

MAKING WATER SENSITIVE CITIES IN GANGA BASIN AIMED AT IMPROVING RIVER HEALTH/FLOWS

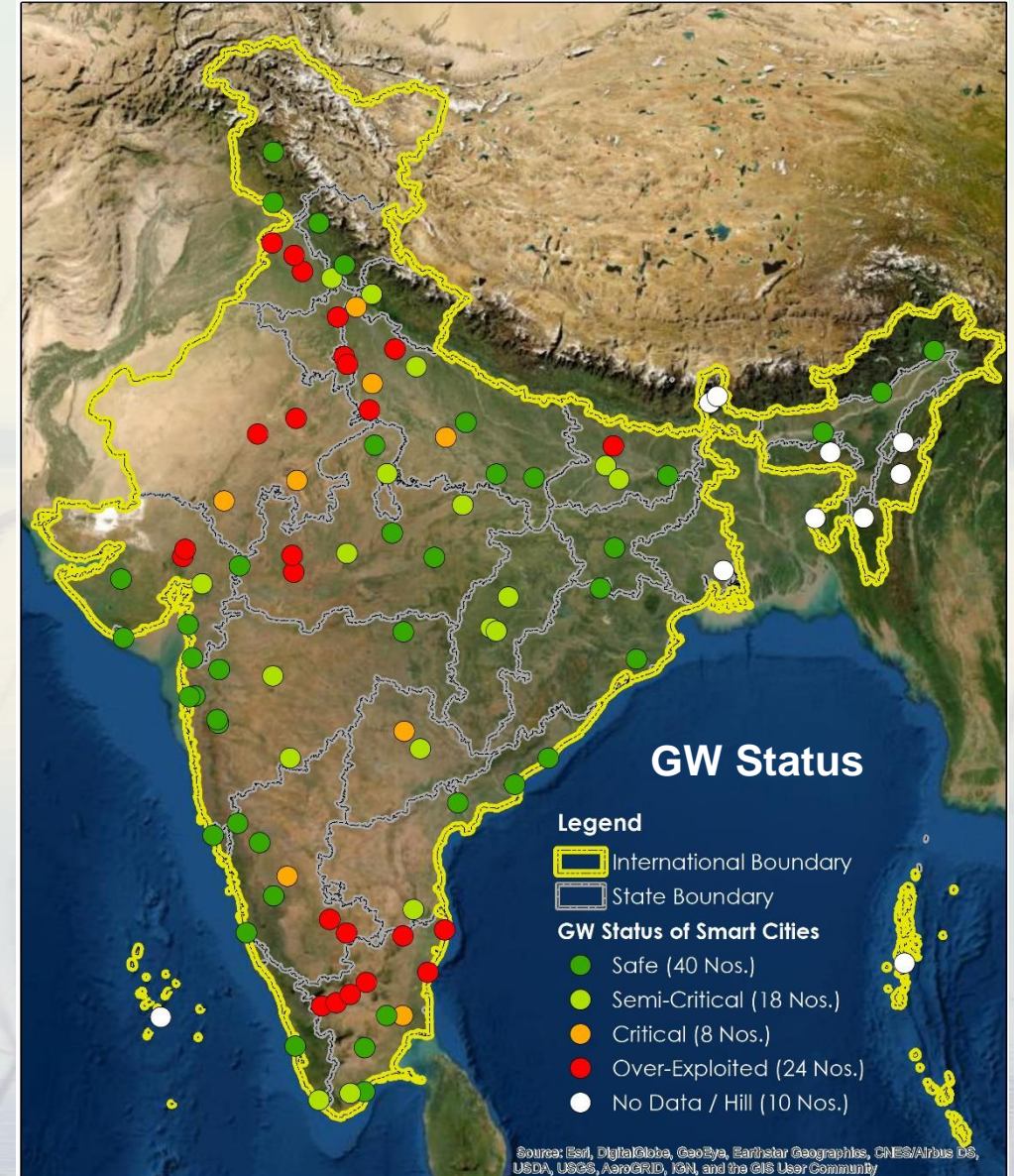
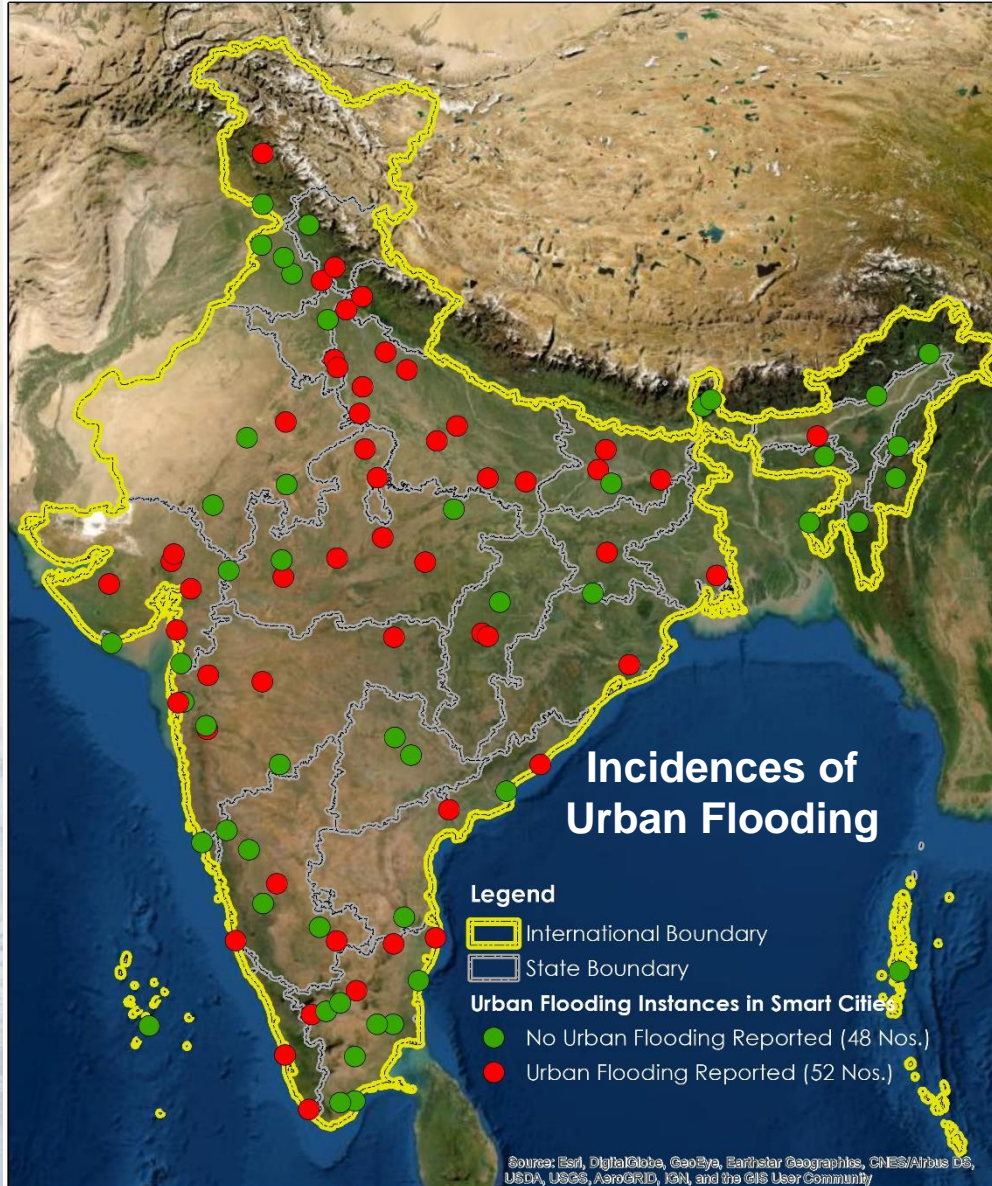
Urban Stormwater Management - Potential and Challenges

Structure of Presentation

Today we will be discussing on CSE's approach for stormwater management in India

- Research Design and Methodology
- Stormwater Management in India – Structural and Non-structural dimensions
- Issues, challenges and opportunities
- CSE's approach on Stormwater Management in India – Principles, Applicability

Why do we need to talk about Stormwater Management?



Urban Flooding and Groundwater Status in *'Smart' Cities* of India

Co-existence of Water Shortage & Abundance



Water Scenario



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



Drainage Scenario

The study is aimed at understating the potential and challenges with the current scenario of stormwater management and thereby suggesting approaches which focus on lowering the hydrological impact of urbanisation in Indian cities.

This study highlights the impact of poor stormwater management in India, in the context of climate change and changing land use and land cover as Indian rapidly urbanises.

The objectives of this study are to:

- Assess the existing stormwater infrastructure provision in India, and identify deficiencies in policy, planning and designing of stormwater infrastructure.
- Identify various structural and non-structural issues and crises in stormwater management in urban India.
- Formulate and recommend principles for stormwater management for Indian cities, based on the WSUDP approach.
- Present best management practices for stormwater management, and infer key learnings and applicability in the Indian context.

The Research

Divided in two sections, with addressing following questions:

- 1. Existing challenges in urban drainage systems in Indian cities**
 - Causes of pluvial flooding and water logging
 - Existing planning approach and infrastructural provisions for stormwater management
 - Gaps and issues in existing urban drainage systems

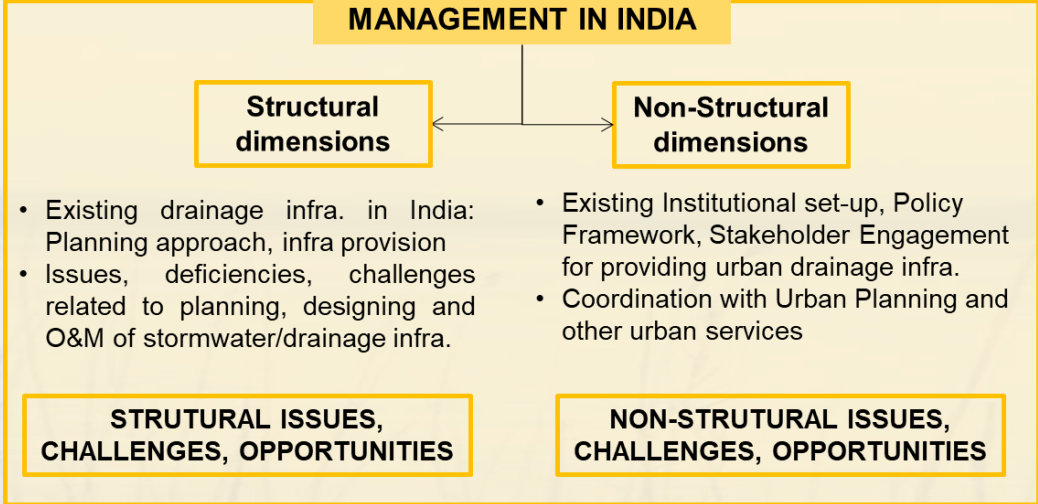
- 2. Potential of existing drainage system to offer efficient stormwater management**
 - Sustainable stormwater planning approach
 - Principles of stormwater management
 - Stakeholders for stormwater management
 - Stormwater/Drainage Masterplan

INTRODUCTION

- Introduction to the document: *Objectives, Scope, Methodology*
- Introduction to urban drainage and stormwater management: *Why is this infrastructure important?*
- Urbanisation and climate change are inevitable phenomenon. The process of urbanisation and sub-sequent stormwater infra provision is unsustainable.
- Poor stormwater management leads to water-logging and urban flooding

- Research papers/journals
- CSE previous research
- News articles

STORMWATER MANAGEMENT IN INDIA



- Structural dimensions**
- Existing drainage infra. in India: Planning approach, infra provision
 - Issues, deficiencies, challenges related to planning, designing and O&M of stormwater/drainage infra.

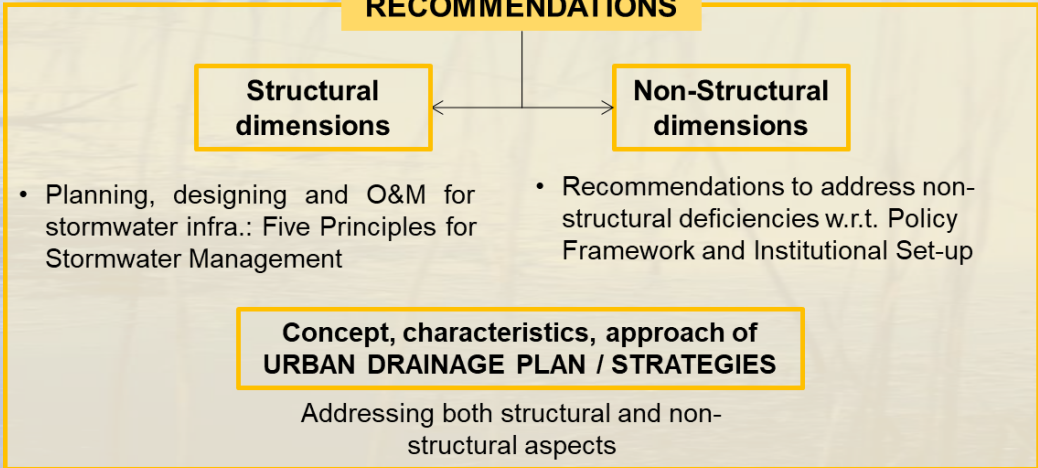
- Non-Structural dimensions**
- Existing Institutional set-up, Policy Framework, Stakeholder Engagement for providing urban drainage infra.
 - Coordination with Urban Planning and other urban services

- Research papers/journals
- CSE previous research
- News articles
- Indian policies and laws
- Stakeholder and data sources for Indian context from Gov. based urban drainage projects

STRUTURAL ISSUES, CHALLENGES, OPPORTUNITIES

NON-STRUTURAL ISSUES, CHALLENGES, OPPORTUNITIES

RECOMMENDATIONS



- Structural dimensions**
- Planning, designing and O&M for stormwater infra.: Five Principles for Stormwater Management

- Non-Structural dimensions**
- Recommendations to address non-structural deficiencies w.r.t. Policy Framework and Institutional Set-up

- Research papers/journals for SUDS based solutions
- Internationally published BMPs

Concept, characteristics, approach of URBAN DRAINAGE PLAN / STRATEGIES

Addressing both structural and non-structural aspects

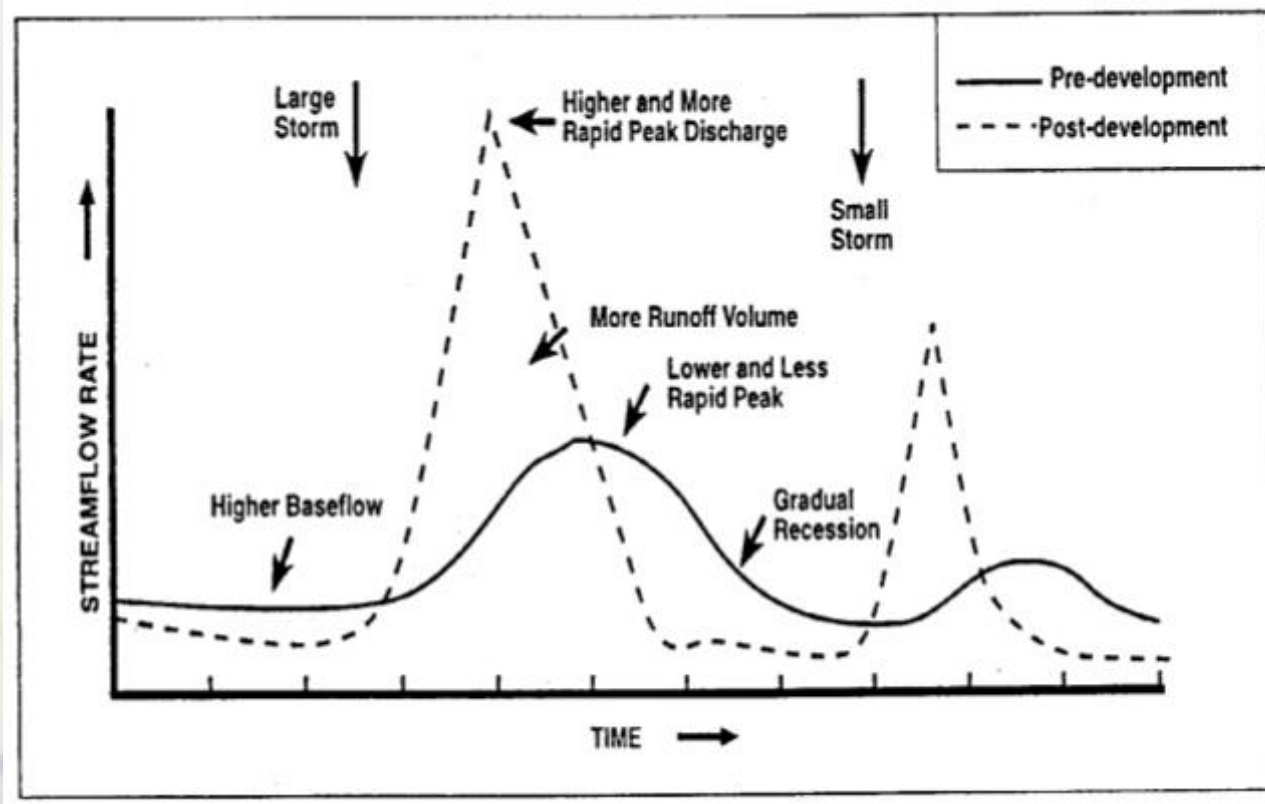
Need for the study, Research Design

Appraise the Stormwater Management Scenario in India – Identify the structural and non-structural issues, challenges and opportunities

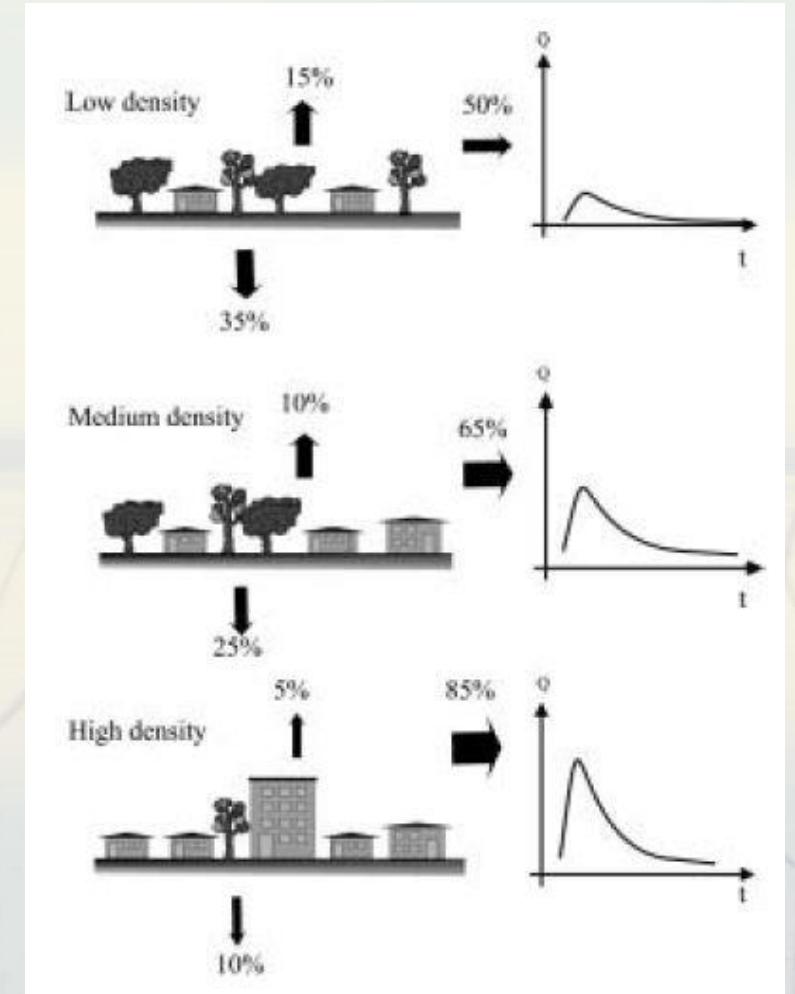
Based on CSE’s research and advocacy, recommend WSUDP approach for Stormwater Management for Indian Cities



Impact of Land Use Land Cover change on run-off



Source: Schueler, 1992

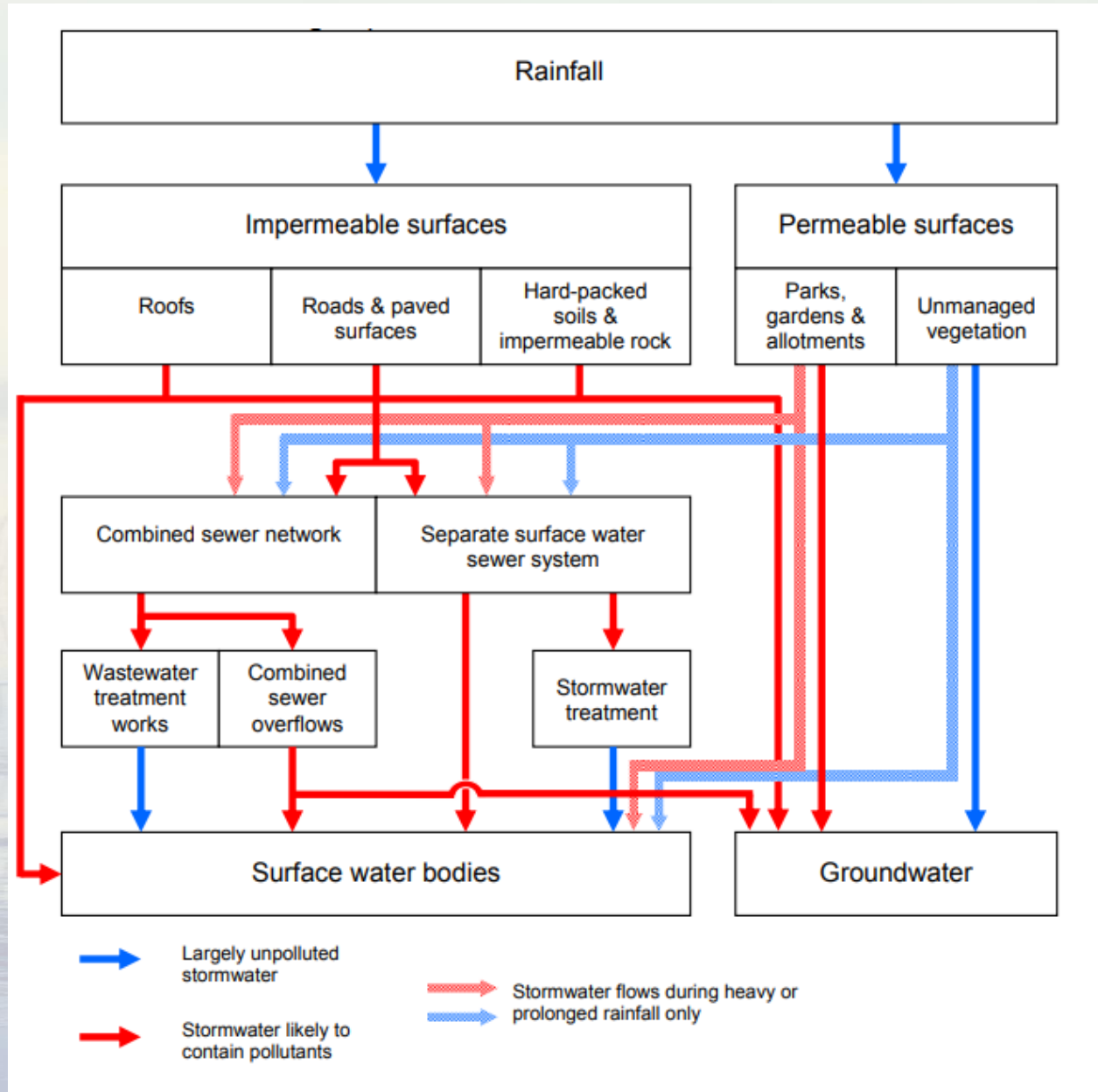


Source: Stormwater Management in Developing Countries, 2006

- Loss of lakes and wetlands in cities
- Reduced infiltration (groundwater recharge)
- Loss of stormwater storage systems
- Increased imperviousness
- Increased runoff volume
- Increased flow frequency, duration, and peak runoff rate

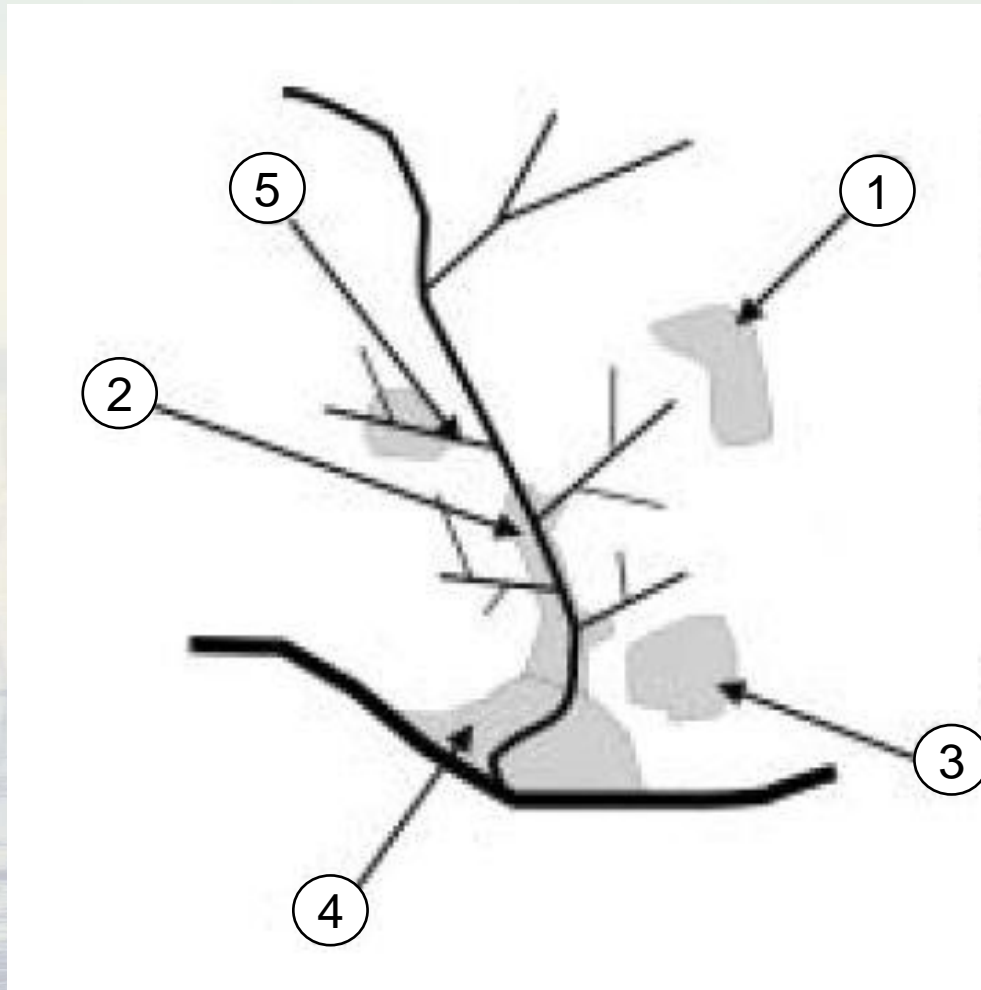
- Modification of the flow pattern
- Faster time to peak, due to shorter time of concentration through storm drain systems

Impact of Land Use Land Cover change on run-off



Apart from stormwater, the drains channels in a typical Indian city carry:

- **Wastewater** (grey water from kitchen and bath room, effluent from OSS, black water in absence of OSS)
- **Excreta** (in case of open defecation/urination in drains)
- **Solid waste** (due to littering and dumping).



1. Lack of Drainage Infra
2. Back-up due to elevated downstream levels
3. Flooding in low-lying areas
4. Inundation caused by high river / stream water levels
5. Blockage of drainage systems

Pluvial flooding

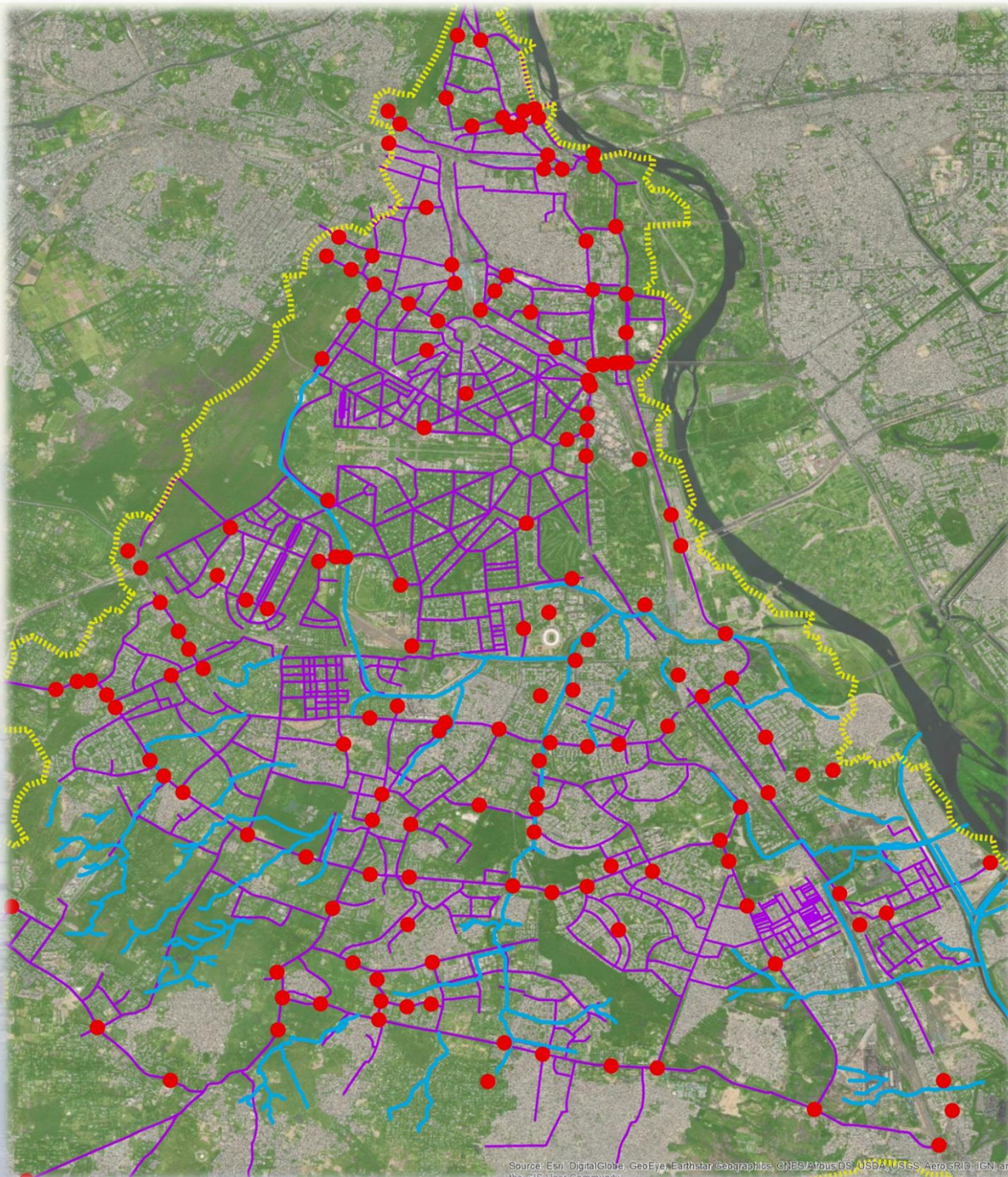
- Drainage systems are **overwhelmed by excessive runoff** flow, resulting in waterlogging and overland flow
- Usually associated with **short duration (up to 3hrs) high intensity rainfall** exceeding 20mm/hr
- Can also occur with lower intensity rainfall (10mm/hr) over longer periods and **can be worse in absence of waterbodies and pervious areas in urban areas.**

Source: Stormwater Management in Developing Countries, 2006

Source: SEPA (2009). Improved Understanding of Pluvial Flood Risk in Scotland. Scotland

Stormwater Infra in Indian Cities

Major Drainage | Minor Drainage
Separate Drainage | Combined Drainage
Roads as Drains | Underground and Surface
Drainage System



Choked Drain in Taimoor Nagar, Delhi

Source: IANS

Legend

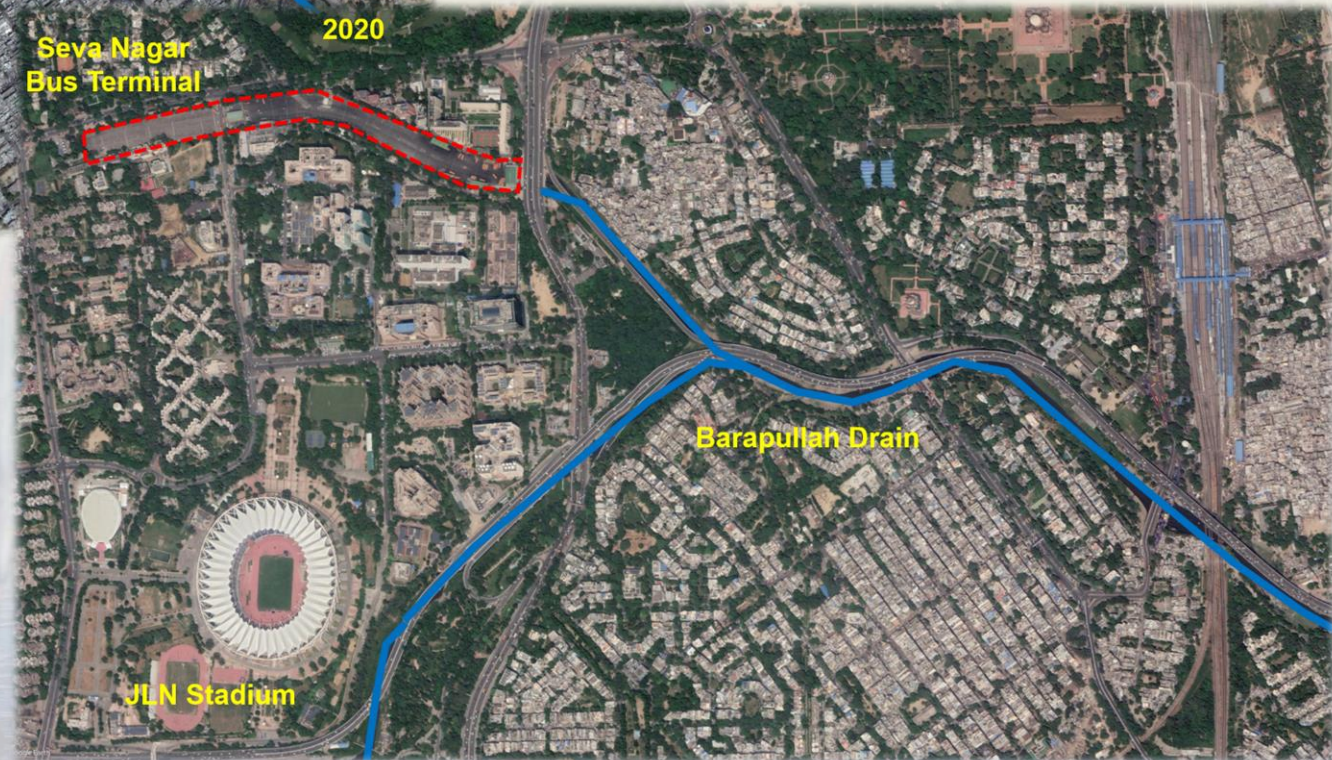
- Barapullah Basin Boundary
- Waterlogging (As reported by Delhi Police)
- Open Spaces
- Roadside Stormwater Drains
- Drain / Nallah



Stormwater Infra in Indian Cities

The conventional design system in Indian cities focuses on the **minor drainage system** as it is easily recognisable and convenient.

It comprises of **construction of drains and channels, road side drains, channelization, rehabilitation, rectification, enlargement of existing storm water drainage networks and also provision of cross drainage works.**



These systems may also **collect wastewaters derived from various domestic, commercial and industrial activities** along with the stormwater.

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



Combined | Separate



Urban Planning issues

- Planned and Unplanned encroachments
- Inadequate Development Control Norms
- Lack of Catchment Area Planning

Existing Policy Framework

- National Water Policy, 2012
- AMRUT
- AMRUT 2.0
- Smart Cities Mission
- National Mission for Sustainable Habitat
- Guidelines on Management of Urban Flooding, 2016
- SOP on Urban Flooding

Policy / Plan / Programme	Water Policy	Urban Flooding	Stormwater Management
National Level	Policy / Plan / Programme exists	Policy / Plan / Programme exists	Policy / Plan / Programme does not exist
State Level	Policy / Plan / Programme exists	Policy / Plan / Programme does not exist	Policy / Plan / Programme does not exist
City Level	Policy / Plan / Programme does not exist	Policy / Plan / Programme does not exist	Policy / Plan / Programme does not exist

Policy / Plan / Programme exists

Policy / Plan / Programme does not exist

CSE Research: Mainstreaming Water sensitive Urban Design in India in Policy & Practice



AAETI **UWE Bristol**
C-GINS
Compendium of Green Infrastructure Network systems
<https://www.cseindia.org/c-gins/home>



Roadmap for Implementation of Water-Sensitive Urban Design and Planning in Odisha
RAINWATER HARVESTING IN PUBLIC PARKS AND OPEN SPACES

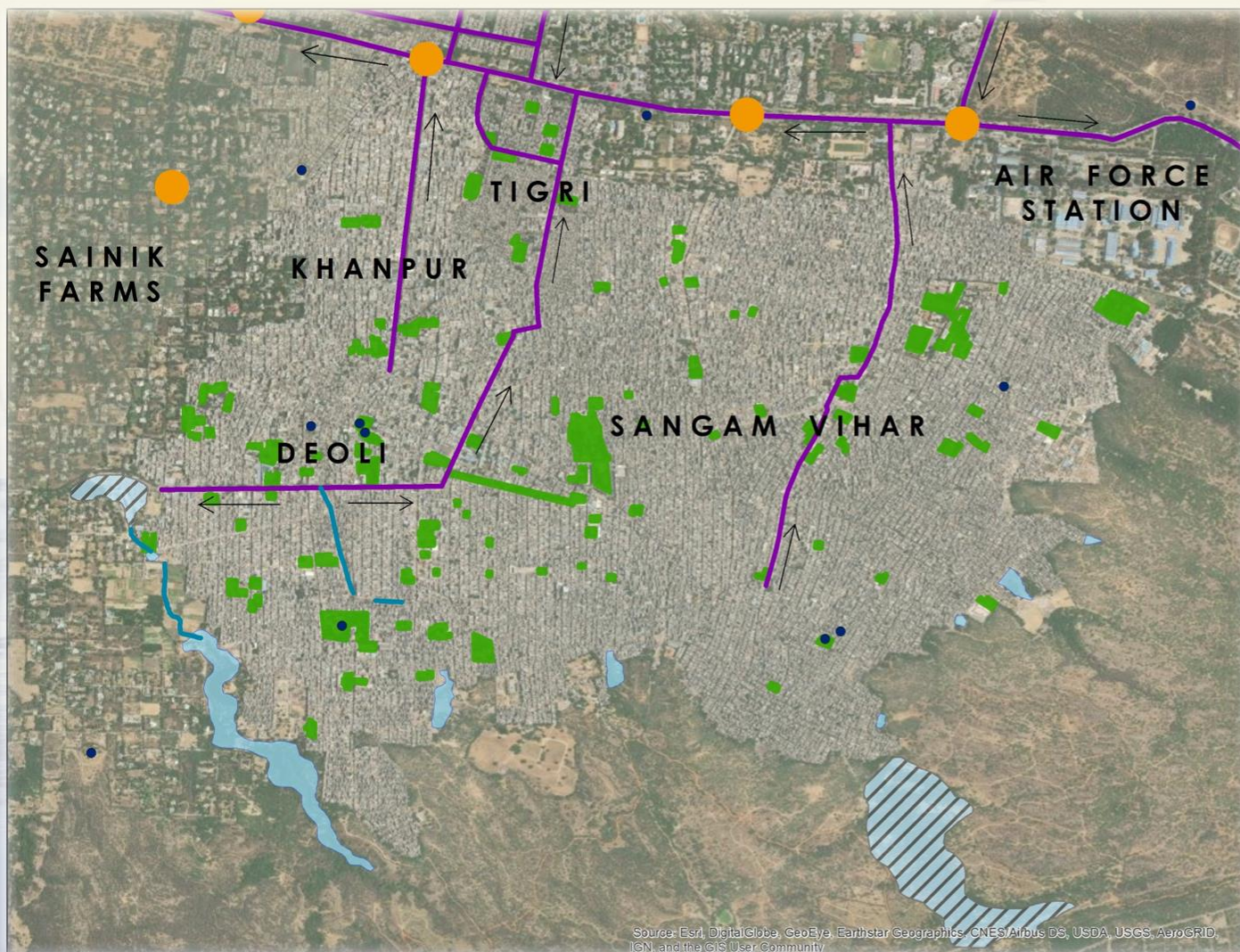
ROADMAP FOR IMPLEMENTATION OF WATER-SENSITIVE URBAN DESIGN AND PLANNING IN DELHI
STORMWATER HARVESTING IN PUBLIC PARKS AND OPEN SPACES

Roadmap for Implementation of Water-Sensitive Urban Design and Planning (WSUDP) in Uttar Pradesh
Stormwater Harvesting in Parks and Open Spaces

Principle I	Principle II	Principle III	Principle IV	Principle V
The major/minor approach to urban drainage	Attenuate and infiltrate first	Interventions at all scales	Locating interventions as per city's urban fabric and natural physical features	Stormwater harvesting

- 1. Major / Minor Approach** – *Combination of conventional systems and SUDS*
- 2. Attenuate and Infiltrate first** – *Control volume and peak run-off from site by retention and detention, and preserve natural streams and waterbodies*
- 3. Interventions at all Scales** – *Follow the SUDS train at individual, neighbourhood and zonal/city scale*
- 4. Context-based interventions** – *Locating interventions as per city's dense urban fabric, topography and along physical features.*
- 5. Stormwater Harvesting** at all scales: *Public open spaces*

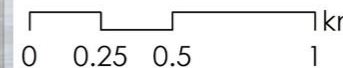
Can we manage urban waterbodies with unplanned/informal development? **WSUDP strategies for wastewater management** for **pollution abatement**, **shoreline protection** and **buffer area management** are essential to manage urban waterbodies in such contexts.



This approach can be implemented in **unauthorised colonies**, **urban villages**, etc.

Legend

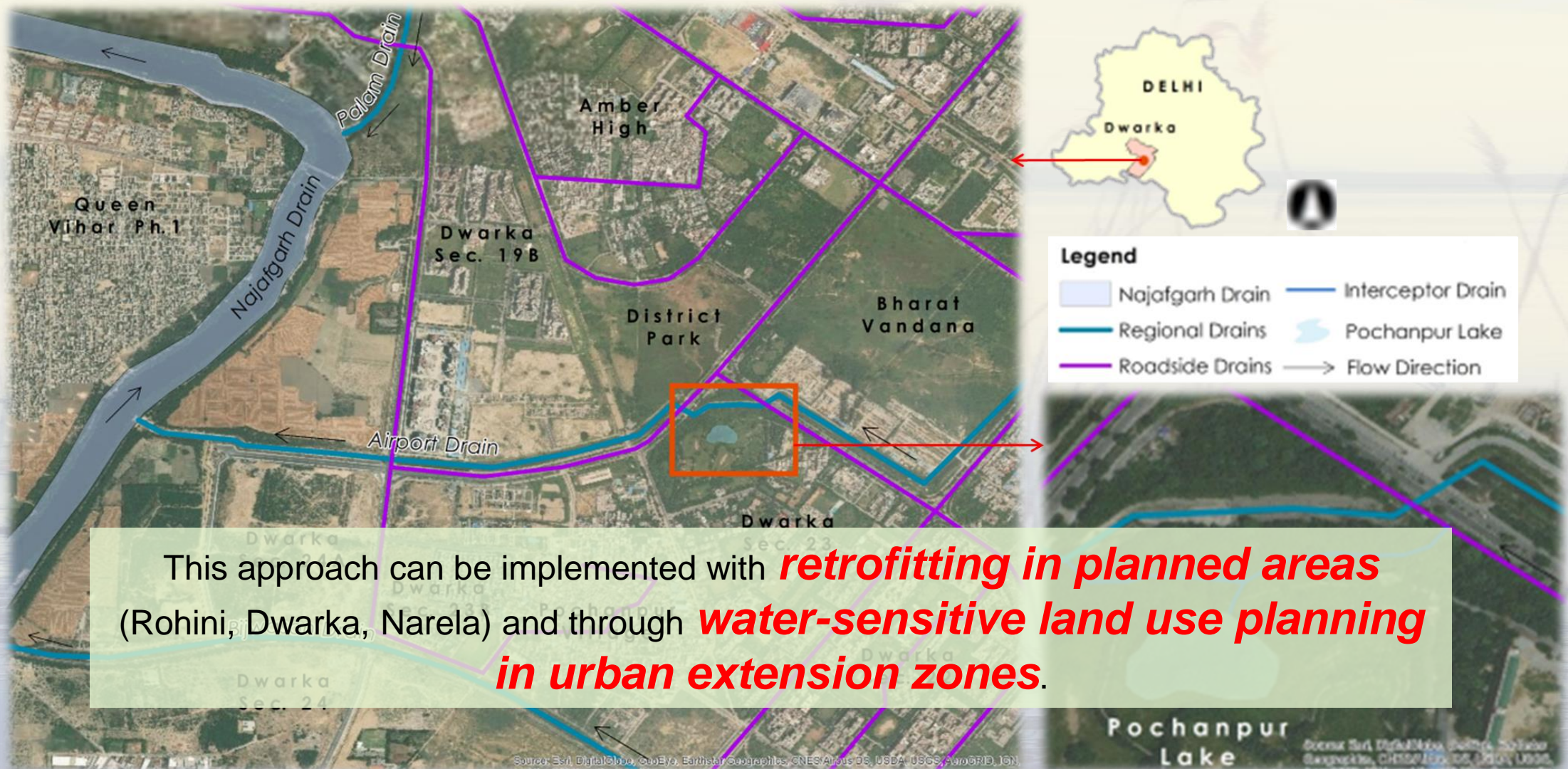
- Stormwater Drain —> Flow Direction
- Nallah
- Waterlogging (As reported by Delhi Police)
- Waterbodies (as per DPGS)
- Existing Water Body
- Water Body (as per Zonal Plan)
- Open Space



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Can we manage urban waterbodies with planned development? **WSUDP strategies for stormwater harvesting** are essential to **build the bridge between urban planning and waterbodies management.**



- Conduct **scientific analysis** of the storm water drainage system; Catchment delineation and drain Analysis – terrain analysis to determine dominant areas contributing the storm runoff for each drain, Local rainfall analysis – return period of extreme rainfall (15 min), preparation of soil type and landuse data to be adopted in the study
- Deploy **models to stimulate the floods**: Capture the drainage infrastructure, validate the model by mapping flooding hotspots, storm drain carrying sewage/ solid waste/ C & D waste, encroachment, analyse to check technical aspects of drains and its performance for conveyance, effectiveness of desilting of storm drains, no construction should be allowed inside any storm drains (pillars of elevated roads etc.).
- **Hydrologic and hydrodynamic modelling** to derive runoff hydrographs, surface water profiles and extent of backwater effects within the storm drainage network under various envisaged scenarios
- **Vulnerability assessment**: to cater equity in distribution of infrastructure
- Design of new **storm drains should not be done in isolation**; retention cum harvesting corridors can be laid along the road to capture the runoff and recharge

In order to manage stormwater effectively, the following principles are to be implemented via short-, medium- and long-term strategies, addressing structural issues:

- **Alternatives for Sustainable Stormwater Management and Suitability in Indian context**: Harvesting at the site scale may prove to be more beneficial as the collected stormwater can be either used for multiple purposes or infiltrated into ground | Retrofitting of site-scale watersheds with SUDS measures: micro scale, infiltration-based SUDS/ LID techniques, applied in decentralized way.



Thank you

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