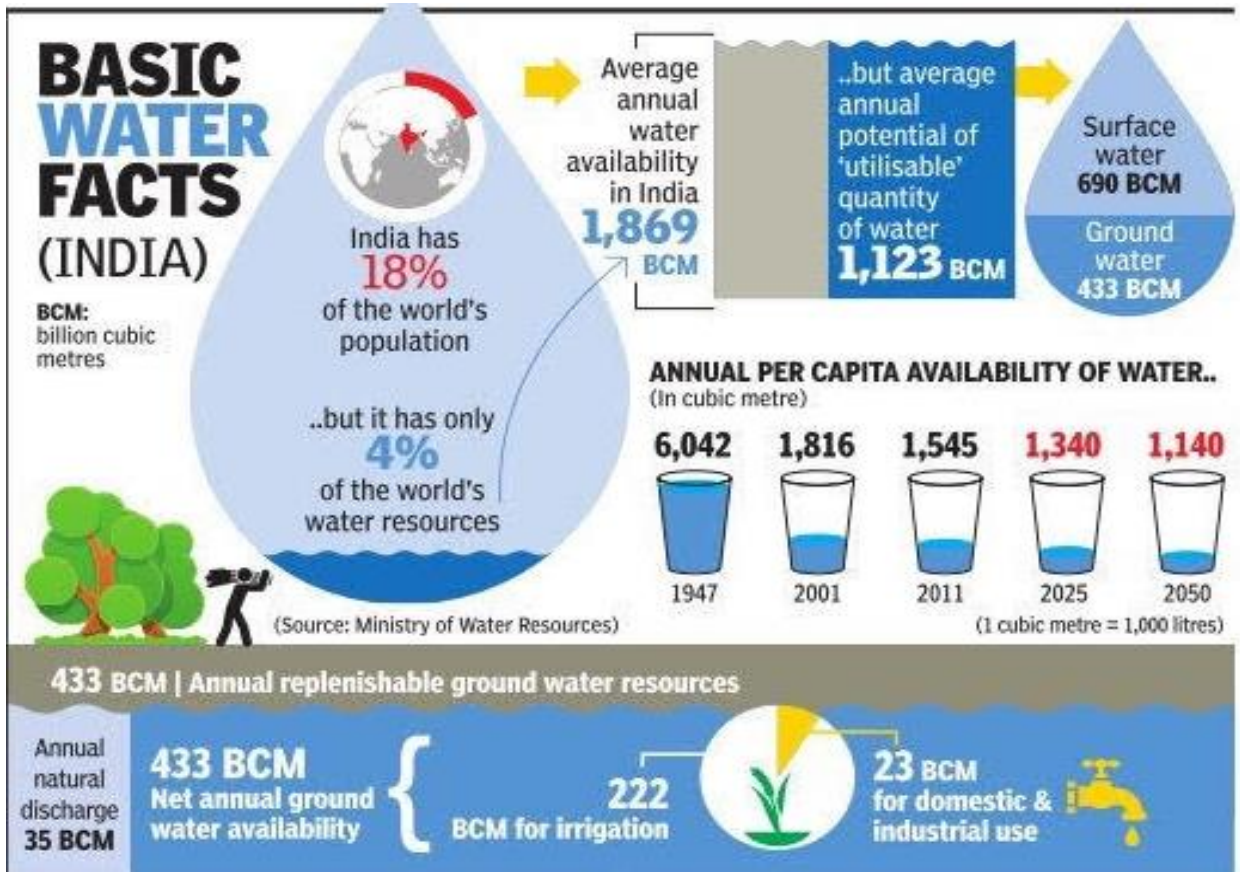
Making our cities

Water sensitive

27th May 2020

CSE – HUDD Dialogue cum Consultation Workshop

India's Water Challenges



600 million people in India face high-to-extreme water crisis

70% of India's water is contaminated

40% Indians will have no access to drinking water by 2030

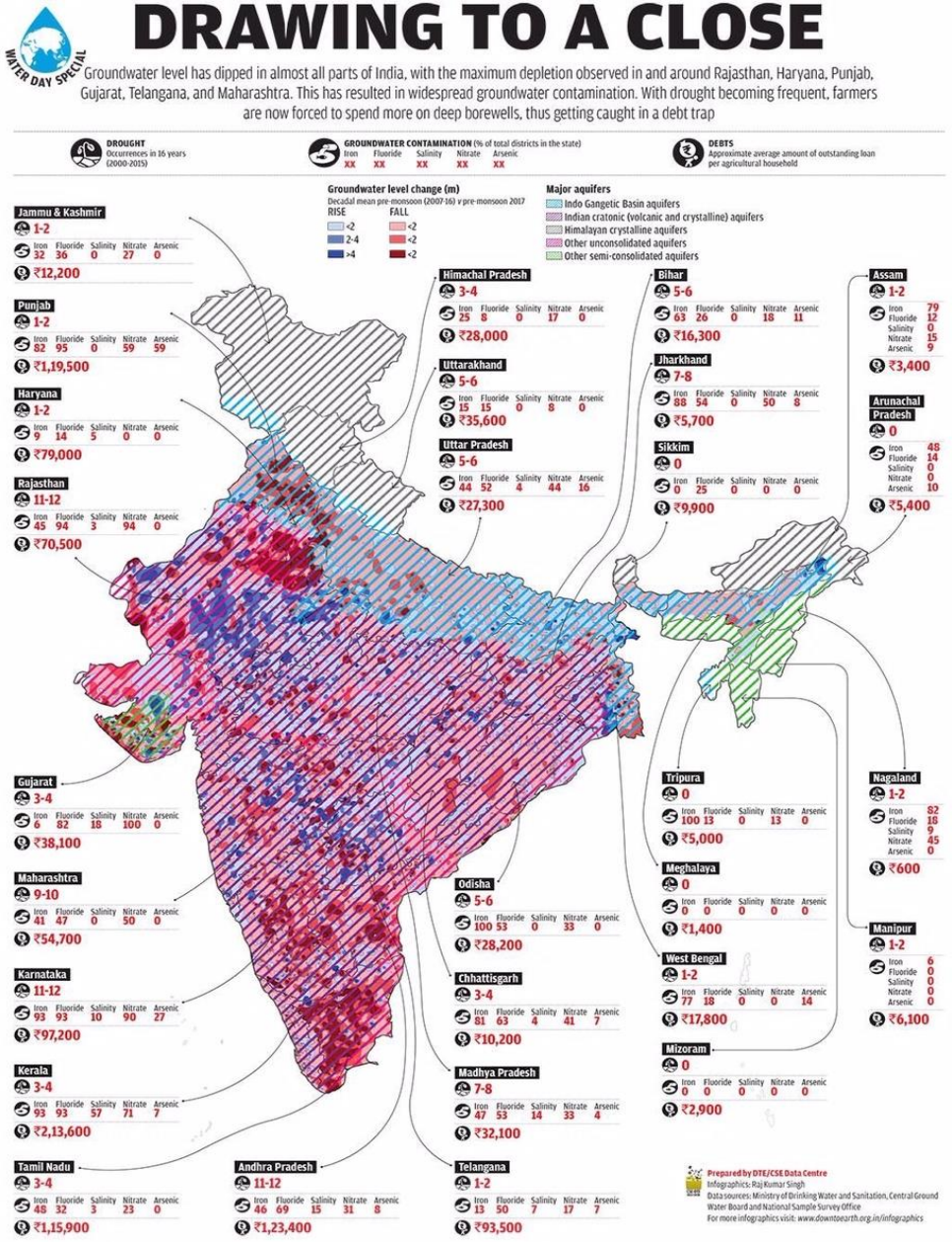
21 cities will run out of groundwater by 2020

Source: Composite Water Management Index, NITI Aayog

NDTV.com

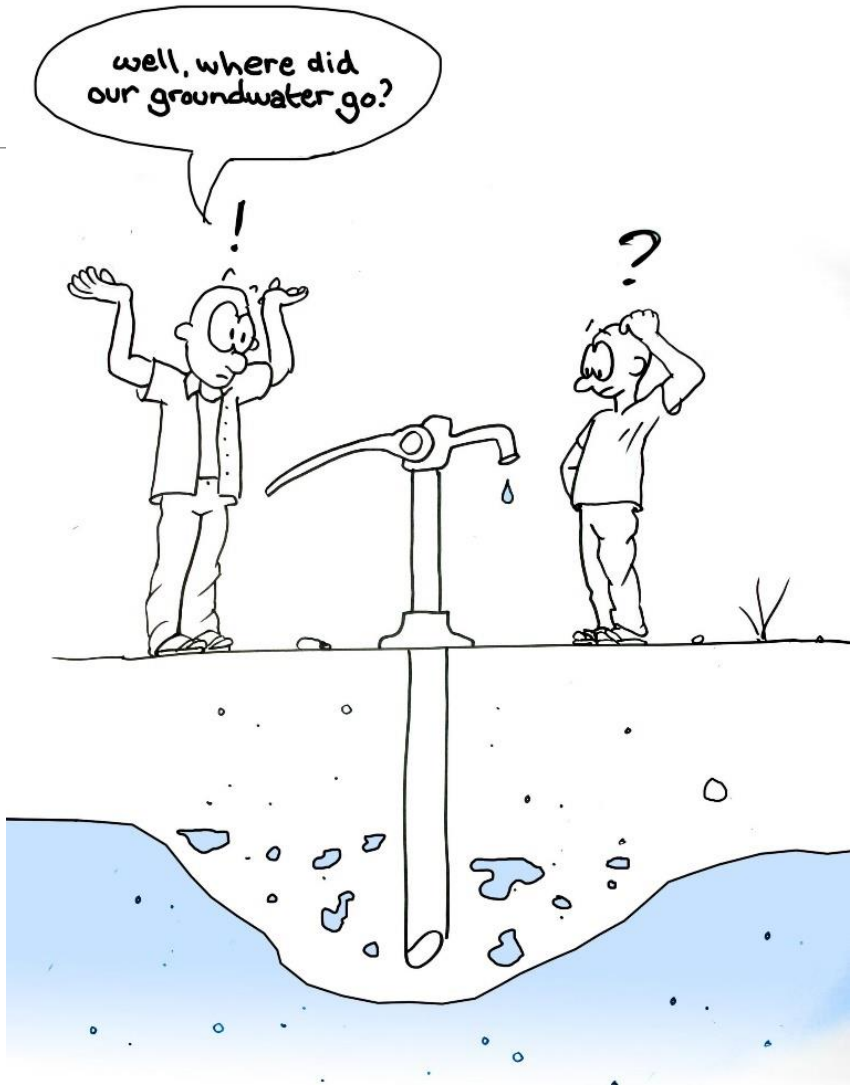
Today not even a single Indian city has 24 X 7 water supply

Groundwater depletion in India 1995-2019



All over country the overexploitation of GW is recorded

Cities – extracting GW at 20 feets are now extracting water from 250-300 feet b.g.l.



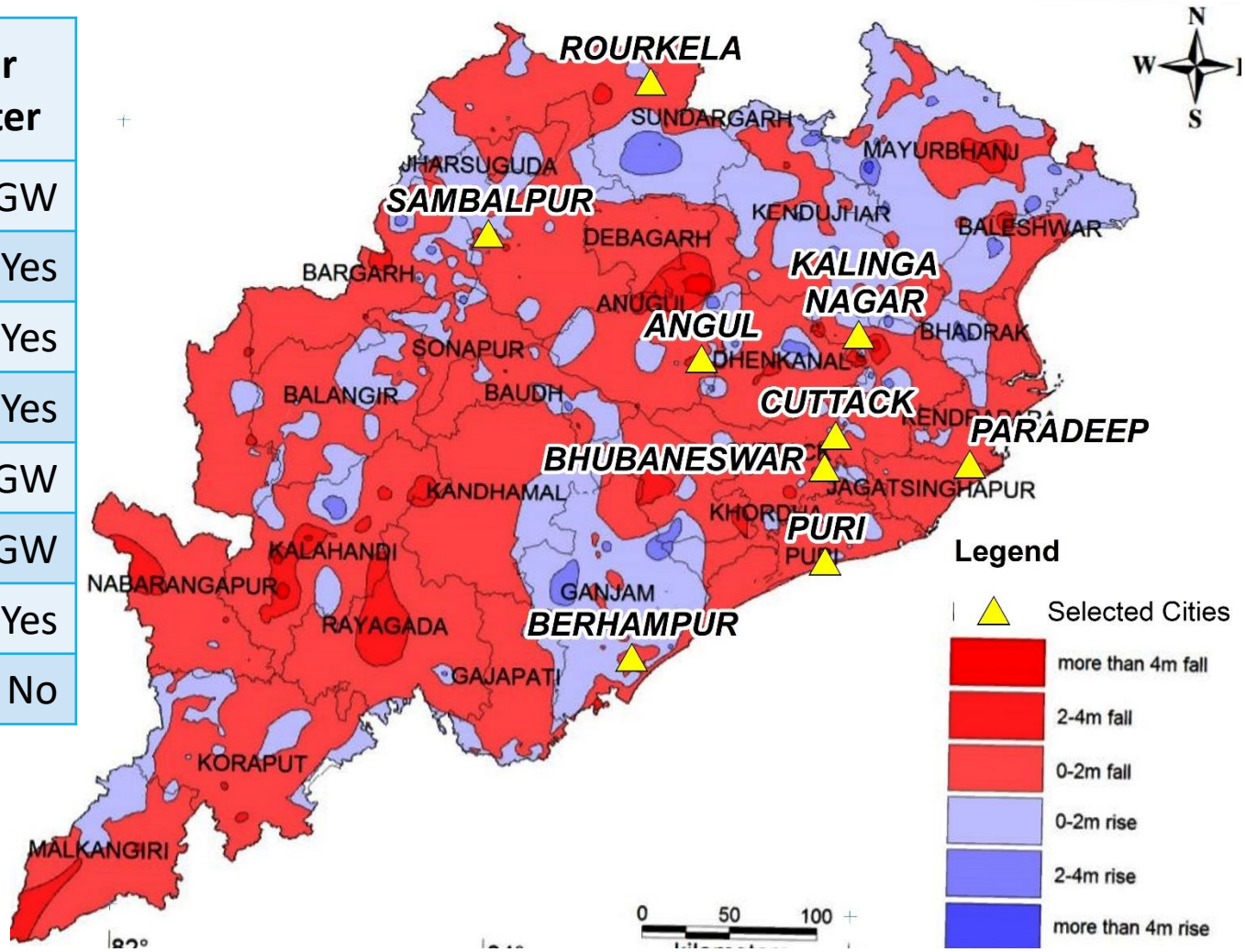
Groundwater table in cities of Odisha

City	GW Table (m. b g l)		GW as major source of water
	Pre	Post	
Bhubaneshwar	2 - 13	2 - 11	22% from GW
Cuttack	2 - 8	0.5 - 6	Yes
Puri	5		Yes
Rourkela	3.7		Yes
Sambalpur	2 - 10	0 – 5	12% from GW
Berhampur	Upto 13	Upto 11	16% from GW
Angul	2 - 12	1 - 9	Yes
Paradeep	0 - 5	0 - 4	No

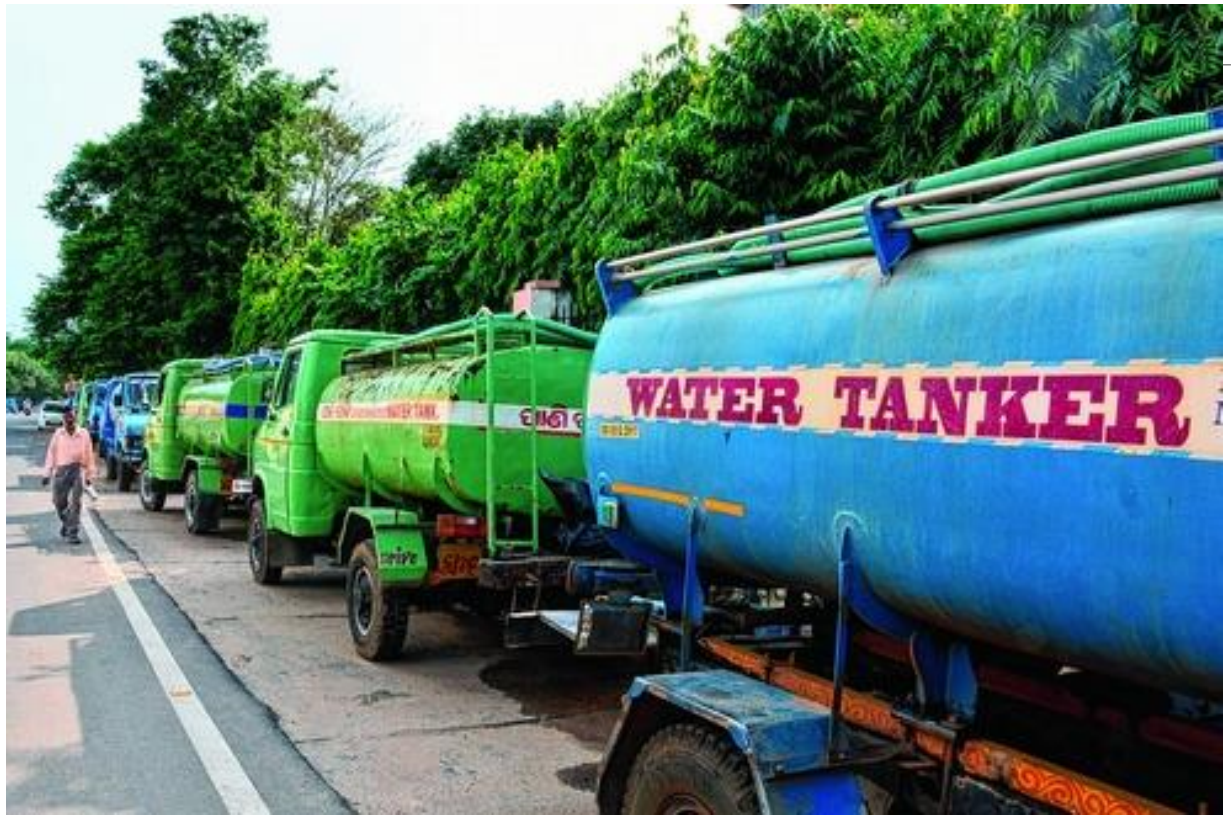
Source(s):

- Groundwater Information Booklets for Cuttack, Ganjam, Jagatsinghpur, Sambalpur Districts
- CSP for Puri
- CDP for Pure
- AMRUT Information sheet for Cuttack, Rourkela, Bhubaneshwar

Groundwater level fluctuation map (April, 2016)



Water scenario

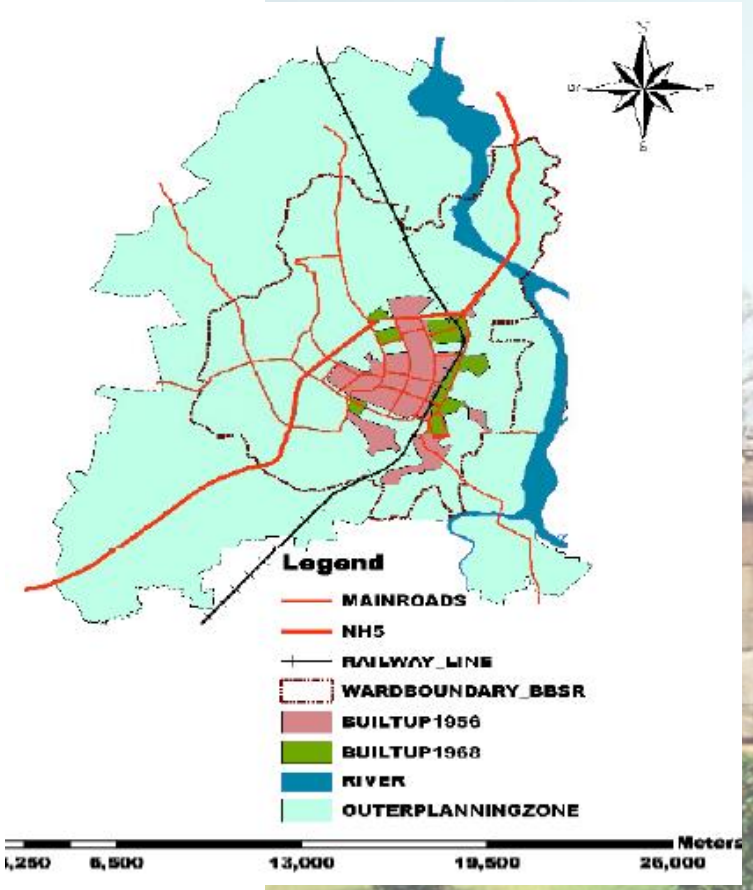


Bhubaneswar

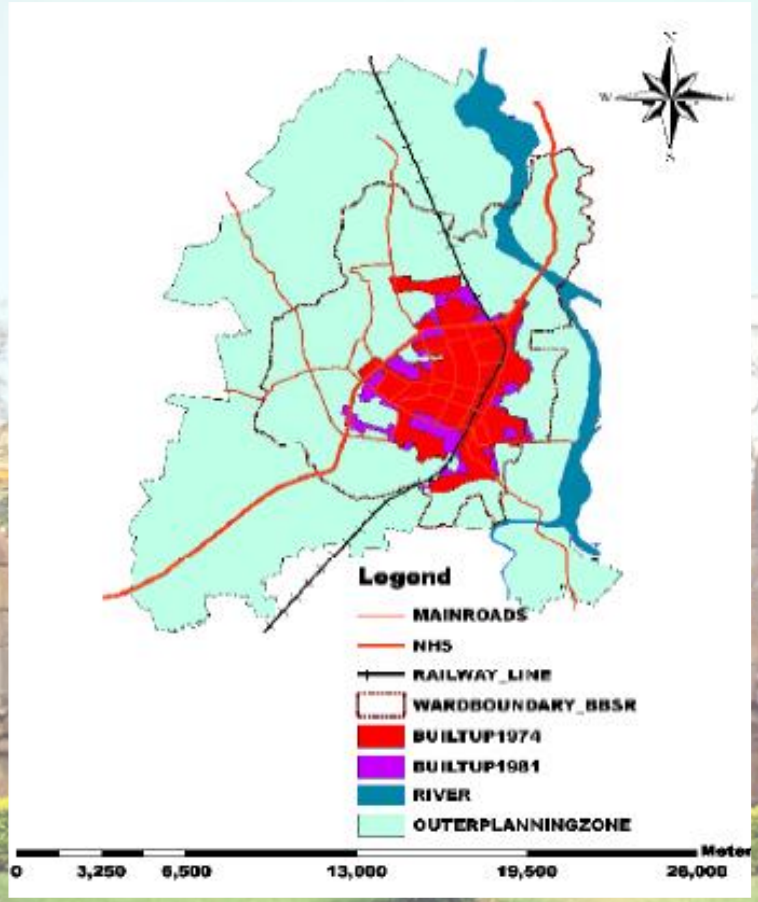
Cuttack

The dilemma of our cities.... Water is everywhere.. but it is no where.

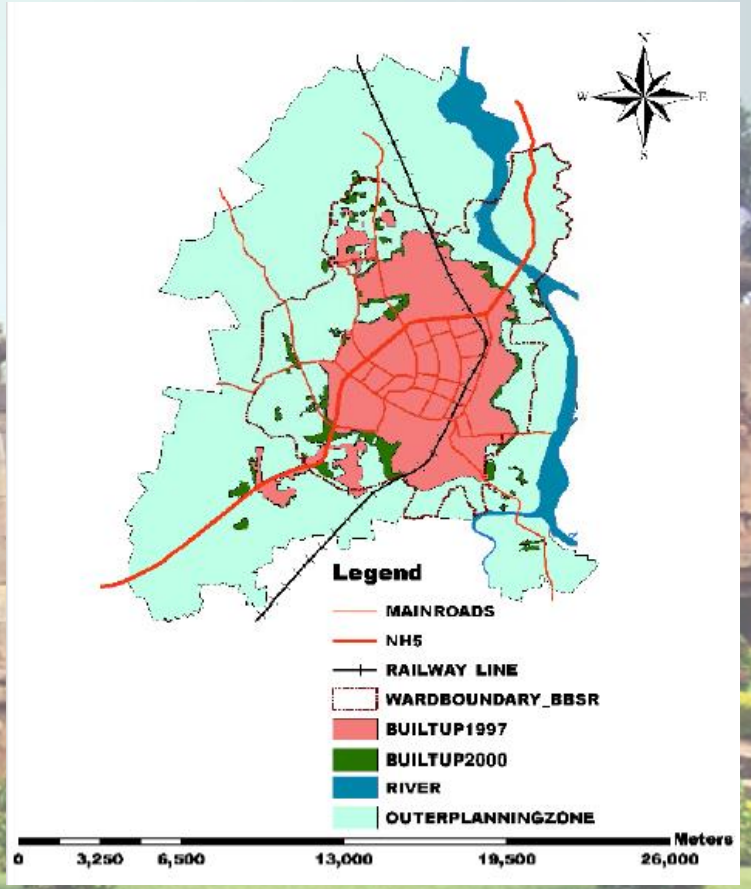
Land Use Transformation: Bhubaneswar



Urban sprawl, 1956



Urban sprawl, 1981

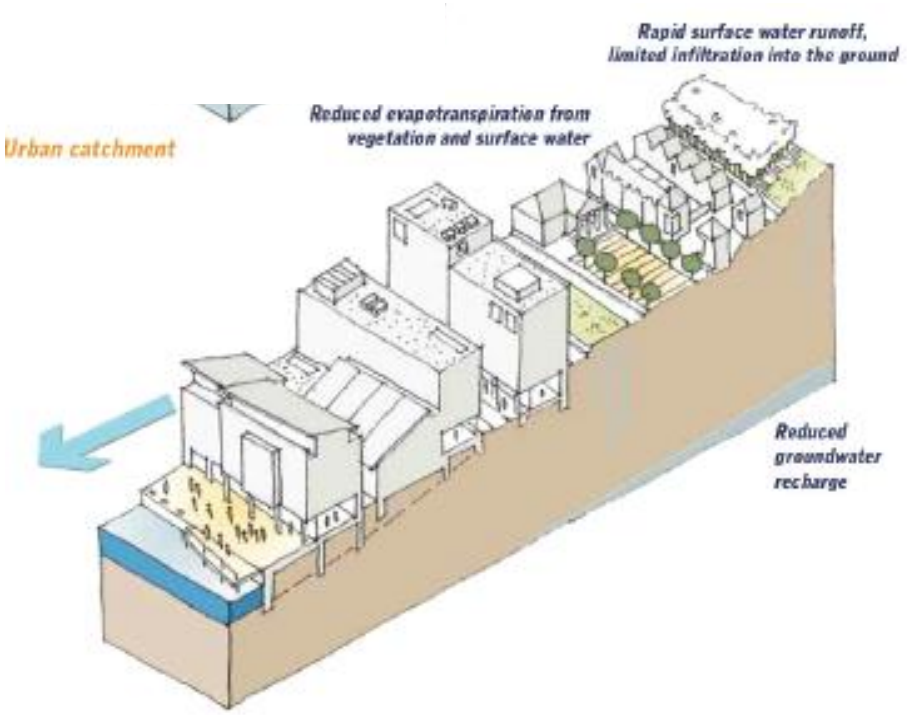


Urban sprawl, 2000

Source: Mishra, M., Mishra, K.K., Subudhi, A.P., Phil, M. and Cuttack, O., 2006. Urban sprawl mapping and land use change analysis using remote sensing and GIS.

Natural Catchment

Urban catchment



Ickle, S., McKay, G., Ions, L. and Shaffer, P., 2010. Planning for SuDS–making it happen. CIRIA Publication C,

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

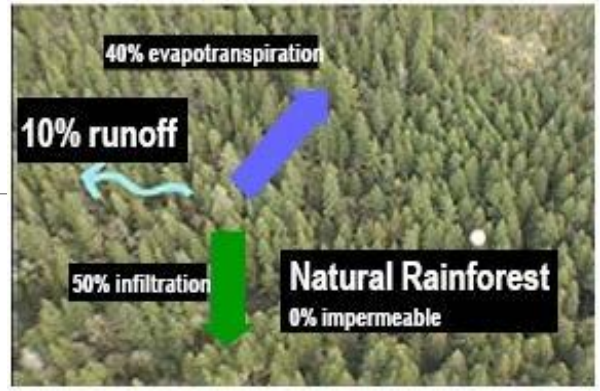
Change in Urban Water Balance

The Natural versus Urban Water Balance:

Precipitation = Evapotranspiration + Runoff + Recharge (interflow & deep ground water)

The Water Balance changes when natural vegetated cover is replaced by suburban development.

The actual percentages will vary from region to region, but the relationships are universal.



Natural rainforest

Residential development

Flooding in urban environment

Commercial development

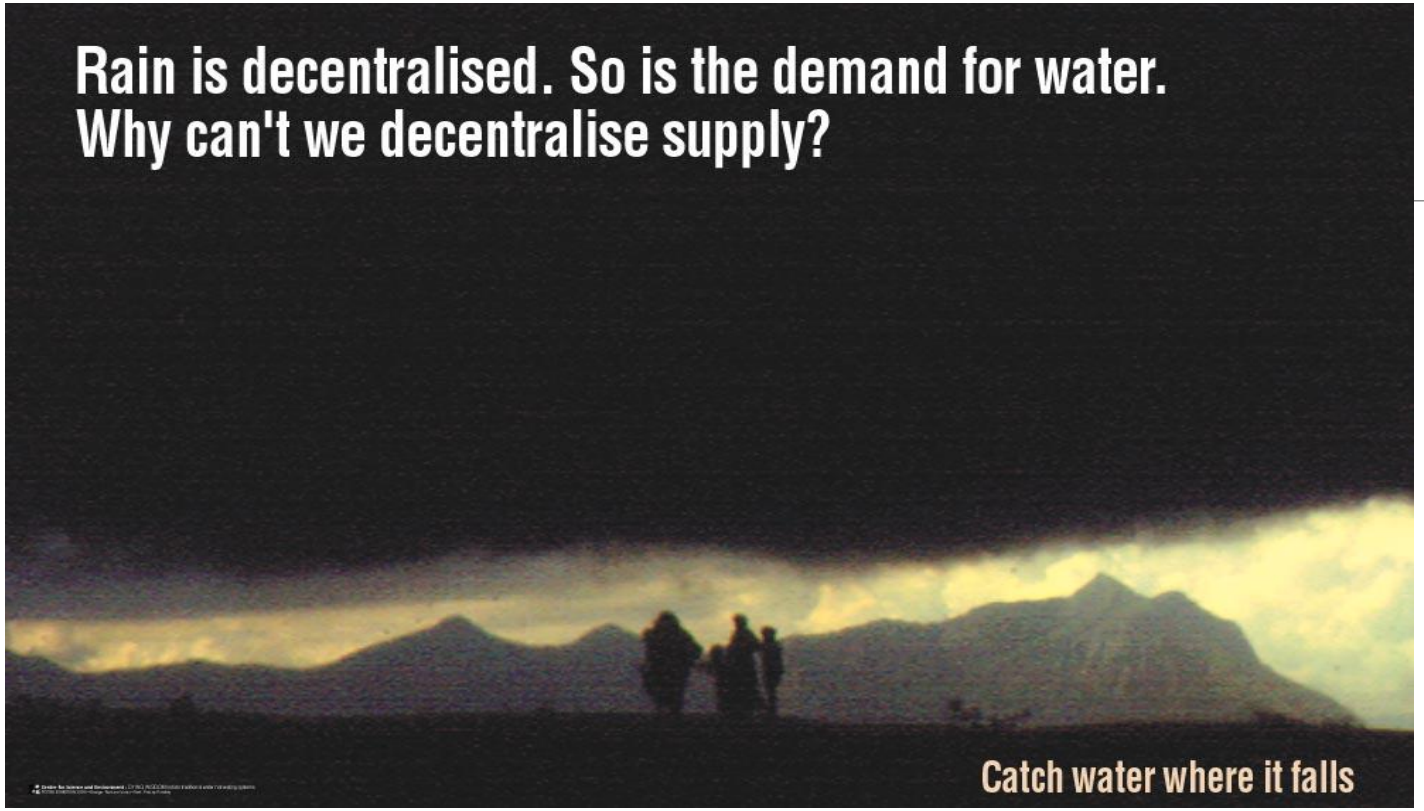
Water Scenario in India

The conventional way:

Bring water into the city – storage, diversion, pipe, pump, treat – from further and further away.

Flush and carry the waste out of the city – pipe, pump, divert, treat – further and further away.

Water > Shortage, or mismanagement?

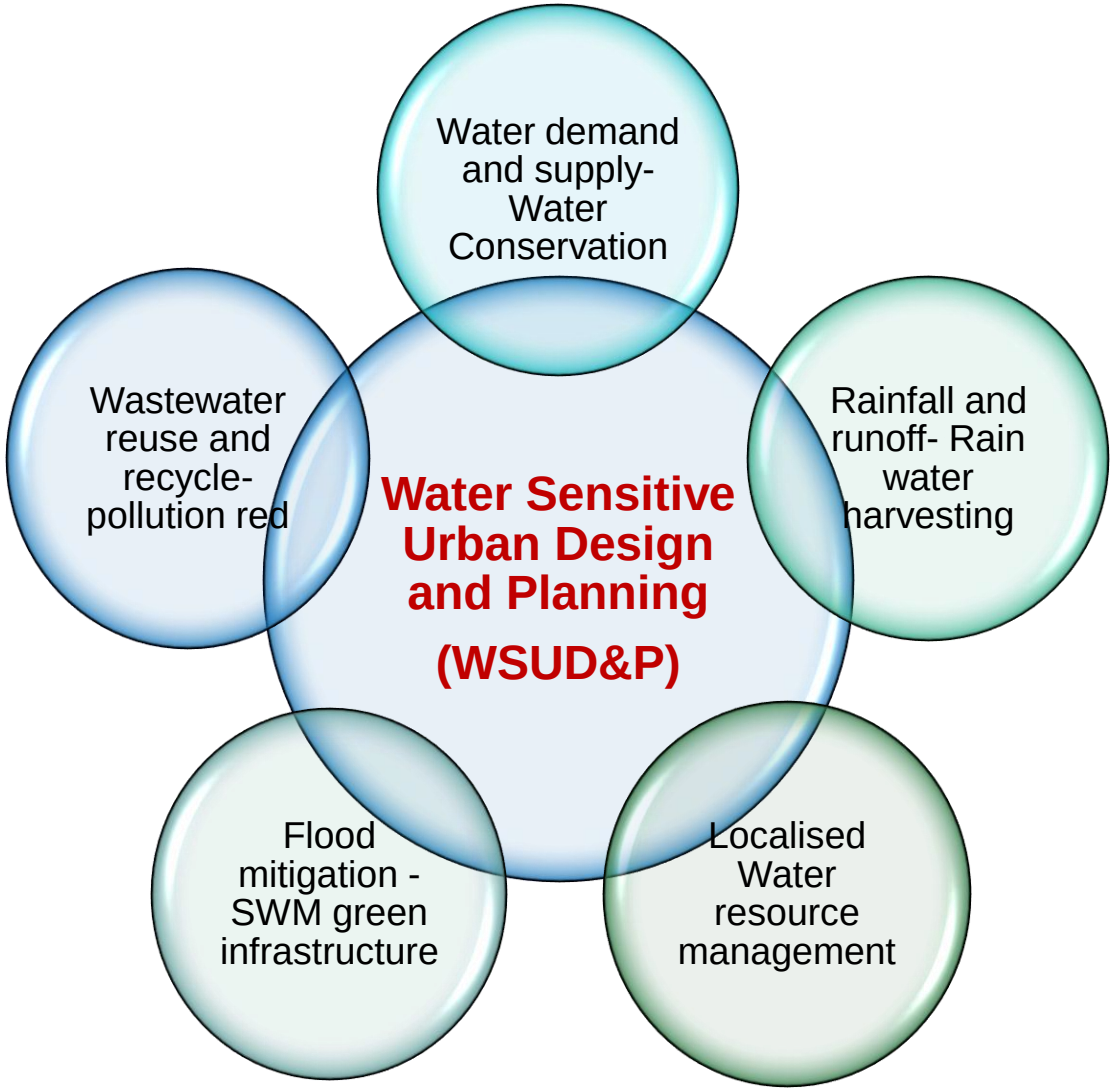


- Community role **destroyed**
- Heavy dependence on surface-ground water
- Lost: Rich **hydrological** traditions

Water is about life. It is about health. It is about livelihoods.
It is about wealth.

Water has to be everybody's business …….

Water sensitive approach



- Protecting local water bodies (lakes, ponds and wetlands) for supplementary water sources

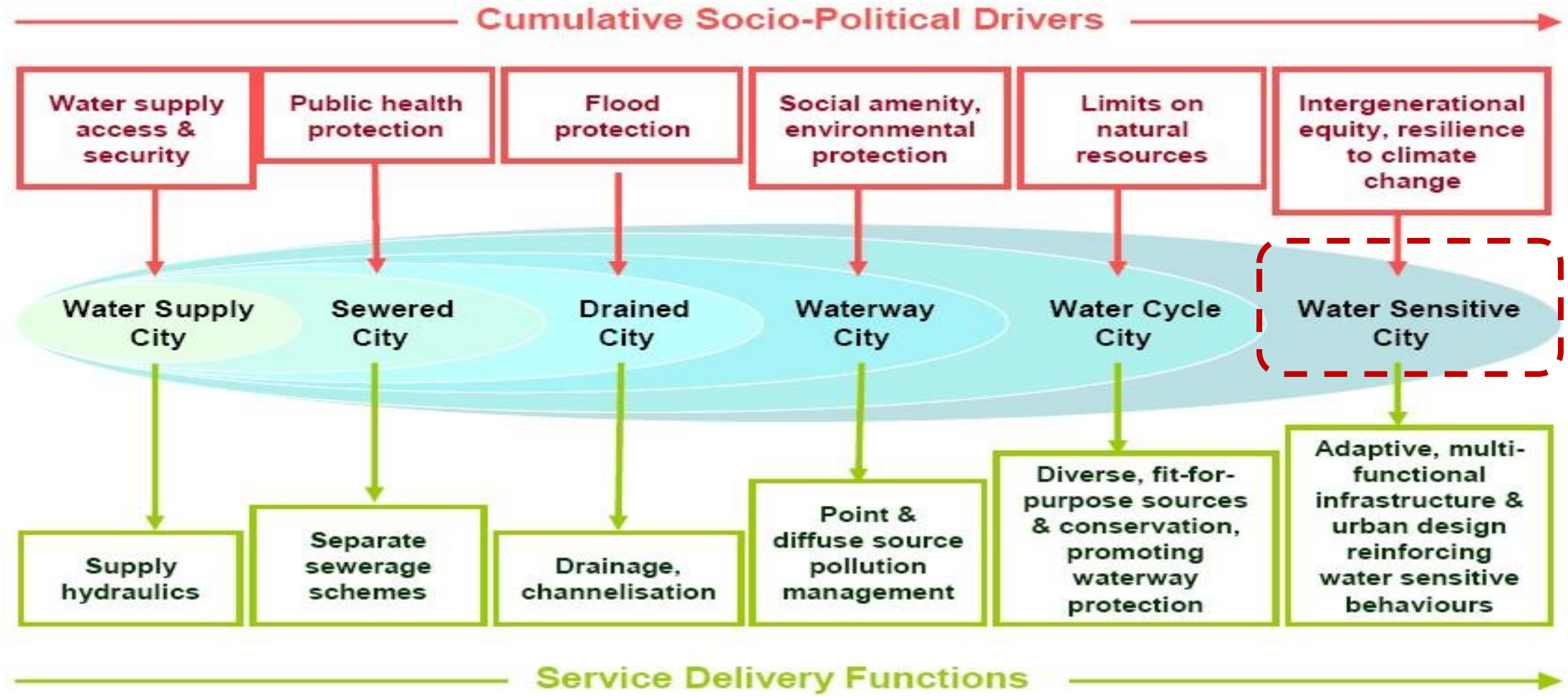
- Storm-water management at public places, including open areas in cities

- Increasing water-conservation approaches at various scales (buildings/campus).

On-site water conservation with rainwater harvesting (RWH) is important to reduce water scarcity.

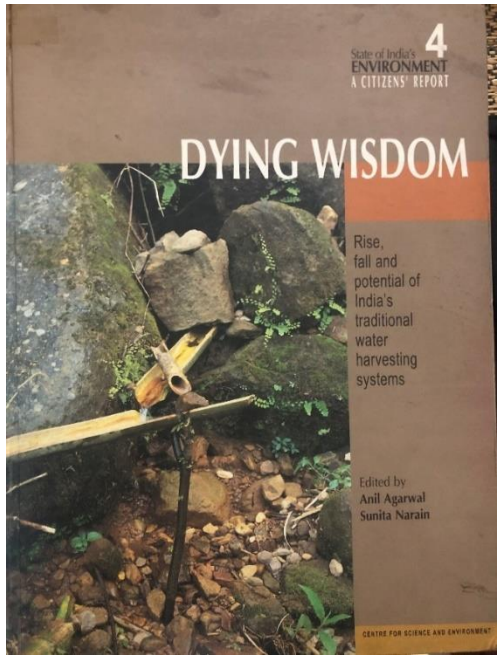
Concept of water sensitive city:
Embed Within Social and service delivery

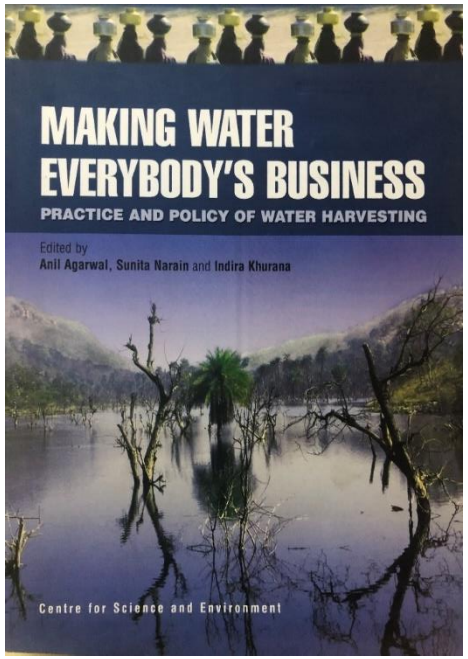
WHAT?

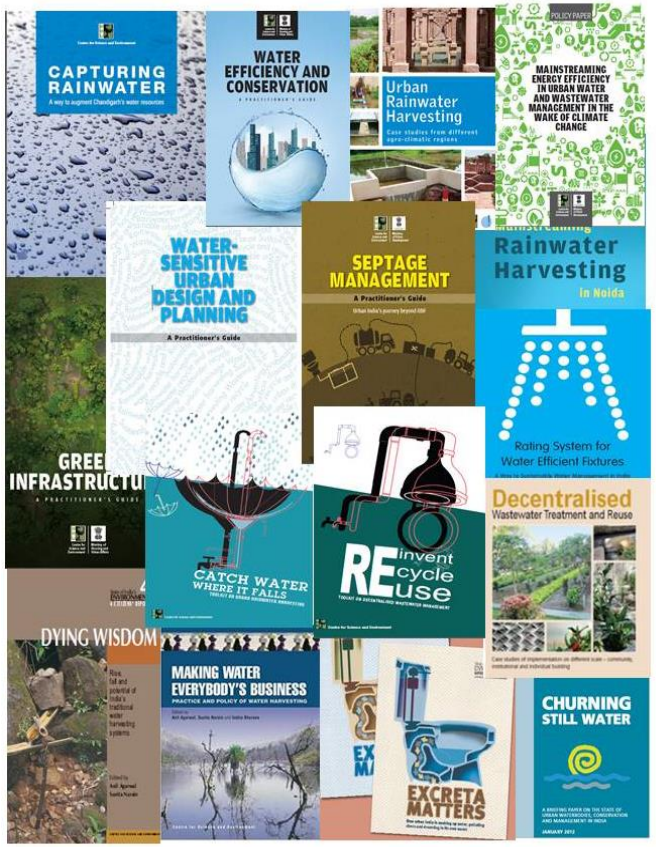


Source: Wong and Brown,11th InternationalConference on Urban Drainage, Edinburgh, Scotland, UK,2008

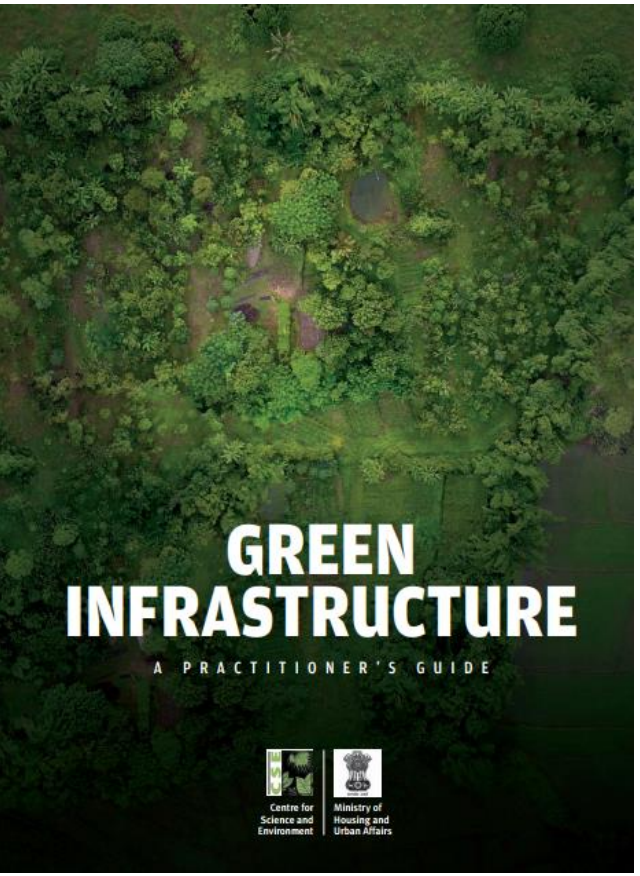
CSE Water Research :

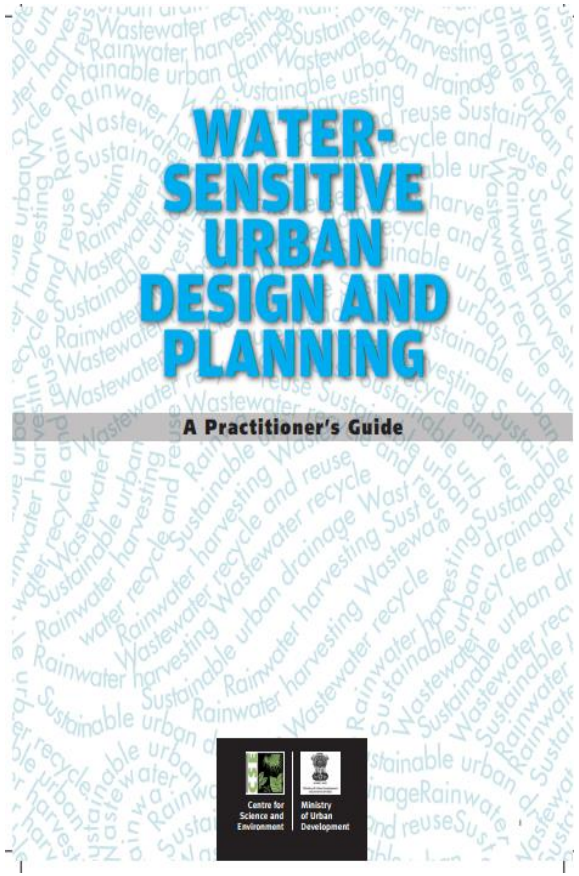






Building a Community of Practice: Rainwater, Technology & Sustainable Water Management in City





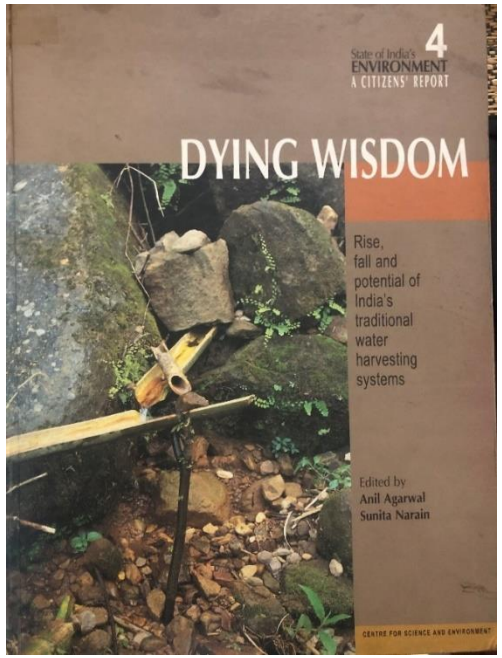
https://youtu.be/xjCAyKY6fJg ,
https://youtu.be/NHTUC-Xs3uw

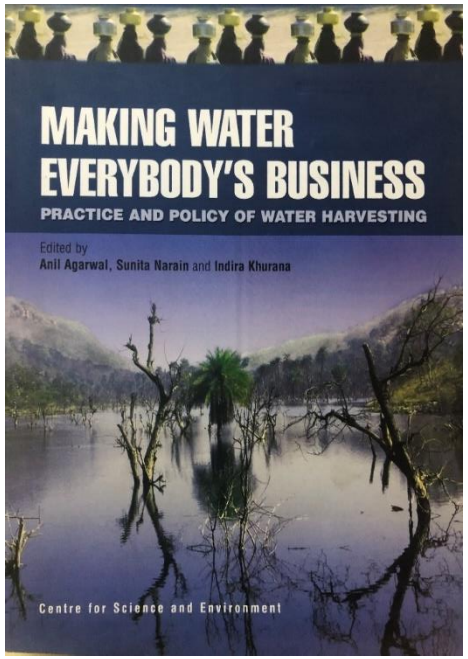
CSE pushing to get different approach in water-waste management - Decentralized, cost-effective technologies

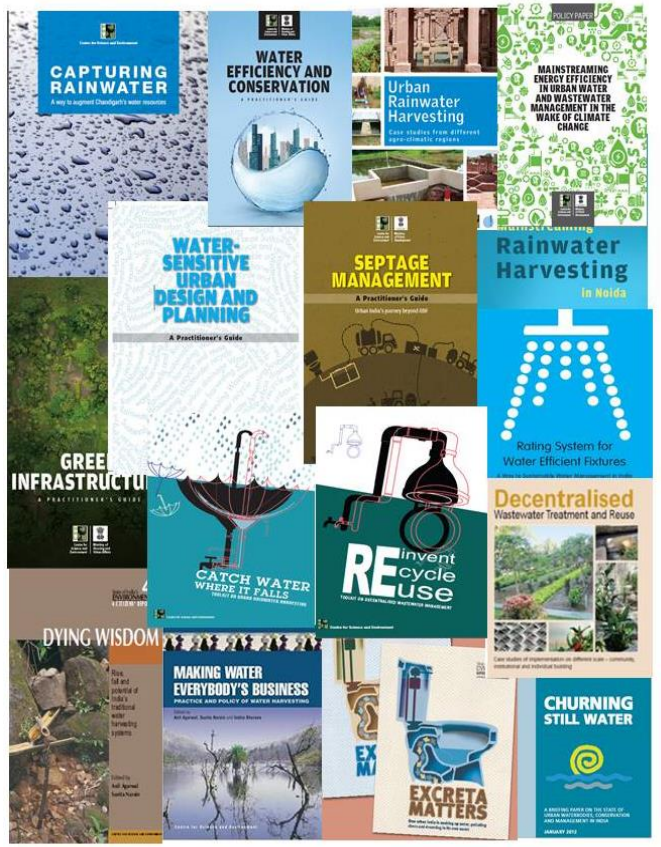
Need capacity in society – training of real users and implementers

Need strategies to experiment / practice and scale-up

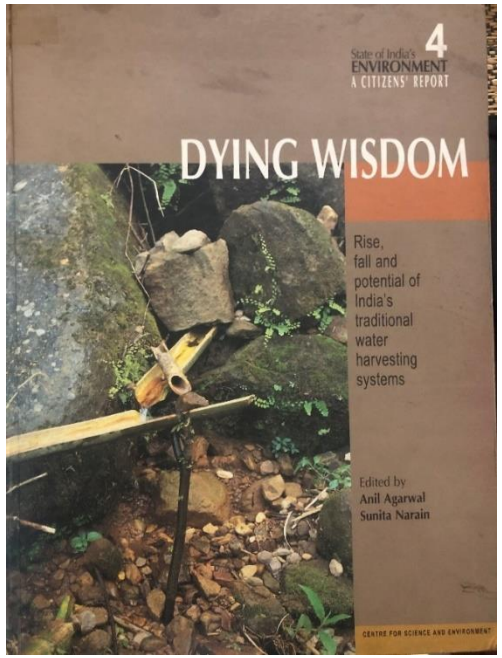
CSE Research : The water-sewage connection

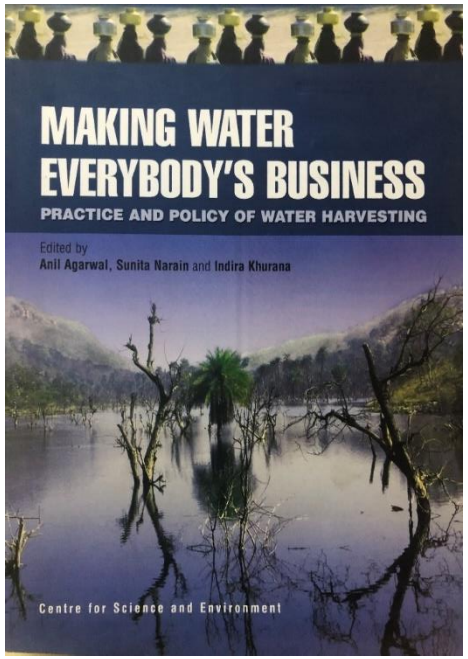


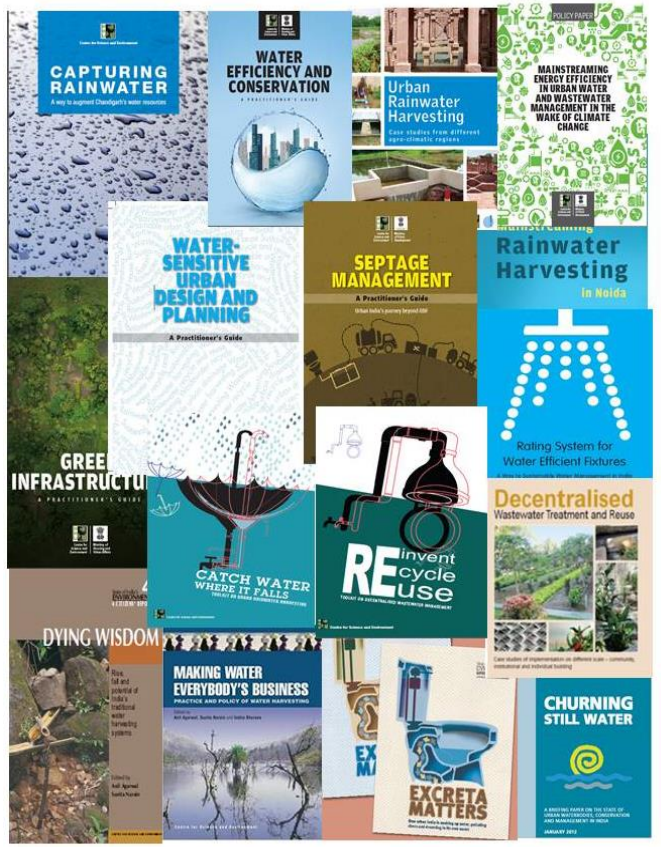


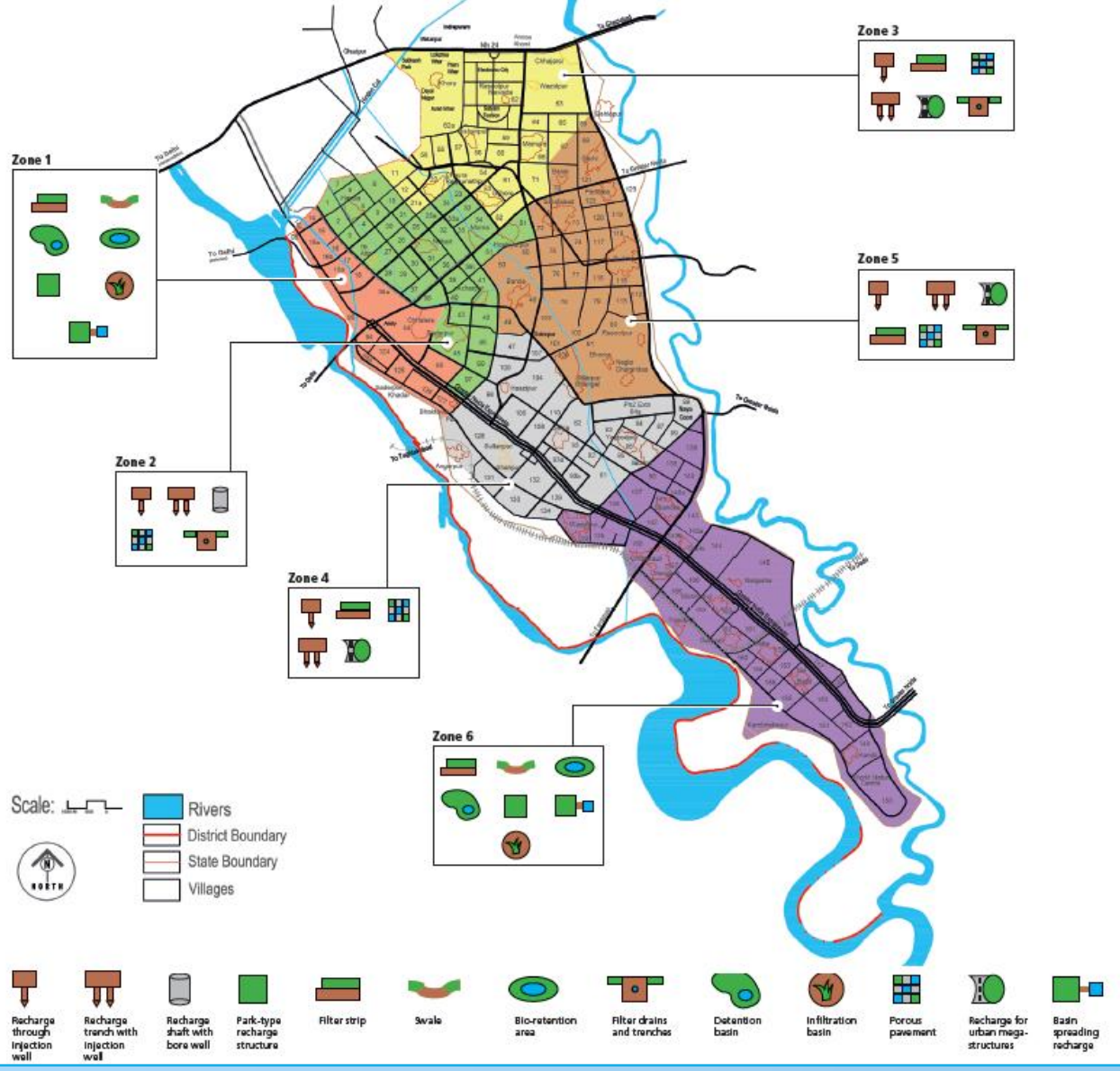


CSE Research : The water-sewage connection

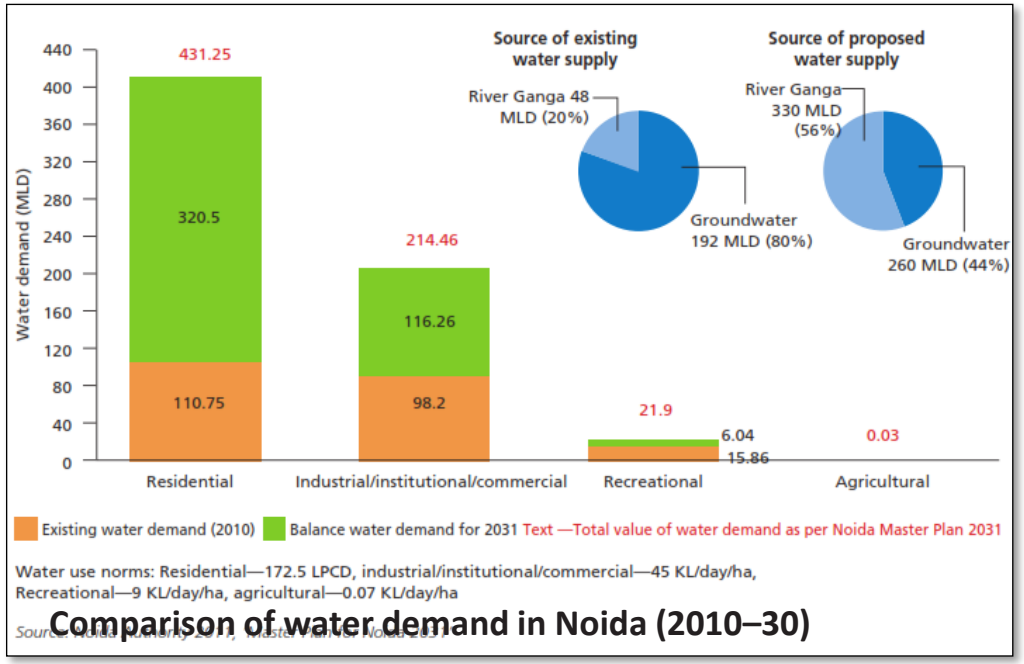








- To overcome the inadequacy of surface water to meet our demands.
- To arrest decline in ground water levels

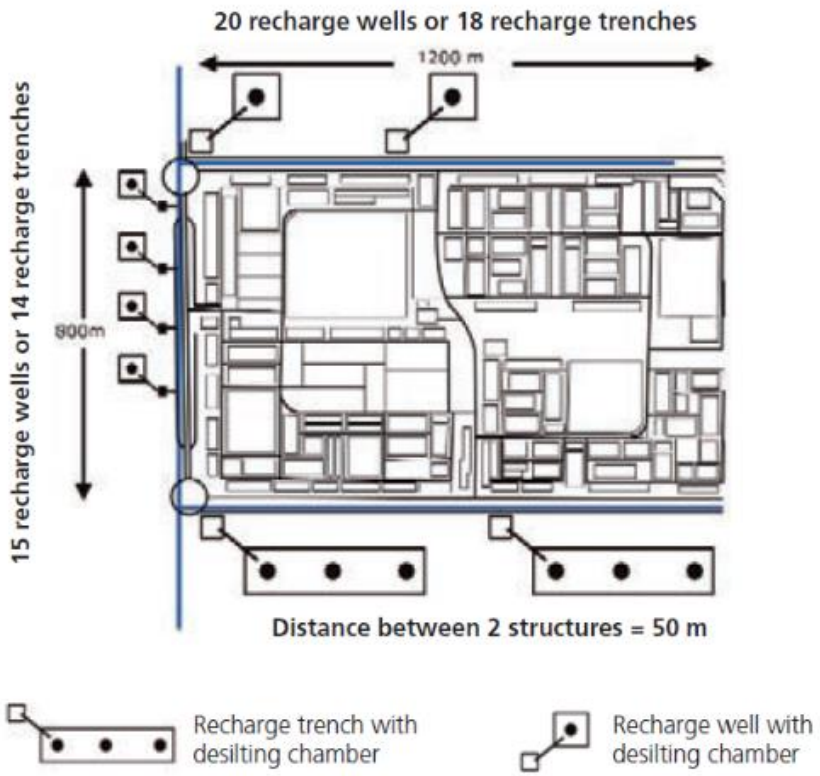


Comparison of water demand in Noida (2010–30)

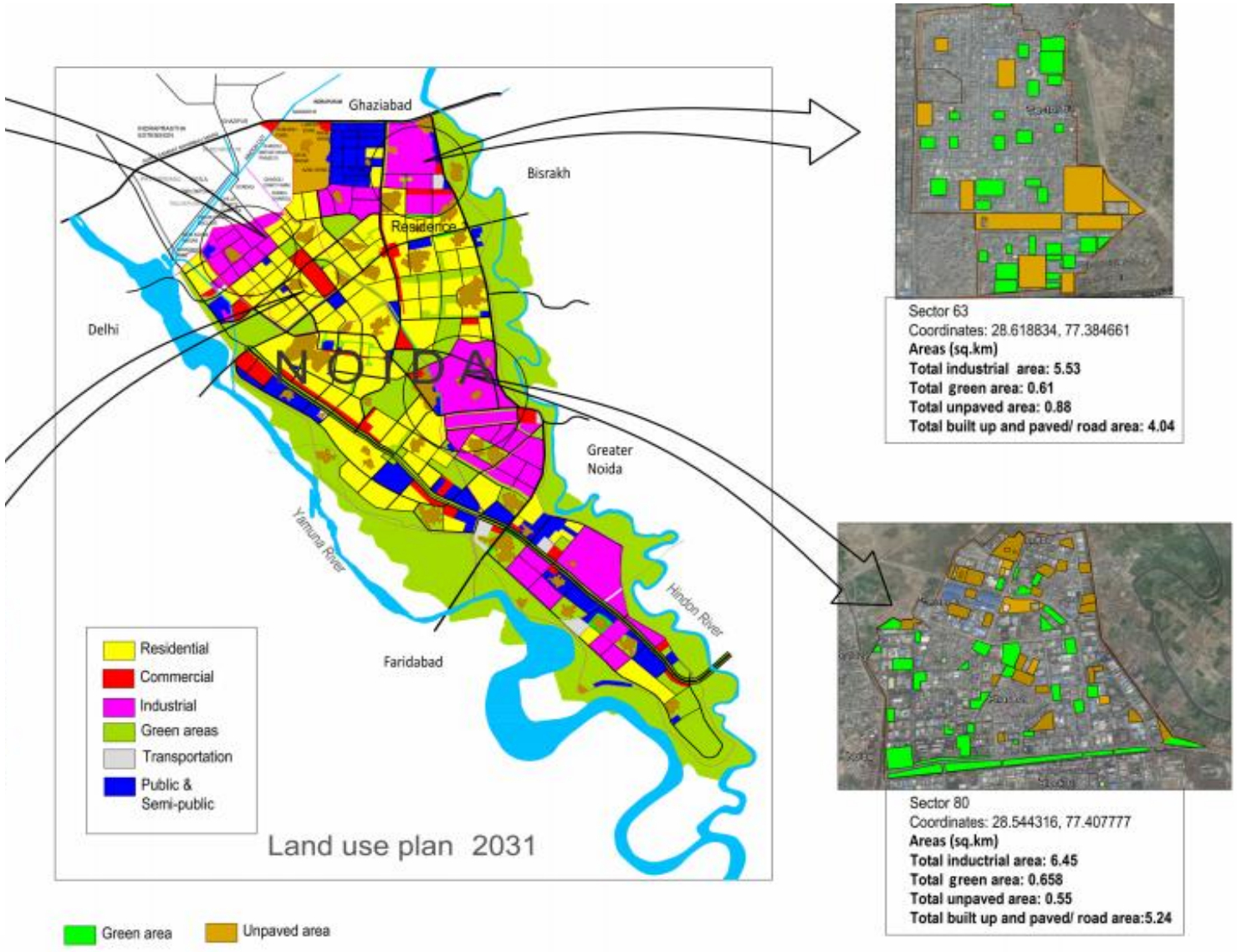
Need for RWH supported by Noida case example

- **RWH potential of Noida is about 27.73 million cubic metres (MCM) (i.e. 27,730 ml), which can meet 26.63 per cent of Noida's water demand annually.**

Identified areas in Chandigarh and Noida for RWH planning



Planning for recharge structures in sector 20, Chandigarh

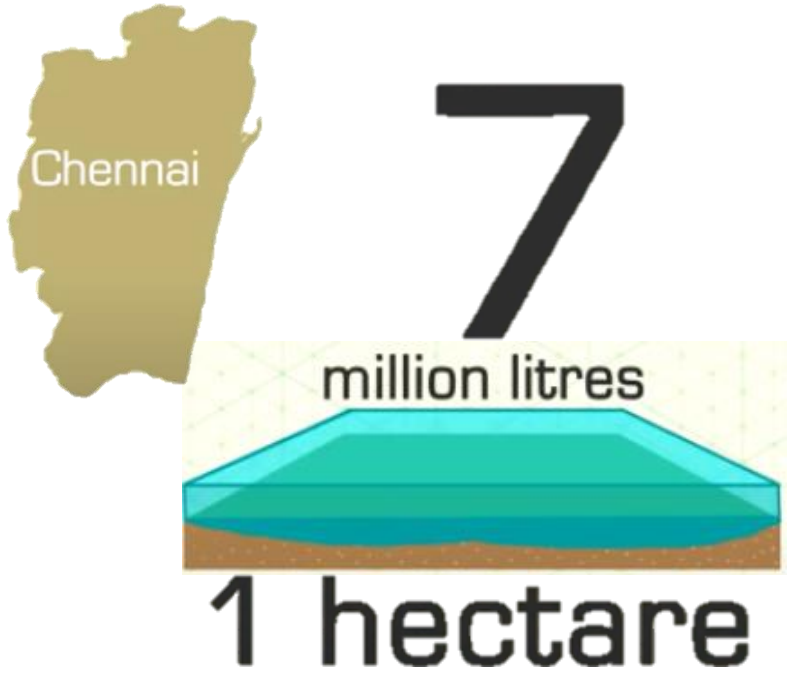


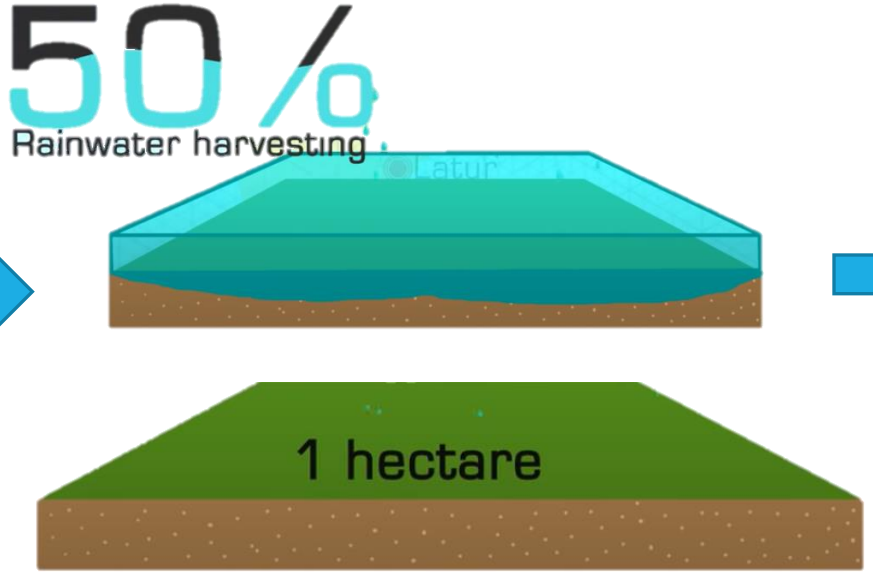
Identified residential areas in Noida for RWH planning

How much storm water can we harvest?

Example: Chennai
Area = 1 Ha (10,000 m²)
Annual rainfall = 1400 mm
= 1,40,00,000 (14 Million litres)

Even if we assume only **50 %** of the rainfall can be harvested,
about **7 million litres** of water can be harvested



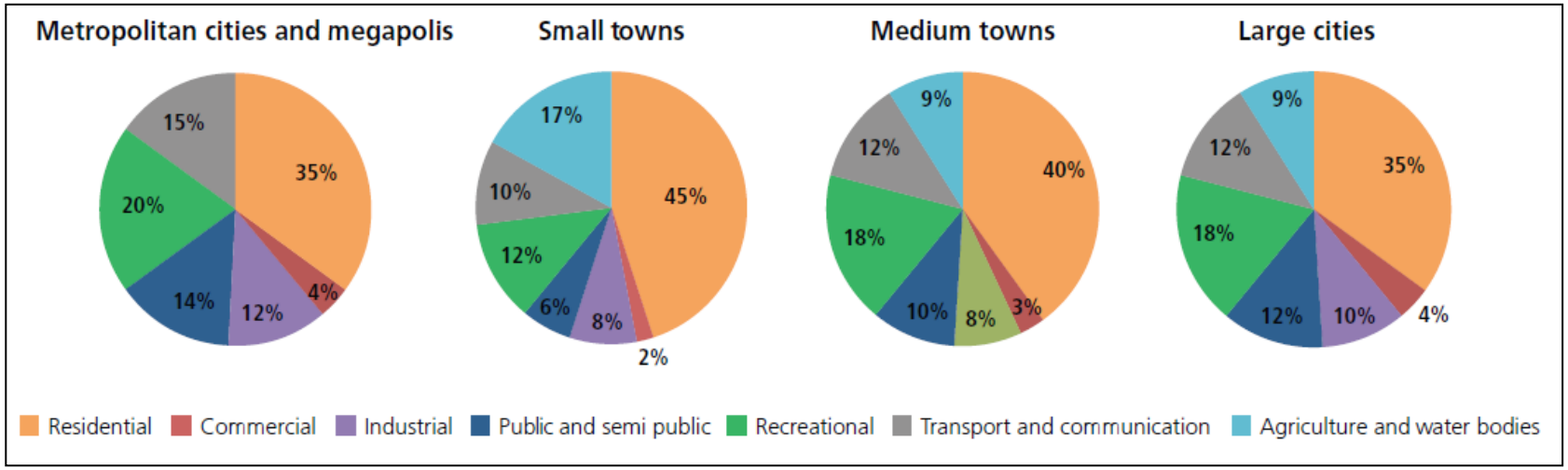


Annual rainfall = 1500 mm
Harvested water = 7.5 Million litres

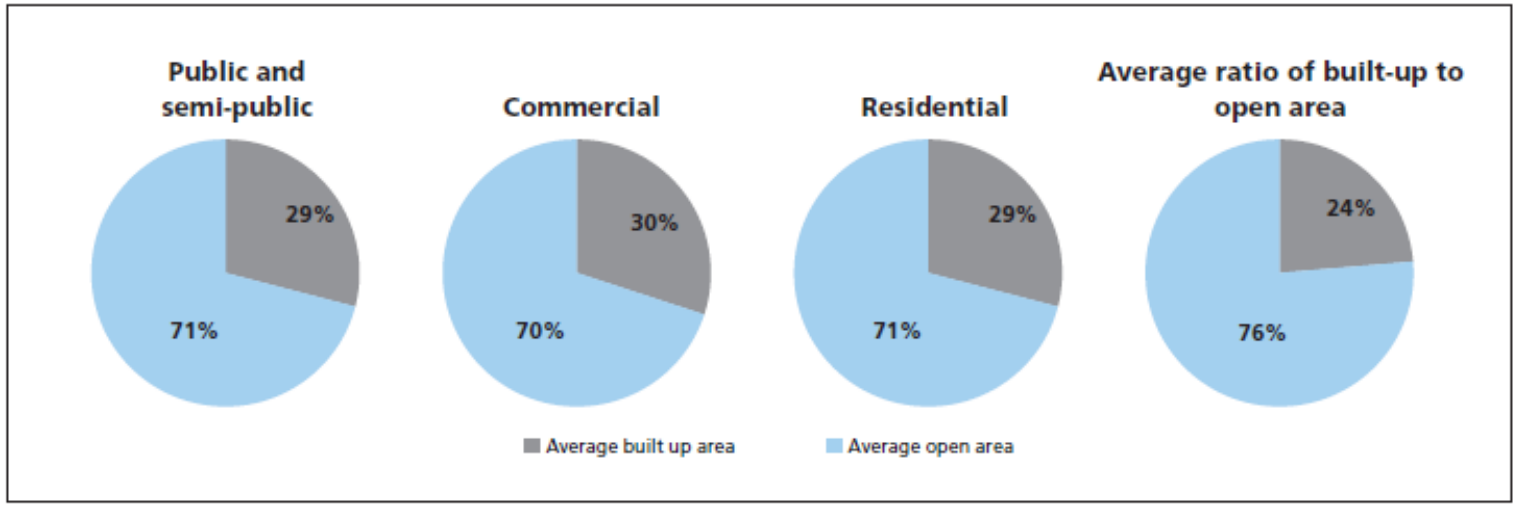
**Based on similar calculations as above*

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

Stromwater and green spaces provision under AMRUT and Smart City mission

AMRUT: Thrust areas under mission

- Storm Water Drainage: Construction and improvement of drains and storm water drains in order to reduce and eliminate flooding.
- Enhancing amenity value of cities by creating and upgrading green spaces, parks and recreation centers, especially for children.

Smart city Mission: **Smart City Proposal (SCP)**

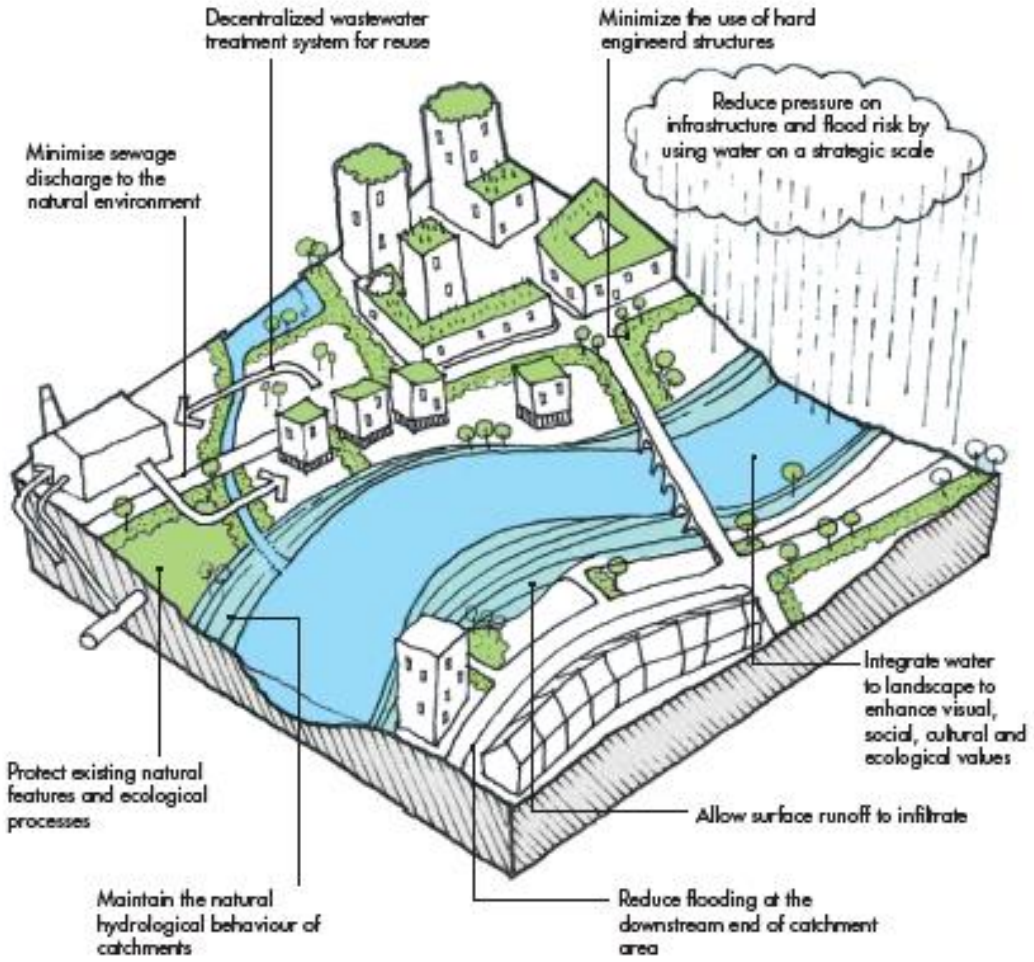
- Adequate water supply including waste water recycling and storm water reuse
- Rain water harvesting
- Innovative use of open spaces

Scope of interventions as per existing provisions and scales

Scale	*Existing documents/provisions*	*Opportunities*
City: open spaces- parks and water bodies, Road Infrastructure	-Master Plans (20 years) -City development plan (5 years) -City Sanitation Plan **Planning stage**	Water bodies, parks, recreational areas, green areas, public, and transport. Proposed location for BMPs
Zone level **(Planning and designing stage)**	-Zonal Plan -Storm water management including water bodies -Urban local bodies (ULB) schemes and sanitation schemes -Detailed project reports (DPRs) for Water Supply, Storm water Drainage	The location of parking lots, roads, parks, open space blocks and storm water management facilities defined in planning documents can be used for environmental services through WSUDP measures. Establishing a template for the more detailed resolution of the design of water sensitive facilities.
Site level **(Designing stage)**	Site plan- Guided by byelaws	Site-specific opportunities are identified to integrate water conservation and onsite water sensitive facilities into all of the components of a development including water efficient fittings, sustainable landscaping, Rainwater harvesting

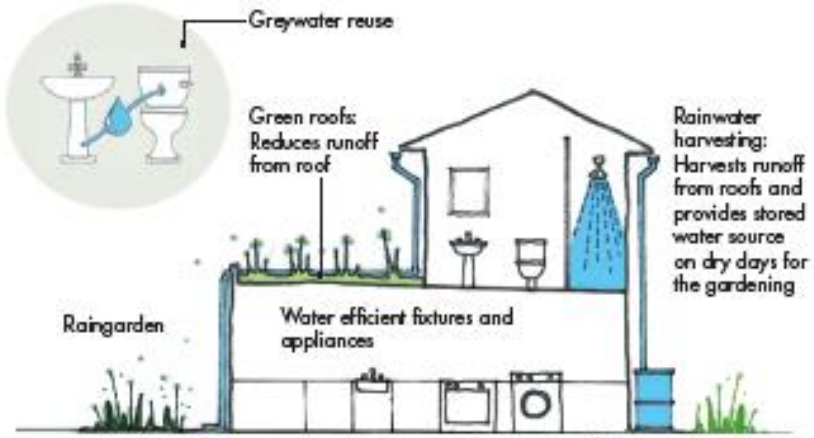
WSUDP APPROACH ON DIFFERENT SCALES

1 WATER-SENSITIVE PLANNING (CITY/ZONAL SCALE)



2 WATER-SENSITIVE DESIGNING (NEIGHBOURHOOD SCALE)

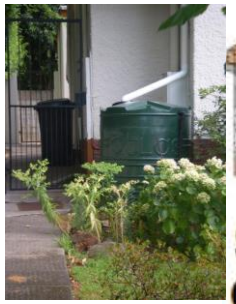
3 WATER-SENSITIVE DESIGNING (INDIVIDUAL SCALE)



Adapted from: Morgan, C., Bevington, C., Levin, D., Robinson, P., Davis, P., Abbott, J. and Simkins, P., 2013. Water sensitive urban design in the UK. Ideas for built environment practitioners. CIRIA report C, 723; Dickie, S., McKay, G., Ions, L. and Shaffer, P., 2010. Planning for SuDS–making it happen. CIRIA Publication C, 687

Scales of intervention

Source Control:
To retain the small frequent rainfall events at the individual lot level.



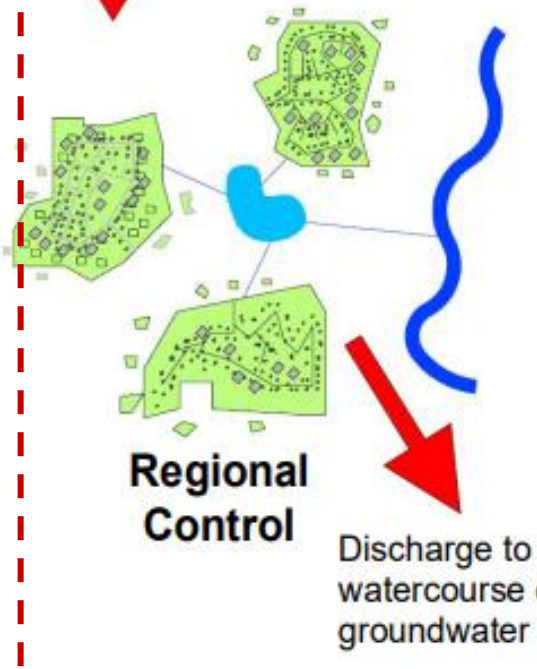
Mainly on private properties

Green roofs
Storage, recharge
Soak ways
Permeable pavements

Conveyance Control - to detain the large events of rainfall at neighborhood level

Mainly within road reserves

Sand filters
Filter strips
Infiltration trenches
Swales
Bio filters / bio-retention cells

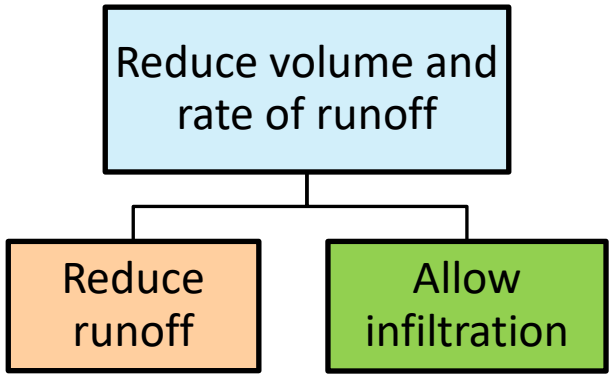


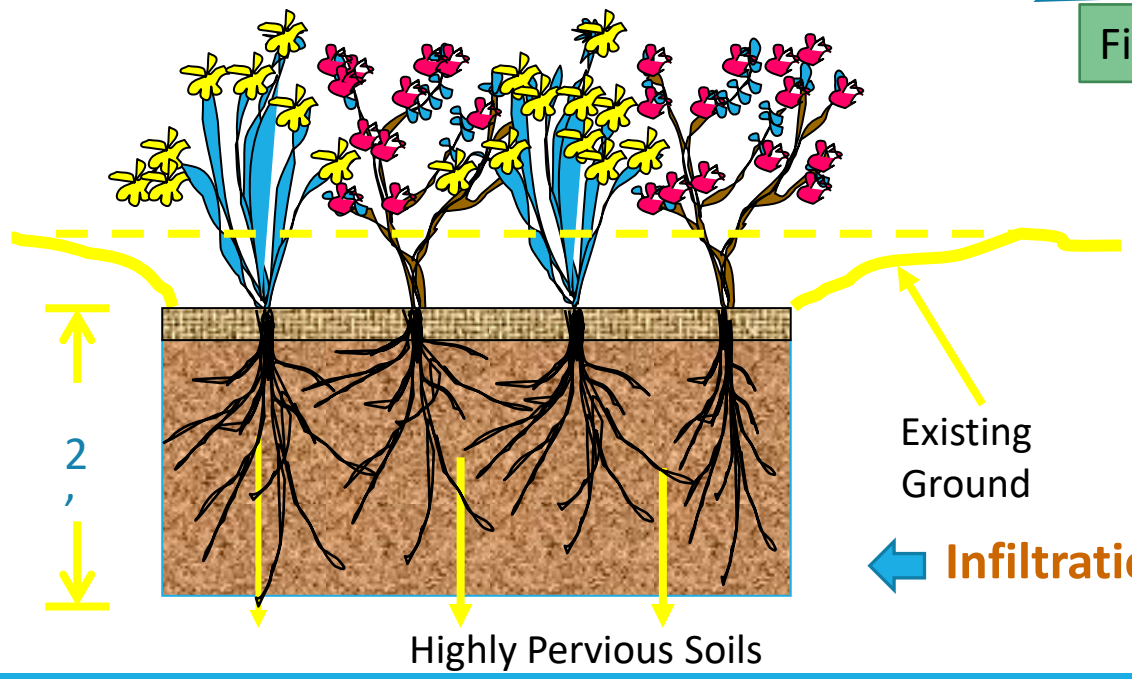
Mainly in public open spaces

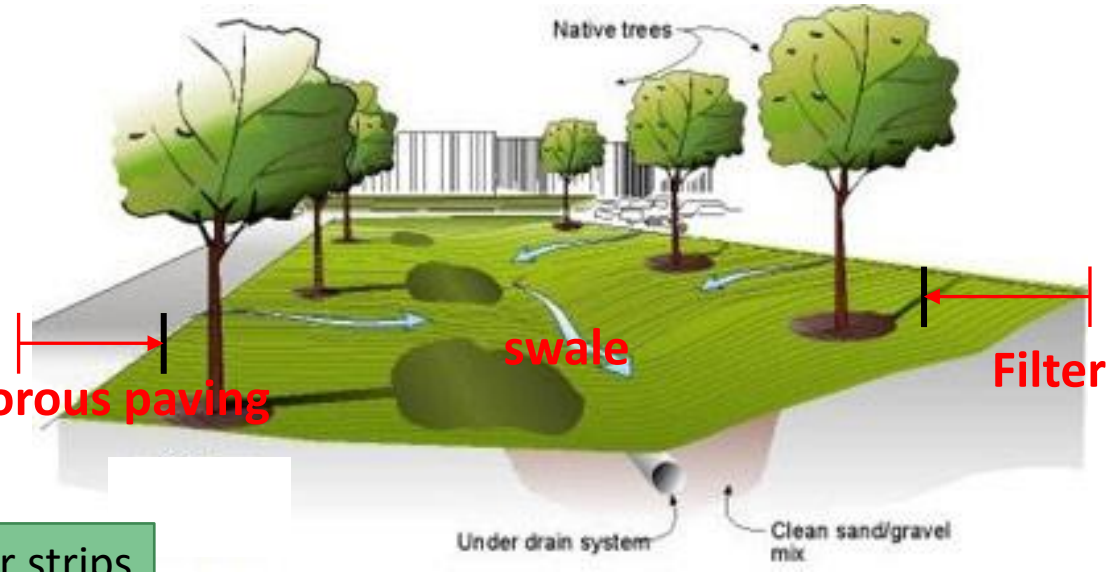
Lake catchment,
river floodplain,
Large wetlands

Discharge Control
For conveying the extreme rainfall events at the watershed level.

Integrating different stormwater harvesting and infiltration management practices options







Porous paving

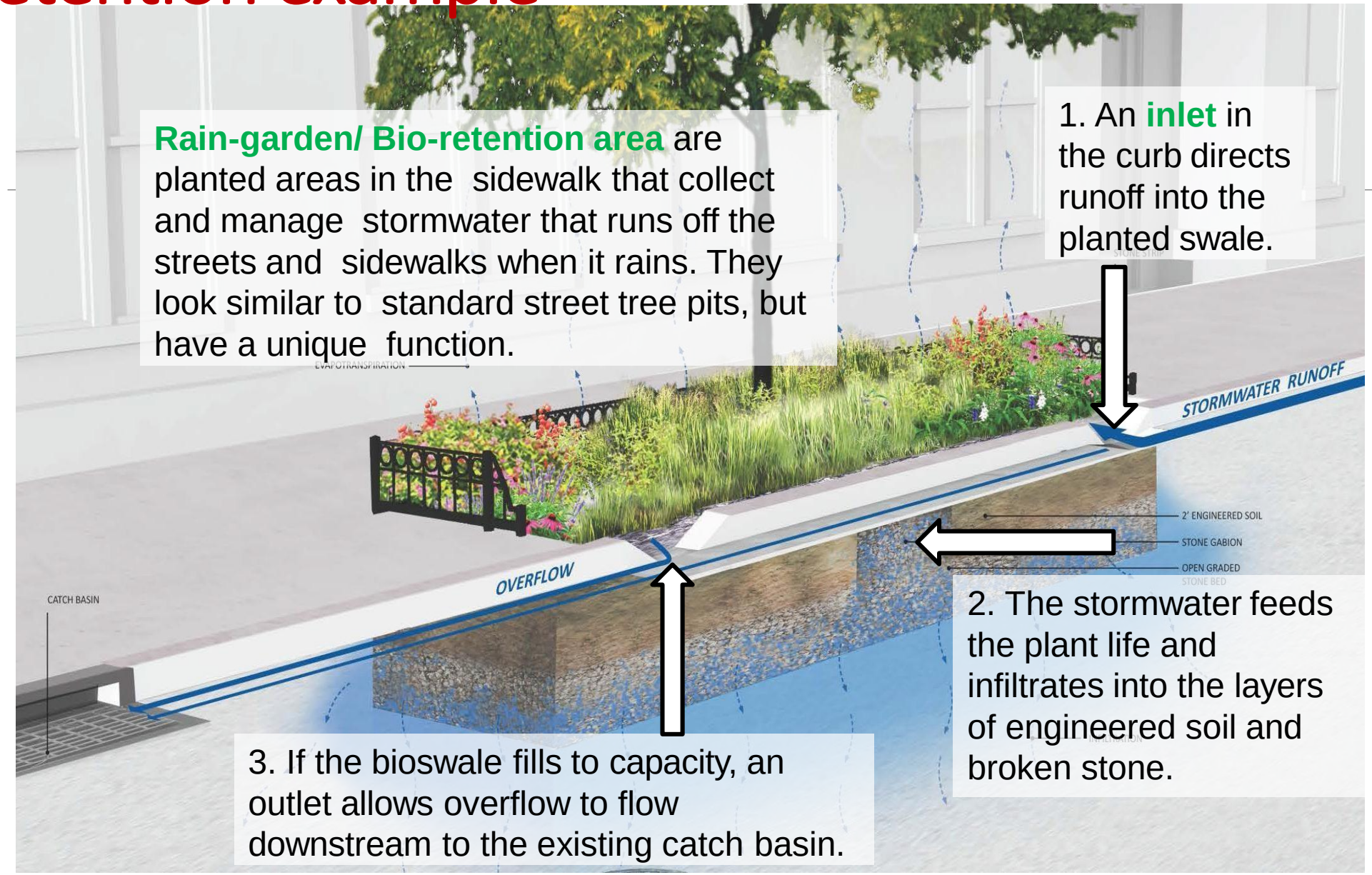
Filter strips

Swales

Bioretention areas and raingardens

Detention basins

Bio-retention example



Rain-garden/ Bio-retention area are planted areas in the sidewalk that collect and manage stormwater that runs off the streets and sidewalks when it rains. They look similar to standard street tree pits, but have a unique function.

1. An **inlet** in the curb directs runoff into the planted swale.

2. The stormwater feeds the plant life and infiltrates into the layers of engineered soil and broken stone.

3. If the bioswale fills to capacity, an outlet allows overflow to flow downstream to the existing catch basin.

Rain Garden example

- Soil Consideration : Work best when made in soils with high permeability (e.g.: sandy soils)
- Holds the rainwater
- Prevents soil erosion
- Checks the run off speed
- Helps in ground water recharge

Specifications:

- The garden should be dug 100-150 mm deep with a slight depression in the center.
- The dug out soil will be used to create a berm along one side of the rain garden which will allow water to be retained during a storm.
- To soil can be replaced with rain garden mix (50-60% sand, 20-30% topsoil, 20-30% compost),
- Size: 20-30% of the catchment area

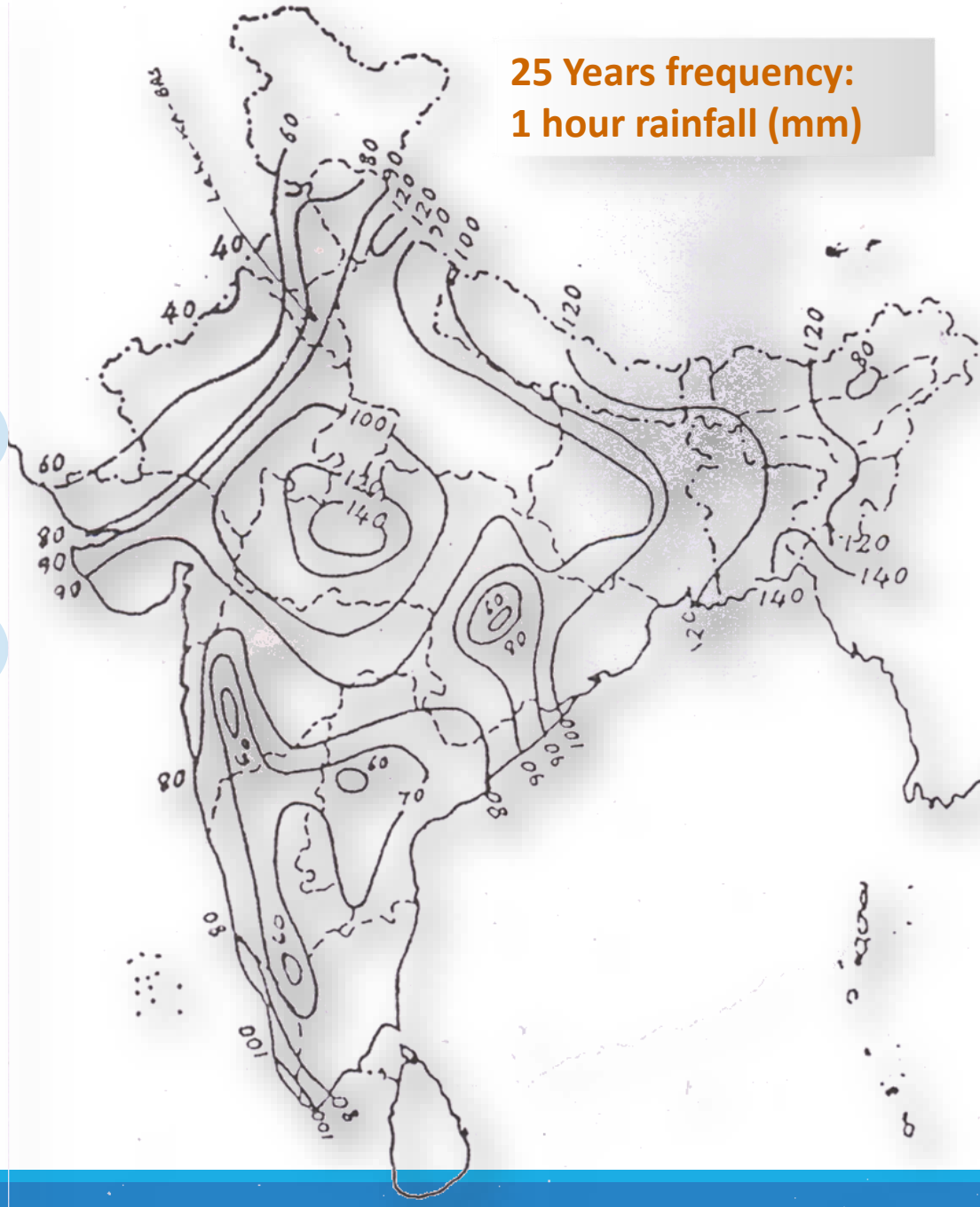
Meteorological data required

METEOROLOGICAL DATA

- Annual Rainfall (Avg. of 25 yrs)
- Rainfall Distribution
- Peak Rainfall Intensity
- Spatial information: Weather stations per KM

DETERMINES

- **Potential of RWH**
- Option Selection

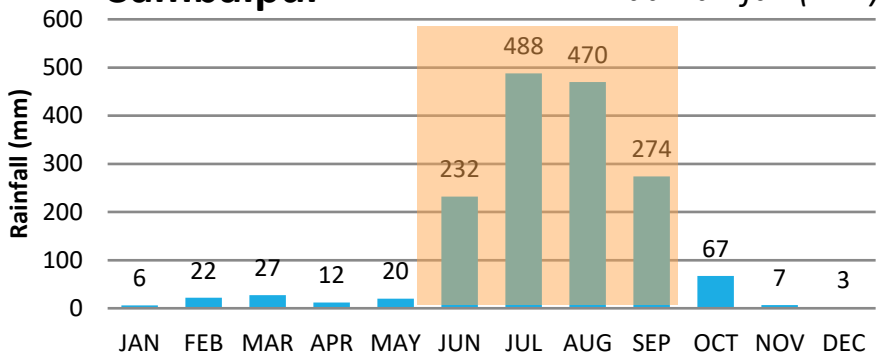


Rainfall patterns analysis

Sambalpur

Annual rainfall (mm): 1628

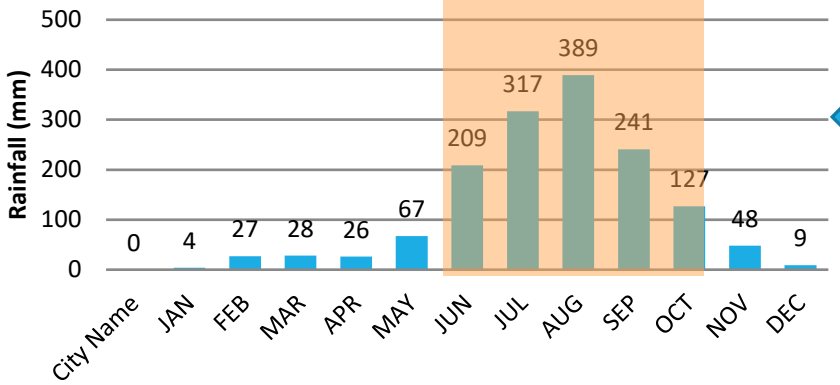
90% of annual rainfall falls in 4 months



Bhubaneshwar

Annual rainfall (mm): 1492

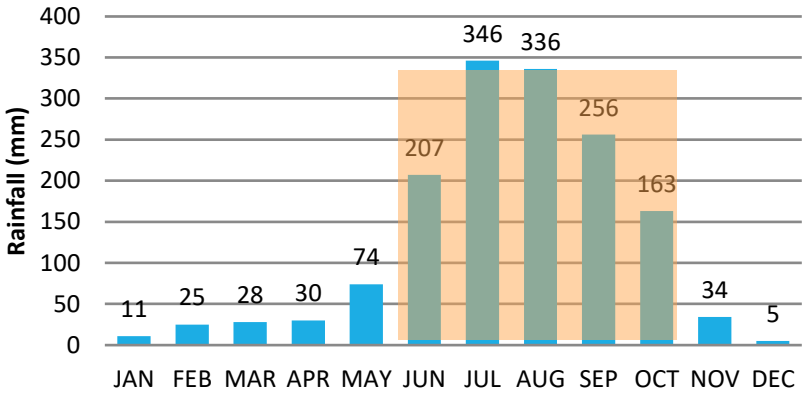
85% of annual rainfall falls in 5 months



Cuttack

Annual rainfall (mm): 1515

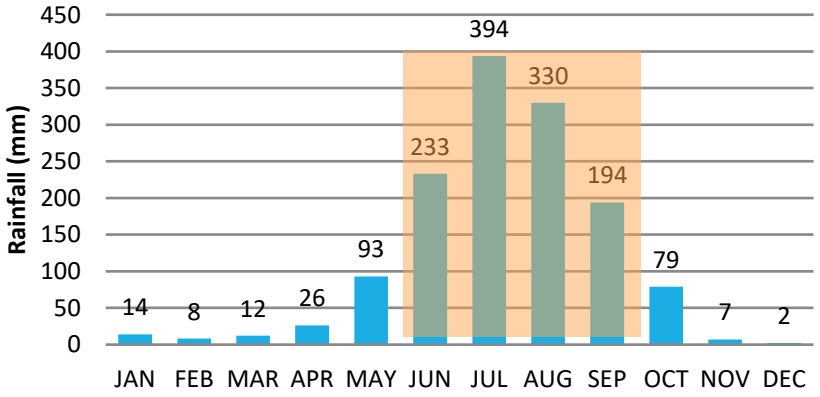
86% of annual rainfall falls in 5 months



Berhampur

Annual rainfall (mm): 1392

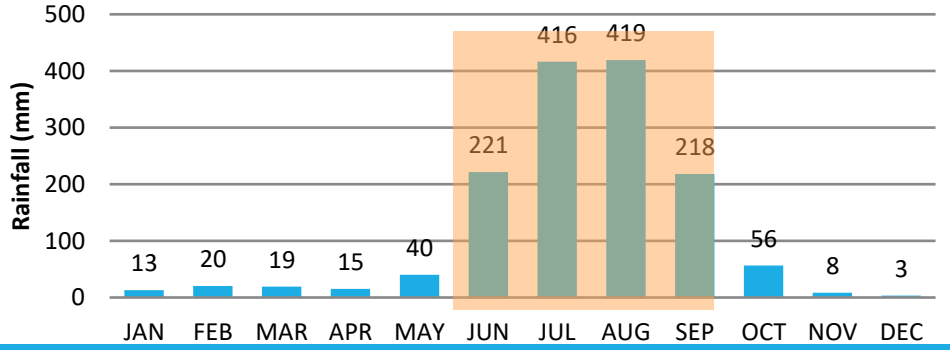
83% of annual rainfall falls in 4 months



Rourkela

Annual rainfall (mm): 1448

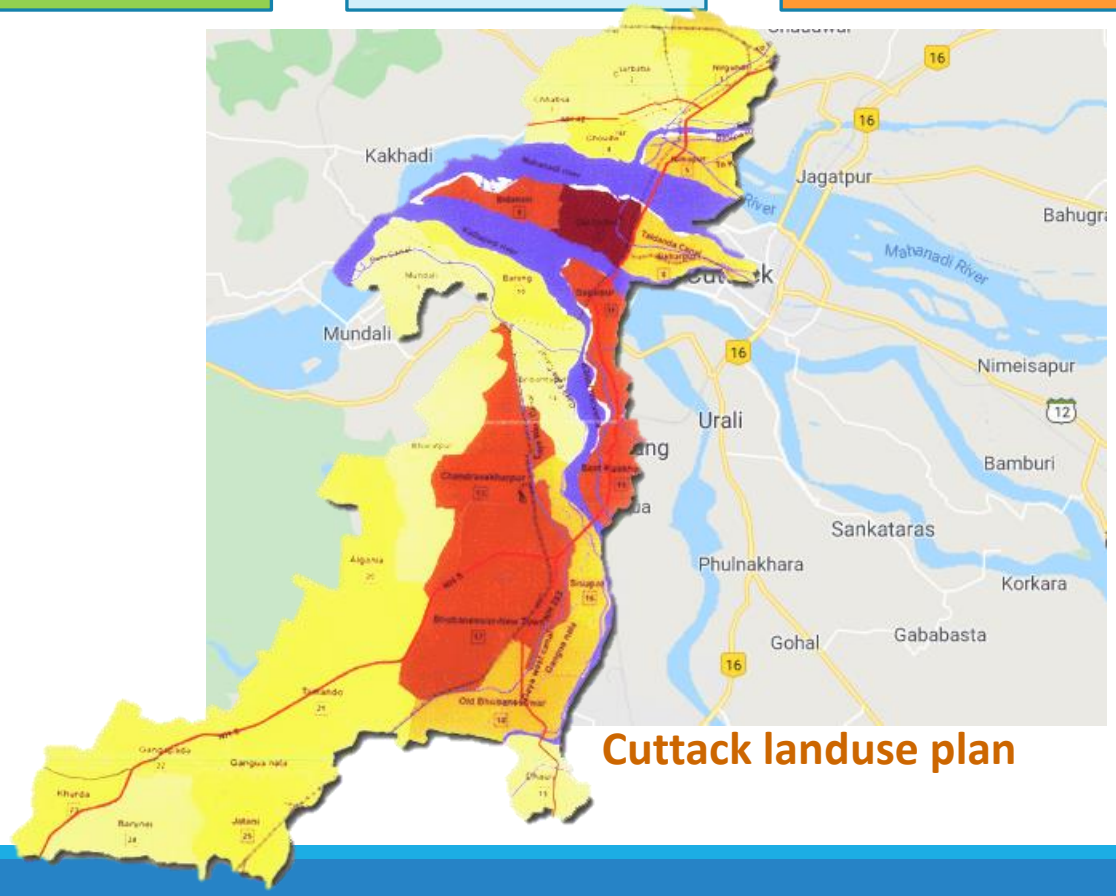
88% of annual rainfall falls in 4 months



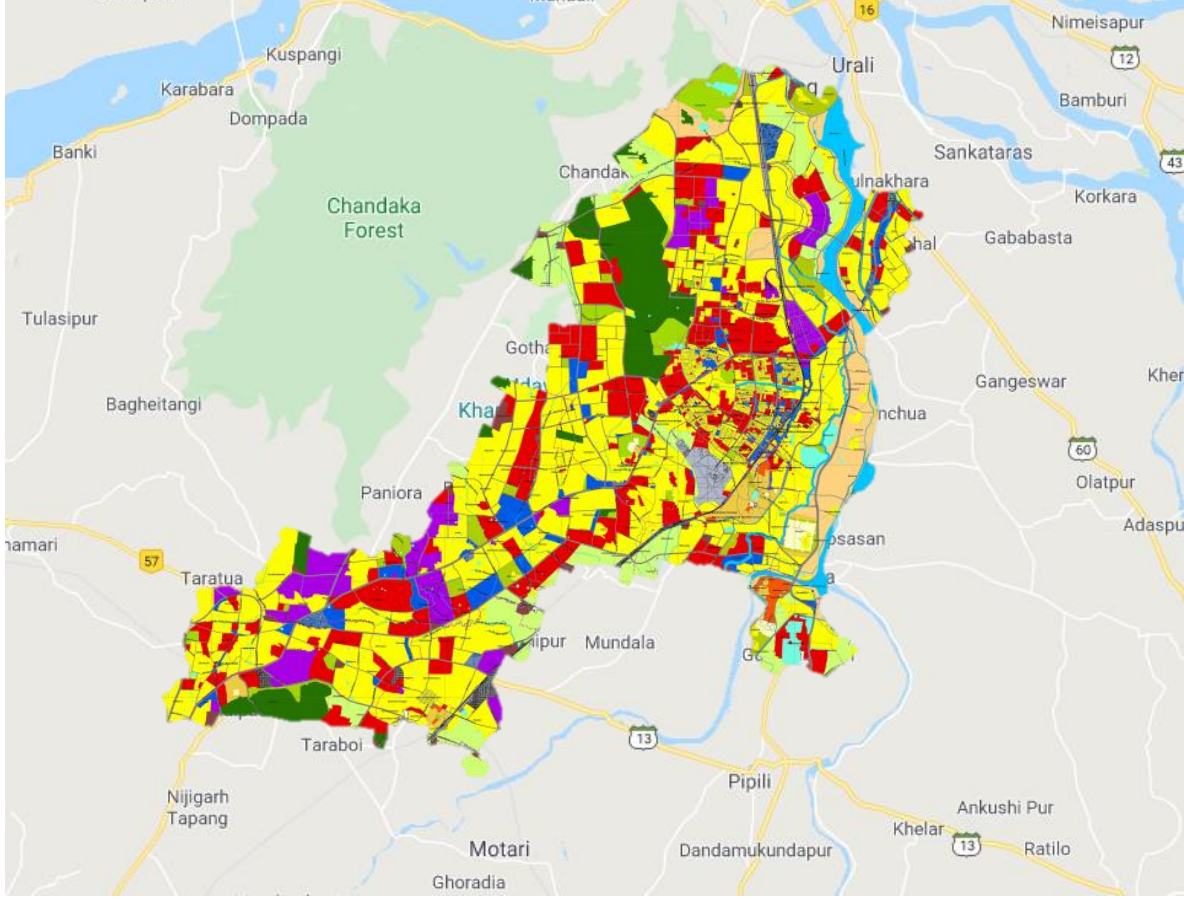
City's spatial data required

City fabric

- Land covered by green spaces
- Area reserved/status of waterbodies
- Percentage of low-lying area



Cuttack landuse plan



Bhubaneswar landuse plan

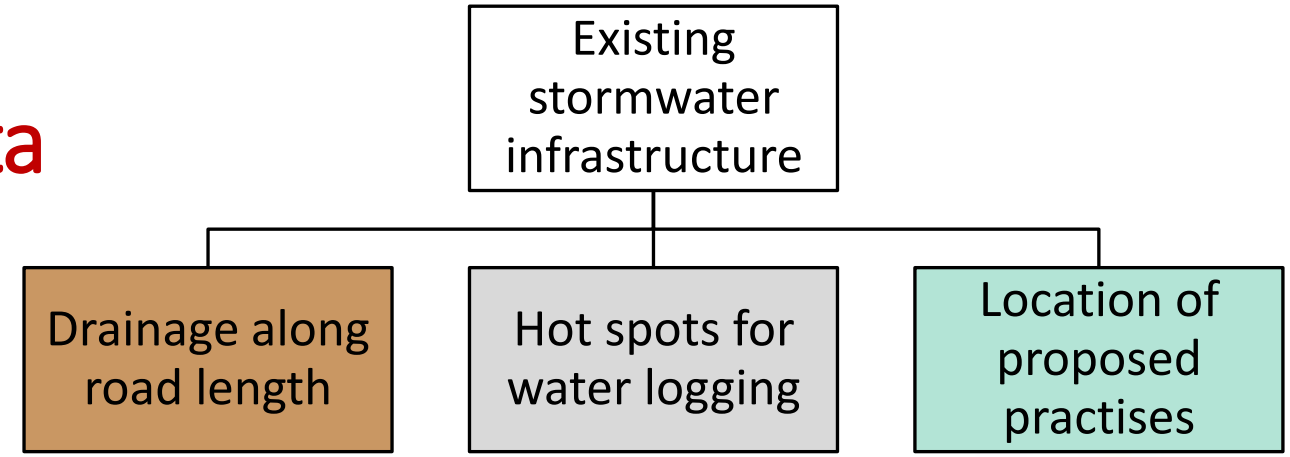
Sources:

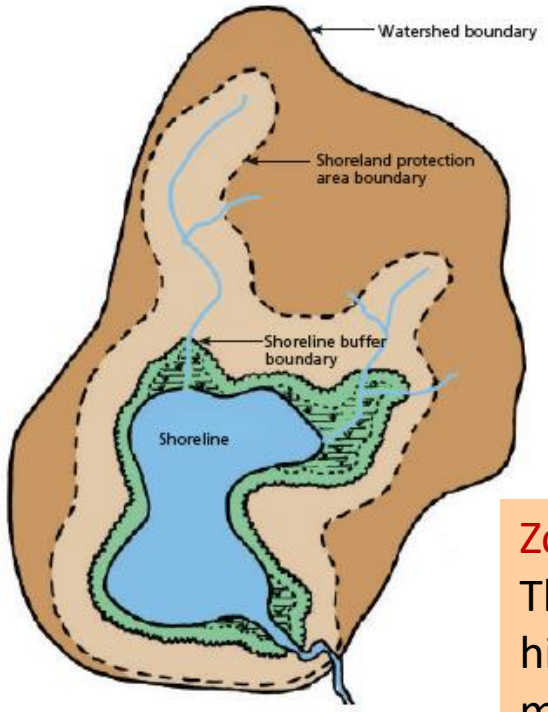
Cuttack Development Authority
www.cdacuttack.nic.in

CDP 2010 Land Use Zonal Map :: Bhubaneswar Development ...
www.bda.gov.in › cdp-land-use-zonal-map

Google maps

Existing ULB infrastructure data required





Buffer zones around identified water bodies in cities

Zone 1: Shoreline: The point where the high water mark meets the land

Zone 2: Shoreline buffer: Extends landward from the high water mark

Zone 3: Shore land protection area

Zone 4: Contributing watershed

Existing drainage channels

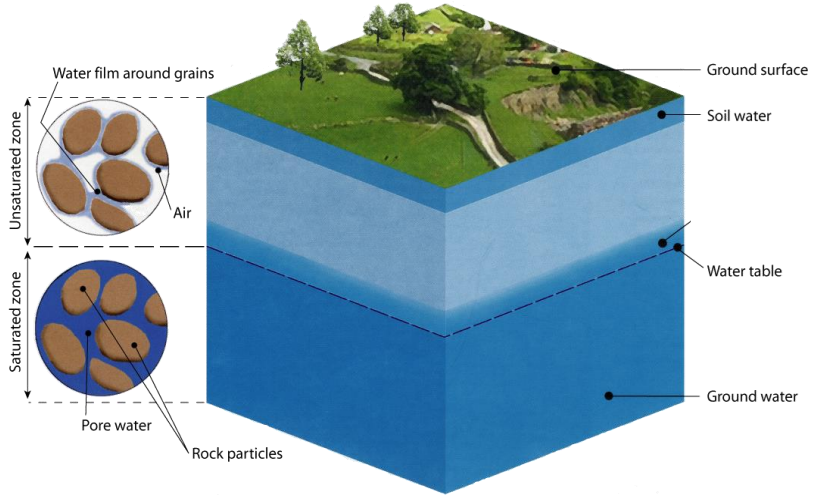
Source: CSP, Bhubaneswar, 2017

Geological and Hydrogeological data required

Geological and Hydrological information

- **Nature of aquifer**
- **Groundwater level**
- **Nature of terrain**
- **Nature of soil**
- **Geological formation**

- If aquifers are **impermeable, non-porous**
- If depth of water level is **less than 8 meters**
- If the terrain is **hilly, rocky or undulating**
- If the soil is **clayey**
- If comprises of **massive rocks** (Basalt, Granite)



- Remote sending and GIS based study
- Inquire with the local drilling agencies
- Litho logs/ borehole strata chart of the existing tube wells on the site.
- Literature survey – Reports of irrigation departments, Central/State Groundwater Board, Geological Survey of India, Soil and water research

Proposed: Rain centre / Water information centre:

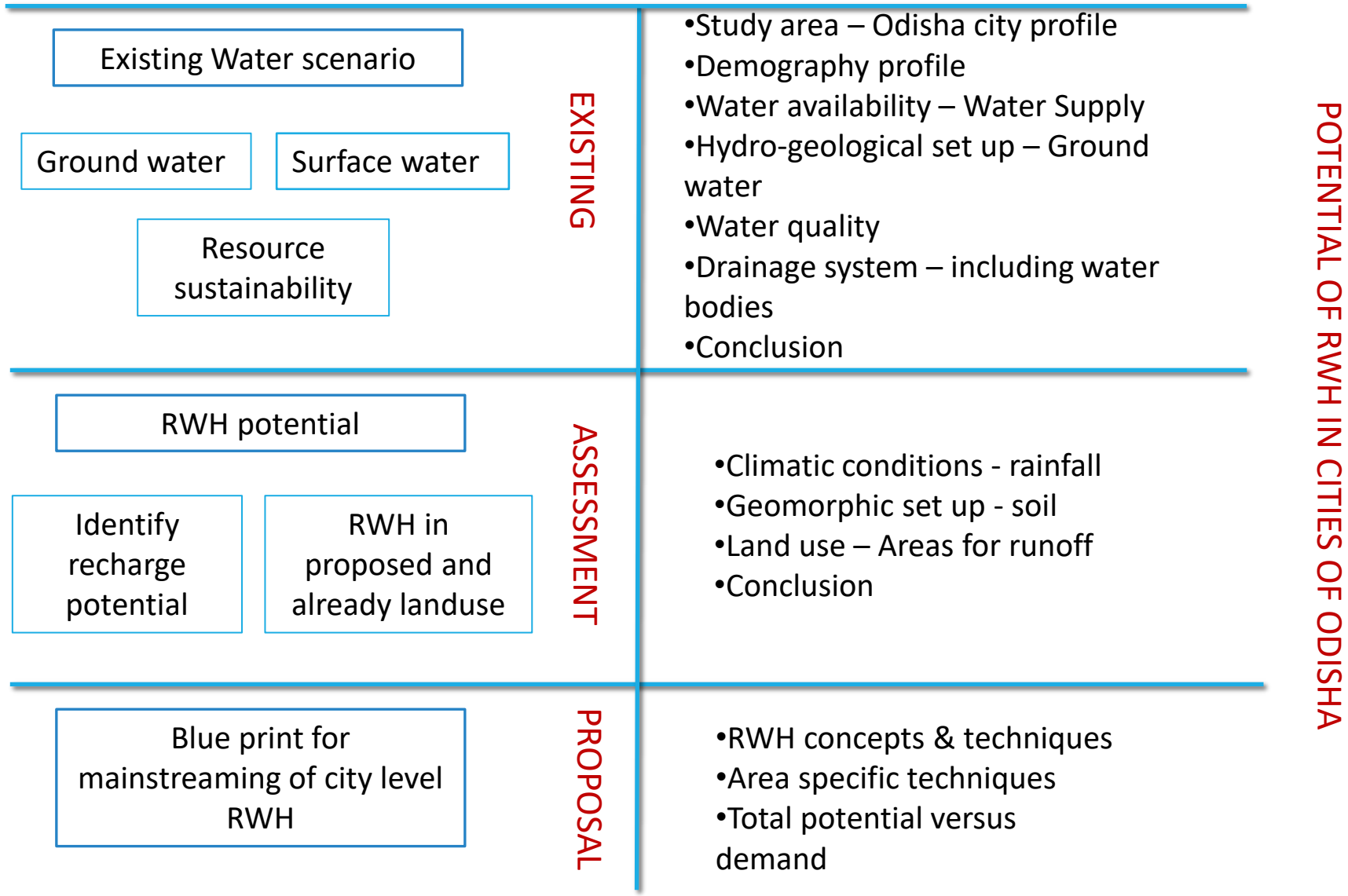
Rain Centre is a local place where visitors could learn from the display of posters, models of water harvesting structures.

Here the visitors can learn about rainwater harvesting initiatives spearheaded in the city according to local conditions and also other water related best management practices prevailing in city/state of Odisha. The Centre also showcases city's water management system and urban water status.

Apart from acting as technical help centre, the Rain Centre also provides opportunity to organize eco tours for school students, researchers and other relevant stakeholders.

It is one of the tool to outreach local people and create awareness among community.

Proposed: Study/Research based decisions



Proposed strategies

Capacity building of enforcement line of officials in town planning deptt., municipality and development authority.

Data collection (like Meteorological, Geological and Hydrogeological data) for research based solution will be given priority

Short, medium and long term strategy based on Study/Research conducted (Methodology shared on last slide) for particular select cities.

Large scale projects will be targeted under long term strategy potential use of water bodies and open spaces, flyover, roads, airports (lack maintenance).

Setting up of **Programme Management Unit (PMU)** for implementation best management practices in high impact and high visibility areas of select 4 cities initially.

Setting up of **High Powered Committee** (with 4-5 members) comprising Geology Dept, Planning Department, Meteorological department, State Groundwater Dept. with CSE as knowledge partner.

Thank you

Name, Centre for Science and Environment, Email