# Pathways for building more climate resilient Indian cities

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CENTRE FOR SOCIAL & ENVIRONMENTAL INNOVATION

atree

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## List of acronyms & abbreviations

| | |
|---|---|
| BWSSB | Bangalore Water supply and Sewerage Board |
| KSPCB | Karnataka State Pollution Control Board |
| ETP | Effluent treatment plant |
| GDP | Gross domestic product |
| GHG | Greenhouse Gases |
| IGBC | The Indian Green Building Council |
| LEED | Leadership in Energy and Environmental Design |
| GRIHA | Green Rating for Integrated Habitat Assessment |
| STP | Sewage Treatment Plant |
| WW | Waste water |

## List of definitions

| | |
|---|---|
| Megalopolis | A thickly populated region centering in a metropolis or embracing several metropolises |
| Tier 1, Tier 2 & Tier 3 cities | According to the Census of India, Indian cities are classified based on population.<br>Tier 1 cities have a population of 1,00,000 and above.<br>Tier 2 cities have a population of 50,000-99,999.<br>Tier 3 cities have a population of 20,000-49,999 |
| Land use planning | "The rational and judicious approach of allocating available land resources to different land using activities and for different functions consistent with the overall development vision/goal of a particular city". |

## Ashoka Trust for Research in Ecology and the Environment (ATREE)

Ashoka Trust for Research in Ecology and the Environment (ATREE) is a global non-profit organisation which generates interdisciplinary knowledge to inform policy and practice in the areas of conservation and sustainability.

ATREE envisions a society committed to environmental conservation, and sustainable and socially just development.

For over two decades, ATREE has worked on issues like biodiversity and conservation, climate change mitigation and development, land and water resources, forests and governance, and ecosystem services and human well-being.

ATREE has consistently ranked in the top 20 Environment and Water Security think-tanks in the world.

## Centre for Social and Environmental Innovation (CSEI)

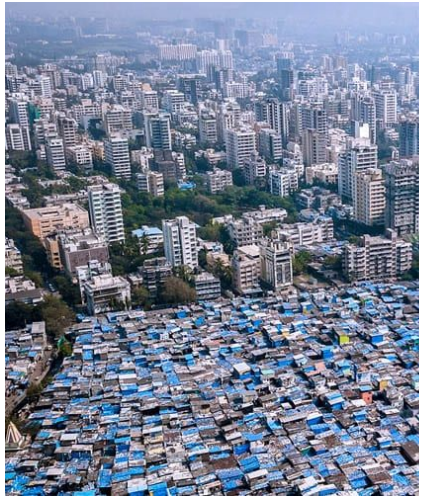
ATREE's Centre for Social and Environmental Innovation (CSEI) aims to translate research to enhance human well-being, while also conserving the natural environment.

CSEI aims to co-create scalable solutions working with partners. We hope to build impact ecosystems to address the problems we work on.

Our solutions are rooted in scientific research. CSEI currently focuses on three problems:  water & foods, invasive plant species, and climate resilient/green cities.

The Centre's focus is on empowering the 'first mile'- in their role as citizens, producers, or consumers.  Our goal is to enable a transition to a more sustainable and fair system.

# Reimagining Indian cities is the need of the hour



*Aerial view of Mumbai*

Cities are central to India's economic growth. By 2030 they will generate 70% of net new jobs, and produce more than 70% of India's GDP.[i]

But many cities are already vulnerable to climate change.[ii] On one hand, the potential financial damage from extreme events, like floods, heat, and drought is likely to be staggering. The urban poor in particular will bear much of the burden.

On the other hand, cities also hold the key to altering this trajectory. Because so much of the new development (much of it greenfield) will occur in and around existing urban areas, how we imagine and plan cities will be crucial to determining the future of our planet.

**483M**

**people live in Indian cities.**[iii]

## Indian cities are largely unplanned

**63M** **people live in slums without access to utilities .**[iv]

It estimated that 590 million people will live in cities by 2030, more than double the 290 million in 2001.[i] So far India's cities have evolved organically, governed mostly by economic forces rather than planning conventions. Government run utilities have struggled with fund allocation, which has led to insufficient access to basic amenities. Unravelling the complexities in India's megalopolises is proving to be extremely challenging. In order to keep up with ever growing urban demand, reimagining Tier 2 and Tier 3 cities is the need of the hour.

# The Problems

## Unplanned urbanisation has led to developmental threats in Indian cities

**Poor waste management:** 80% of the daily garbage remains untreated in Indian cities.[v]

**Poor water, sewage and WW management:** Only 28% of wastewater generated is currently treated in India.[vi]

**Unmet freshwater demand:** Only 48% of the current urban water demand is being met.[vii]

**Poor air quality:** 21/30 of the world's most polluted cities are Indian cities.[viii]

**High energy consumption:** 20% increase in per capita energy consumption in the past 5 years.[ix]

**Poorly designed buildings and urban form:** 30% higher energy demand from buildings. [x]

**77%**

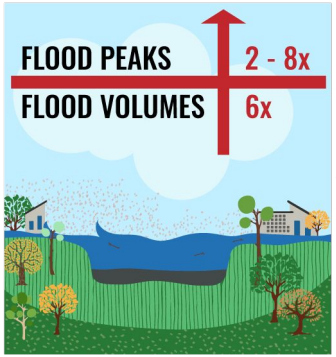
of blue and green cover has been lost.[xi]

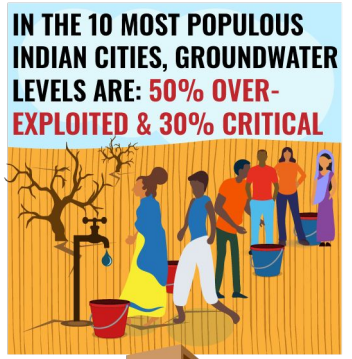
## Indian cities are also hotspots vulnerable to climate threats

**Extreme Heat:** A recent study by IIT-KGP found that the Surface Urban Heat Island Intensity (SUHII) for 44 Indian cities was upto 2°C higher than surrounding rural areas.[xii]

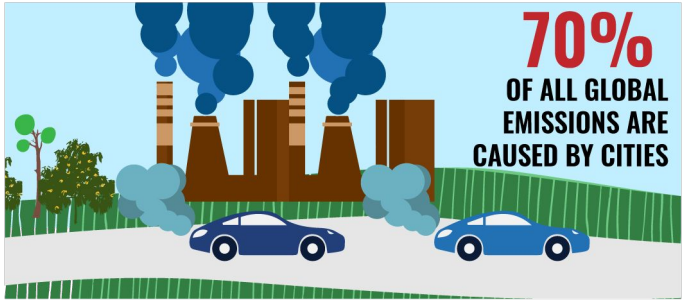
**Droughts:** A ground water availability assessment study conducted by Central Ground Water Board (CGWB) of India in 2017 shows that out of the 10 most populous cities in India, the groundwater resources in 50% were over-exploited, 30% had critically low levels and only 20% were found to be within safe limits.[xiii]

**Floods:** Urban India has seen an increase in flood peaks by 2-8x & flood volumes to 6x.[xiv]







## Developmental threats have accelerated the susceptibility of cities to climate threats

The rapid influx of people into India's cities has resulted in ad hoc construction, and a fragmented development paradigm, resulting in rampant environmental degradation.

-Increased concretization has reduced evapotranspiration and groundwater recharge.

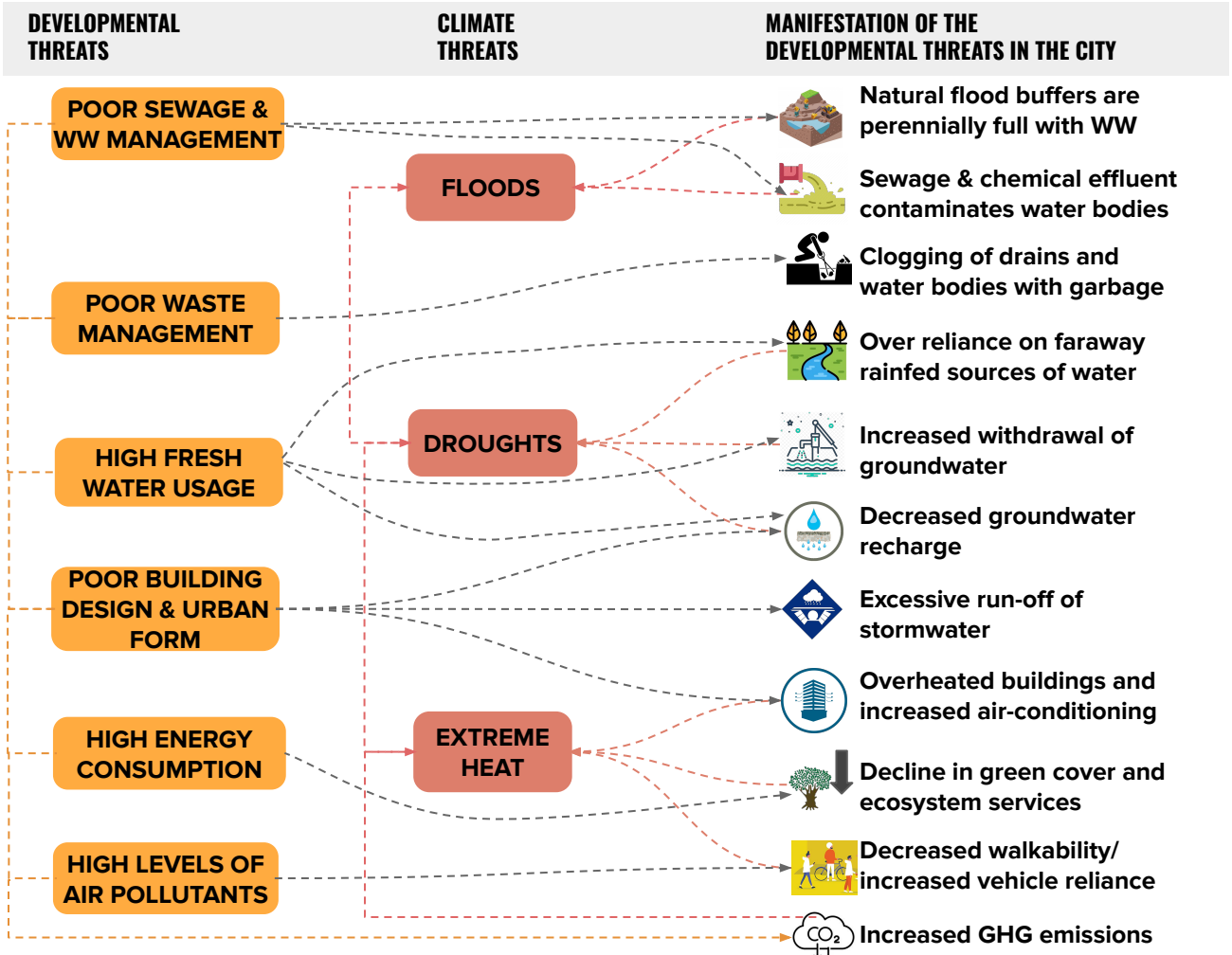
-Poorly designed buildings and urban form have exacerbated urban heat islands

-Planning oriented around motor vehicles has led to poor air quality and noise pollution.

-Lagging infrastructure investments and weak enforcement have led to land & water pollution.

- Poor stormwater management has caused water bodies to dry up leading to encroachment.

## Manifestations of the developmental threats exacerbate climate threats



# The Solutions

## In order to address the threats, cities need blue, green & grey infrastructure

Cities need to cater to rising populations without causing environmental degradation. They must ensure that they are climate resilient, equitable and livable.

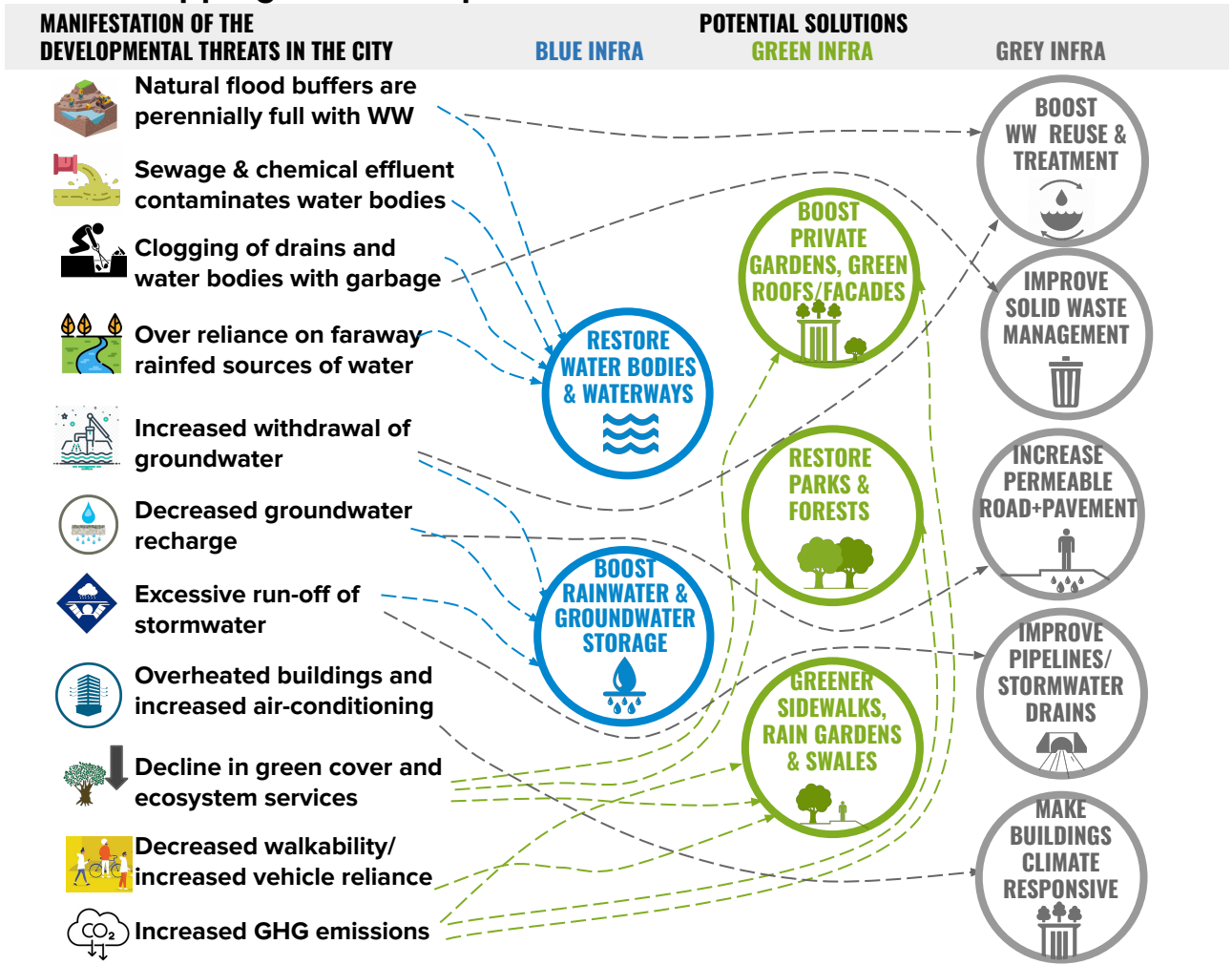
Cities need blue, green and grey infrastructure investments that can address combined climate and developmental threats.

**Blue infrastructure:** refers to surface water bodies (lakes, rivers, canals, ponds) and underground water (aquifers) systems.

**Green infrastructure:** refers to trees, gardens, parks, fields, forests, sustainable urban drainage systems and green roofs/facades.

**Grey infrastructure:** refers to sewage treatment plants, pipeline networks, stormwater channels, road networks and buildings

# Mapping the developmental & climate threats to solutions



**Lack of integration, ignoring material flows between blue, green and grey systems, can lead to suboptimal solutions.**

**For instance:**

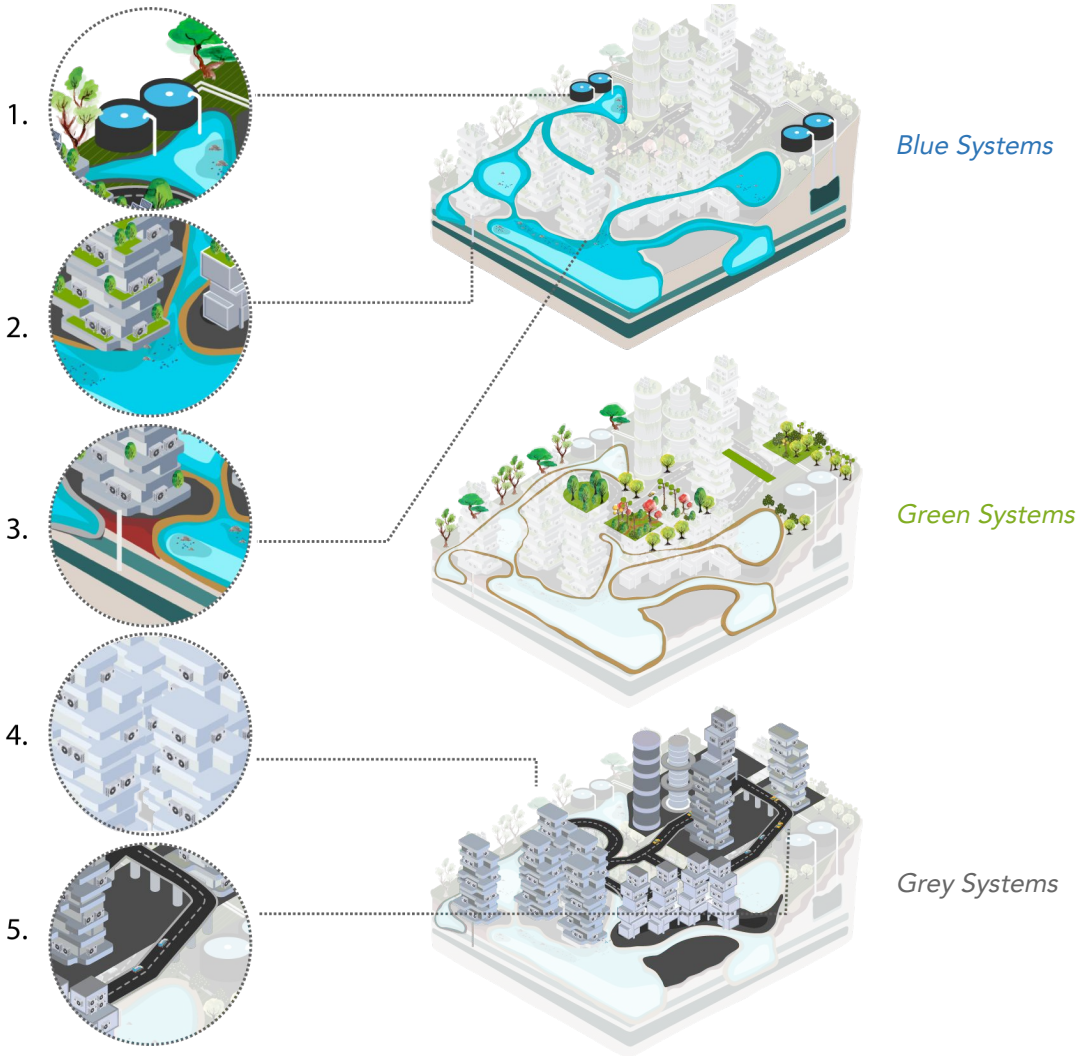
**1. Pollution of water bodies and waterways** from ingress of poorly treated effluent (from STPs and ETPs) & untreated sewage

**2. Man-made flooding** due to poor stormwater management, lack of permeable surfaces, and breakdown of lake connectivity.

**3. Decline in aquifer levels** due to increased groundwater pumping and reduced rainwater infiltration due to reduction in permeable surfaces.

**4. Increased cooling needs** due to declining green and blue cover.

**5.Inadequate mitigation of air pollutants** due to insufficient tree/green cover.

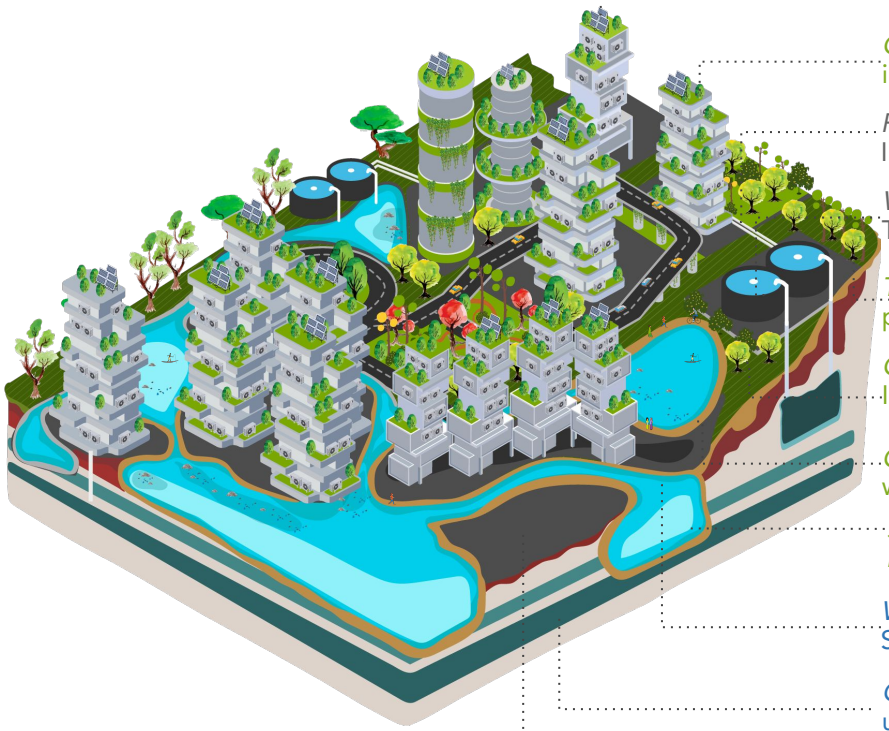


## The 3 systems should not be viewed in silos as they play complementary roles.

Integrating man-made (grey) and natural or nature-based solutions (blue and green) can effectively help in building more resilient and livable cities.These two systems play complementary roles.

While grey infrastructure is essential in densely populated cities, owing to its efficiency in providing access to utilities, it's expensive and energy intensive. It's designs use narrow metrics that serve a singular purpose without co-benefits.

On the other hand blue and green infrastructure can serve multiple functions simultaneously. For instance, sponge cities use natural landscapes to temporarily hold excess stormwater preventing floods. This is not only cheaper than building larger stormwater drains but also provides other co-benefits like infiltration, improved water quality etc.



*Climate responsive buildings:* Reduce energy consumption

*Green roofs and facades:* improve internal temperatures

*Pipeline network:* Improves water supply

*WW treatment technology(STPs):* Treats sewage & reclaims water

*Treescapes:* Boost air quality, and provide ecosystem services

*Green cover:* Increases groundwater infiltration

*Green Sidewalks:* Increases walkability reducing vehicle usage

*Swales, Infiltration trenches & bioretention cells:* Stores rainwater

*Water bodies and waterways :* Store excess rainwater for reuse

*Groundwater aquifers:* Recharged using rainwater and treated WW

*Permeable roads & pavements:* Increases groundwater infiltration

# Lack of integration ignores potential synergies & leads to unintended consequences

**Potential Synergies**
- ● Contributes to a large extent
- ◒ Contributes to a limited extent
- ○ Does not contribute

**Unintended consequences**
- ■ Positive impact on benefit
- □ Negative impact on benefit

| | SOLUTIONS \ BENEFITS | Blue layer: Reduces flooding | Blue layer: Increases available water supply | Blue layer: Boosts groundwater recharge | Green layer: Reduces storm water runoff | Green layer: Improves air quality (sequesters carbon) | Green layer: Improves internal temps/microclimate | Green layer: Increases biodiversity | Grey layer: Reduces pollution of water bodies | Grey layer: Reduces energy usage | Grey layer: Increases infiltration/ reduces drought risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Blue Layer | Treated WW reuse+groundwater recharge | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ● |
| | Restored water bodies & waterways | ● | ● | ● | ● | ◒ | ○ | ● | ● | ◒ | ● |
| | Recharge Wells | ◒ | ○ | ● | ◒ | ○ | ○ | ○ | ○ | ○ | ● |
| | Rain Barrels | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ● |
| | Infiltration Trenches | ● | ○ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● |
| Green Layer | Private gardens | ◒ | □ | ● | ● | ● | ● | ● | ○ | ○ | ● |
| | Private rooftops and facades | ○ | □ | ○ | ● | ● | ● | ● | ○ | ● | ○ |
| | Parks & Forests | ◒ | □ | ● | ● | ● | ● | ● | ○ | ○ | ● |
| | Green sidewalks, swales, rain gardens | ● | □ | ● | ● | ● | ○ | ◒ | ○ | ◒ | ● |
| Grey Layer | Pipeline network | ○ | ○ | ◒ | ○ | ○ | ○ | ○ | ○ | ○ | ■ |
| | Stormwater drains | ● | ○ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● |
| | Solid waste management | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● | ○ |
| | Permeable roads+pavements | ● | ○ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● |
| | Climate responsive buildings | ○ | ○ | ● | ● | ○ | ○ | ○ | ● | ● | ● |

## Why is the integration of the three systems not already happening?

**Development:** Urban development is governed by economic forces, rather than environmental concerns. Illegal deviations from the planned land use map has led to encroachment of some lakes and green spaces.

**Planning:** The assets are handled by different agencies, who work in silos with little interagency coordination.

**Investment:** Agencies allocate large funds for revenue -generating grey infrastructure projects, while blue and green infrastructure lags behind. E.g. in Bangalore, 80% of the municipal funds are allocated to grey infrastructure; only 4% was to greening and 15% to lakes.

**Culture:** Cities are set in the broader context of "use and throw" consumption patterns, rather than use and reuse loops.

## In this brief, we focus on solutions that leverage "first mile" actors - citizens, consumers and businesses - to promote integration.

### Solutions with strong "first mile" involvement


In 2016 the KSPCB imposed mandates making commercial complexes and institutions with over 2000 sqm & apartments (with over 20 units) treat and reuse wastewater.

In a 2019 BWSSB mandate required builders to use treated WW in constructions.


More companies have adopted sustainability mandates. So there is increased focus on building climate responsive buildings.

There has also been greater interest in green building certifications such as, LEED IGBC Green and GRIHA.


There is a rise in terrace and community gardening in Indian cities propelled by an interest in fresh organic food and recreational spaces.

This is being facilitated by a growing number of farming and gardening start-ups.


In 2009, BWSSB mandated the provision of rainwater harvesting structures for new and existing structures both for use and/or recharging groundwater.

There are a number of consulting firms that facilitate this.


Rejuvenation of lakes has been a largely collaborative effort between the government and citizen-led lake groups.

Maintenance and monitoring of lake health has been handed over to lake groups.

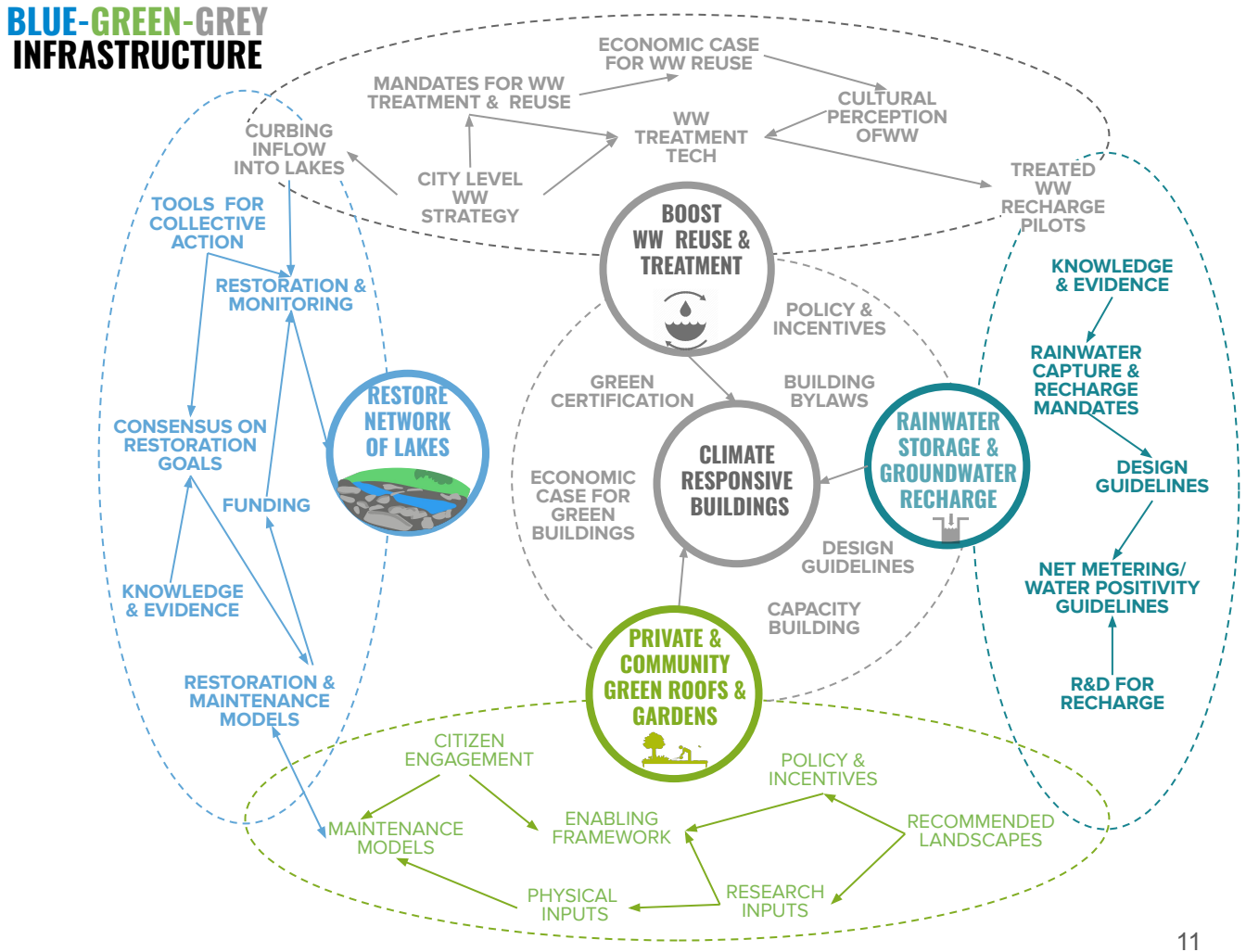
**To ensure the adoption of climate resilient solutions that simultaneously boost ecosystem services, there are several levers at play:**

The key levers for change are:

- Scientific research & models
- Citizen action
- Technology innovation
- Incentives
- Regulations & guidelines
- Coordinating mechanisms
- Capacity for implementation
- Maintenance models

By placing the solutions within the larger context of the city we could uncover the interlinkages and solve unintended consequences.

**In our subsequent articles we explore all the pieces required to facilitate each of these levers through stakeholder analysis, interviews and surveys.**



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