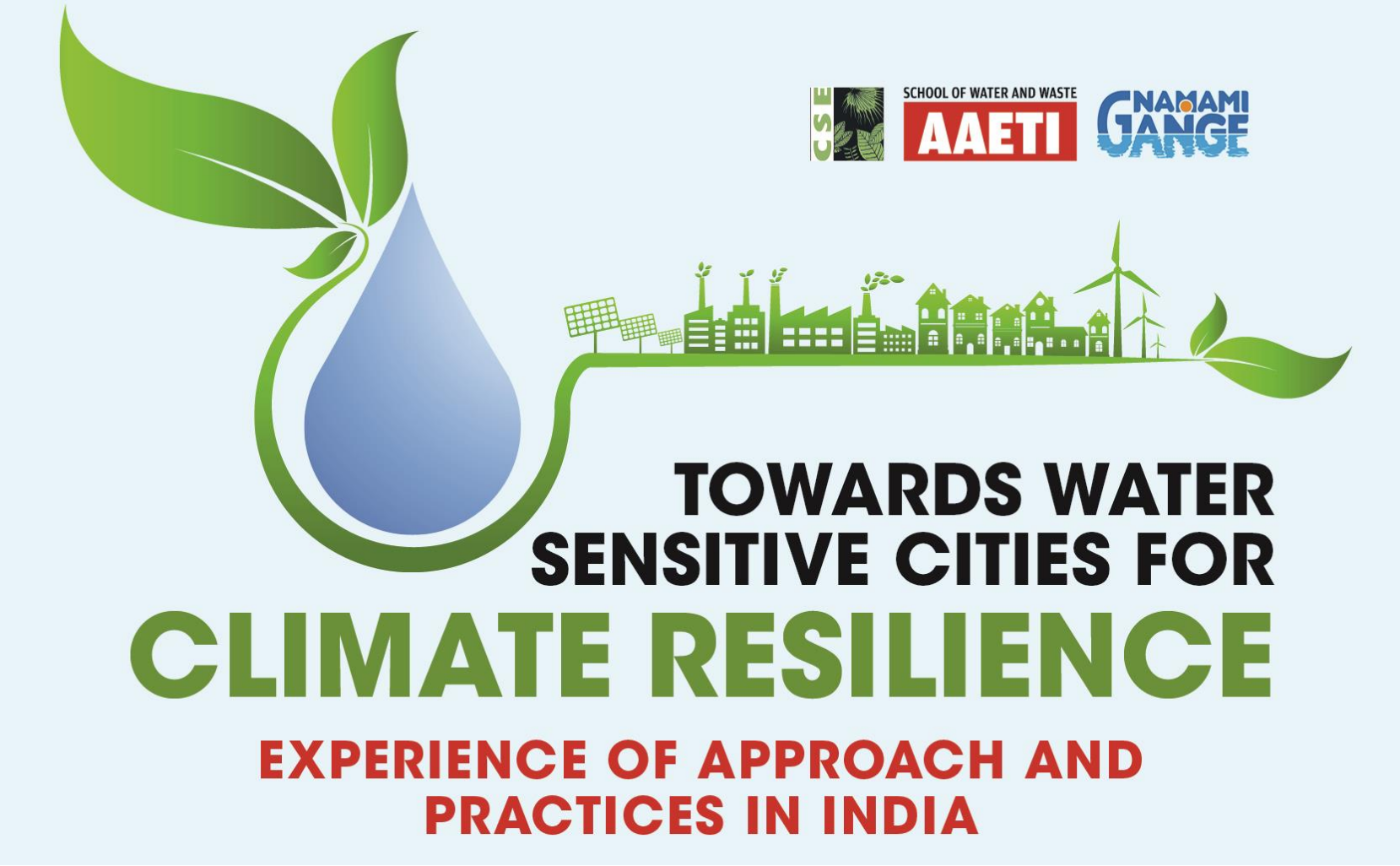
CSE-NMCG Webinar



Stormwater Harvesting in Parks and Open Spaces: Experiences from India

Dhruv Pasricha, Deputy Programme Manager, Urban Water; dhruv.pasricha@cseindia.org

Structure of Presentation

This presentation will give you all a quick overview of CSE's WSUDP approach, and research on stormwater harvesting in parks and open spaces.

- Why WSUDP and GI?
- CSE's research – Moving towards WSUDP and Green Infrastructure
- WSUDP for Climate Resilience
- Stormwater Harvesting in Parks and Open Spaces
- Case studies: Delhi, Uttar Pradesh
- Way forward

Co-existence of Water Problems - Shortage & Abundance

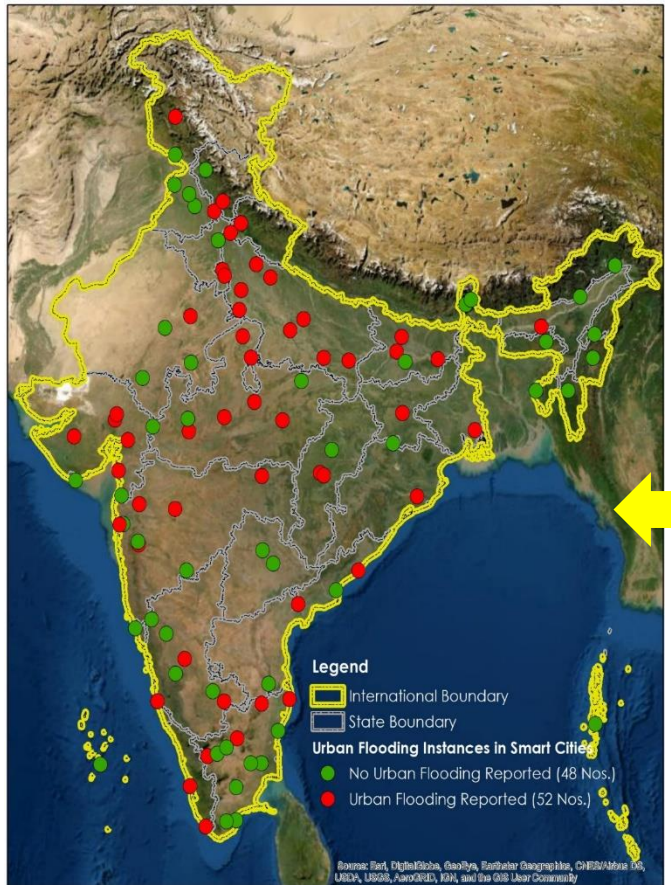
No city has 24x7 water supply

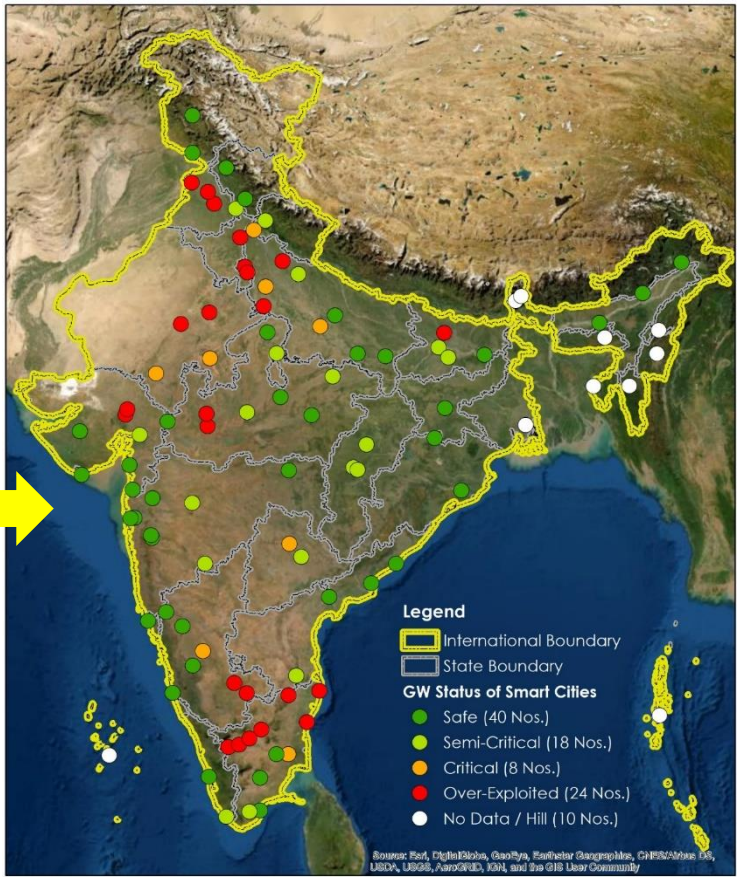
Groundwater Exploitation, More recharge – **40 % India falls under dark zone**

Heavy rain causes waterlogging at Ring Road near Sarita Vihar in Delhi. (TOI photo)

Drainage Scenario

Urban Flooding Incidences & Status of Groundwater





Urban Flooding Incidences

Status of Groundwater

Emerging Urban Scenario

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Urbanisation and Increase in Built up Area

Largest cities significant population and built up area both are outside ULB boundaries

Most cases proportion of built up area is greater then the population outside administrative boundaries implying low density sprawl

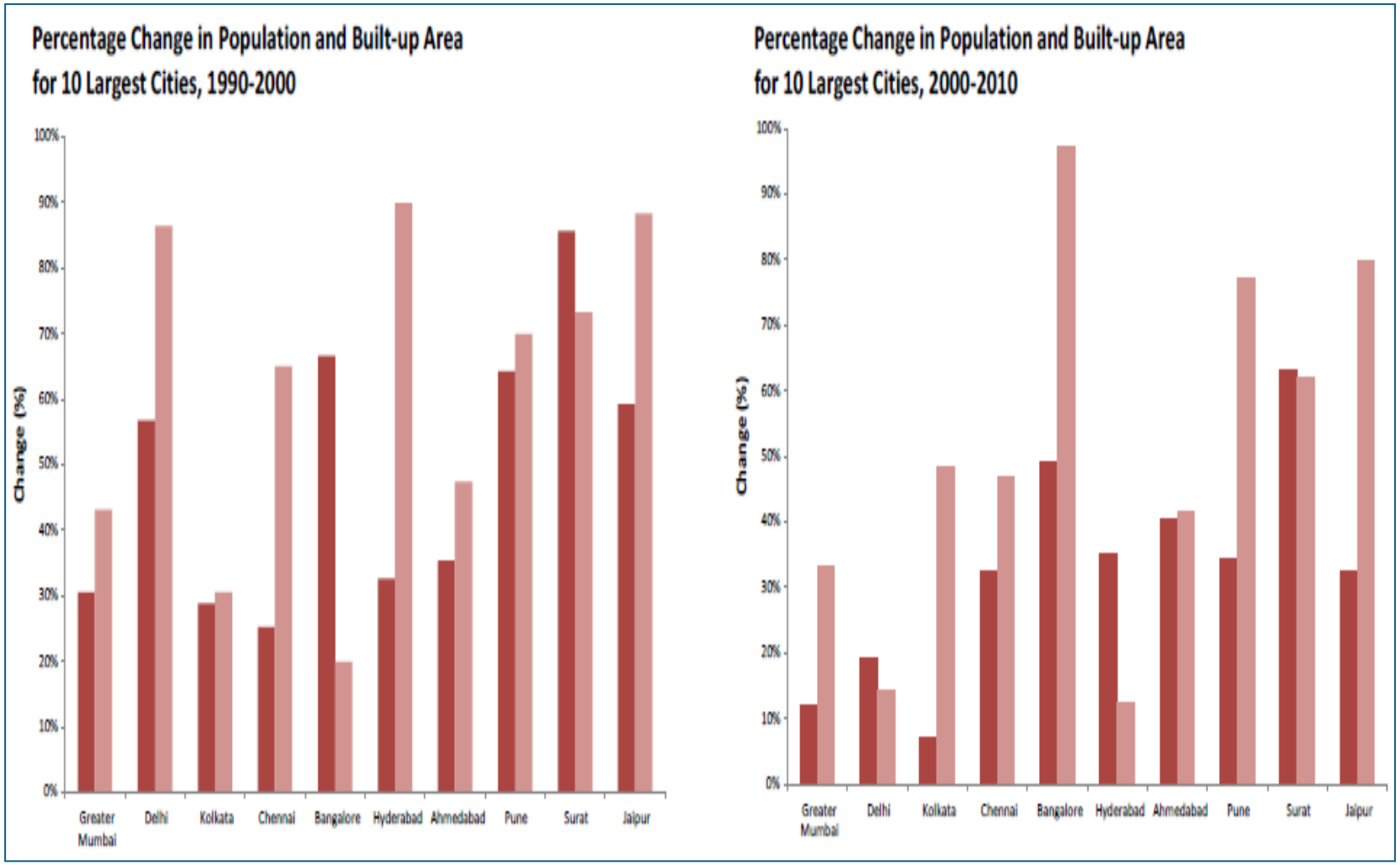
Land /city development process that takes more than two decades or even more

Spatial expansion has accelerated in top ten largest cities from 2000-10

Built up density is decreasing for most of core areas of largest ten cities

Evolution of density outside ULB boundaries varies more, but is less then city cores.

Source: Aromar Revi 'Urban India 2011 - Evidence, IIHS Publication (2012)



Built up area has been growing faster than population in nearly all of India's the largest cities in past two decades.

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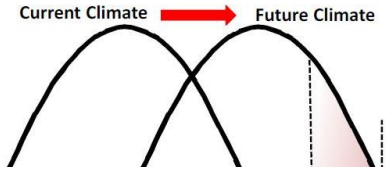
Climate Change?



CLIMATE CHANGE

Wet century ahead: Extreme rainfall here to stay for Western Ghats, North East

Extreme rainfall events have become more frequent since the 1980s, the analysis noted

NEXT NEWS >

By Rohini Krishnamurthy
Published: Tuesday 23 August 2022

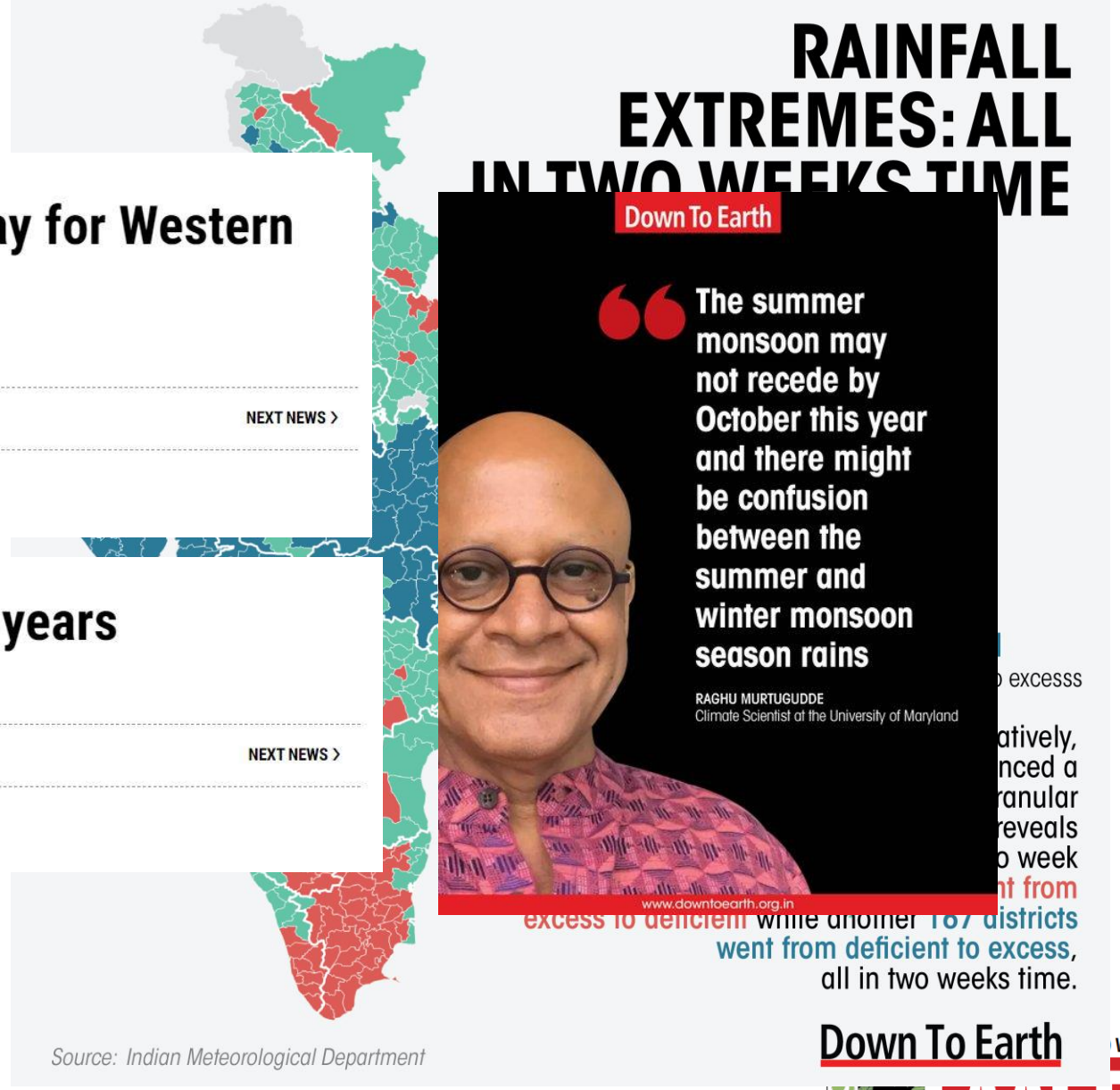
CLIMATE CHANGE

North East India records lowest rainfall in 122 years

The IMD predicts that below-normal rainfall will persist over the remaining part of August

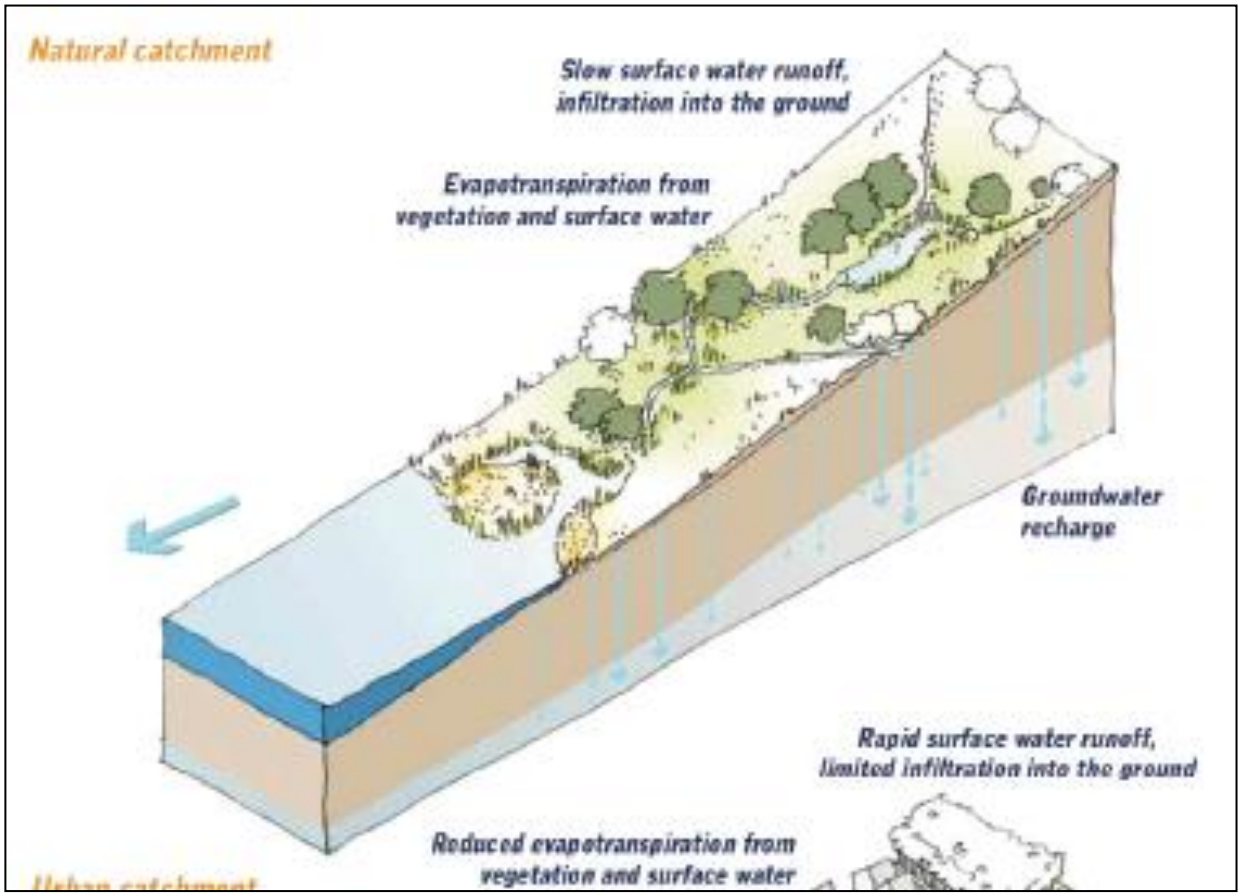
NEXT NEWS >

By Himanshu Nitnaware
Published: Tuesday 23 August 2022

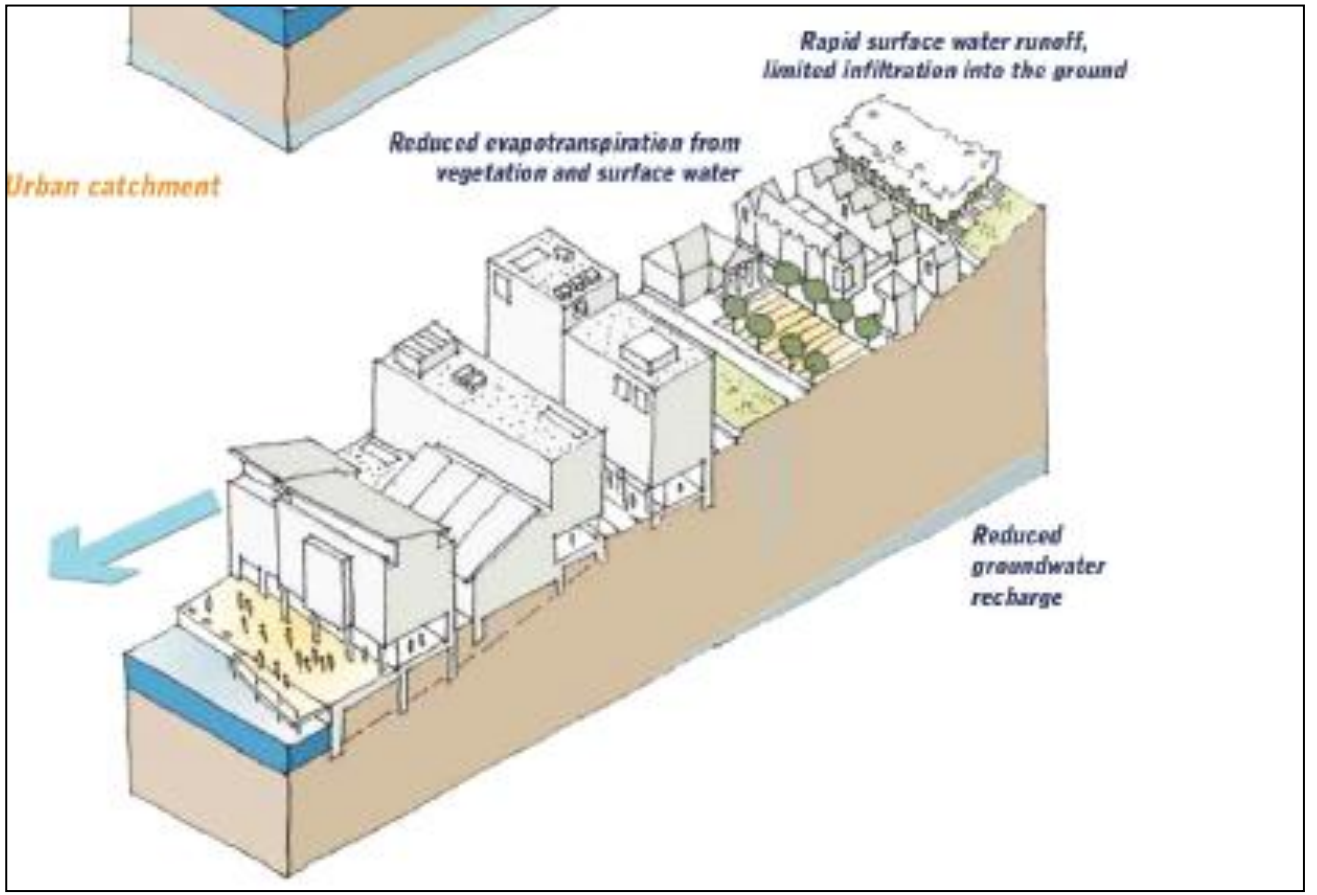


Natural Catchment v/s Urban Catchment

Natural catchment



Urban catchment



Urban development can be planned and executed so as to **lower the hydrological impact of urbanization by using current opportunities** to increase the carrying capacity of the area in terms of **improved water management**

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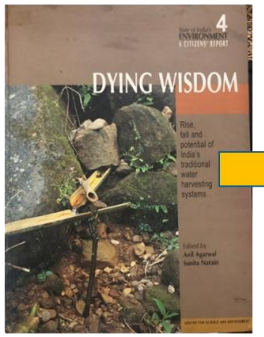
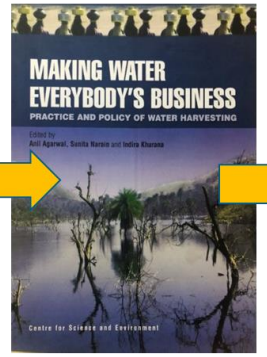
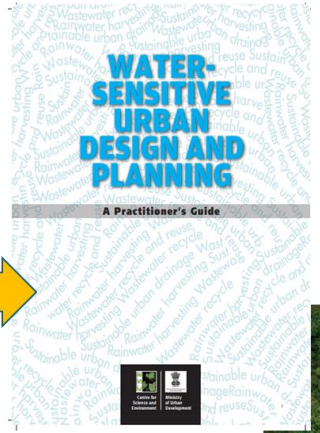
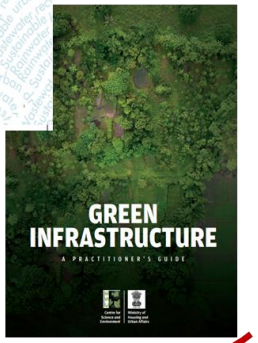
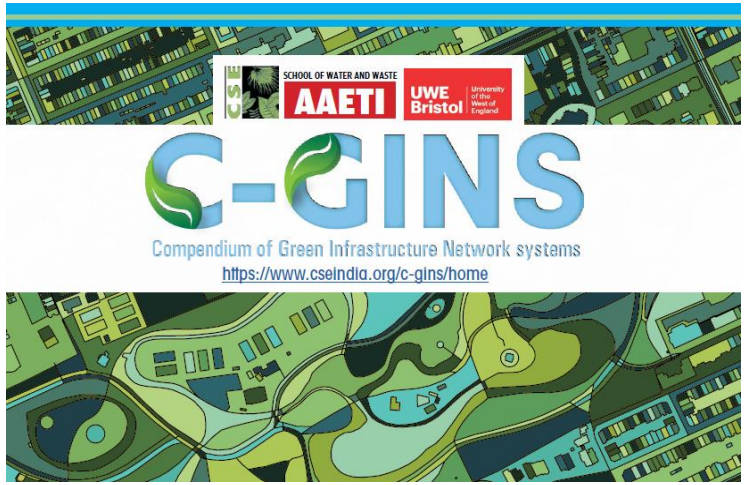
CSE Research: Mainstreaming WSUDP in India - Policy & Practice

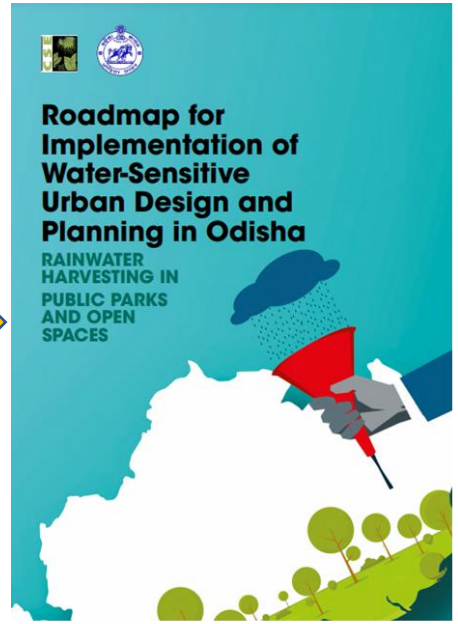


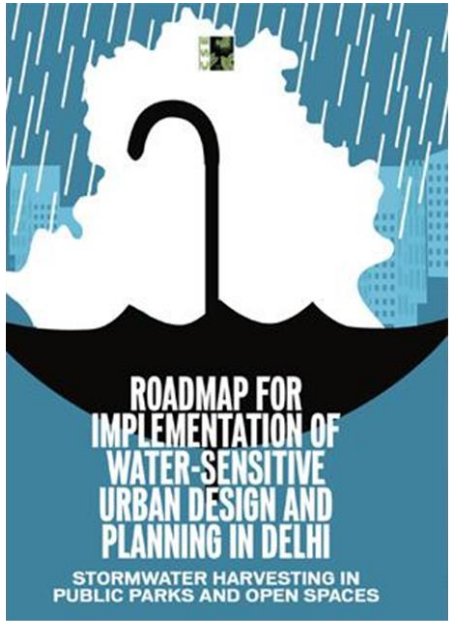


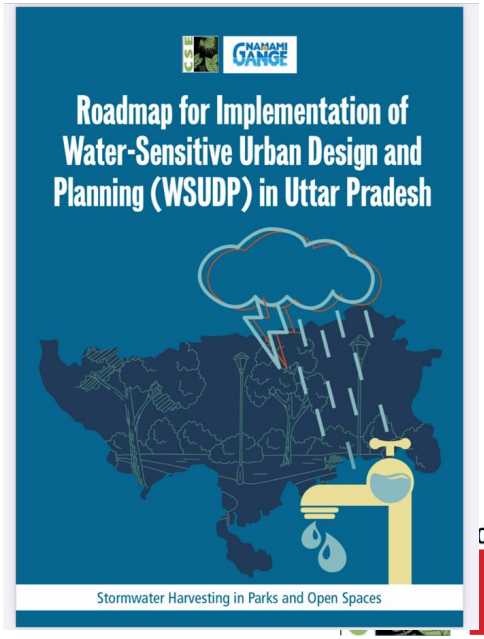












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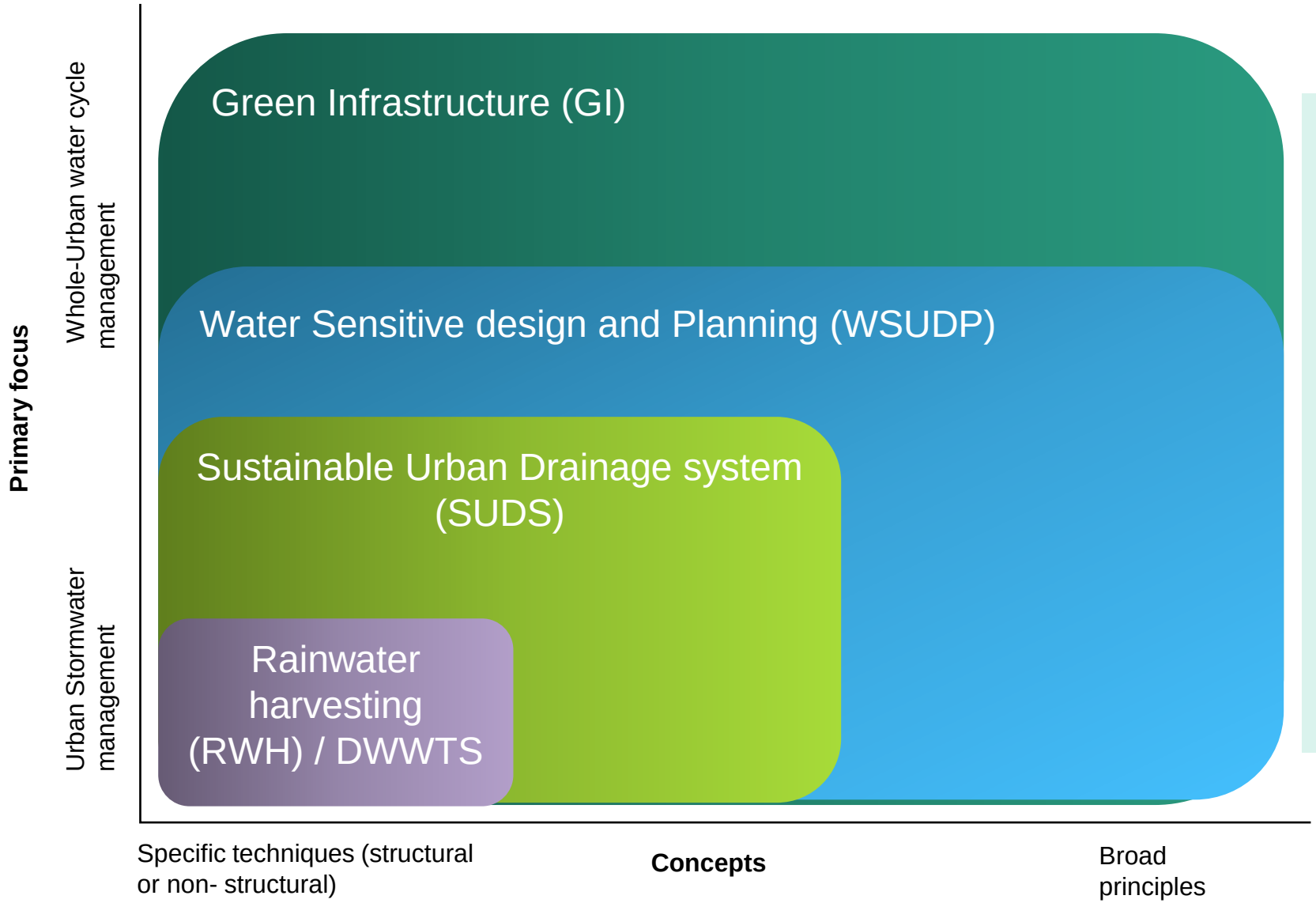
WSUDP, GI and other overlapping terms



All terms are generally underpinned by two broad principles:

1) Mitigation of changes to hydrology and evolution towards a flow regime as much as feasible towards natural levels or local environmental objectives

2) Improvement of water quality and a reduction of pollutants.

What is WSUDP? CSE believes…

- Protecting local water bodies (lakes, ponds and wetlands) for supplementary water sources
- Storm-water management at public places, including open areas in cities
- Recycling and reusing wastewater naturally (low cost/low energy) and not treating it as a liability
- Increasing water-conservation approaches at various scales (buildings/campus). On-site water conservation with rainwater harvesting (RWH) is important to reduce water scarcity.
- Adding value to the social and ecological aspects of areas by planning and designing the built environment in accordance with community needs and water issues
- Connecting the urban water cycle by collaborating with practitioners of different disciplines to bring different perspectives and expertise
- Associating upcoming policies, regulations and approvals with WSUDP.

WSUDP is an approach that integrates and optimizes the use of available water sources and completes the water cycle by incorporating the following in planning and designing.

Integrating water-cycle management

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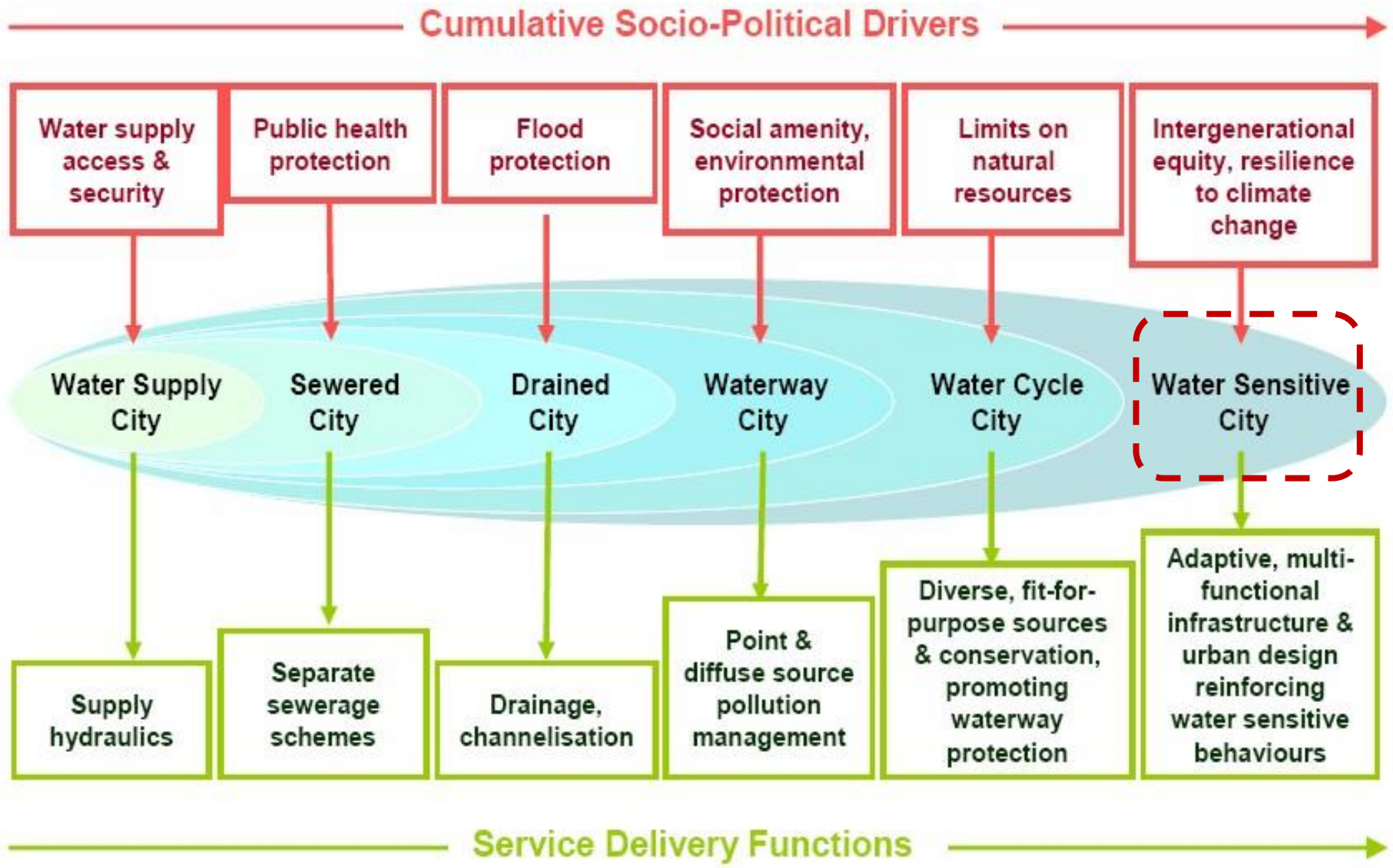
What is WSUDP? CSE believes… social and service delivery



Source: Wong and Brown,11th InternationalConference on Urban Drainage, Edinburgh, Scotland, UK,2008

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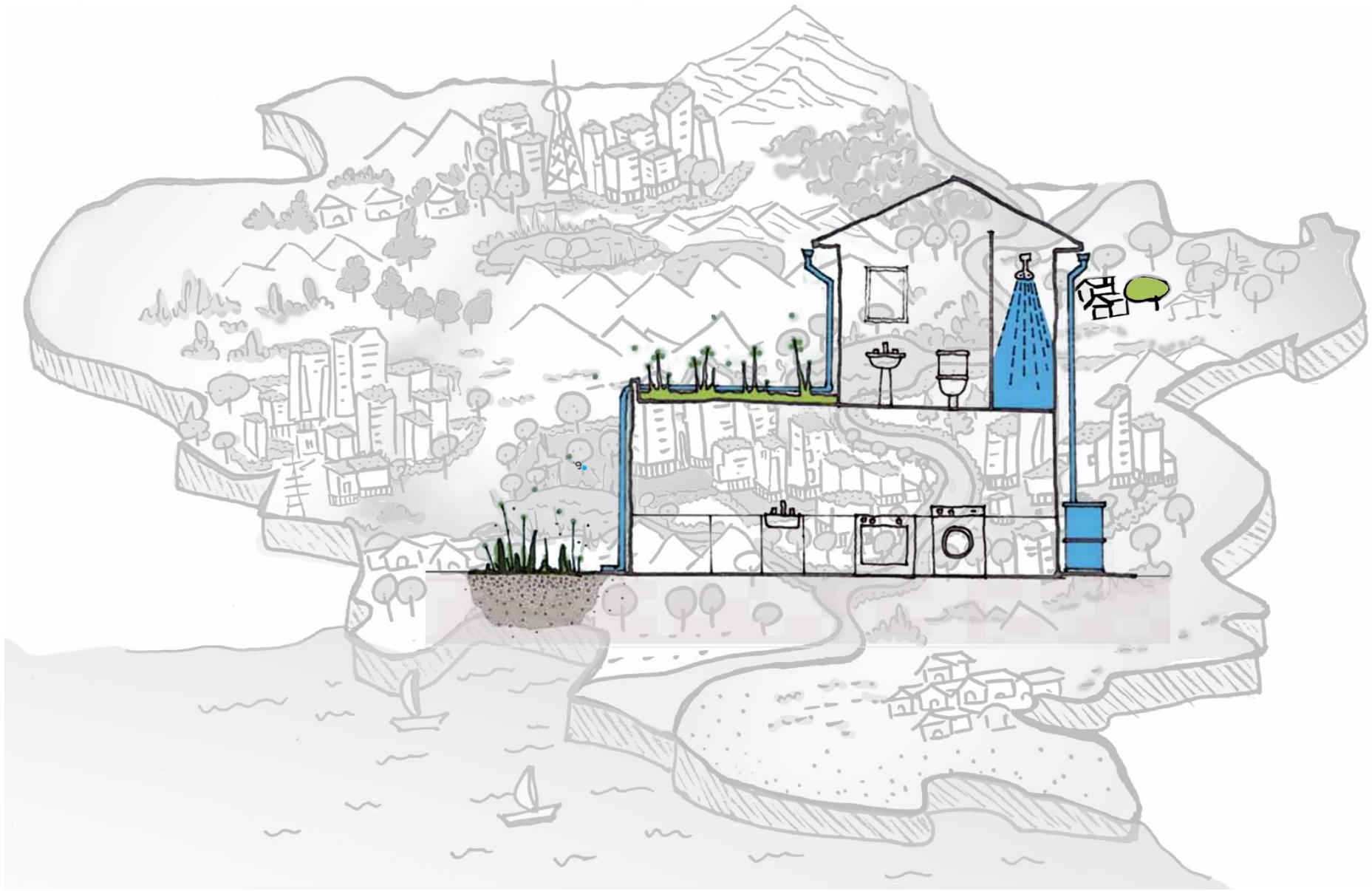
Conventional Practice v/s WSUDP Approach

Conventional approach	WSUDP approach
Fragmented approach: Integration is by accident. Water supply, wastewater and storm water may be managed by the same agency as a matter of historical coincidence but physically the three systems are separated.	
Linear urban water cycle: Water follows a one-way path from supply, to a single use, to treatment and disposal to the environment.	
Increased demand: Increased demand is met through investments in resources and centralized infrastructure leading to leakage losses. Water of potable quality is supplied for all uses.	
Storm water as nuisance: Storm water is conveyed away from urban areas as rapidly as possible.	
Bigger/centralized is better: To get water from distant source and then to treat wastewater at far places, thereby increasing the overall infrastructure.	

Comparison between conventional practice and WSUDP **lists the currently practised and WSUDP approaches for managing urban water resources.**

Different scales for implementing WSUDP



Regional

(Medium density: more than 400-400 persons per hectare (pph), catchment...

City/ Zonal

(Medium density: 200–400 persons per hectare (pph), commercial areas…

Neighbourhood

(Institutional/ commercial buildings/ Residential Complexes)

Individual

(Residential buildings (plotted/ four– five storied)

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WSUDP – Concept and Approach

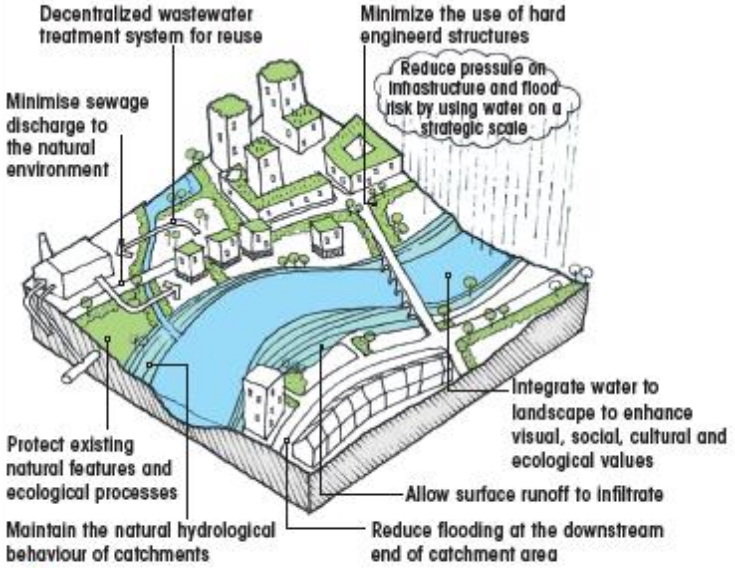
URBAN GROUNDWATER MANAGEMENT

URBAN WATERBODIES MANAGEMENT

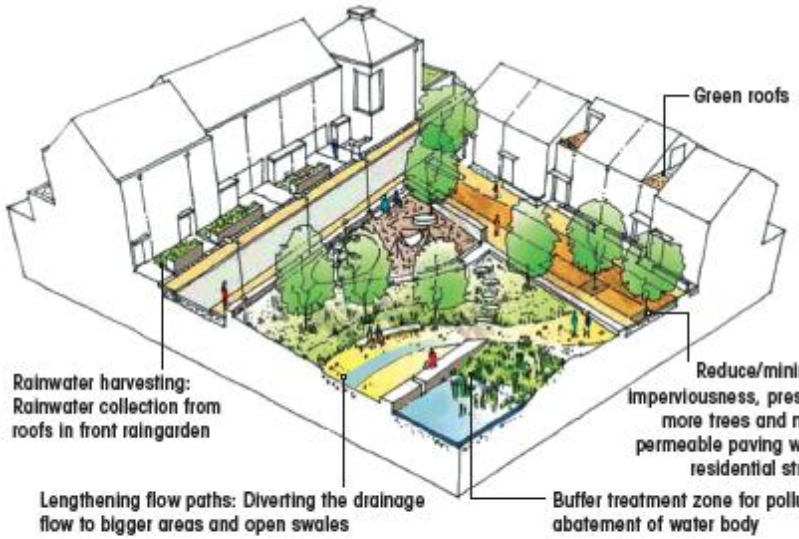
DECENTRALISED WASTEWATER TREATMENT FOR LOCAL REUSE

WATER EFFICIENCY AND CONSERVATION

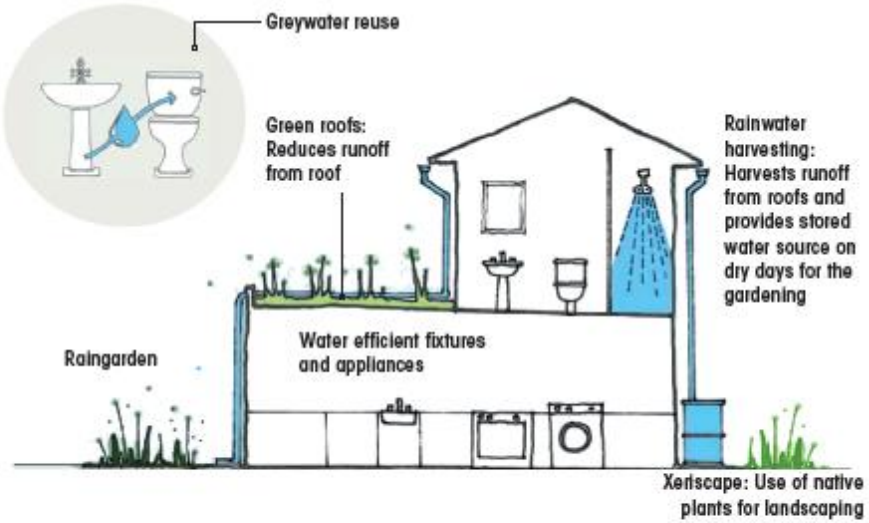
1 WATER-SENSITIVE PLANNING (CITY/ZONAL SCALE)



2 WATER-SENSITIVE DESIGNING (NEIGHBOURHOOD SCALE)



3 WATER-SENSITIVE DESIGNING (INDIVIDUAL SCALE)



STORMWATER HARVESTING AT ALL LEVELS

Decentralized Water Management

WSUDP is an approach that **integrates and optimizes the use of available water sources** and completes the water cycle by incorporating the following in **planning and designing**

This approach contributes to **sustainability and liveability**, particularly when considered part of an overall urban strategy

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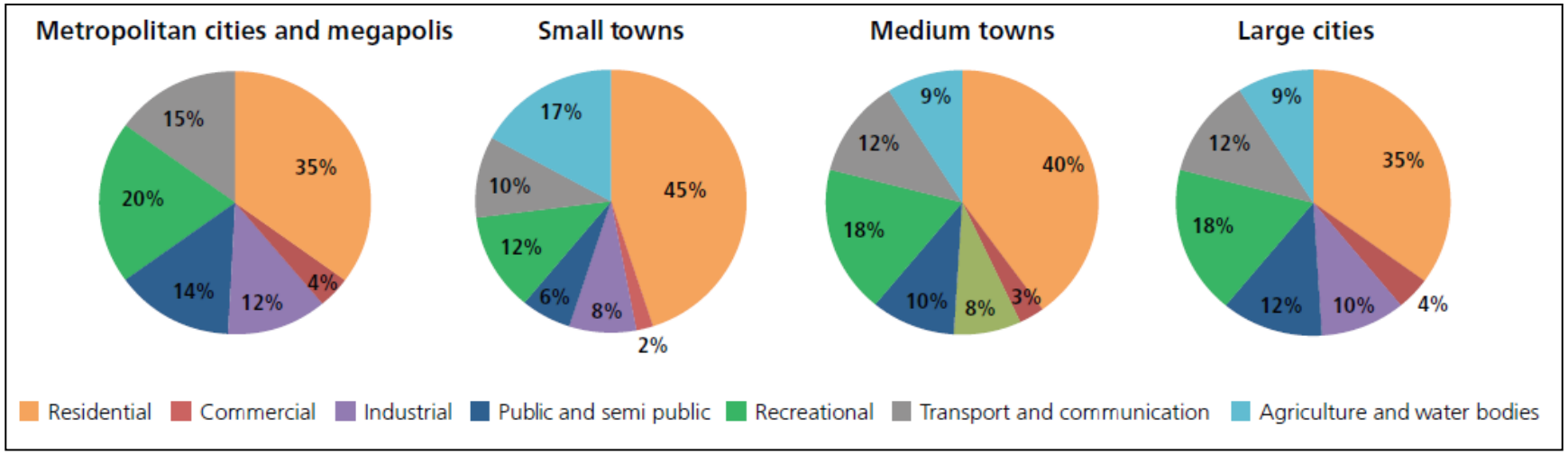
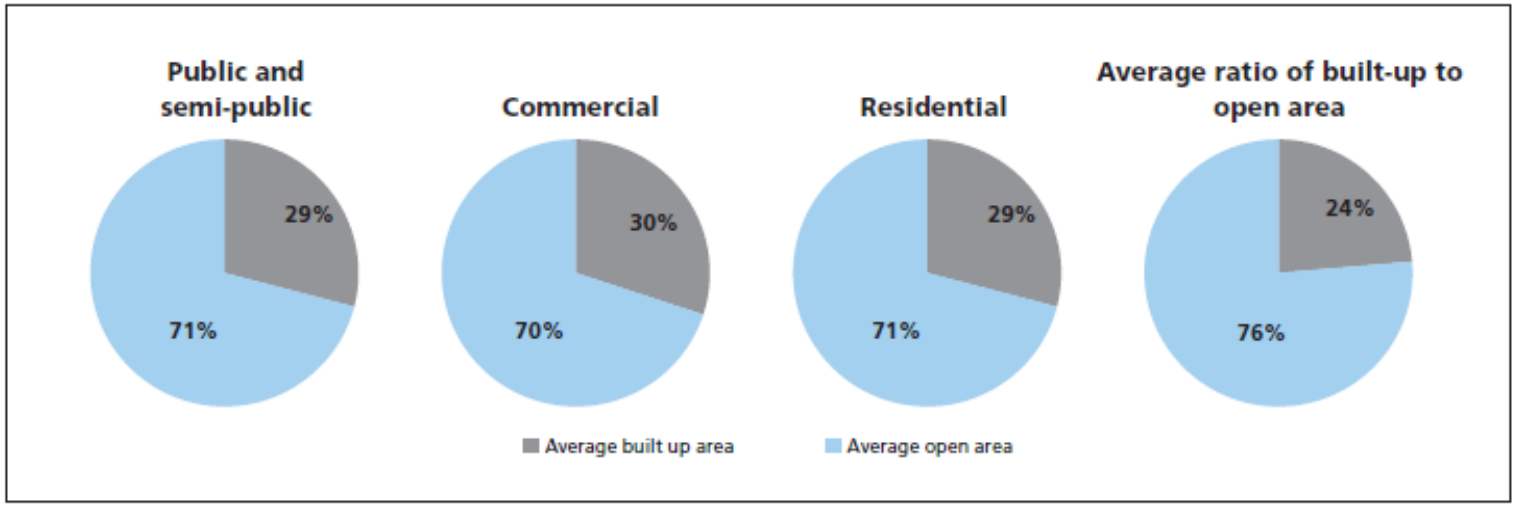
Scope of interventions as per existing provisions

The residential cluster, which occupies the largest share of land use in city and towns, contains building rooftops, sidewalks, paved parking spaces, pervious areas that could be a garden or just open land and accessible roads.



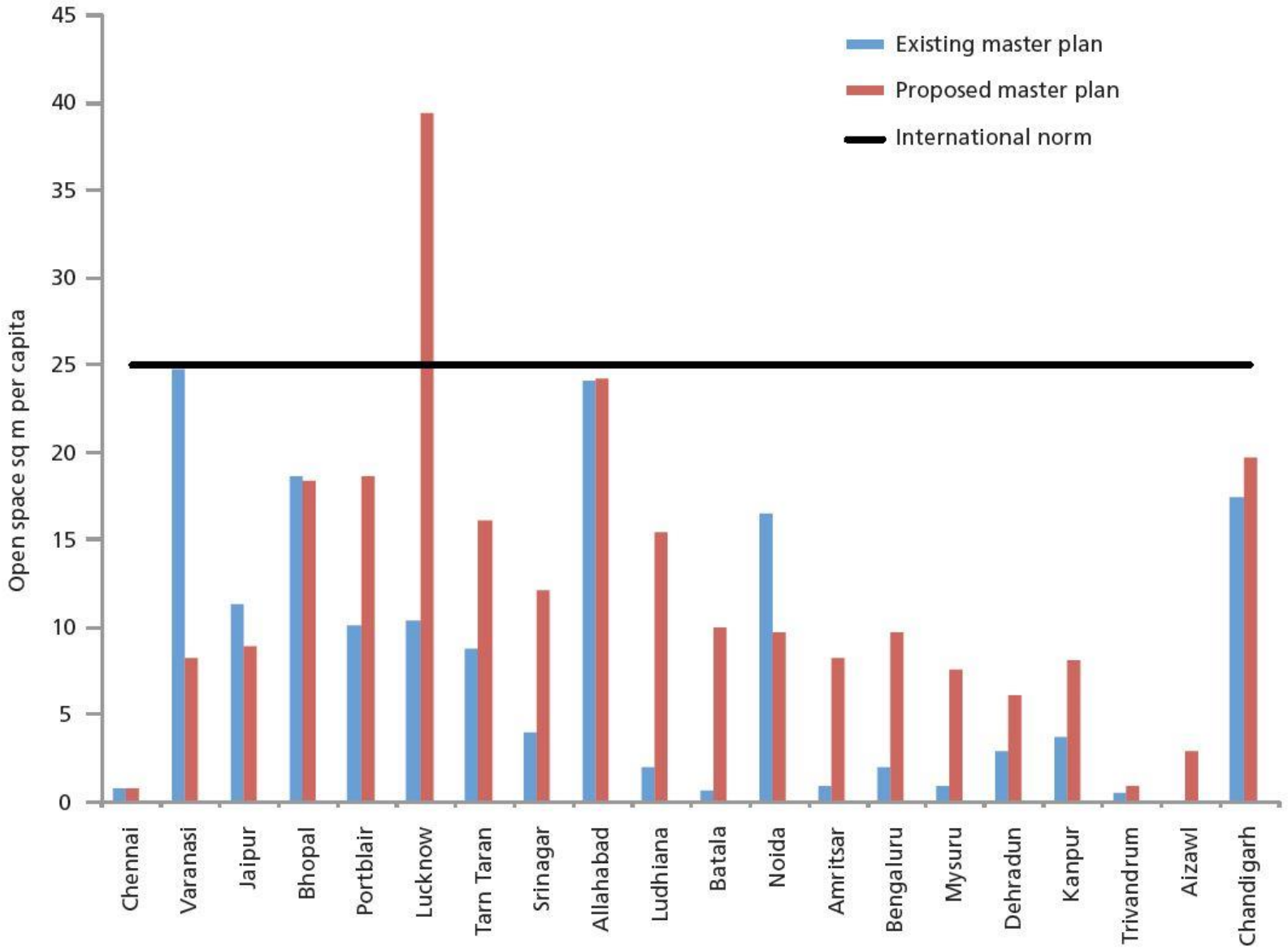
Land-use pattern for different urban centres of India



Ratio of built-up to open area in different land uses

The average Built up area range for a city/urban area is 21-26% while for open space , it is 74 - 79 %. The standards and guidelines provide enough open area to design the SUDS structures

Scope of interventions as per existing provisions



Source: Urban Green Guidelines, 2014, Town and Country Planning Organization, Government of India, Ministry of Housing and Urban Affairs, India

Scope of interventions as per existing provisions

Hierarchy	Population	Green space	Area/unit		Units	Total area	
			(sq m)	ha		(sq m)	ha
Housing area	5,000	Totlots	125		20	2,500	0.25
		Housing area park	5,000	0.5	1	5,000	0.5
		Housing area play	5,000	0.5	1	5,000	0.5
		Total				12,500	1.2
Neighbourhood	10,000	Neighbourhood park	10,000	1.0	1	10,000	1.0
		Neighbourhood play	10,000	1.0	1	10,000	1.0
		Housing area green	12,500	12.5	2	25,000	2.5
		Total				45,000	4.5
Community	100,000	Community park	50,000	5.0	1	50,000	5
		Multi-purpose ground	20,000	2.0	1	20,000	2
		Neighbourhood green	45,000	4.5	10	450,000	45
		Total				520,000	52
District	500,000	District park	250,000	25.0	1	250,000	25
		Multi-purpose ground	40,000	4.0	1	40,000	4
		Community green	520,000	52.0	5	2,600,000	260
		Total				2,890,000	289
Zonal/sub-city	1,000,000	City park	1,000,000	100.0	1	1,000,000	100
		Multi-purpose ground	80,000	8.0	1	80,000	8
		District green	2,890,000	289.0	2	5,780,000	578
		Total				6,860,000	686

Source: Urban and regional development plans formulation & implementation (URDPFI) Guidelines 2014.

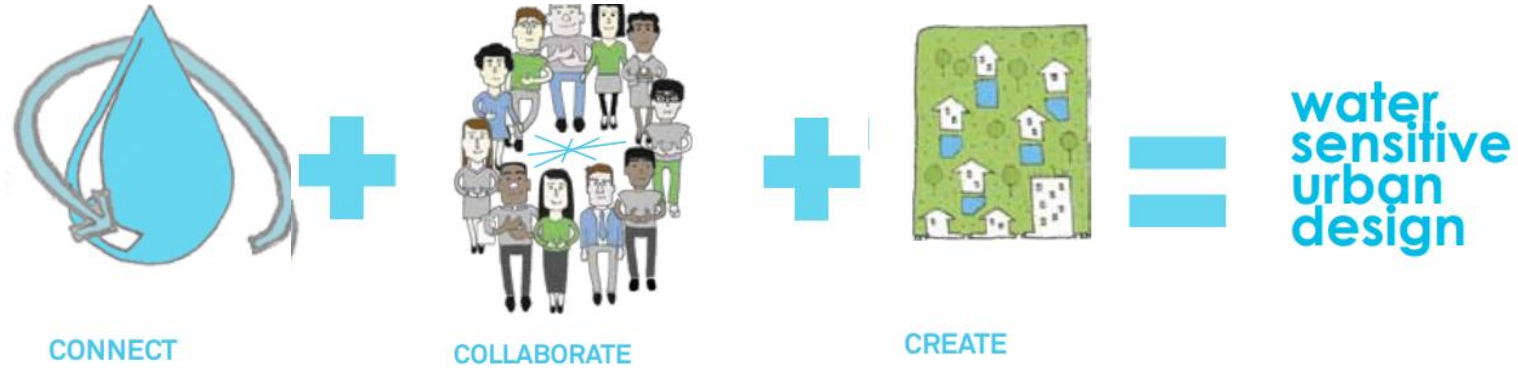
Components of water-sensitive urban design and planning

Sustainable water management					Urban planning				Landscape design	
Ensure water supply	Manage storm water	Treat/ recycle waste-water	Ensure/ improve waterway health	Protect surface water-bodies and groundwater	Consider ecological demands	Consider economical demands	Consider social demands	Consider cultural demands	Provide aesthetic quality	Contribute to cities amenity
Engineers	Environmental scientists		Environmental planners		Urban and landscape planners	Administrative officers	Architects/ engineers		Landscape architects	Urban designers/ architects

Multidisciplinary but also interdisciplinary

Integration for Sustainable Urban Development.

Integration along levels of planning



WSUDP integrates water cycle management with the built environment through planning and urban design, providing multiple benefits and opportunities in order to overcome challenges with water management

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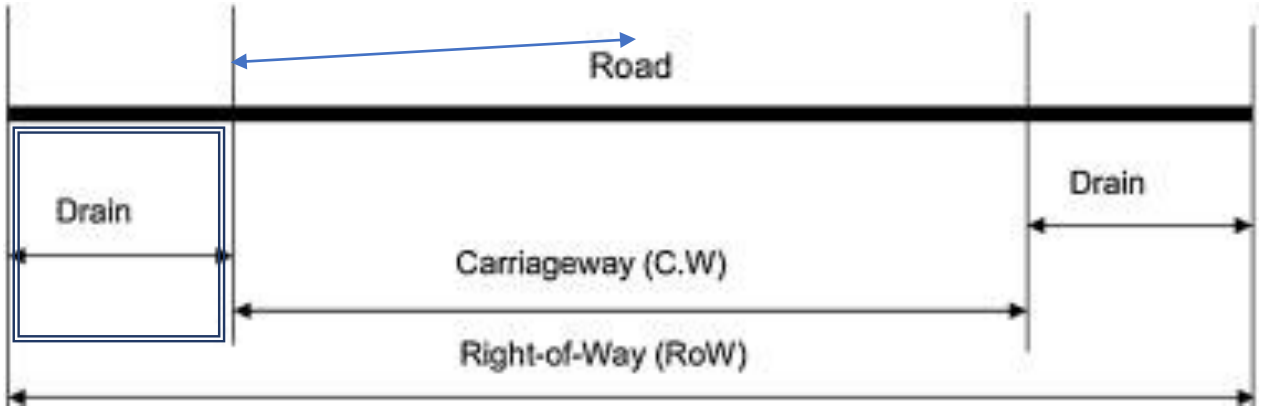
Conventional Drainage Design

- Storm drains on both sides of the road
- Connected with cross drains across the road at suitable intervals having gratings to collect rain water from surface of the road during rains
- Drains for removal of stormwater runoff from the carriageway, just to avoid water logging



CPHEEO recommended Design Return Periods for various urban sub-catchments

S. No.	Urban Catchment	Return Period	
		Mega Cities	Other cities
1.	Central Business and commercial	Once in 5 years	Once in 2 years
2.	Industrial	Once in 5 years	Once in 2 years
3.	Urban Residential Core Area, Peripheral Area	 Once in 5 years Once in 2 years	 Once in 2 years Once in 1 years
4.	Open space, Parks and landscape	Once in 6 months	Once in 6 months
5.	Airports and other critical infrastructure*	Once in 100 years	Once in 50 years

*critical infrastructure includes Railway Stations, Power stations, etc.

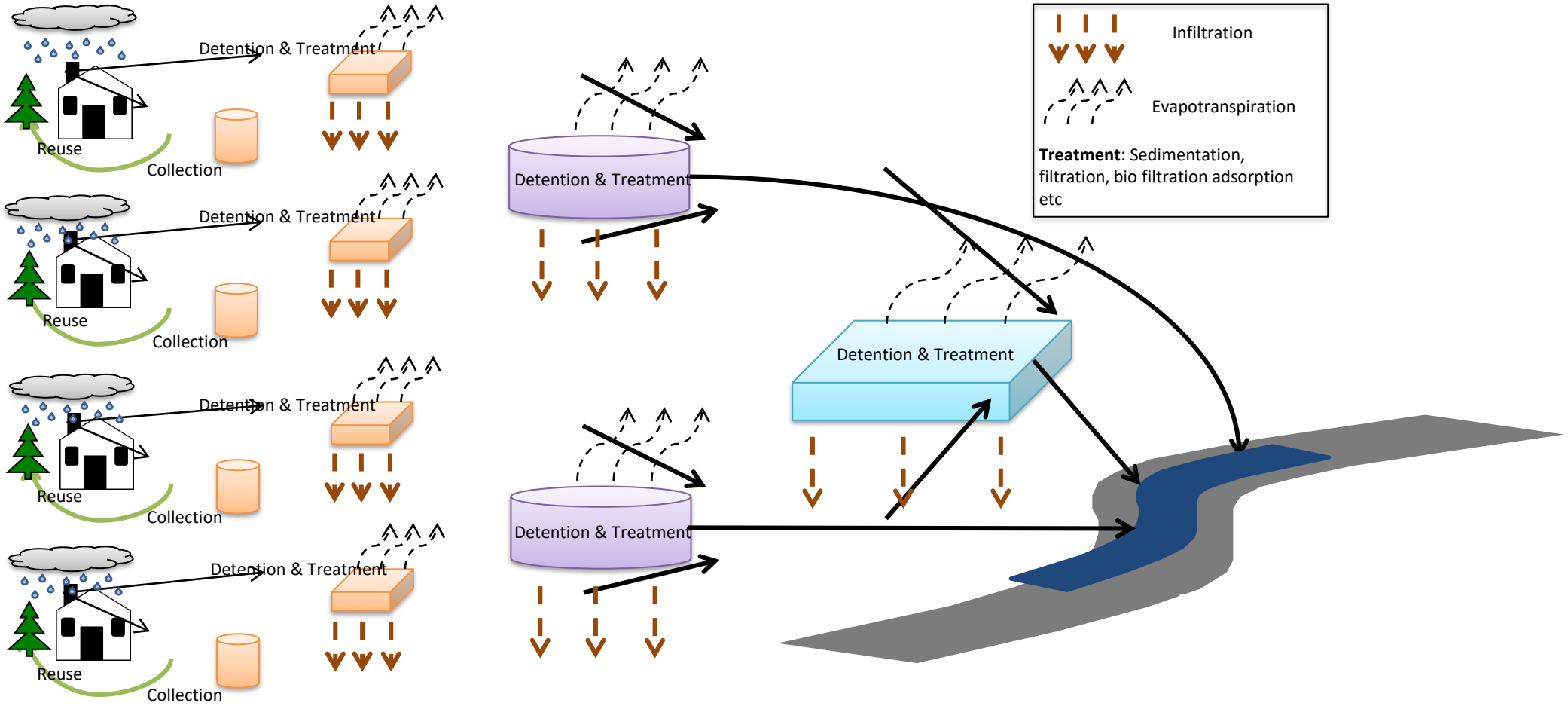
Source: Draft Manual for Stormwater Drainage Systems – CPHEEO, 2019

As per IRC: SP:42- 2014 road side drains It must **drain the surface and subsurface water away from the roadway** and dissipate it in a way that **prevents the excessive collection of water** in unstable areas and subsequent downstream erosion

The design return periods are inadequate for extreme rainfall. How can we augment these systems?

SUDS Train

Good House Keeping | Source Controls | Local Controls | Regional Controls | Receiving water



Good House Keeping | Source Controls | Local Controls | Regional Controls | Receiving water

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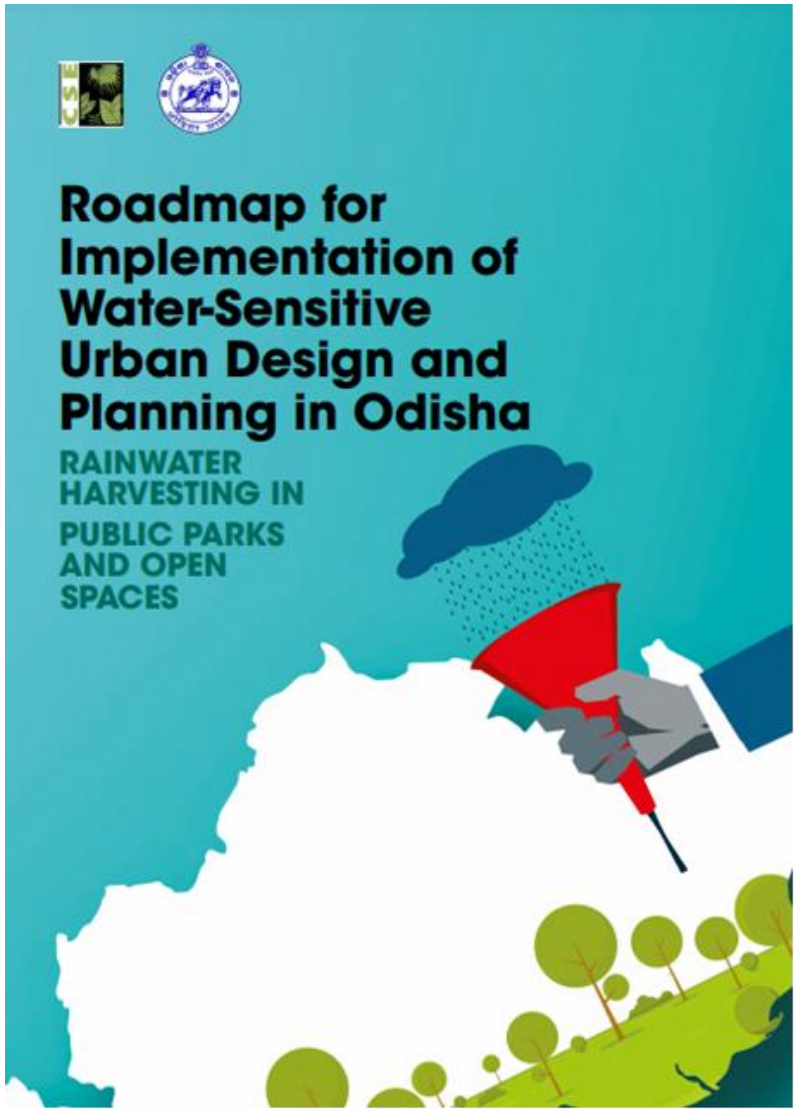
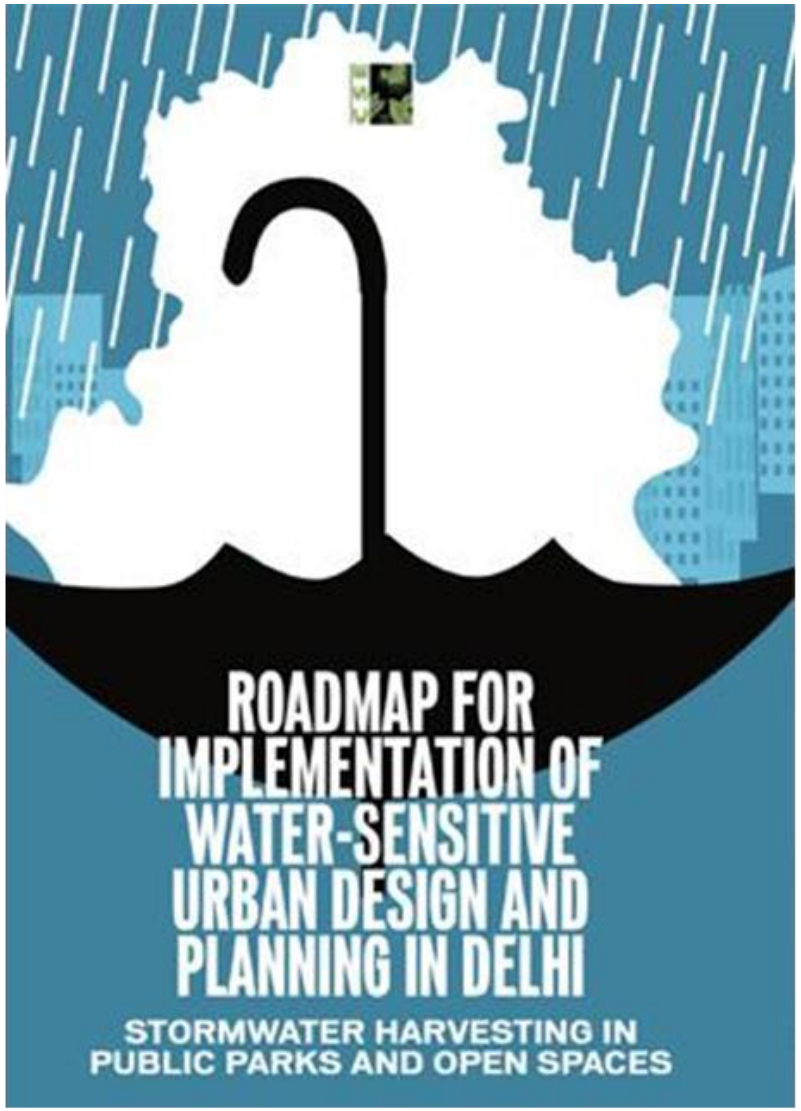
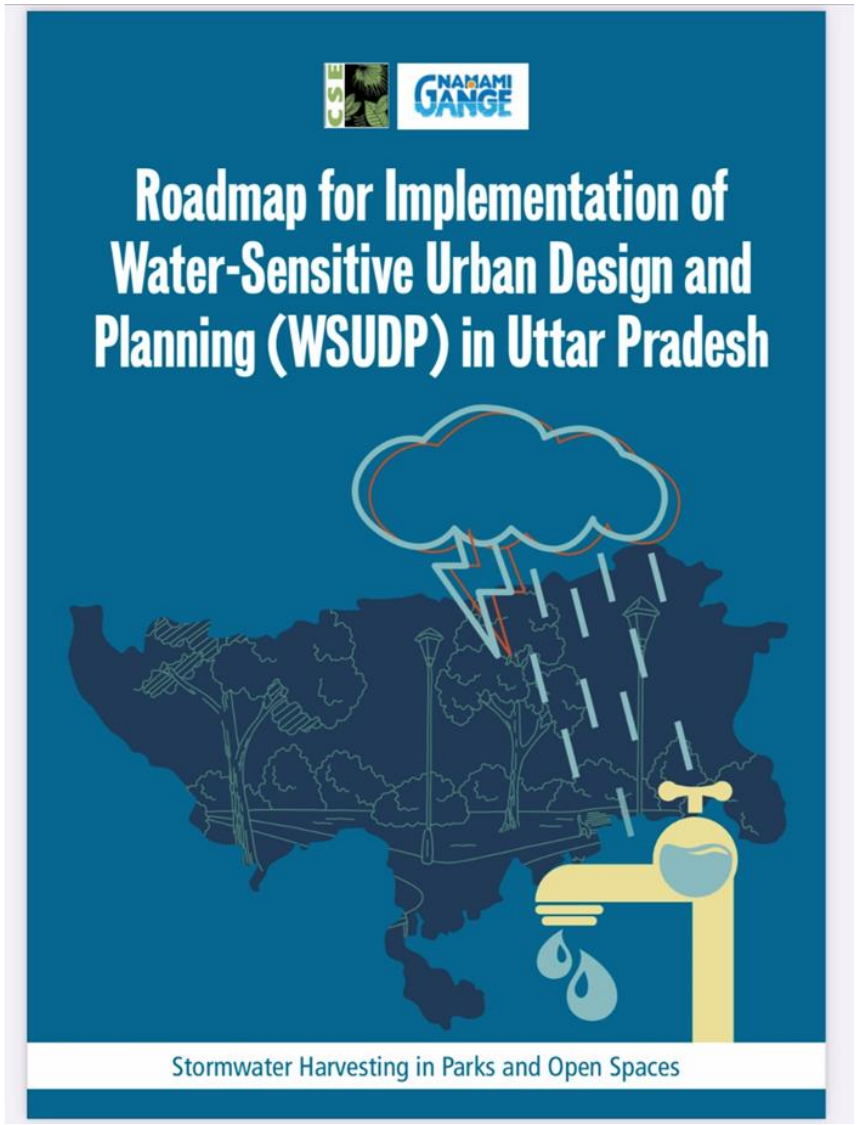
Roadmap Series: Stormwater Harvesting in Parks and Open Spaces







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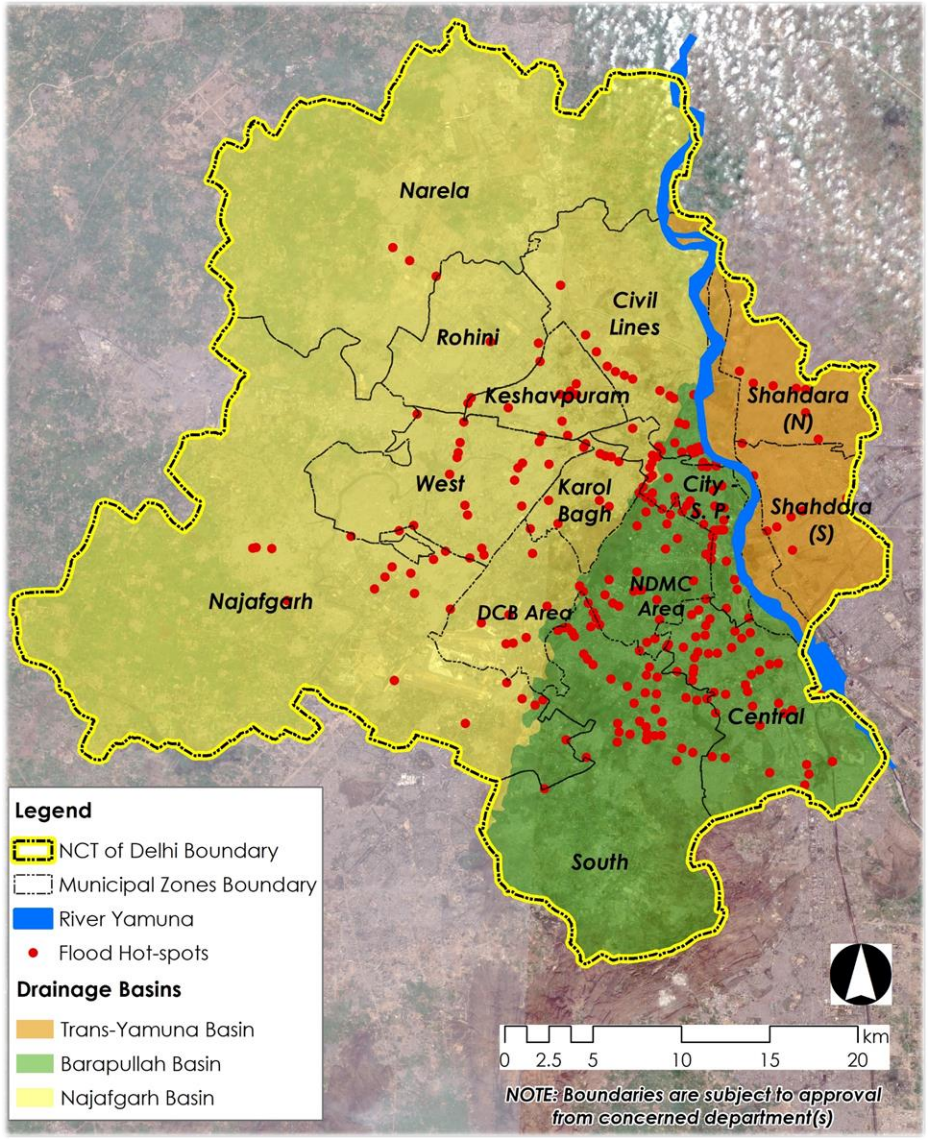
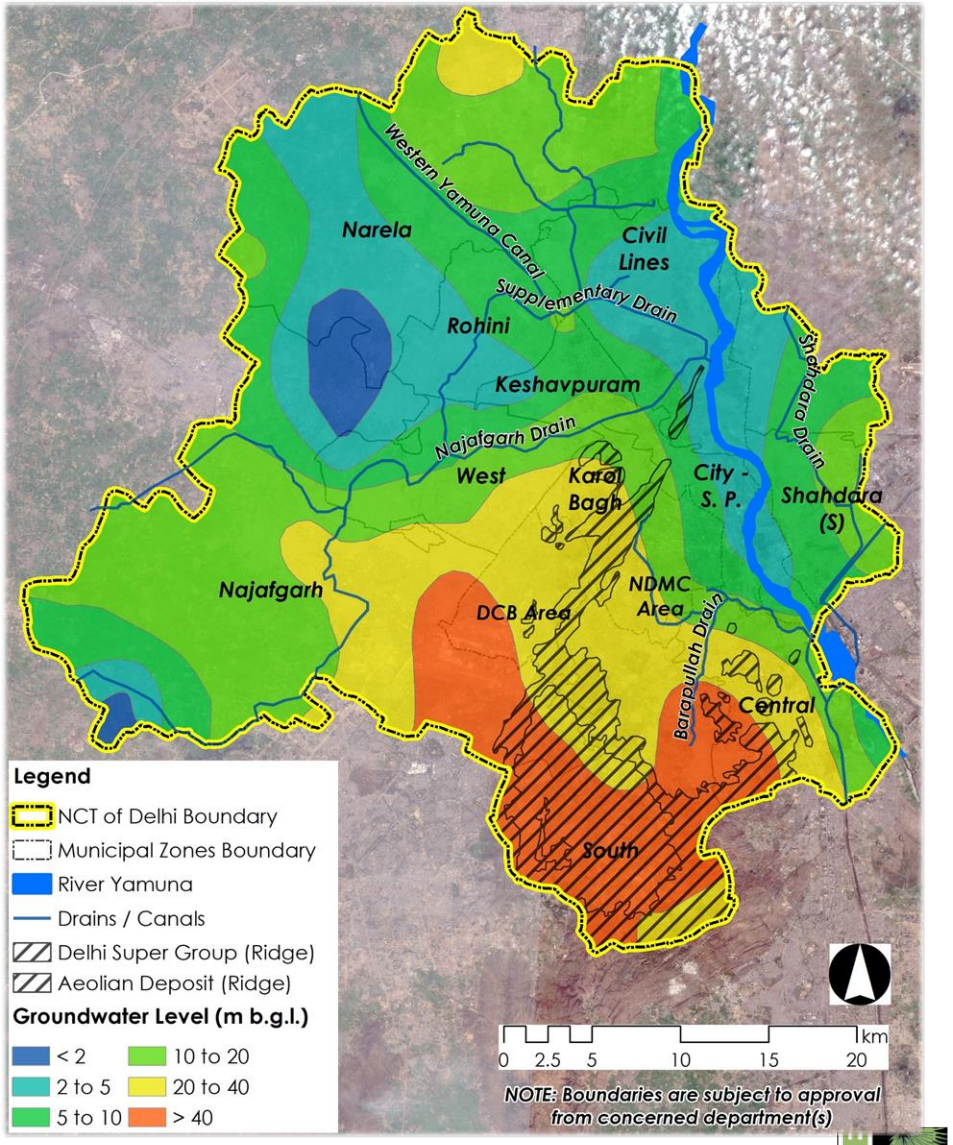
Stormwater Harvesting: NCT of Delhi

Delhi | Pop.: 25 million | Area: 1,483 sq. km.



161 'official' flood hotspots identified



Groundwater levels at 40 m b.g.l. in 30% of the city, and further depleting.

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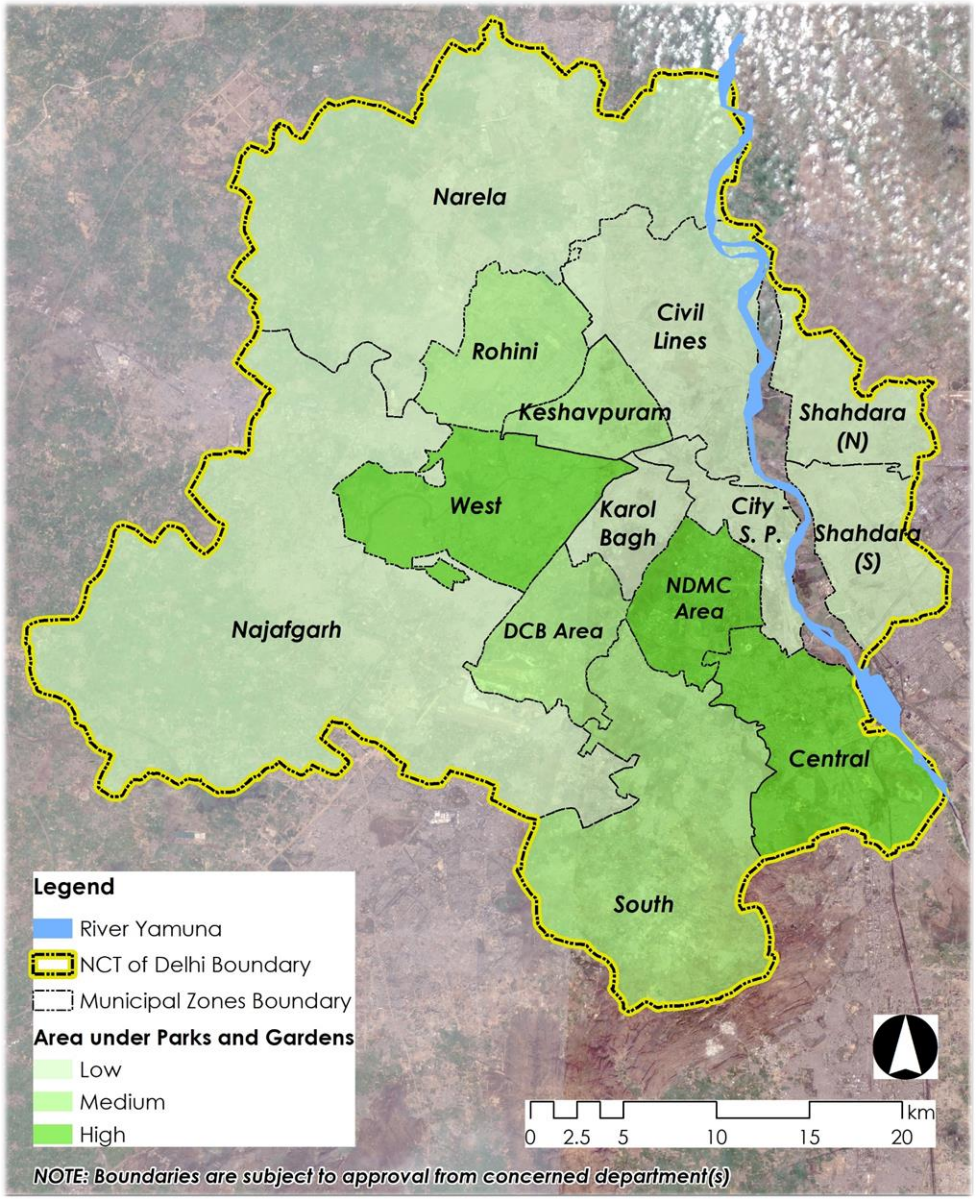
Stormwater Harvesting: NCT of Delhi

16,299 Parks in Delhi



INDICATORS

- Area under parks
- Post-monsoon groundwater level
- Soil type, Geology
- Flood hot-spots, areas vulnerable to flooding

Neighbourhood Parks	
Total Park Area (Ha)	**1,864**
Annual Potential Run-off (Mil L)	**2,384**
Area of WSUDP interventions (Ha)	**28**
Community Parks	
Total Park Area (Ha)	**647**
Annual Potential Run-off (Mil L)	**828**
Area of WSUDP interventions (Ha)	**10.4**
Regional Parks	
Total Park Area (Ha)	**165**
Annual Potential Run-off (Mil L)	**211**
Area of WSUDP interventions (Ha)	**3.3**
Total WSUDP Potential (Mil L)	**3,423**

Missed potential which sometimes becomes liability in the city. If managed efficiently, the same runoff can be stored, recharged and moderated during peak rainfall.

Delhi has more than 8,000 Ha of area under natural and planned greens, having an estimated annual stormwater harvesting potential of 12,800 Mil L.

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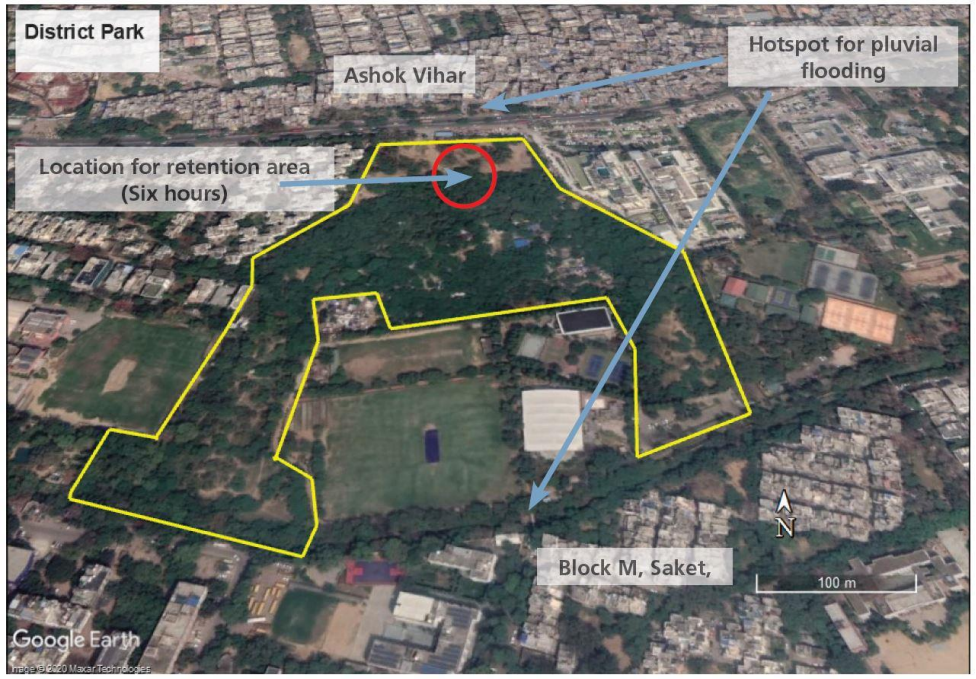
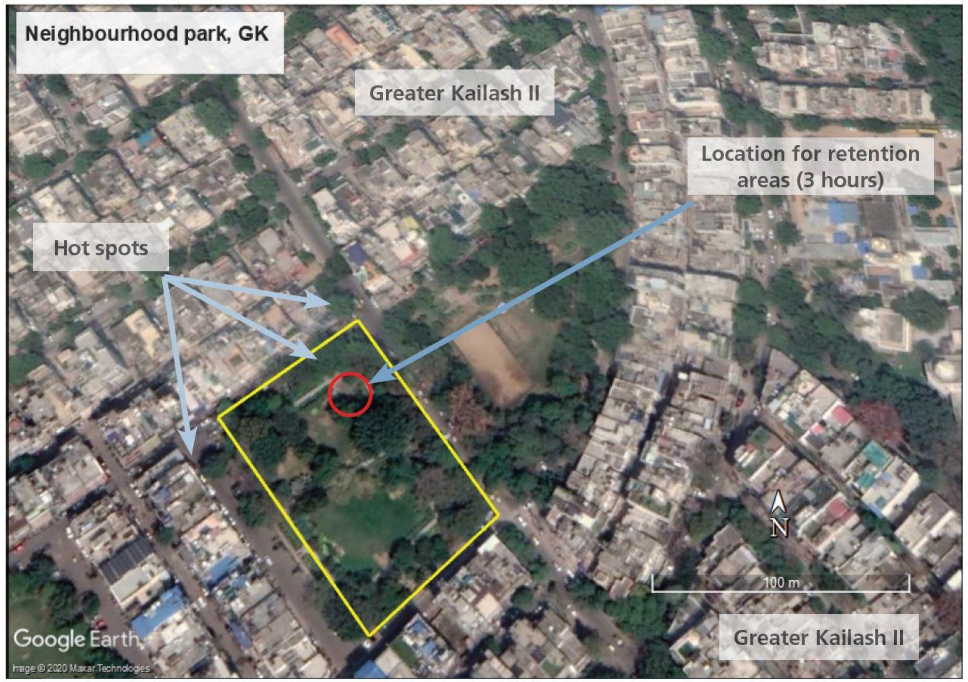
Stormwater Harvesting: NCT of Delhi



Three pilot parks identified as flood sinks, based on the vicinity to flood hotspots. Details:

- Cumulative stormwater harvesting potential: **59,000 KL**
- Structures: rain-garden, bio-retention area, swale, infiltration basin
- Area: **2-5% of total park area** | Average depth: 2 m
- Implementation: Urban Local Body | O&M: Residents Welfare Association
- **No. of flood hot-spots addressed: 7**



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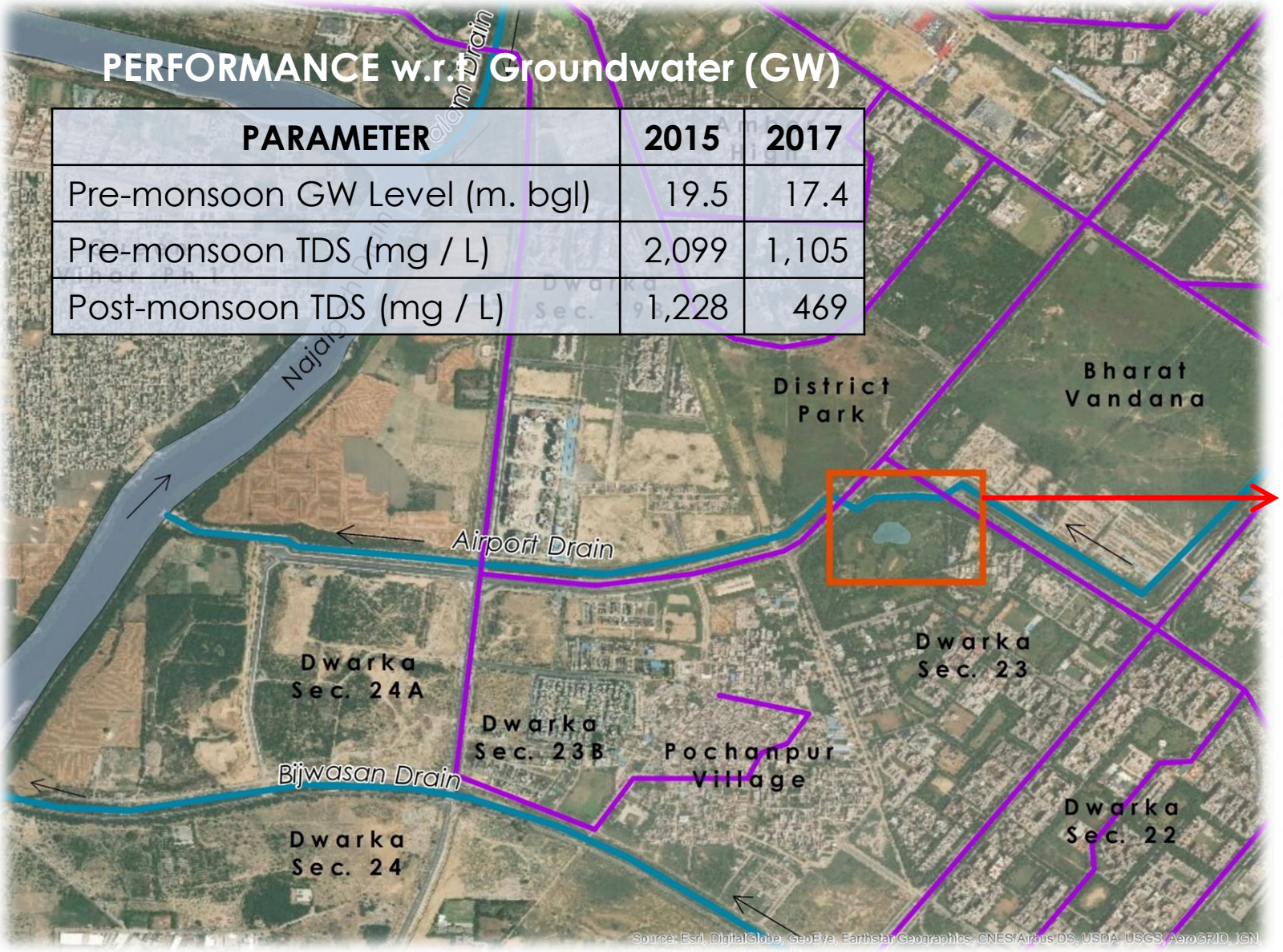
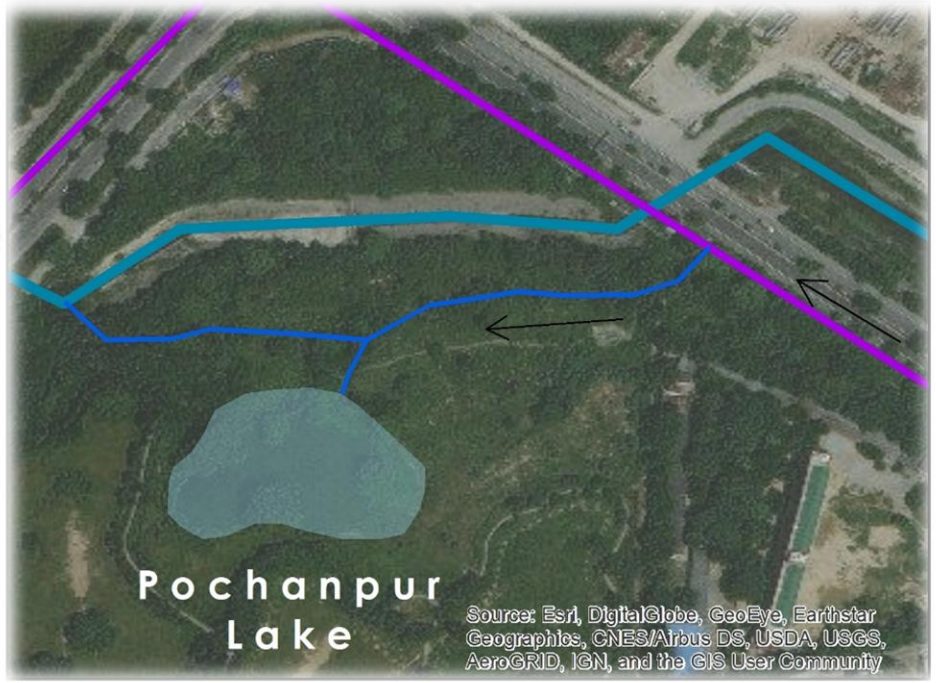
Stormwater Harvesting: NCT of Delhi

PERFORMANCE w.r.t Groundwater (GW)

PARAMETER	2015	2017
Pre-monsoon GW Level (m. bgl)	19.5	17.4
Pre-monsoon TDS (mg / L)	2,099	1,105
Post-monsoon TDS (mg / L)	1,228	469





Area: 1.6 acres | Depth: 8-10 feet | Capacity: 1.9 mil L

Legend

- Najafgarh Drain
- Interceptor Drain
- Regional Drains
- Pochanpur Lake
- Roadside Drains
- Flow Direction

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Stormwater Harvesting: Uttar Pradesh

Cities in UP

- Smart cities in UP
- NMCG priority Ganga cities and towns
- Population and pace of urbanization of cities
- Ganga Cities in UP with master Plans and City Development Plans

Status of Urban Water Challenges in the cities

- Status of Groundwater exploitation
- Urban Flooding issues
- Loss of Water bodies
- Swach Sarvekshan Score 2020

5 Selected Smart Cities

Different hierarchical parks and open spaces of neighbourhood scale and zonal or city scale have been selected as pilot case studies

Methodology for selection of cities for Pilot Projects

Key factors considered for selection of 5 smart cities

City	Pop. - 2011 (in Lakhs)	Master Plan	Swachh Sarvekshan, 2020 Rank	Groundwater Status (as per GEC-2015)	Urban Flooding	Loss of Waterbodies
Lucknow	29.02	Yes	12	Over – Exploited	Yes	Yes (46 %)
Kanpur	28.76	Yes	25	Over – Exploited	Yes	Yes
Varanasi	11.98	Yes	27	Over – Exploited	Yes	Yes
Prayagraj	11.95	Yes	20	Over – Exploited	Yes	Yes
Moradabad	8.78	Yes		Over – Exploited	Yes	

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Stormwater Harvesting: Uttar Pradesh

City	Area under Parks (Ha)	WSUDP Potential (Million L)
Lucknow	259	309
Kanpur	260	305
Varanasi	776	971
Prayagraj	140	166
Moradabad	725	873
Total	2,160	2,624

2,624 million litres run-off quantity is the missed potential

which sometimes become a liability in these cities.

If managed efficiently, the runoff can be stored, recharged and moderated during peak rainfall

Stormwater Harvesting: Lucknow, Uttar Pradesh

Park	Dr Ram Manohar Lohia Park	Neighbourhood Park, LDA Colony	Indira Park
Area (sq. m.)	2,82,047	18,008	5,227
Scale	Sub-City	Community	Neighbourhood
Annual RWH Potential (KL)	32,760	2,092	607
Recommended Structure(s)	• Swale • Trench with filter strips • Bio-retention Area • Detention Basin • Infiltration Basin	• Swale • Bio-retention Area • Trench with Filter Strips • Infiltration basins	• Swale • Raingarden • Trench with Filter Strips
Total Area of Structures (sq. m)	3526 to 4512.7	225.1 to 288	65.3 to 83.6

- RWH structures require **1-3% of total area of Parks**
- **35.45 Mil L** can be harvested from these three parks annually
- Assuming **15 Neighbourhood parks** implement RWH in Lucknow, additionally **31.38 Mil L** can be harvested. **A total of 66.83 Mil L can be harvested annually**

As per CDP plan, 2041, Lucknow has 1,684 parks and gardens, spread across an area of 259 hectares, where stormwater harvesting can be implemented. Therefore, a **total of 309 million litres of rainwater can be harvested in Lucknow annually.**

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Data Checklist for SUDS in Parks and Open Spaces

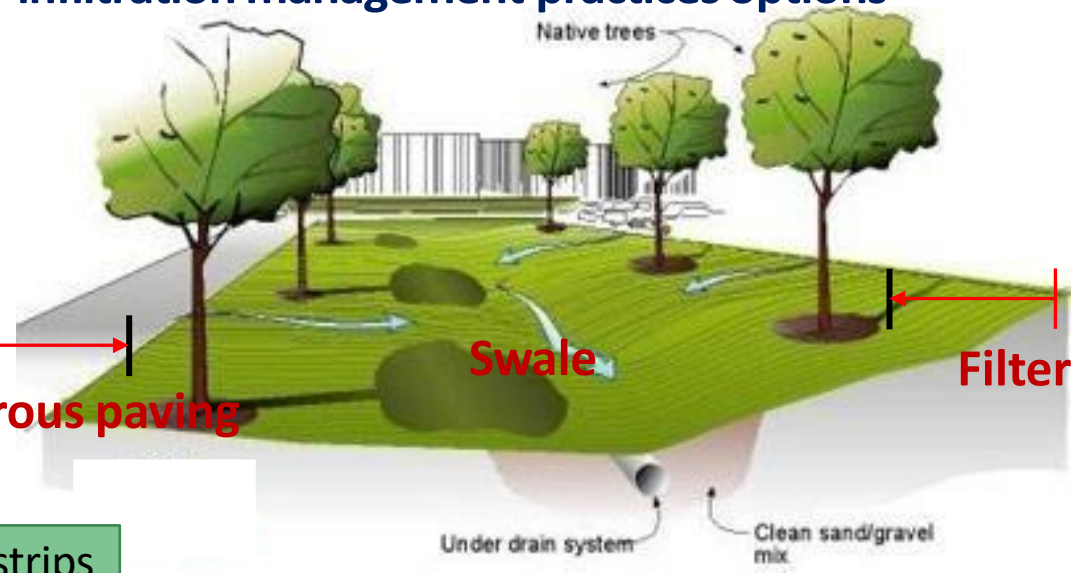
- No. of Parks ✓
- The Locational details (along the geo- coordinates, if possible) ✓
- Size of the Parks (in Sq. Mts.) ✓
- Topography- General gradient/ slope and orientation of the park ✓
- The soil condition (information on the soil profile) ✓
- The storm water drains existing in or near the parks ✓
- RWH structures existing in or near the parks ✓
- Rainfall data of the locality ✓
- Data on Aquifers: Type of Aquifer, Depth ✓
- Data on Groundwater Table, Groundwater Quality ✓
- Nature and type of green cover inside the park ✓
- Nature and extent of land covered by the water bodies, if any, inside the park ✓
- Utilities commissioned inside the parks and open spaces ✓
- Information on drinking water demand and Supply ✓
- Mining activities, if any in Urban Areas ✓

Options for Stormwater Harvesting in Parks

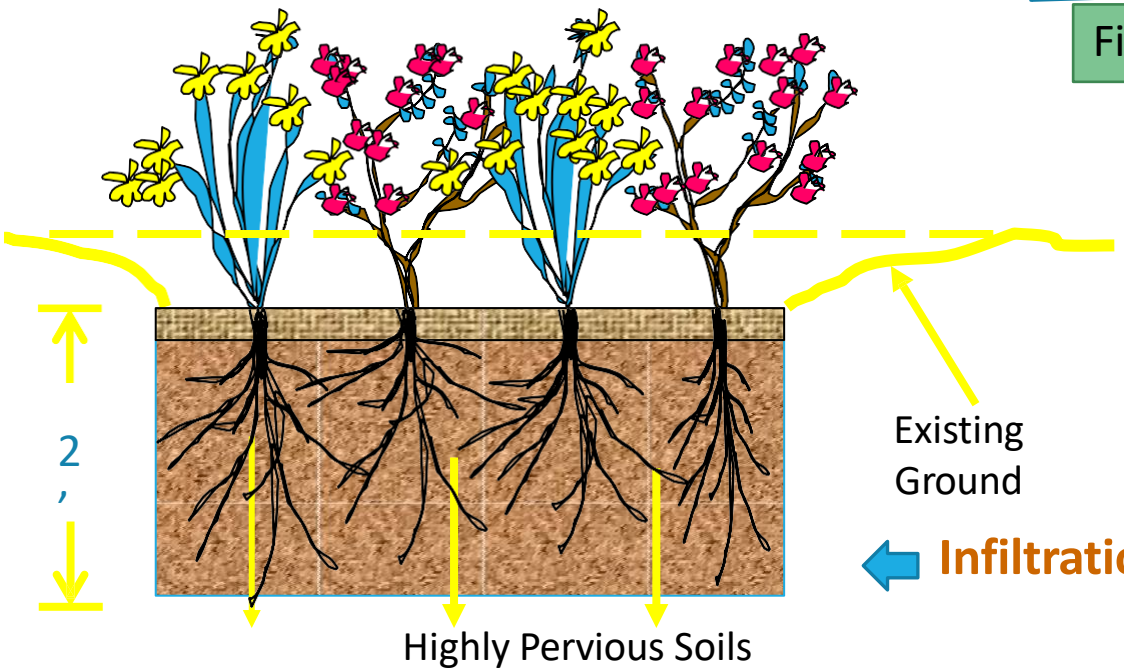
Integrating different stormwater harvesting and infiltration management practices options

Reduce volume and rate of runoff

- Reduce runoff
- Allow infiltration



- Porous paving
- Filter strips
- Swales
- Bioretention areas and raingardens
- Detention basins



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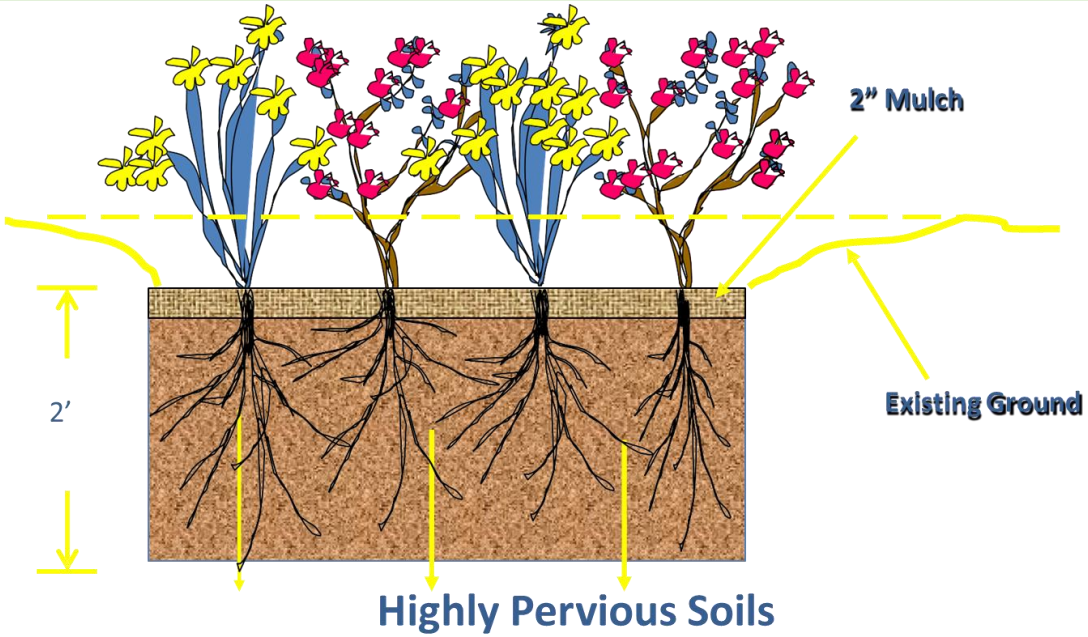
Planning and Designing – Example for Detention Basin

Detention basins are surface storage basins or facilities that provide flow control through attenuation of stormwater runoff.

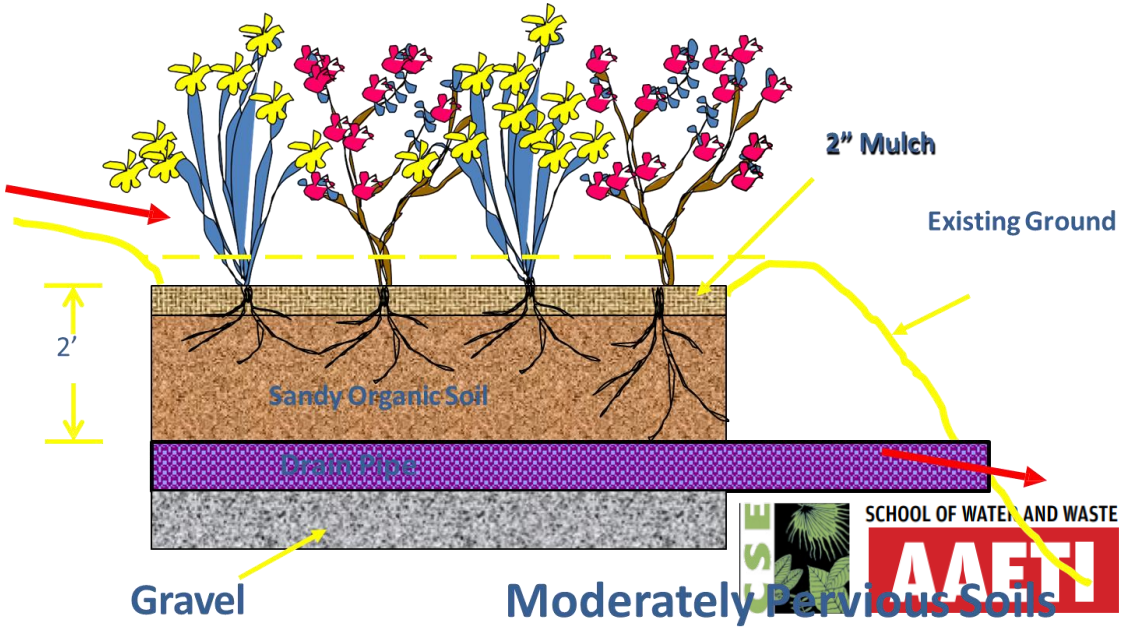
- Provide temporary storage
- controlled release of detained runoff

} Can cater to frequent storm water events

The land may also function for recreational facility



Combination Filtration / Infiltration

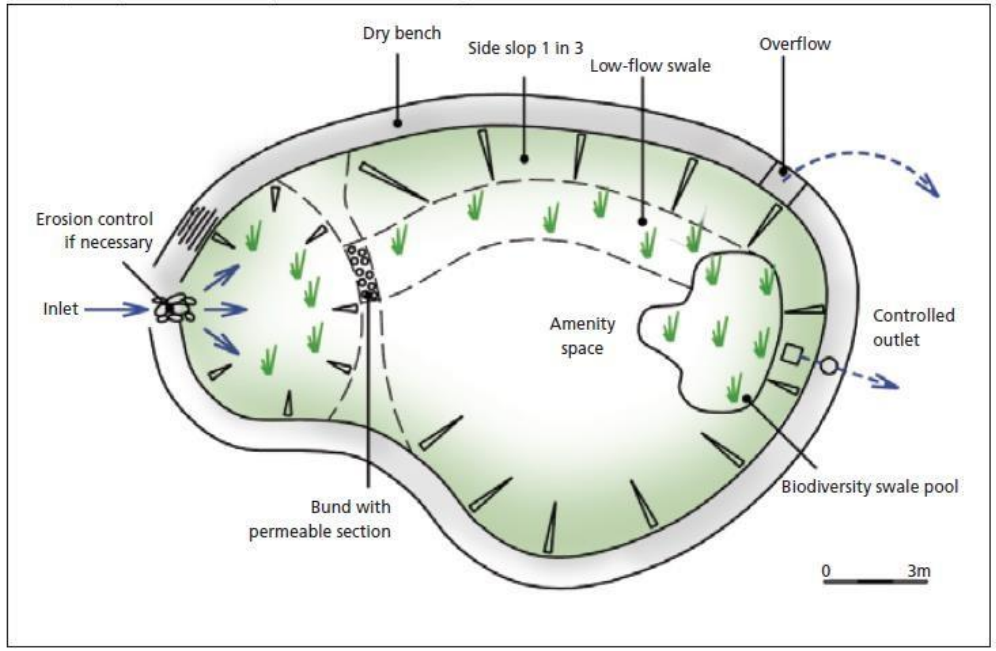


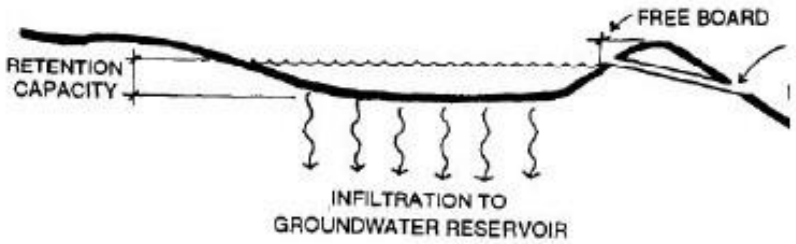
Planning and Designing – Example for Detention Basin

- Allow infiltration of surface water runoff to the ground
- Potential for dual land use
- Can cater to wide range of rainfall events
- Used for large sites

Key design thumb rule:
- Length With ratio: 2:1
- Side slopes: 1:4 (shallow + gentle slope)
- Max water depth: 3m

Can be used as:
- Playgrounds
- Recreational areas





Reference: CIRIA Manual 696

Detention basin example

1. Grassed base of detention basin
2. Vegetated bank: opportunities for play whilst feature is dry
3. Native vegetation and naturalistic aesthetic creates exciting and dynamic landscape feature
4. Natural surveillance of amenity space as opposed to fencing off the facility

Location: Ipswich, UK

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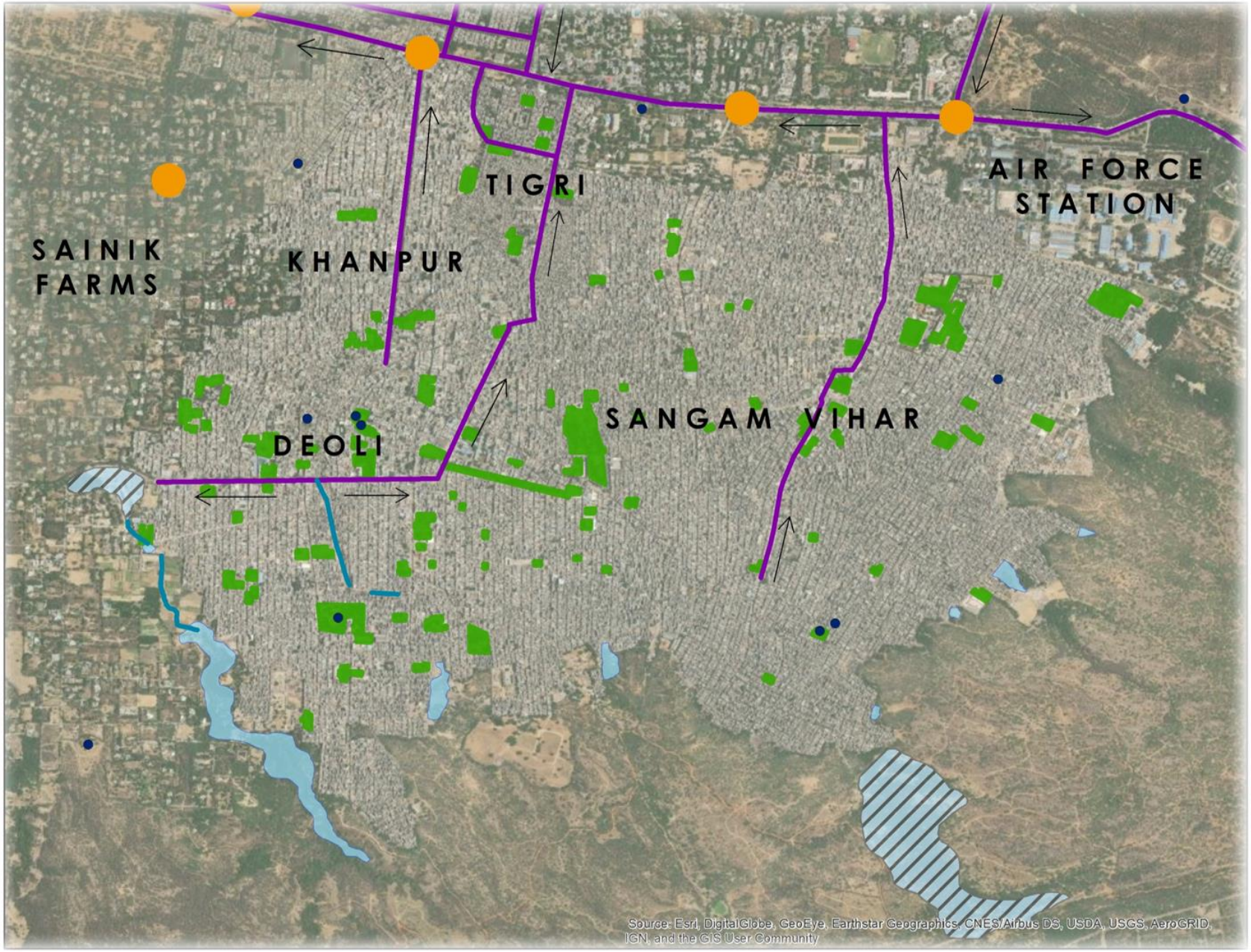
Stormwater Harvesting in Unplanned Areas?



Legend

- Stormwater Drain → Flow Direction
- Nallah
- Waterlogging (As reported by Delhi Police)
- Waterbodies (as per DPGS)
- Existing Water Body
- Water Body (as per Zonal Plan)
- Open Space

0 0.25 0.5 1 km

Combination of conventional drainage and harvesting in 'incidental open spaces', along natural topography.

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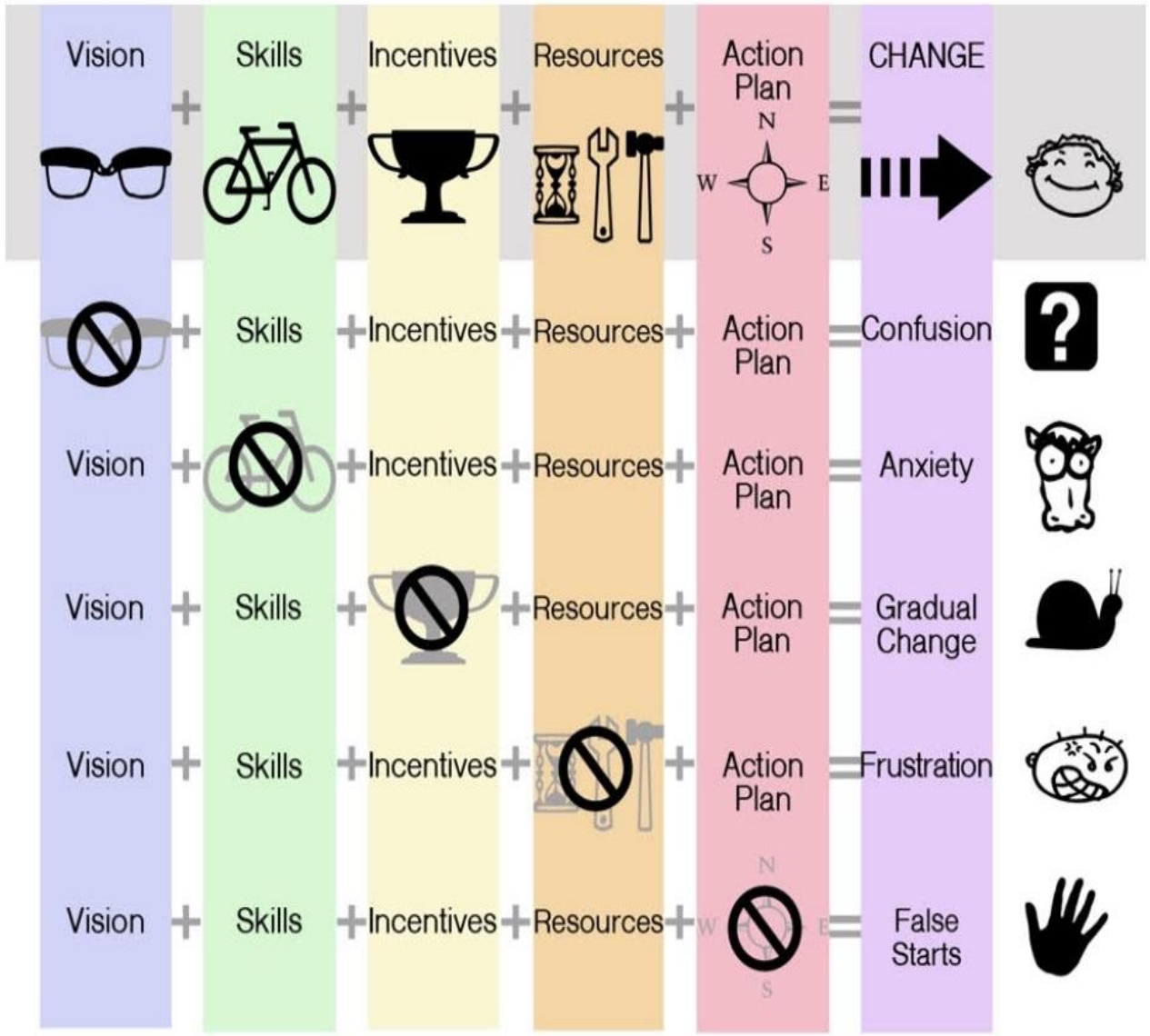
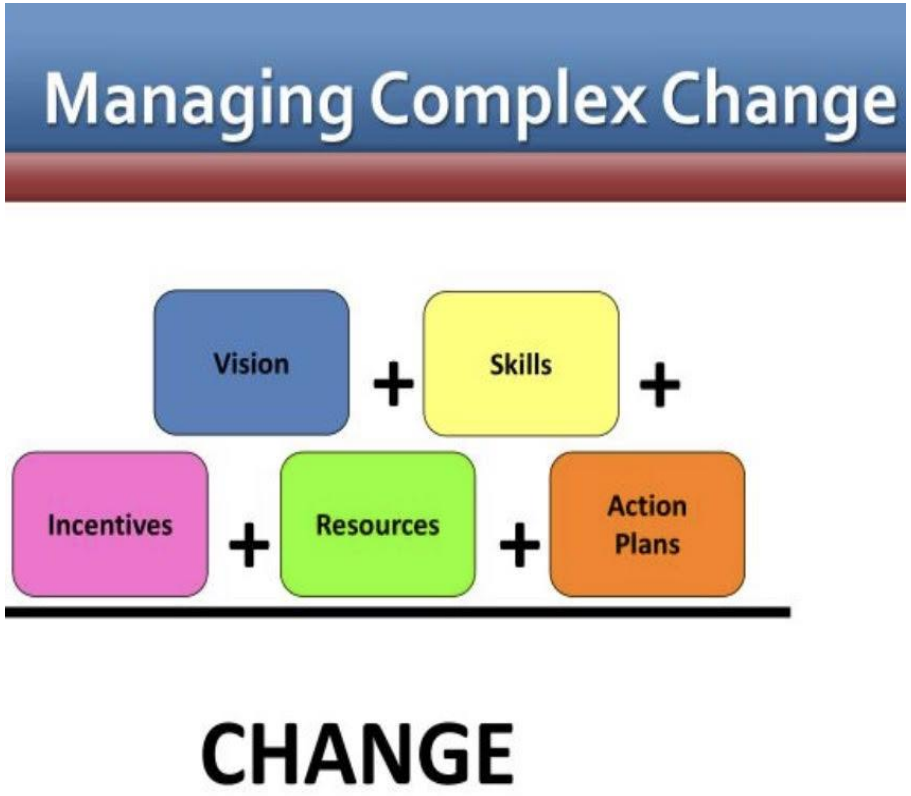
Roadmap for impact on ground: Managing complex change





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Thank you!

For any queries, please contact us at:

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