Urban Water Systems in India
A Way Forward

Mihir Shah

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Scoping Paper: Goals

- review available literature
- present state-of-the-art knowledge
- innovative statement of the problem
- propose possible hypotheses
- scan best plausible solutions
- framework to understand urban water issues in India

Point of Departure

- Global urban population to nearly double to 6.4 billion by 2050
- 90% of the growth in low-income countries
- Urban slum dwellers will number 2 billion in 30 years time
- Urban Indians 800 million by 2050

Point of Departure

- In India, cities produce nearly 40,000 million litres of sewage every day
- Barely 20 percent of it is treated
- According to the CPCB only 2% towns have both sewerage systems and sewage treatment plants
- Huge challenges of water supply and water quality

Deconstructing “Urban” India

- India’s urban population has grown 5-fold over the last 50 years
- Grown in all 4 categories of towns and cities
- 112 million live in towns with < 1 lakh people
- 160 million live in large cities with > 1 million people
- Each urban settlement has its own unique characteristics and challenges

Share of Urban Population in Cities and Towns in India, 1981-2011

Year	Population							
	> 5 million		1- 5 million		1 lakh - 1 million		< 1 lakh	
	Cities	% of urban population	Cities	% of urban population	Cities	% of urban population	Towns	% of urban population
1981	3	15.60	9	12.10	207	33.50	3027	38.90
1991	4	17.40	19	15.60	276	31.40	3401	35.70
2001	6	21.10	29	16.70	359	30.80	3984	31.40
2011	8	22.59	45	20.03	415	27.62	5698	29.76

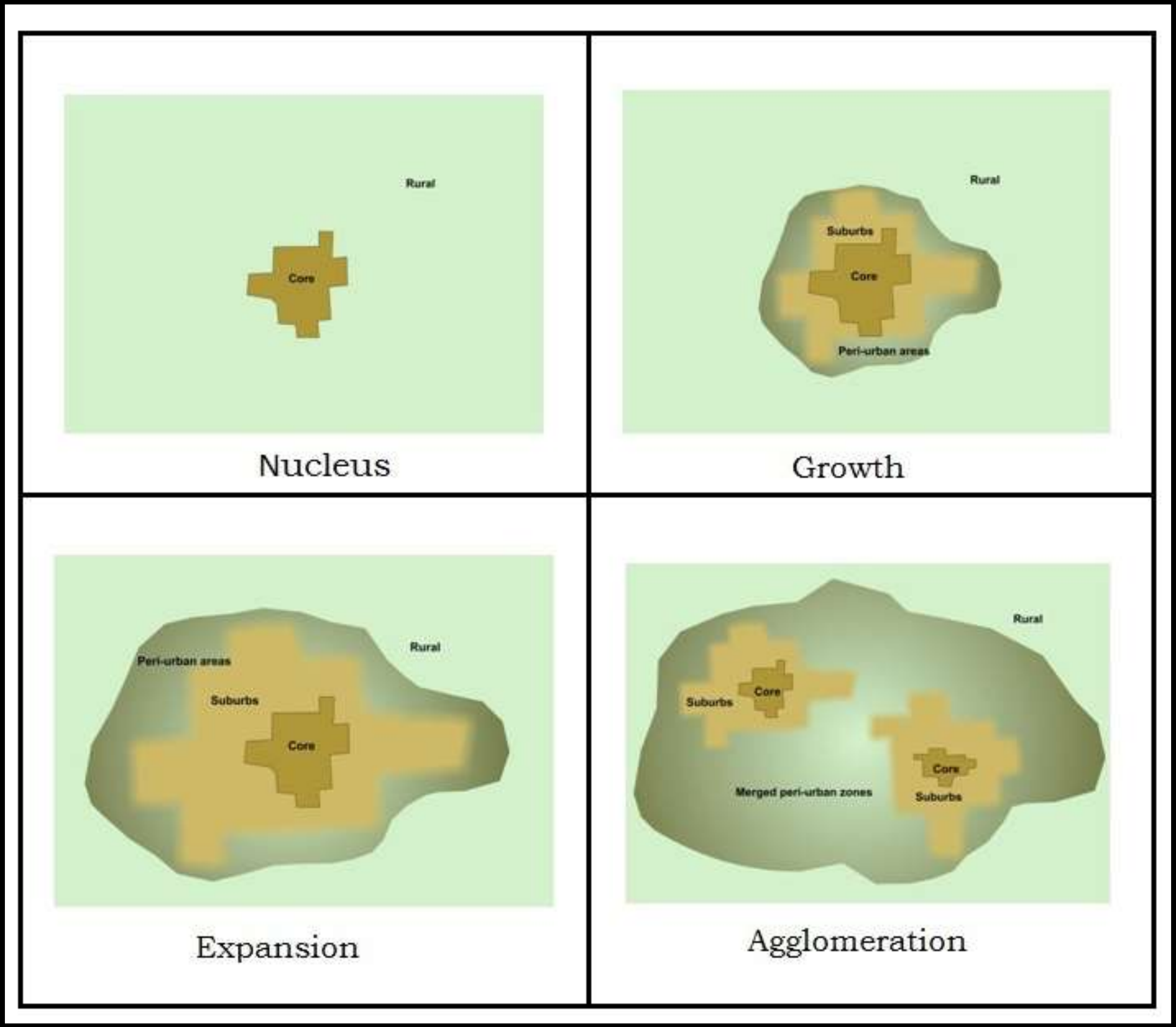
Source: HPEC, 2011 and Census of India, various years

Population in Cities and Towns of India 1981-2011

Population (in millions)					
Year	> 5 million	1- 5 million	1 lakh - 1 million	< 1 lakh	Total
1981	24.88	19.29	53.42	62.03	159.6
1991	37.86	33.95	68.33	77.68	217.8
2001	60.37	47.78	88.12	89.85	286.1
2011	85.18	75.54	104.17	112.21	377.1

Source: HPEC, 2011 and Census of India, various years

The Urban Continuum: A Schema in Four Stages



Deconstructing “Urban” India

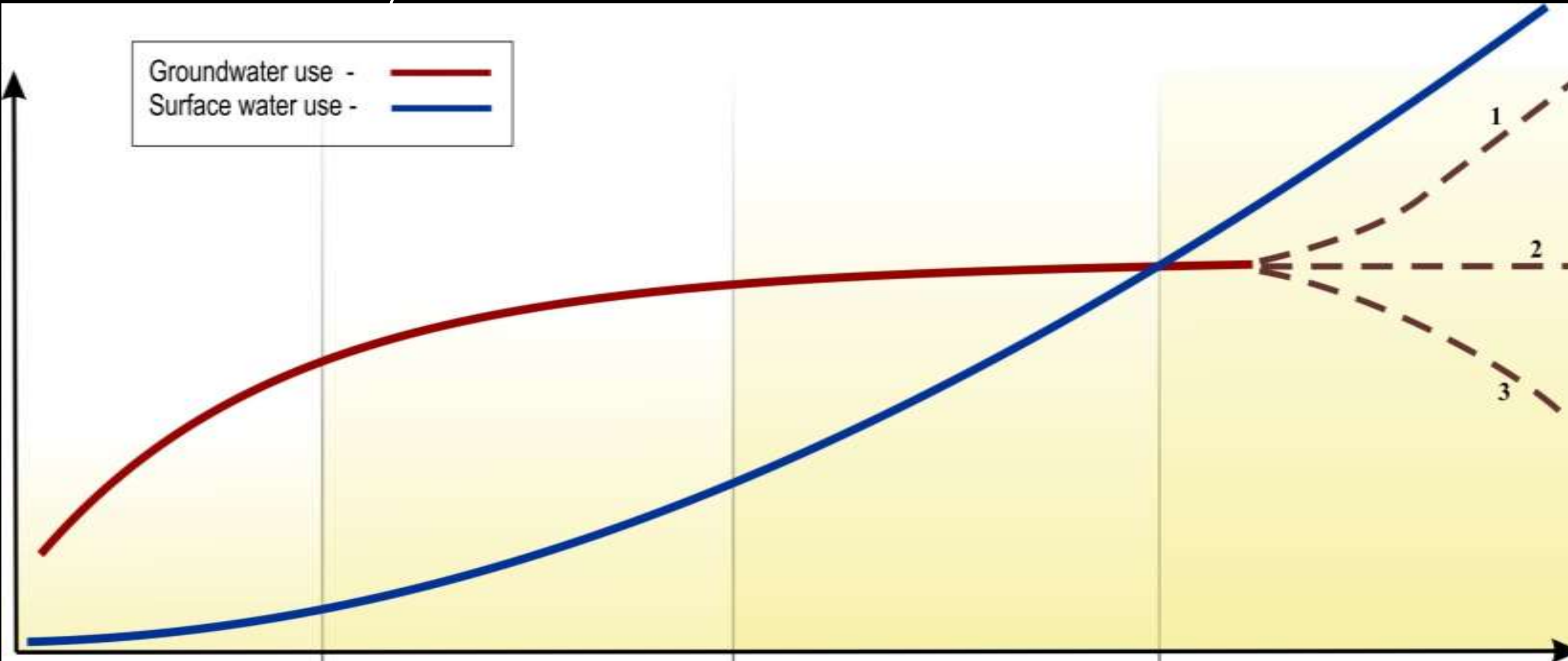
- We look at these as stages in a continuum, with unique situations and solutions
- Four stages of nucleus, growth, expansion and agglomeration
- Which correspond to the population-wise classification of towns and cities
- And to varying degrees of dependence on sources of water in differently sized towns and cities

Deconstructing “Urban” India

- We propose a hypothesis of stages of evolution of urban settlements in India and their changing dependence of sources of water supply

- This needs to be further tested as more robust data becomes available on sources of water in urban India

Trends in Surface and Groundwater Use across variously sized Urban Settlements in India



SMALL TOWNS →	LARGE TOWNS OR SMALL CITIES →	LARGE CITIES →	METROS
Surface water use limited to ponds/water bodies Groundwater use significant, largely through wells; sometimes through springs	Surface water use may increase as formal water supplies established Groundwater usage shifts outwards into suburbs and peri-urban areas; groundwater and surface water are transported from peri-urban/rural areas inward	Near equal share of surface water and groundwater, although much of the groundwater share 'unacknowledged' in civic water supply; Large water transports through tanker-supply; Wells are drilled into aquifers feeding springs	Large share of 'imported' formal surface water supply, with even greater share of 'unacknowledged' groundwater abstraction and transport in suburbs and peri-urban areas; uncertainty in the projected trends of groundwater use (1, 2 or 3) - possibly different in different metros. Spring-water supply almost gone / negligible

The Four Stages and their Water Sources

- I: Small towns emerge from rural hinterlands, mainly groundwater
- II: Core town-surface water, periphery still dependent on groundwater
- III: Surface and groundwater grow but groundwater quality, levels both fall
- IV: Surface water outstrips groundwater, which can go 3 ways

Groundwater: The Blind Spot in Urban Water Planning

- In over 71 cities and towns, ground water is 48% of urban water (CSE)
- 56 per cent of metropolitan, class-I and class-II cities are dependent on groundwater (NIUA)
- Unaccounted groundwater in urban areas exceeds 50% in 28 Indian cities (CGWB)

Groundwater: The Blind Spot in Urban Water Planning

- Haphazard groundwater abstraction driven by individualistic pumping has filled out gaps in public water supply
- However, it has also led to co-terminal depletion and contamination of aquifers
- Sustainable management of groundwater needs a much deeper understanding of the aquifers within which it is located

A Typology of Urban Aquifers

1. Himalayan Mountain: Aizawl, Darjeeling, Dharamsala, Gangtok, Mussoorie, Nainital, Shillong, Shimla
2. Extensive Alluvial: Bhubaneshwar, Chandigarh, Delhi, Guwahati, Kolkata, Lucknow, Patna, Varanasi
3. Volcanic: Aurangabad, Bidar, Bijapur, Buldana, Dewas, Indore, Mumbai, Nagpur, Nasik, Pune, Solapur, Ujjain
4. Crystallines: Bhilwara, Bengaluru, Bolangir, Dindigul, Coimbatore, Hyderabad, Mysore, Ranchi, Thrissur
5. Consolidated Sedimentary: Adilabad, Bundi, Chandrapur, Dhanbad, Hazaribagh, Kota, Raipur, Rewa
6. Transition Zones: Bagdogra, Bhopal, Bhuj, Gurgaon, Haldwani, Kalka

Classification of Towns and Cities by Stage of Development and Aquifer Type

Aquifer Type / Stage of Urban Development	Nucleus	Growth	Expansion	Agglomeration
Mountain systems – mainly Himalaya	Banihal (J&K), Kaza (HP), Bhimtal (UK), Namchi (Sikkim), Jowai (Meghalaya)	Leh (J&K), Palampur, Hamirpur (HP), Nainital, Almora, Mussoorie (UK)	Anantnag (J&K), Nainital (UK), Darjeeling (WB), Itanagar (AP)	Jammu, Srinagar (J&K), Shimla (HP), Shillong (Meghalaya), Gangtok (Sikkim)
Extensive alluvial systems	Fazilka, Abohar, Sangrur (Punjab), Kaithal (Haryana), Raebareli, Fatehpur (UP), Sitamarhi, Bettiah (Bihar), Nadadwip (WB)	Barmer (Rajasthan), Ferozepur (Punjab), Meerut (UP), Hissar (Haryana), Madhubani (Bihar), Burdwan (WB), Dibrugarh (Assam)	Jodhpur (Rajasthan), Kanpur, Gorakhpur (UP), Ludhiana, Amritsar (Punjab), Darbhanga (Bihar)	New Delhi, Varanasi (UP), Ahmedabad (Gujarat), Patna (Bihar), Kolkata (WB), Guwahati (Assam), Bhubaneshwar (Odisha)
Deccan Volcanic plateau	Palghar, Paud, Saswad (Maharashtra), Bagli (MP)	Lonavala, Ratnagiri, Beed (Maharashtra), Pithampur, Dewas (MP)	Satara, Wardha, Amravati (Maharashtra), Ujjain (MP)	Mumbai, Pune, Nagpur, (Maharashtra), Indore (MP)
Crystalline Rock Formations	Chalakudy (Kerala), Sivakasi (TN), Kunigal (Karnataka), Kosigi, Daulatabad (Telangana), Khunti, Lohardaga (Jharkhand)	Palakkad (Kerala), Madanapalle (AP), Chitradurga (Karnataka), Karimnagar (Telangana), Purulia (West Bengal), Jhansi (Jharkhand)	Thrissur (Kerala), Coimbatore, Madurai (TN), Jamshedpur (Jharkhand)	Bengaluru (Karnataka), Hyderabad (Telangana), Thirupati (AP), Ranchi (Jharkhand), Ernakulum, Thiruvananthapuram (Kerala)
Sedimentary Rock Formations	Karaikudy, Ariyalur (TN), Tadipatri (AP), Badami (Karnataka)	Tiruchirapalli (TN), Kadapa (AP), Shahbad (Karnataka), Satna (MP)	Kurnool (AP), Bilaspur (CG), Bhuj (Gujarat), Jabalpur (MP)	Raipur (CG)
Transition zones	Jaisalmer, Neemrana (Rajasthan)	Sangamner (Maharashtra), Hazaribagh (Jharkhand),	Gwalior (MP), Siliguri (West Bengal)	Vadodara (Gujarat), Dehradun (UK), Agartala (Tripura)

11 Common Elements of the Solution

1. Sustainable Groundwater Management
2. Recycle and Reuse Wastewater
3. Imaginative Reuse & Recycle Options
4. Decentralised Wastewater Treatment
5. Reducing Industrial Water Footprint
6. Protect & Prioritise Local Water Bodies
7. Focus on Management and Distribution
8. Utilise Alternative Technologies
9. Focus on ULB Capacity Building
10. Participatory Planning Framework
11. Focus on Local River Systems

Urban Groundwater Management

- Mapping and Registration of Key Groundwater Sources
- Participatory Aquifer Mapping
- Stakeholder database: users, driller, tanker-operators
- Groundwater Recharge Programme
- Securing Groundwater from Waste Disposal
- Protection of Recharge Zones
- Participatory Groundwater Management

Recycle and Reuse Wastewater

- 12th Plan: tackle water and waste water together, with primacy being given to treatment of sewage
- Census 2011: 33% urban Indians are connected to piped sewer system; 13% (50 million) still defecate in the open
- We have installed capacity to treat 30 per cent of the excreta we generate
- Delhi and Mumbai, which generate around 17 per cent of the country's sewage, have nearly 40 per cent of this installed capacity

Reuse Recycle Options

- With basic level treatment of sewage, the water can be reutilised in industries and power plants
- The water sludge after treatment can also be used as manure in agriculture
- Potential source of revenue for ULBs
- Cities need to work out effluent profile of their treated effluent and segregate their waste to meet the needs of the end-user

Decentralised Wastewater Treatment

- More easily cater to un-served areas
- Minimize pressure of transporting to a single location
- Reduces cost of treatment and O&M
- Site-specific treatment technologies can be designed based on land use
- Minimise land needed for treatment

Reducing the Industrial Water Footprint

- Water footprint of Indian industry is unacceptably high. We need to
  - reduce consumption of fresh water through alternative water-efficient technologies or processes
  - reuse and recycle waste water and make the reclaimed water available for use in secondary activities within or outside the industry
  - reduce the volume of polluted water dumped into rivers and groundwater

Reducing the Industrial Water Footprint

- Of all water discharged by Indian industry, 80-90% is cooling water discharge of thermal power plants
- For every MW of power produced, Indian thermal power plants consume 8 times more water than developed nations
- This is mainly attributed to the once-through cooling system (open loop system)
- By converting to closed-cycle cooling systems, 65,000 MLD of fresh water could be saved
- The payback period on these investments is less than 3 years

Reducing the Industrial Water Footprint

- Make it mandatory for companies to report every year on their water footprint:
  - volume of fresh water used by them in their various production activities
  - volume of water used reused or recycled
  - commitment that the company would reduce its water footprint by a definite amount within a specified period of time
- Simultaneously, develop benchmarks for specific water use in different industries and ensure their application in the grant of clearances for industrial projects

Protect and Prioritise Local Water Bodies

- The first priority for cities when planning water supply should be the protection, restoration and recharge of their traditional water bodies
- This would reduce costs of supply from a distance and also help groundwater recharge
- Encroachments severely reduce the water holding capacity of natural reservoirs
- This results in outflow of water during monsoon, leading to widespread floods

Protect and Prioritise Local Water Bodies

- On September 6, 2014, the Madurai Bench of Madras High Court directed the Government not to grant layout approval or building plan permission on lands located on water bodies
- In 2013, the Supreme Court directed Kanpur Dehat District to check encroachments on the water bodies in their jurisdiction
- The Rajasthan High Court in 2012 also came down heavily on the State government over illegal allotments and encroachments in the catchment area of water bodies

Shift Focus to Management and Distribution

- 12th Plan: as important as the quantum of water to be supplied, is the problem of its management and equitable supply
- NSS 65th round: 53% urban households have individual water connections
- Cut the length of the pipeline to reduce the electricity and pumping costs and resultant leakage
- Cut the costs and transportation of sewage

Need for Alternative Technologies

- HPEC (2011): Rs. 5,64,000 crore over next 20 years for water supply and sewerage treatment
- Pune will need 3000 MW power per day for its conventional sewage treatment plants
- This would daily release 3000 tons of carbon dioxide into the environment. Nation-wide, it will be 120,000 tons each day
- Untreated wastes left in water bodies will lead to increase of GHGs mostly due to generation of methane gas in enormous quantities

Need for Alternative Technologies

- Anaerobic, micro-aerophilic and aerobic process for organic pollution treatment and nitrate and phosphorus removal
- All these processes, occurring in different treatment units separately, create a cumulative effect in the **soil-scape process** for point source pollution or **green bridge system** for non-point source pollution
- Successfully piloted in
  - College of Military Engineering, Pune
  - Udaipur’s Ahar river
  - Buddha Stream of Sutlej river in Ludhiana
  - Rasoolabad Ghat Complex in Allahabad

Participatory Planning and Capacity Building

- Strengthening the Data Baseline
- Building a Strong Framework of Participatory Planning
- Building Capacities of relevant stakeholders, especially ULBs
- Focus on Local River Systems

Thank You