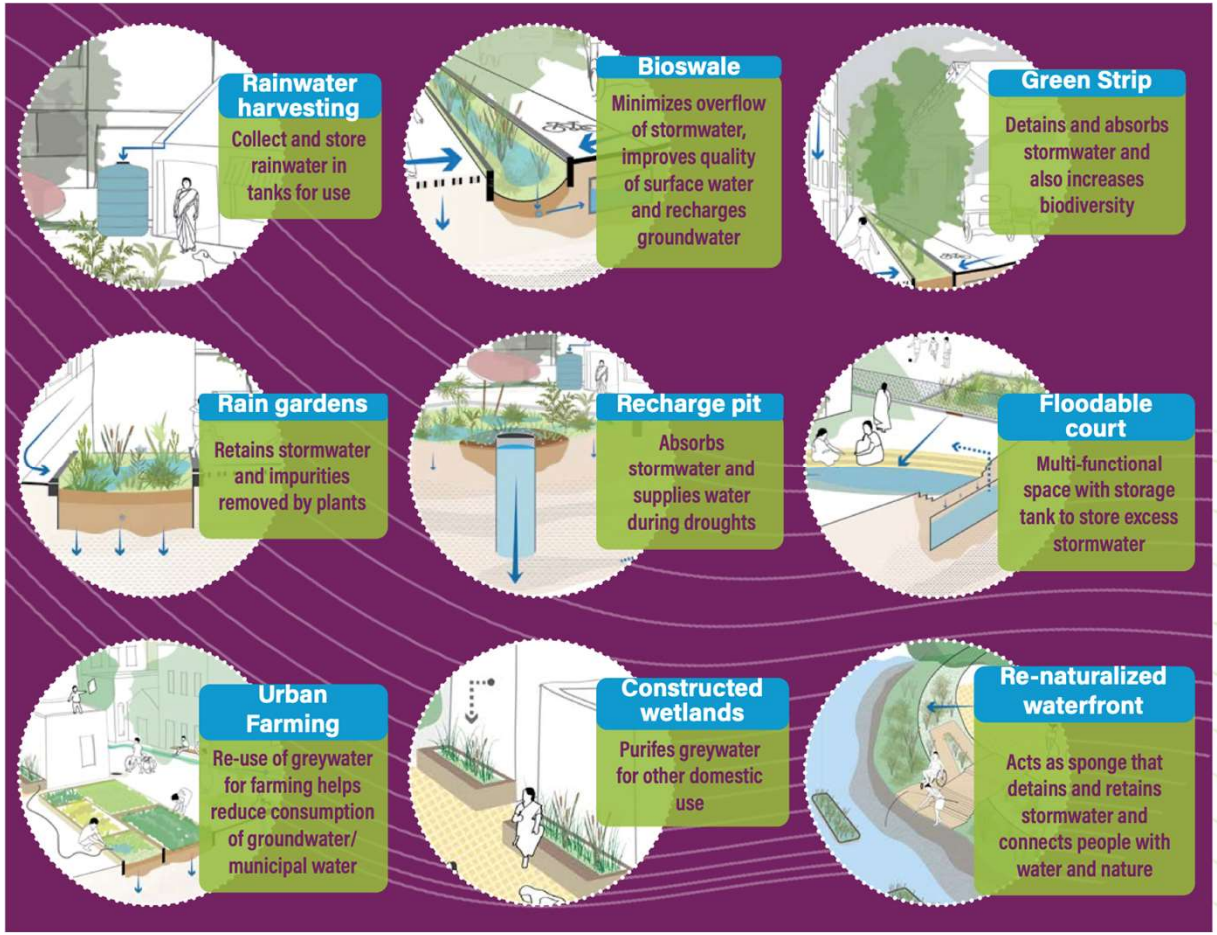
Alternative Stormwater Management Approaches: Low-Impact Developments(LID)



- Low impact development (LID) is a land planning and design approach that uses natural processes to protect water quality and aquatic habitats.
- LID aims to mimic a site's pre-development hydrology by using techniques that filter, store, and evaporate stormwater.

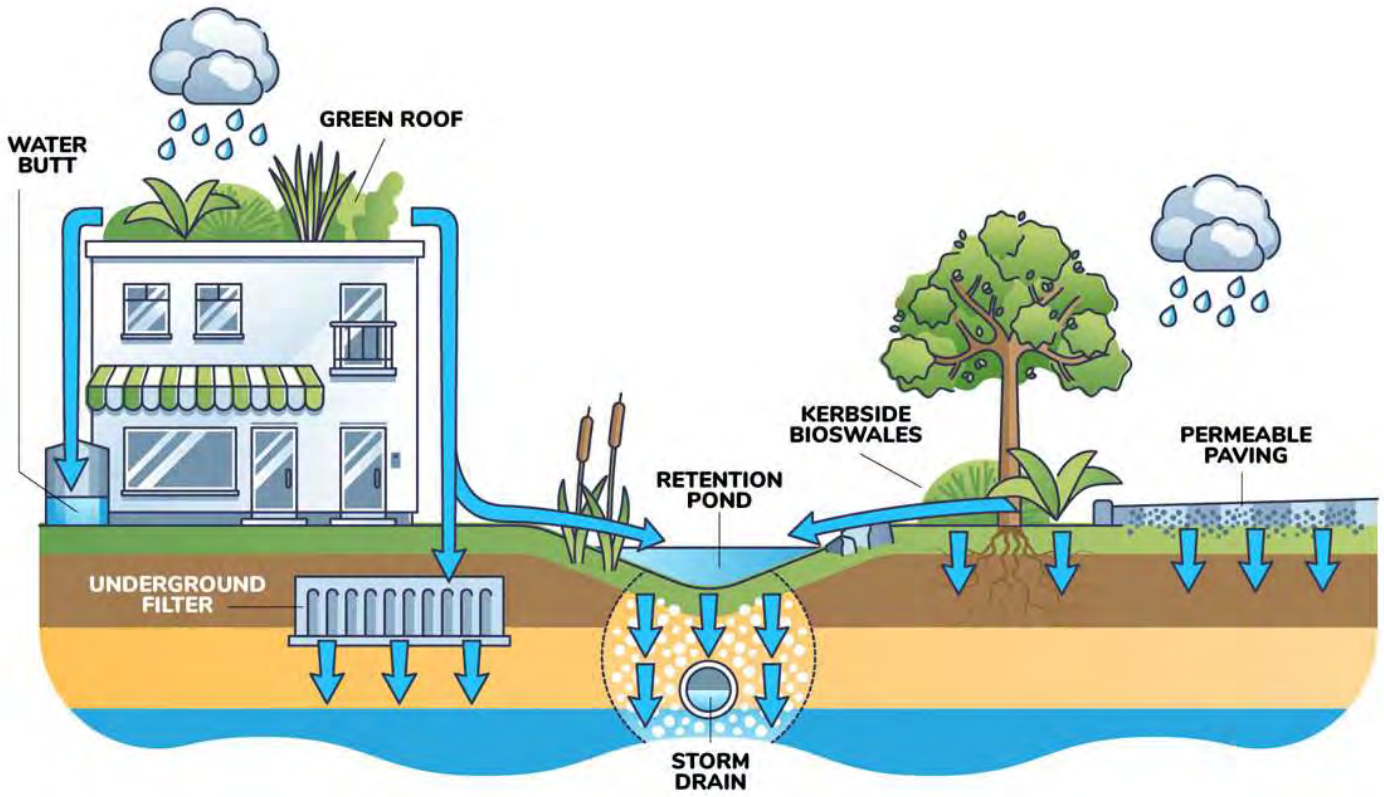
Source: *http://uacdc.uark.edu/work/low-impact-development-a-design-manual-for-urban-areas*

Alternative Stormwater Management Approaches: Water Sensitive Urban Design (WSUD)



- Water sensitive urban design (WSUD) is a planning and design approach that integrates water systems into urban environments.
- WSUD aims to reduce the impact of development on water resources and improve water quality.

Alternative Stormwater Management Approaches: Sustainable Urban Drainage Systems (SUDS)



- Sustainable Urban Drainage Systems (SUDS) are a network of green spaces and engineered areas that manage surface water. They are designed to mimic natural water processes to reduce runoff and improve water quality.

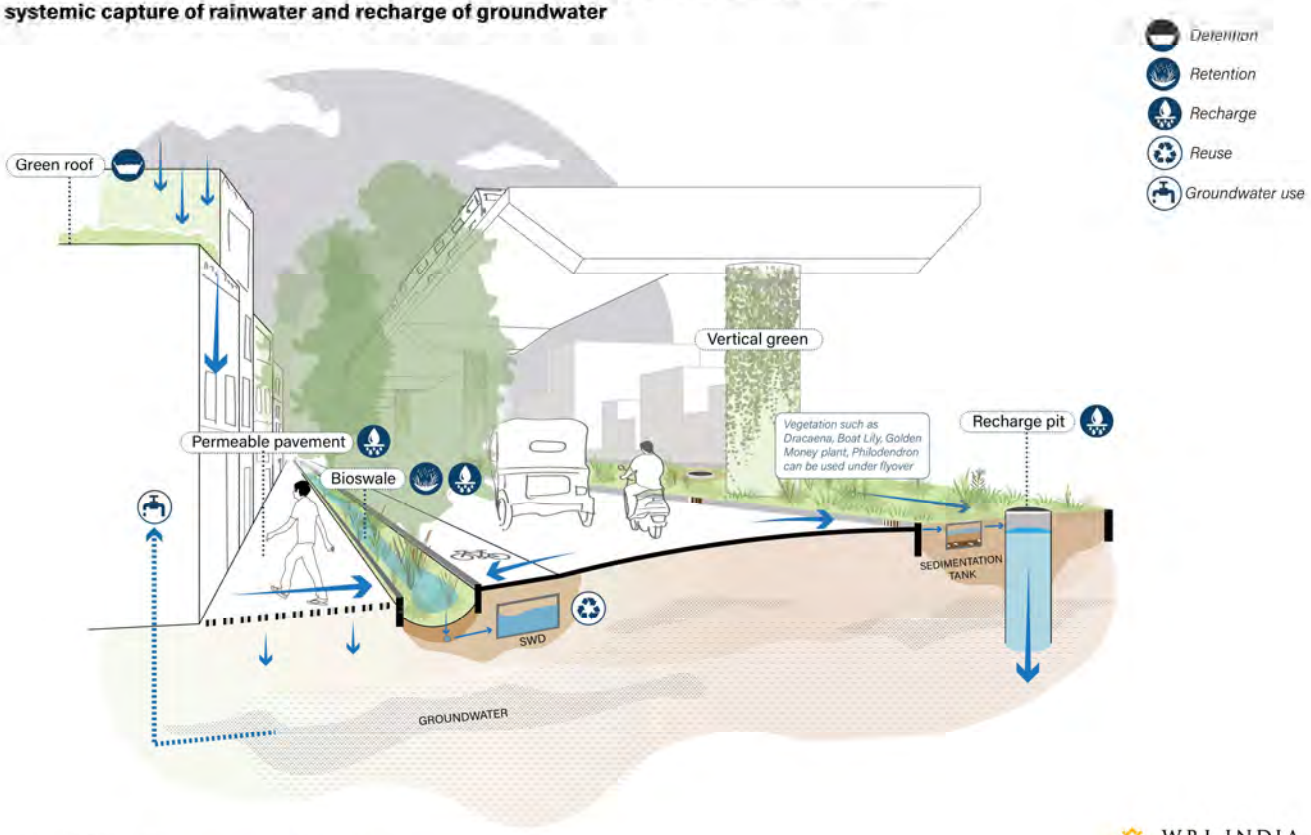
Scales of Intervention for Urban Stormwater Management

Scales of Intervention for Urban Stormwater Management: Watershed and regional interventions

- Flood management for urban areas often requires large watershed scale interventions such as river restoration with re-naturalizing floodplains, wetland conservation and daylighting covered streams.

Scales of Intervention for Urban Stormwater Management: Citywide Network Solutions

Interlinking transit corridors, building roofs, and neighbouring unused urban spaces for systemic capture of rainwater and recharge of groundwater

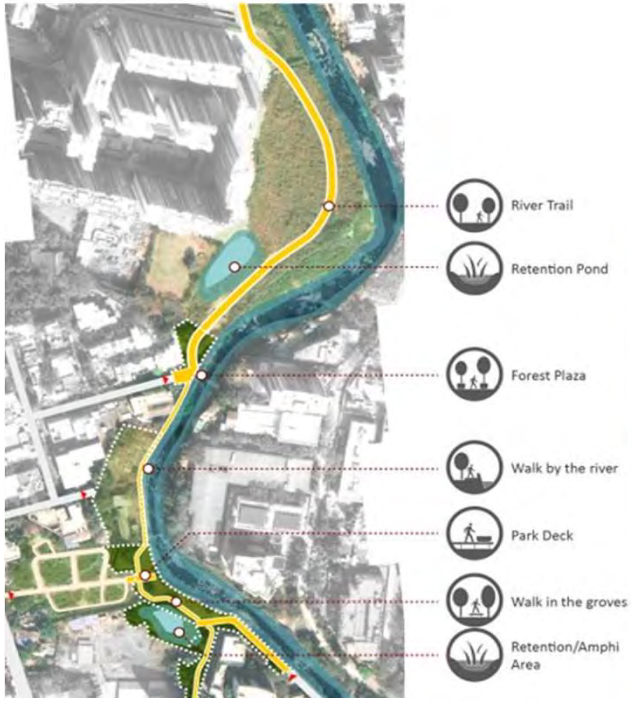


Source: WRI India. Illustration created by Sindhuja Janakiraman

WRI INDIA
ROSS CENTER

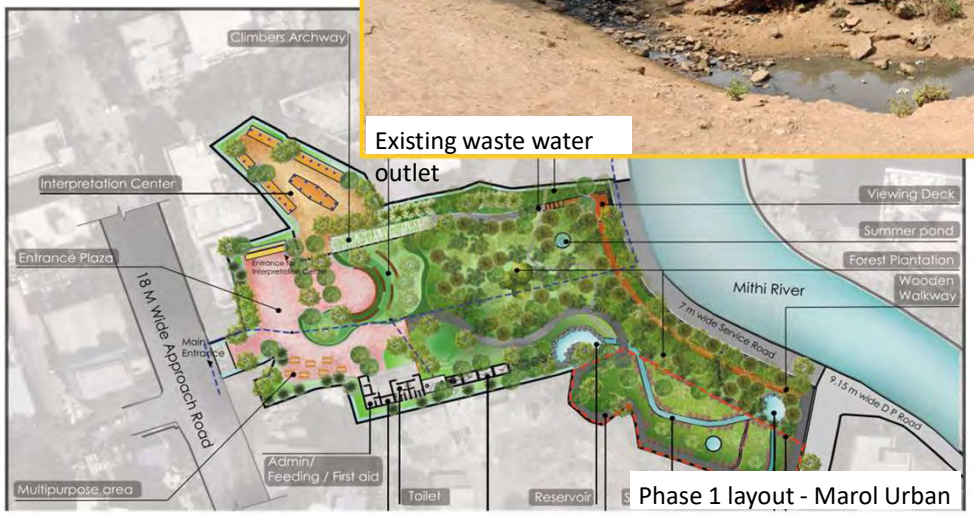
- City-scale flood management solutions typically involve a combination of structural measures like improved drainage systems, underground tunnels, alongside nature-based approaches like wetlands, flood pools, bioswale, street side rain gardens, and permeable pavements.

Case example: Increasing Absorptive Landscapes Along the Mithi River



Vision for Marol Urban Forest – 1 km stretch

Existing waste water outlet



Phase 1 layout - Marol Urban Forest

Landscape interventions particularly around greening and vegetation have added co-benefits of heat mitigation, micro-climate control and potentially air quality improvements

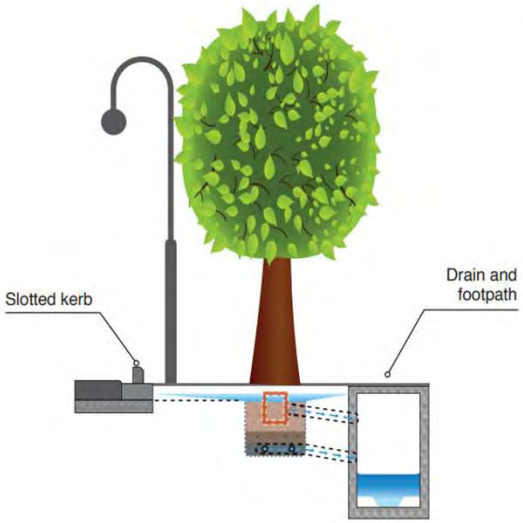
Case example: Increasing Absorptive Landscapes Along the Mithi River

Retaining pond

Forest, elevated boardwalk

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

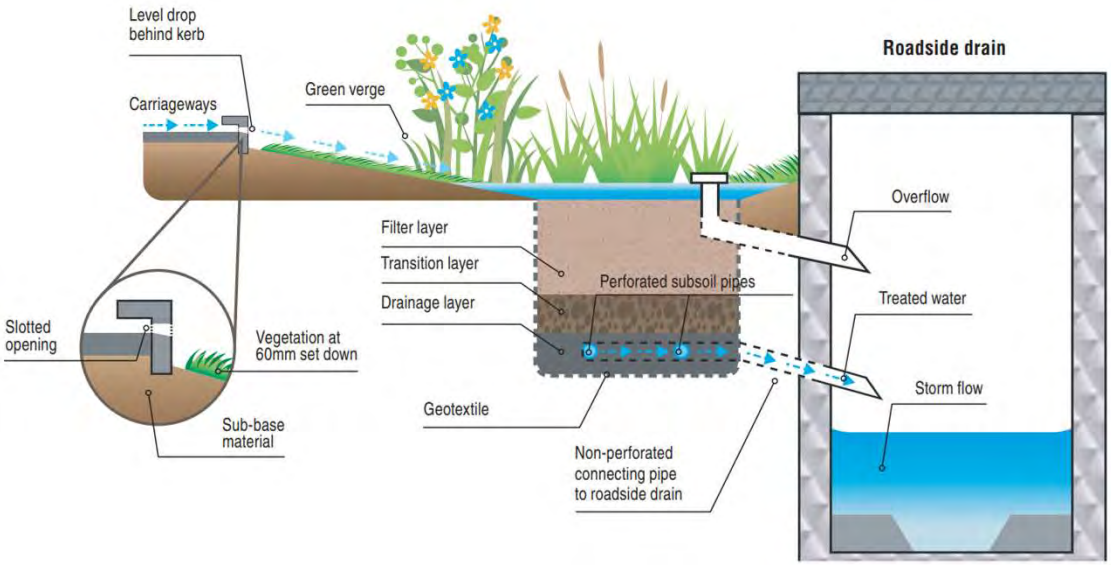
Roadside Blue-Green Infrastructure



Design of rain gardens along roads, which increases green cover along roadside and slows the surface-runoff, increasing permeability.

Source: pub.gov.sg/-/media/PUB/Reservoirs/ABC/PDF/Condensed_Booklet_of_Engin_Procedures.pdf

Roadside Blue-Green Infrastructure



Multi-functional roadside landscape. Increasing green cover and permeable surface along with road safety and greening.

Street side rainwater harvesting structures in Chennai, India

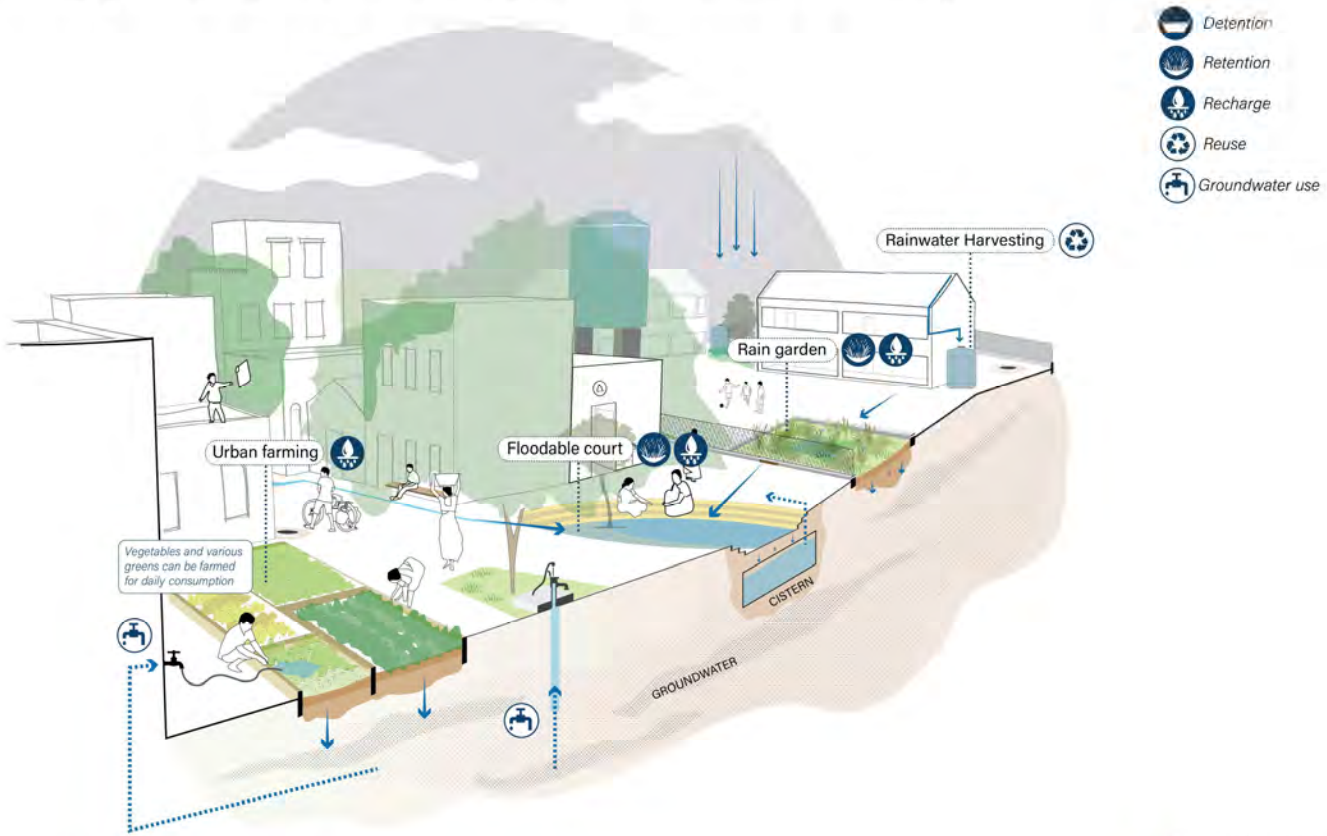
Application

- Roadside landscape on footpath
- Median landscape
- Traffic island landscape
- Retention areas

Source: pub.gov.sg/-/media/PUB/Reservoirs/ABC/PDF/Condensed_Booklet_of_Engin_Procedures.pdf

Neighborhood Projects

Leveraging small open spaces to act as temporal grounds for water to benefit the community



Source: WRI India. Illustration created by Sindhuja Janakiraman

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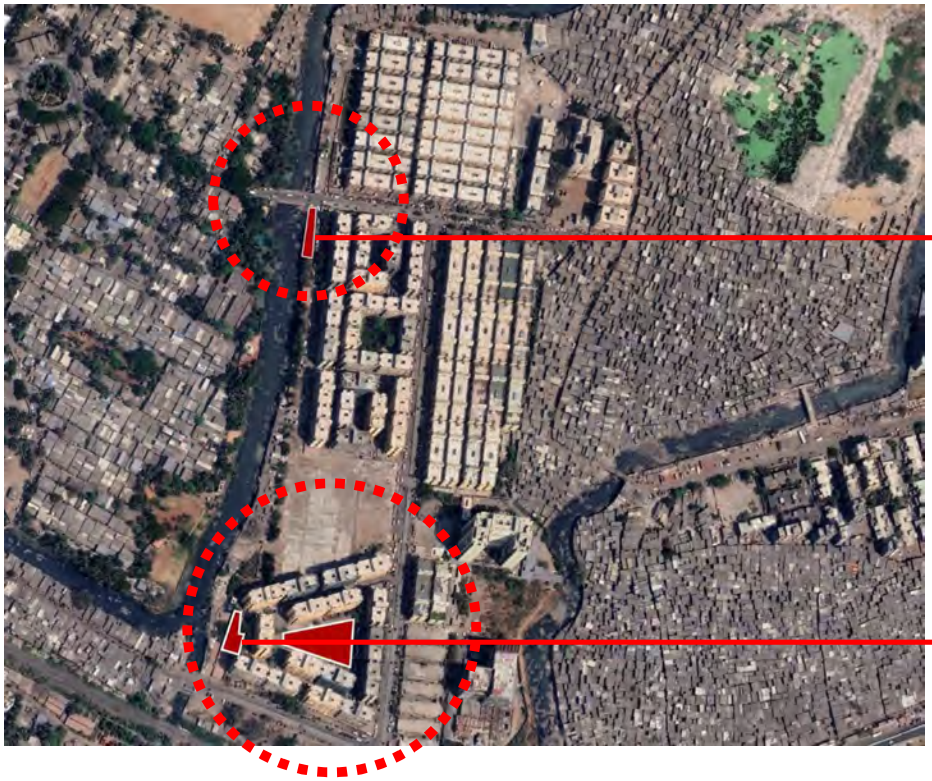
Neighbourhood scale flood solutions focus on managing stormwater runoff through nature-based approaches like rain gardens, bioswales, permeable pavements, green roofs, and improved drainage systems.

Case example: Lallubhai Compound as ‘Sponge infrastructure’, Mumbai, India



- **Lallubhai Compound** is a Rehabilitation and Resettlement colony located in Mankhurd, Mumbai.
- **Holistic solutions for greening** were proposed and carried out in two plots to address flooding and heat issues together

Case example: Lallubhai Compound as ‘Sponge infrastructure’, Mumbai, India

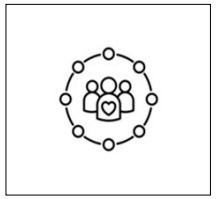
Proposed Landscape Master Plan with context of Nala Scale 1:250

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

BIODIVERSITY RESTORATION

WATER MANAGEMENT

WASTE MANAGEMENT



PEOPLE CENTRIC APPROACH

Property Scale Projects

Image: Lamiot, Wikimedia Commons

A **property-scale rainwater harvesting** project involves capturing, storing, and utilizing rainwater runoff from a property's surfaces, primarily rooftops, for various purposes. This can range from simple residential setups to more complex systems for larger properties like commercial buildings or agricultural lands.

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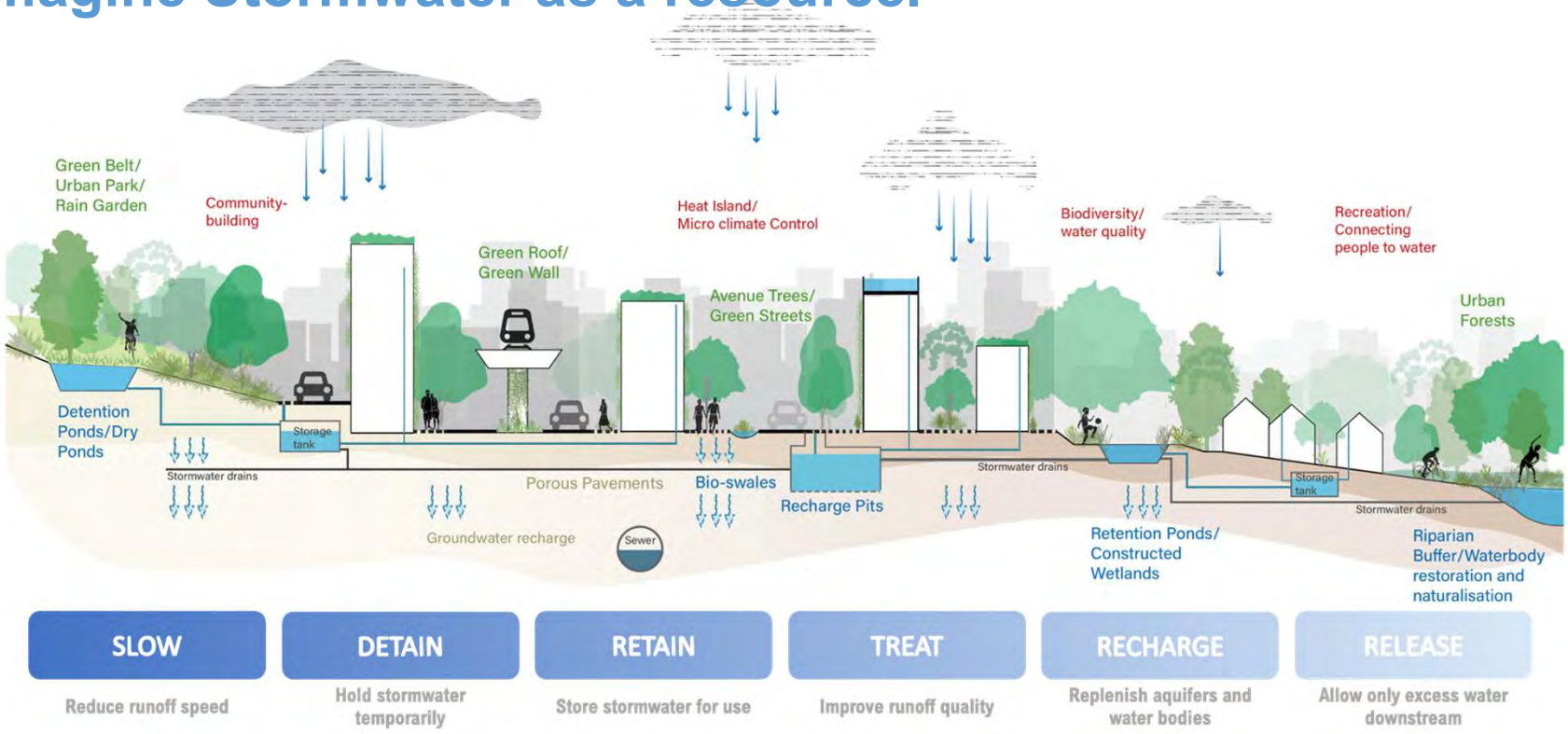
Call to Action

Reimagine Stormwater as a resource.



Drain it as the last resort

Call to Action

Urban Practitioner

- Test and measure effectiveness of drainage alternatives for stormwater management methods
- Explore NBS as augmentation to improve conventional drainage solutions

City Planners

- Enable integration of NBS in stormwater management practices
- Apply a range of (integrated) solutions for stormwater management instead of only drainage solutions
- Develop policy for encouraging property level runoff reduction practices

Community

- Be good stewards and be involved in monitoring and upkeep of stormwater infrastructures (both grey and NBS)
- If stewarding, managing or owning large properties implement on-site stormwater management practices to reduce load on municipal stormwater systems
- Be champions of alternative measures to simultaneously improve stormwater management and reduce water scarcity

Contact Us

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Panel Discussion

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Chennai (India)

Natasha Naidu
Johannesburg
(South Africa)

Mesalin Maimbu
Jayapura (Indonesia)

Moderator: **Dr Priya Narayanan**
WRI India

Hadibandhu Behera
Odisha State (India)

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Closing Remarks

Mukta Salunkhe

- Materials from all three webinars will be made available as self-study capacity building learning modules on the UrbanShift website in the next month
- Video recordings of previous webinars are available

SCAN ME

How to Conduct a Climate Hazard Vulnerability Assessment

SCAN ME

Urban Heat and Greening

URBAN SHIFT

Thank you! J(0

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Slide 64

J(0 [@Urvi Patel] update this. Priya, Mukta, Sahana. Thanks

John-Rob Pool (He/Him/His), 2025-03-24T10:47:44.674

TITLE OF PRESENTATION

URBAN SH/FT