

World Environment Day 2026

Urban India: Building Sustainable, Resilient and Livable Cities

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## Introduction

World Environment Day (WED) observed annually on **5 June**, is the United Nations' foremost platform for promoting environmental awareness and action worldwide. The **Republic of Azerbaijan** is hosting **World Environment Day 2026**. Through its stewardship of the global event, Azerbaijan seeks to draw attention to the interconnected challenges of **climate change, ecosystem degradation, and sustainable development** while fostering international collaboration on climate action.

- It was established by the **United Nations General Assembly in 1972** following the landmark **United Nations Conference on the Human Environment** held in Stockholm, Sweden.
- The **first World Environment Day** was celebrated in **1973** under the theme “**Only One Earth**,” emphasizing the need for collective responsibility towards protecting the planet.
- Over the past five decades, it has evolved into the **largest global environmental outreach event, bringing together governments, international organizations, businesses, civil society groups, educational institutions, and millions of citizens across more than 150 countries.**
- World Environment Day plays a **vital role in highlighting the urgent environmental challenges facing humanity, including climate change, biodiversity loss, deforestation, pollution, desertification, and water scarcity.**
- The theme for **World Environment Day 2026** is “**Inspired by Nature. For Climate. For Our Future.**” The campaign focuses on **addressing climate change through nature-based solutions and emphasizes the critical role that healthy ecosystems play in enhancing climate resilience.**

## Introduction

Urbanization in India has accelerated rapidly since the late twentieth century, transforming the social, economic, and ecological landscapes of cities.

- ▶ While urban growth has contributed significantly to economic development, industrial expansion, and modernization, it has also generated serious environmental challenges.
- ▶ Among the most pressing concerns are the growing pressure on urban infrastructure and basic services, increasing water scarcity, rising levels of air pollution, inefficient waste management systems, and the gradual decline of urban biodiversity.
- ▶ Conventional urban planning approaches often rely heavily on modern technology, with limited attention to indigenous, context-specific solutions.
- ▶ Indian Knowledge Systems (IKS) represent a **rich repository of traditional wisdom related to ecology, water conservation, architecture, health, and community-based governance and sustainability.**
- ▶ Historically, Indian cities and settlements were designed in **harmony with nature, emphasising balance, resource efficiency, and sustainability.**

# Introduction

Rapid population growth in cities has resulted in **excessive extraction of groundwater, depletion of lakes and ponds**, and increasing dependence on **distant river basins/ water sources** .

- Several metropolitan cities such as Delhi, Chennai, and Bengaluru have experienced **severe water shortages** due to unsustainable water management practices and declining groundwater levels.
- Air pollution is another major environmental problem linked with rapid urban growth. The expansion of motorised transport, industrial emissions, construction activities, and the burning of solid waste have contributed to deteriorating air quality in many Indian cities.
- **Several urban centres** consistently rank among the **most polluted cities in the world**, posing serious threats to public health and environmental sustainability.
- High population density, shrinking green spaces, and heavy dependence on fossil fuels further aggravate the situation

- Waste management has also become a critical issue. Increasing consumption patterns and lifestyle changes associated with urbanization have led to the **generation of enormous quantities of municipal solid waste**.
- Many urban local bodies face **serious challenges in the collection, segregation, recycling, and disposal of waste**, resulting in contamination of land, air, and water resources.
- Urbanization has also contributed to the **decline of urban biodiversity**. The rapid expansion of built-up areas, **encroachment upon wetlands and green spaces**, and fragmentation of natural habitats have resulted in the disappearance of several plant and animal species from urban ecosystems.
- The **conventional urban planning** has often **prioritized infrastructure development** over ecological conservation, leading to the **loss of natural ecosystems within cities**. The urban planning approaches is heavily reliance on modern technology and standardized planning models often derived from Western contexts.
- These approaches frequently overlook indigenous and context-specific knowledge systems that historically guided sustainable settlement planning in India.

- These structures served not only as water sources but also as social and cultural spaces within cities.
- Climate-responsive architecture using locally available materials such as stone, mud, and lime mortar ensured natural cooling and reduced dependence on artificial energy sources.
- **Traditional urban layouts** also **incorporated temple tanks, gardens, and sacred groves** that helped maintain ecological balance and support biodiversity.
- Traditional architecture further contributed to sustainable urban environments through the use of locally available materials and climate-responsive designs.
- Buildings were often constructed using stone, mud bricks, lime mortar, and timber, which had lower environmental impacts and were well suited to local climatic conditions.
- Architectural features such as **courtyards, thick walls, shaded verandas, jaalis (perforated screens), and high ceilings enhanced natural ventilation** and lighting while reducing dependence on artificial cooling systems.
- These design principles ensured thermal comfort even in extreme climatic conditions.
- **Resource efficiency and recycling** were also integral features of traditional urban life. Historical communities practiced reuse and repair of materials rather than disposal, thereby minimizing waste generation.
- Building materials from older structures were often reused in new constructions, while biodegradable household waste was commonly converted into manure for agricultural fields and gardens.
- Such practices reflected a circular approach to resource use that closely aligns with contemporary sustainability frameworks such as the circular economy .

**Integrating Indigenous Knowledge Systems (IKS) can significantly strengthen urban resilience by supporting:**

- Heritage conservation
- Sustainable sanitation systems
- Water Harvesting
- Urban Forestry & Biodiversity Conservation
- Climate change adaptation strategies

**Circular** economy practices

## Issues of Climate Change

- ▶ An urban environment is complex primarily because of rapidly changing variables such as socio- economic and demographic indicators, land-use patterns, resource demand and utilization patterns, lifestyle changes etc..
- ▶ In the light of climate change, a new layer of uncertainty is added in terms of changes in precipitation, temperature and occurrence of extreme events.
- ▶ The increased incidences of **urban flooding and heat land** are result of poor planning for infrastructure development and intensive use of conventional energy resources .
- ▶ There is **increased pressure for the use of ground water** while surface water is being polluted .
- ▶ The ground water level is gradually declining in urban centres.
- ▶ Additionally, the climate change causing extreme weather events causes increase in frequency and intensity of floods, storms, torrential rains, and droughts etc. that take thousands of lives and affect millions of people.
- ▶ The projected climate change estimates from 2036 to 2060 for 57 Indian cities show that 33 cities are likely to experience rise in **extreme rainfall and exacerbated flood risk**.
- ▶ The remaining 24 cities will observe precipitation declines, reflecting **higher drought risk** .

# WHEN CHANGE ISN'T GOOD

Climate change or not, there's little doubt now that extreme weather events in India are becoming more common



## Extreme Heat

### WHAT WE KNOW

Annual mean temperature of India has risen by 0.6°C in past 114 years  
West coast and southern India are projected to shift to new, high-temperature climatic regimes

### WHAT CAN BE DONE

Stop towns from being heat 'islands' through planning



## Rainfall

### WHAT WE KNOW

A decline in monsoon rainfall since the 1950s has happened.  
A 2°C rise in global average temperature will make India's monsoon go haywire

### WHAT CAN BE DONE

Boost hydro-meteorological systems to conserve water



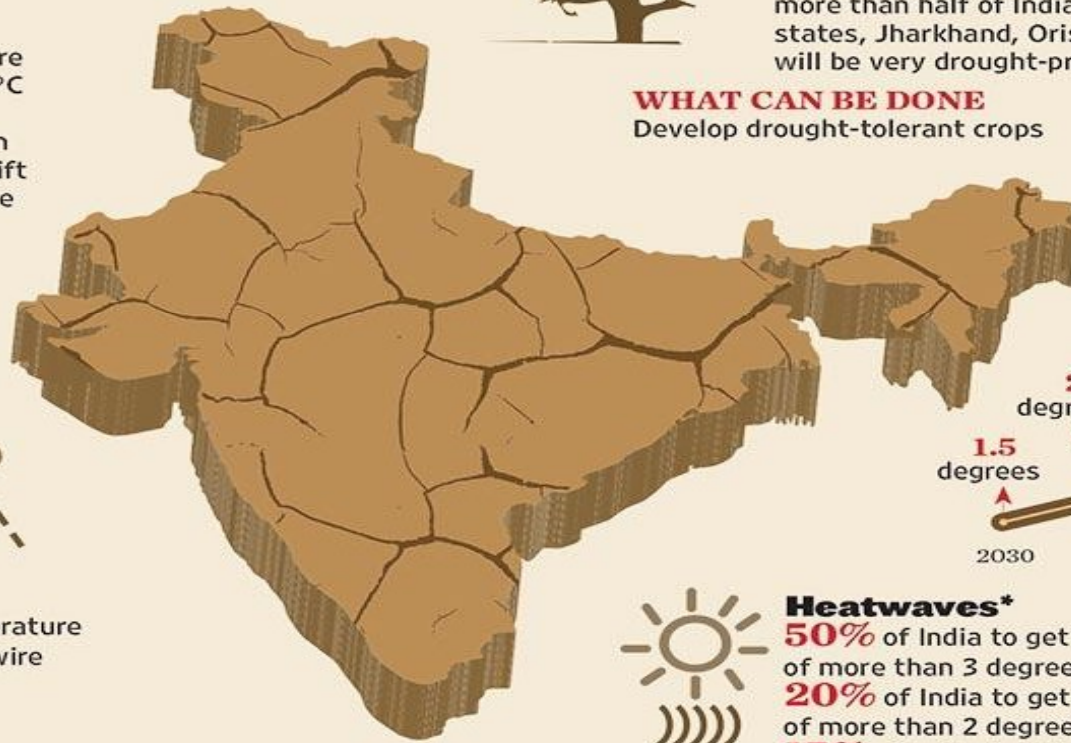
## Droughts

### WHAT WE KNOW

In 1987, 2002-2003 and 2009 droughts gripped more than half of India's sown area. Western states, Jharkhand, Orissa and Chhattisgarh will be very drought-prone

### WHAT CAN BE DONE

Develop drought-tolerant crops



## Projections\* India Warming scenarios



## Heatwaves\*

**50%** of India to get heatwaves of more than 3 degrees

**20%** of India to get heatwaves of more than 2 degrees

**15%** of India to witness heatwaves of more than 1.5 degrees

\* In the absence of climate change solutions

## Urban Heat Stress in Cities of India

### Urban Heat Stress Hotspots in Indian Cities (2025–26)

Peak Summer Temperature (°C) and Urban Heat Risk Ranking

| Rank | City      | Peak Summer Temperature (°C) |                          |
|------|-----------|------------------------------|--------------------------|
| 1    | Delhi     | 46–48                        |                          |
| 2    | Jaipur    | 45–47                        |                          |
| 3    | Ahmedabad | 45–47                        |                          |
| 4    | Nagpur    | 45–46                        |                          |
| 5    | Lucknow   | 44–46                        |                          |
| 6    | Kanpur    | 44–46                        |                          |
| 7    | Patna     | 43–45                        |                          |
| 8    | Bhopal    | 43–45                        |                          |
| 9    | Hyderabad | 42–44                        |                          |
| 10   | Raipur    | 42–44                        |                          |
| 11   | Kolkata   | 40–43                        |                          |
| 12   | Mumbai    | 37–40                        | MODERATE-HIGH (HUMIDITY) |
| 13   | Chennai   | 39–42                        | MODERATE-HIGH (HUMIDITY) |
| 14   | Bengaluru | 35–38                        | MODERATE                 |
| 15   | Pune      | 36–39                        | MODERATE                 |

#### Risk Level

##### RISK LEVEL GUIDE

**VERY HIGH RISK**  
Extreme heat stress, frequent heatwaves, high health impact

**HIGH RISK**  
Frequent heatwaves, high heat stress, health concern

**MODERATE-HIGH RISK**  
High humidity with moderate to high heat stress

**MODERATE RISK**  
Relatively lower heat stress compared to other cities

#### Key Insights (2025–26)



Northwest and Central India remain the most heat-stressed urban regions.



Delhi, Jaipur, Ahmedabad and Nagpur continue to face recurring extreme heatwave conditions.



Coastal cities like Mumbai and Chennai experience high heat index due to humidity.



Rising nighttime temperatures reduce body recovery and increase health risks.

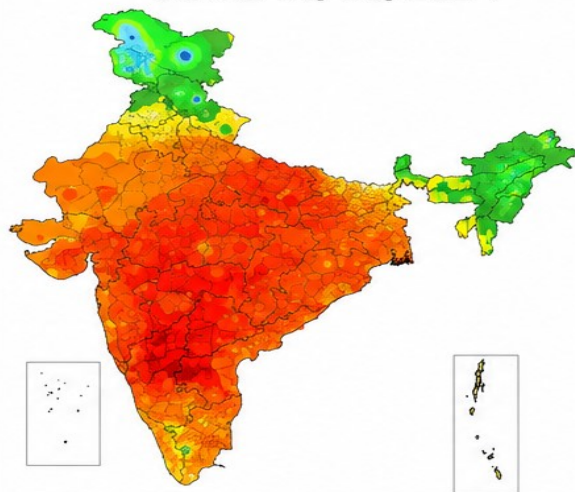


Urban heat stress will continue to rise with climate change and urbanization.

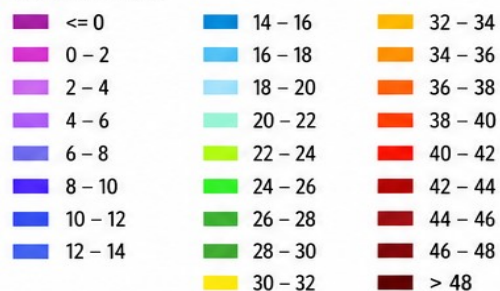
Source: IMD, CEEW, MoHFW Heatwave Reports, News Reports (2024–25)

Note: Temperature ranges indicate typical peak values during March–June.

## MAXIMUM TEMPERATURE Dated 31/03/2024



Max. Temp. (°C)



**SOURCE** India Meteorological Department (IMD)

## HOT DAYS INCOMING?

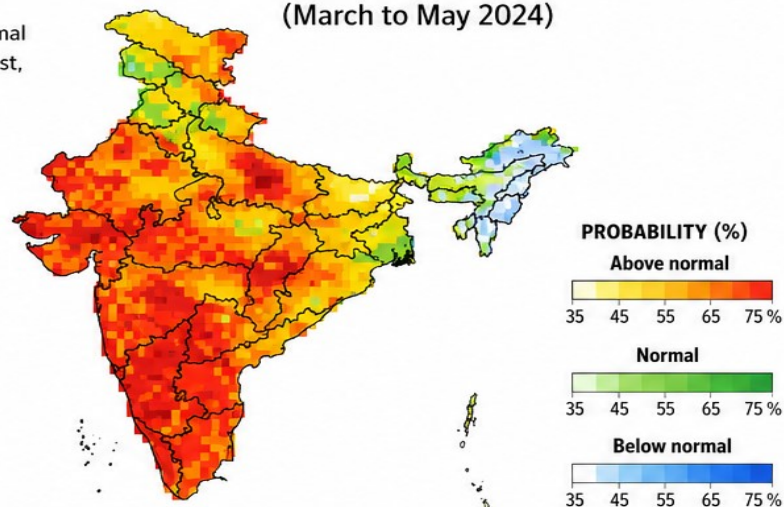
Temperatures in the summer are likely to be above-normal over most of India, except for some areas in the northeast, IMD said.

**117%+** Above normal rainfall is likely through March, averaged over the country

### IMPACT OF EL NINO: HEATWAVES MORE LIKELY

- The number of heatwave days are also likely to be higher over most part of northwest and peninsular India.
- Some regions in the northeast, western Himalayas, and the southwest parts of the country may be spared heatwaves during the summer, the forecast said.

## PROBABILITY FORECAST OF MAX TEMPERATURE (March to May 2024)



### MAXIMUM TEMPERATURE (°C) IN MAJOR CITIES Dated 31/03/2024

| City          | Max. Temp. (°C) | City           | Max. Temp. (°C) | City            | Max. Temp. (°C) |
|---------------|-----------------|----------------|-----------------|-----------------|-----------------|
| 1. Phalodi    | 42.6            | 11. Chhindwara | 39.6            | 21. Hyderabad   | 38.3            |
| 2. Barmer     | 41.9            | 12. Akola      | 39.5            | 22. Solapur     | 38.2            |
| 3. Churu      | 41.5            | 13. Amaravati  | 39.3            | 23. Nanded      | 38.1            |
| 4. Ganganagar | 41.3            | 14. Allahabad  | 39.2            | 24. Bhubaneswar | 37.8            |
| 5. Bikaner    | 41.1            | 15. Jaipur     | 39.1            | 25. Patna       | 37.6            |
| 6. Jaisalmer  | 40.8            | 16. Gwalior    | 39.0            | 26. Lucknow     | 37.5            |
| 7. Kota       | 40.6            | 17. Delhi      | 38.9            | 27. Varanasi    | 37.3            |
| 8. Jhansi     | 40.4            | 18. Agra       | 38.7            | 28. Ranchi      | 37.0            |
| 9. Jodhpur    | 40.2            | 19. Raipur     | 38.6            | 29. Guwahati    | 36.2            |
| 10. Nagpur    | 39.8            | 20. Aurangabad | 38.5            | 30. Shillong    | 28.4            |

NOTE: Data is provisional and subject to change.

### HEATWAVE RISK OUTLOOK (MARCH TO MAY 2024)

| REGION                 | CITIES (EXAMPLES)                                                    | HEATWAVE RISK |           |           |
|------------------------|----------------------------------------------------------------------|---------------|-----------|-----------|
|                        |                                                                      | MARCH         | APRIL     | MAY       |
| Northwest India        | Jaisalmer, Jodhpur, Bikaner, Barmer, Churu, Ganganagar, Jaipur, Kota | High          | Very High | Very High |
| Central India          | Bhopal, Jabalpur, Gwalior, Indore, Nagpur, Chhindwara, Raipur        | High          | Very High | High      |
| West India             | Ahmedabad, Rajkot, Surat, Vadodara, Nashik, Aurangabad, Solapur      | High          | Very High | High      |
| East India             | Patna, Ranchi, Bhubaneswar, Asansol, Durgapur, Kolkata               | Moderate      | High      | High      |
| South India (Interior) | Hyderabad, Vijayawada, Tirupati, Kurnool, Bellary, Warangal          | Moderate      | High      | High      |
| South India (Coastal)  | Chennai, Visakhapatnam, Mangaluru, Kochi, Thiruvananthapuram         | Low           | Moderate  | Moderate  |
| Northeast India        | Guwahati, Shillong, Imphal, Aizawl, Agartala, Itanagar               | Low           | Low       | Low       |

Risk Levels: ■ Low ■ Moderate ■ High ■ Very High

## CAUSE FOR CONCERN

Of the 25 most polluted cities,  
22 were in India

| Rank | City                    | 2020<br>AVG PM2.5*<br>(µg/m³) |
|------|-------------------------|-------------------------------|
| 1    | Hotan, China            | 110.2                         |
| 2    | Ghaziabad, India        | 106.6                         |
| 3    | Bulandshahr, India      | 98.4                          |
| 4    | Bairnihat, India        | 97.2                          |
| 5    | Bisrakh Jalalpur, India | 96.0                          |
| 6    | Bhiwadi, India          | 95.5                          |
| 7    | Noida, India            | 94.3                          |
| 8    | Greater Noida, India    | 89.5                          |
| 9    | Kanpur, India           | 89.1                          |
| 10   | Lucknow, India          | 86.2                          |
| 11   | Delhi, India            | 84.1                          |
| 12   | Faridabad, India        | 83.3                          |
| 13   | Meerut, India           | 82.3                          |
| 14   | Jind, India             | 81.6                          |
| 15   | Hisar, India            | 81.1                          |
| 16   | Kashgar, China          | 81.0                          |
| 17   | Patna, India            | 79.7                          |
| 18   | Muzaffarpur, India      | 79.1                          |
| 19   | Varanasi, India         | 78.4                          |
| 20   | Agra, India             | 77.2                          |
| 21   | Gurgaon, India          | 76.5                          |
| 22   | Rohtak, India           | 74.4                          |
| 23   | Gaya, India             | 73.1                          |
| 24   | Bengaluru, India        | 72.6                          |
| 25   | Dhanbad, India          | 71.5                          |

\*Unit: µg/m³

SOURCE: 2020 WORLD AIR QUALITY REPORT

## THE WORST 15

| Rank<br>2022<br>(2019)* | City        | Annual<br>PM2.5<br>2022<br>(µg/m³) | Annual<br>PM2.5<br>2019*<br>(µg/m³) | Change<br>in Rank |
|-------------------------|-------------|------------------------------------|-------------------------------------|-------------------|
| 1 (3)                   | Delhi       | 99.7                               | 110.2                               | ↑2                |
| 2 (-)                   | Faridabad   | 95.6                               | —                                   | —                 |
| 3 (1)                   | Ghaziabad   | 91.3                               | 106.6                               | ↓2                |
| 4 (-)                   | Patna       | 90.9                               | —                                   | —                 |
| 5 (-)                   | Muzaffarpur | 86.9                               | —                                   | —                 |
| 6 (2)                   | Noida       | 80.4                               | 94.3                                | ↓4                |
| 7 (-)                   | Meerut      | 77.7                               | 82.3                                | —                 |
| 8 (8)                   | Gobindgarh* | 72.4                               | 72.2                                | —                 |
| 9 (-)                   | Gaya        | 70.8                               | 73.1                                | —                 |
| 10 (6)                  | Jodhpur     | 69.3                               | 69.2                                | ↓4                |
| 11 (-)                  | Lucknow     | 68.7                               | 86.2                                | —                 |
| 12 (-)                  | Varanasi    | 67.9                               | 78.4                                | —                 |
| 13 (-)                  | Agra        | 66.1                               | 77.2                                | —                 |
| 14 (-)                  | Gurgaon     | 65.5                               | 76.5                                | —                 |
| 15 (-)                  | Bhiwadi     | 64.8                               | 95.5                                | —                 |

### NEW ENTRANTS IN 2022 (NOT IN TOP 15 IN 2019)

|               |               |               |              |              |
|---------------|---------------|---------------|--------------|--------------|
| 16. Bengaluru | 17. Rohtak    | 18. Dhanbad   | 19. Ranchi   | 20. Amritsar |
| 21. Raipur    | 22. Prayagraj | 23. Jalandhar | 24. Ludhiana | 25. Shimla   |

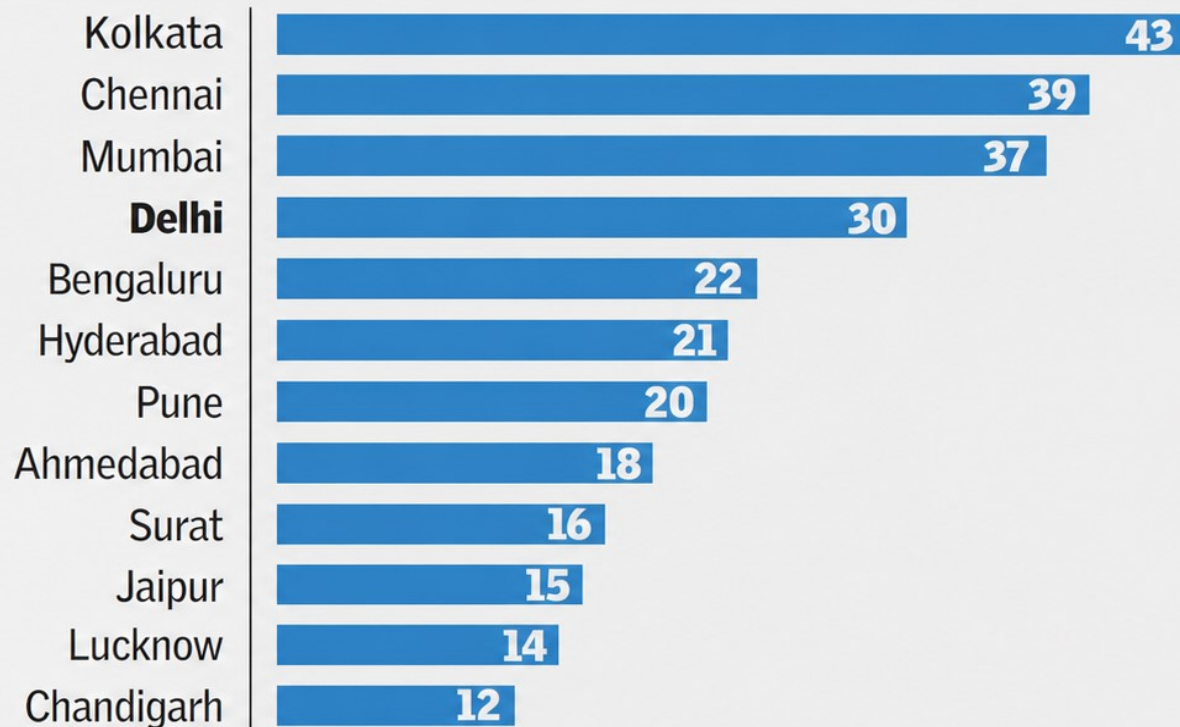
\*Figures in brackets represent 2019 ranks.  
(-) signifies no data available for 2019.

\*Gobindgarh (Punjab)

SOURCE: IQAIR WORLD AIR QUALITY REPORT 2019 & 2022

## RED ALERT

### Greenhouse gas emission from the domestic sector in various cities (in %)

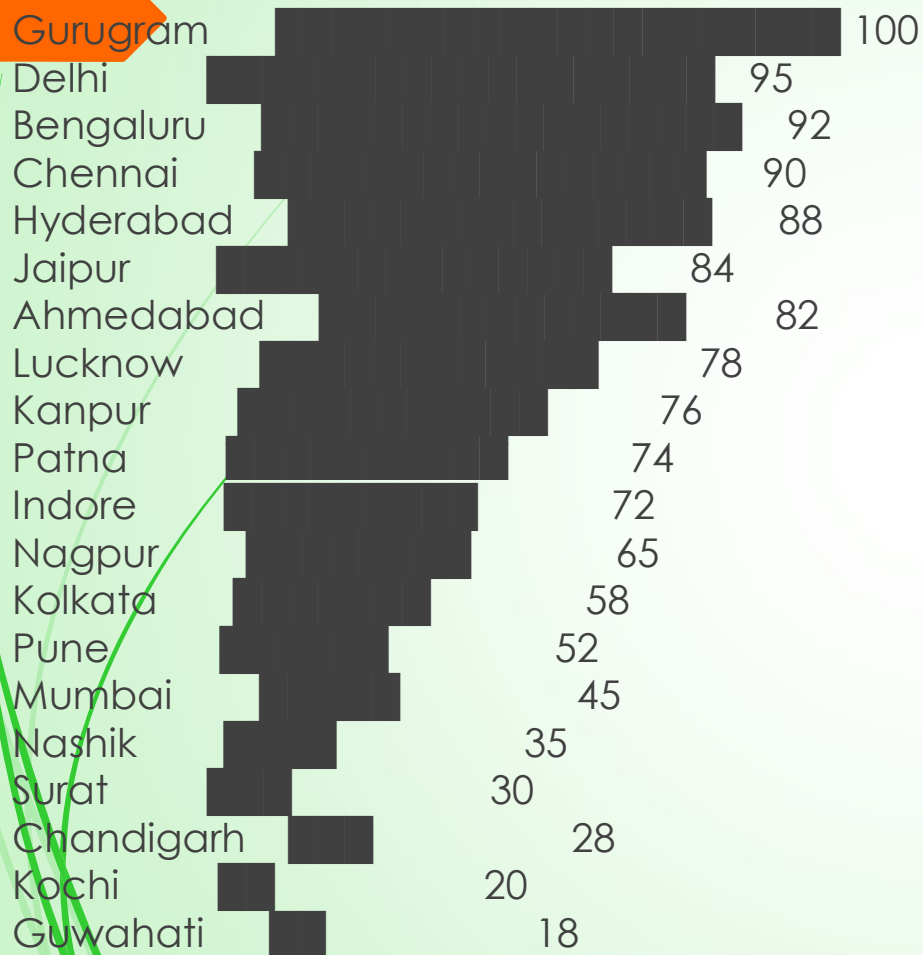


### *Urban homes emit more greenhouse gases than industry*

A recently published study by the Centre for Ecological Sciences of the Indian Institute of Science, Bengaluru found that the domestic sector was one of the highest contributing factors to greenhouse gases in cities.

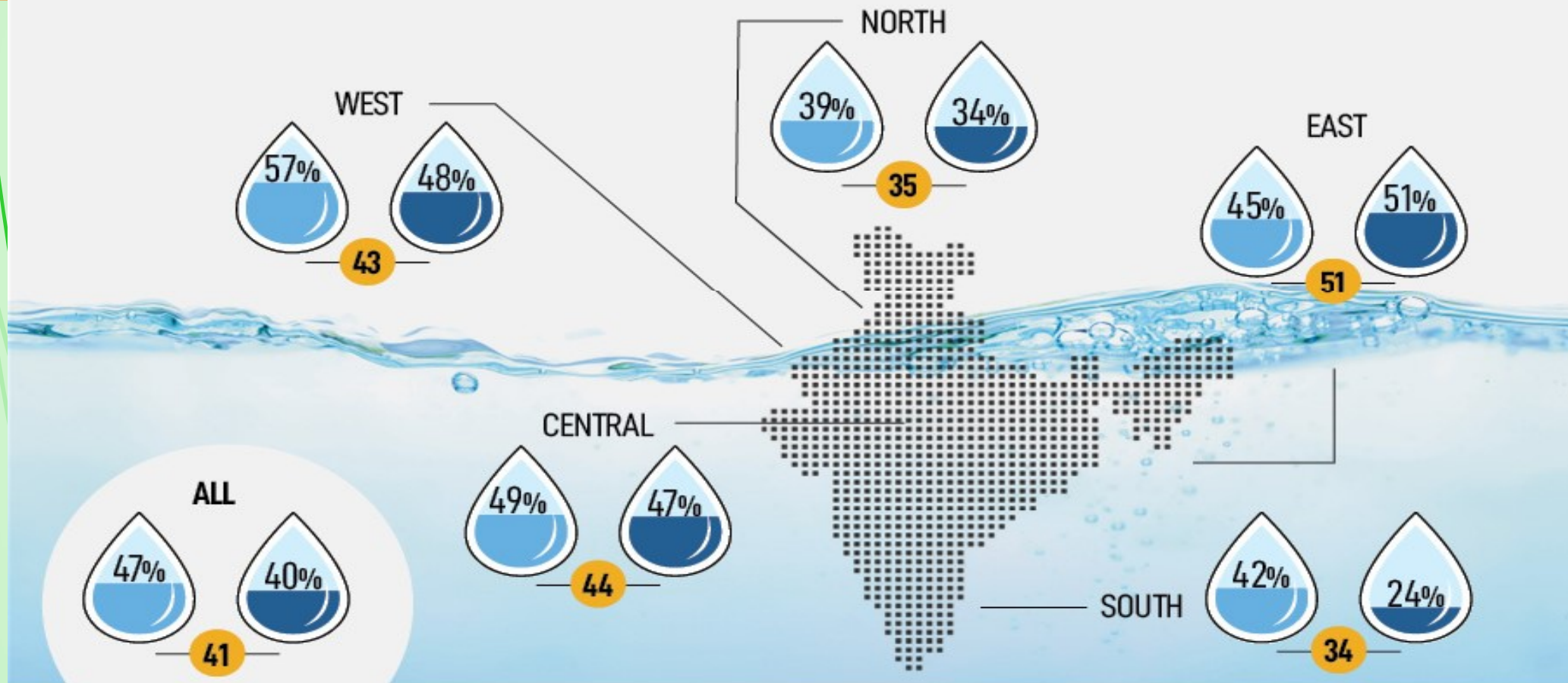
The study revealed that the major sources of energy consumption in the domestic sector were electricity for lighting and household appliances and fuel for cooking. The fuels considered during the study were liquefied petroleum gas, piped natural gas and kerosene.

## Groundwater Stress & Water Table Status in Indian Cities (2025–26)



# Depleting water levels

 Storage/capacity 2023    Storage/capacity 2024    10-year ratio

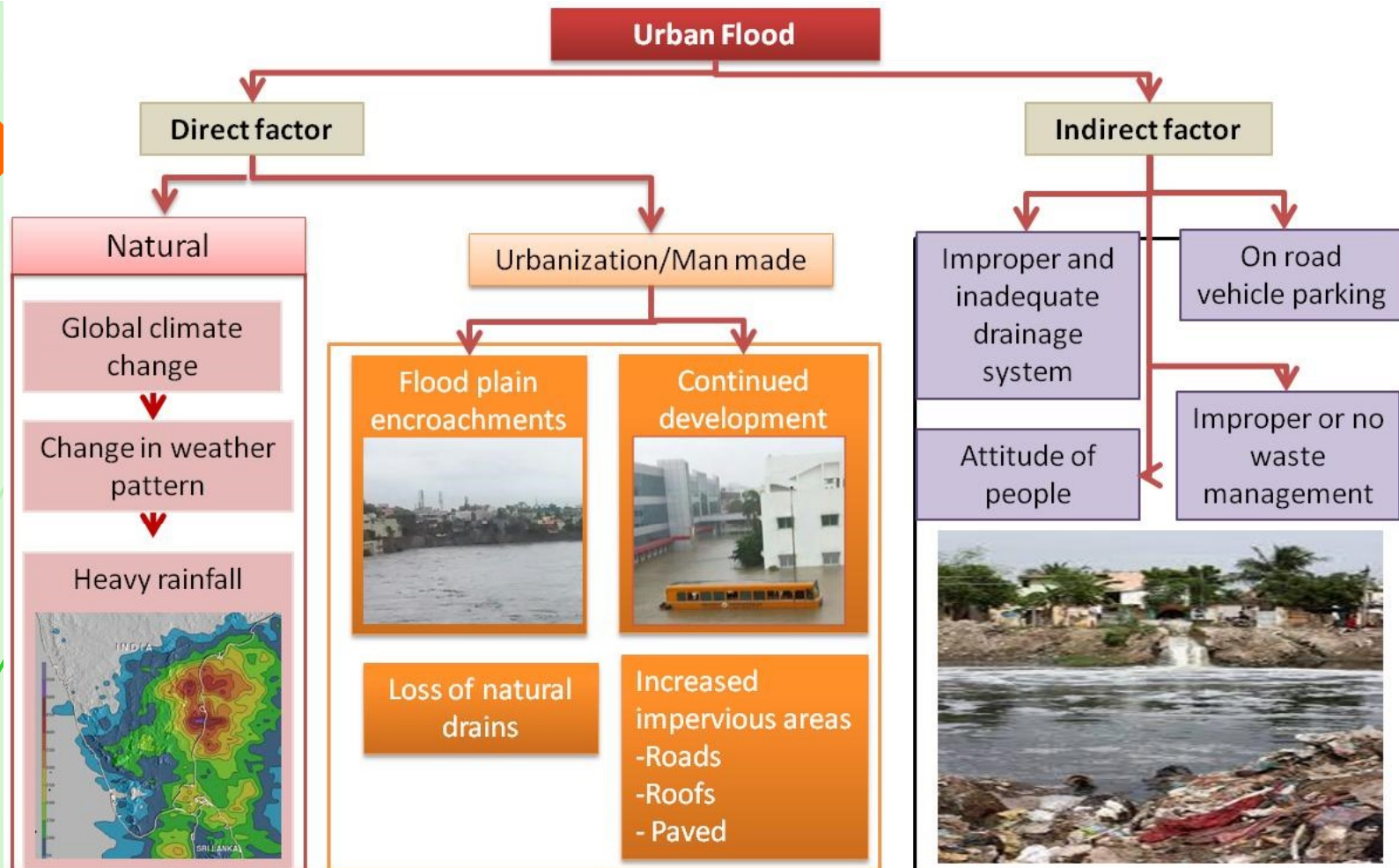


Data as on March 14, 2024

**SOURCE** Central Water Commission

- ▶ India's urban water supply traditionally depends on rivers, lakes, reservoirs, wetlands, and groundwater aquifers.
- ▶ However, rising temperatures, **erratic rainfall, excessive groundwater extraction, and increasing urban demand are causing many water sources to dry up** seasonally or permanently.
- ▶ Bengaluru's lakes and borewells have experienced recurring water shortages.
- ▶ **Chennai's reservoirs nearly reached "Day Zero" conditions in 2019** and continue to face periodic stress.
- ▶ Several stretches of urban rivers experience reduced flows during summer months.
- ▶ Rapid urbanization has led to encroachment, reclamation, and degradation of lakes, ponds, wetlands, and floodplains.
- ▶ Urban wetlands around **Delhi, Hyderabad, and Chennai have shrunk considerably over recent decades.**
- ▶ **Urban water bodies are increasingly contaminated by untreated sewage, industrial effluents, solid waste, and agricultural runoff**
- ▶ The Himalayas contain the largest ice reserves outside the polar regions and act as Asia's "Water Tower." **Rising temperatures are accelerating glacier retreat. Snow cover duration is decreasing** in many Himalayan regions. There is **formation of unstable glacial lakes.**
- ▶ Major Rivers Dependent on Himalayan Glaciers. Ganga, Yamuna, Indus, Brahmaputra river systems support hundreds of millions of people and many Indian cities.
- ▶ *India's major cities are facing increasing groundwater pressure because of rapid urbanisation, rising water demand, shrinking recharge zones, and dependence on borewells. Cities such as Delhi, Bengaluru, Chennai, Hyderabad, and Gurugram remain among the most water-stressed urban centres*

- 
- ▶ Delhi NCR remains one of India's most groundwater-stressed urban regions, with Gurugram among the most over-exploited cities.
  - ▶ Bengaluru's water crisis has intensified due to drying borewells and rising tanker dependence.
  - ▶ A recent study linked groundwater depletion to land subsidence risks in Delhi, Mumbai, Chennai, Kolkata, and Bengaluru.
  - ▶ Indore imposed restrictions on new tube wells in 2026 because of falling groundwater levels.
  - ▶ Some cities such as Nashik and parts of Gujarat reported post-monsoon groundwater recovery due to stronger recharge.
  - ▶ **Nearly half of urban water demand in India is met through groundwater**, making depletion a major urban sustainability challenge.
  - ▶ India's urban water crisis is no longer only a question of scarcity—it is increasingly driven by the combined effects of drying water sources, shrinking water bodies, worsening pollution, and climate-induced Himalayan glacier loss. Together, these pressures threaten the long-term sustainability, resilience, and livability of India's cities.





# **Urban Heritage Conservation and Indian Knowledge Systems**

- Indian Knowledge Systems emphasise harmony between built environments, nature, and society.

Over the centuries, heritages in Urban India reflect indigenous planning, architecture, craftsmanship, and community life developed.

- **Traditional Urban Planning Principles**

- Cities planned using *Vastu Shastra*, *Shilpa Shastra*, and regional ecological wisdom.
- Orientation of streets, water bodies, temples, markets, and residential areas ensured climatic comfort and social cohesion.

- **Indigenous Architectural Practices**

- Use of locally available materials such as stone, lime mortar, wood, and bricks enhanced durability and climate responsiveness.

- Techniques like lime plastering, jaali work, courtyards, and step roofs improved ventilation and thermal efficiency.
- Traditional urban water structures such as stepwells (*baolis*), tanks, ponds, and canals were integral to city planning.
- These systems ensured **water security, groundwater recharge, and resilience against droughts.**
- **Sacred groves, temple complexes, ghats, and processional routes formed living heritage landscapes.**
- Cultural practices helped protect biodiversity and maintain ecological balance within urban areas.
- **Traditional construction supports low-carbon urban development.**



- ▶ The water conservation system of **Kumbhalgarh Fort** is a **15th-century engineering masterpiece that allowed the citadel to remain self-sufficient during prolonged military sieges.**
- ▶ Perched **1,100 metres high in the arid Aravalli Range**, Rana Kumbha's engineers used natural topography, advanced structural architecture, and **rainwater harvesting techniques** to support a thriving population without relying on external perennial rivers.
- ▶ **Catchment zones** were carefully chosen across the fort's **36 square kilometres** to capture every drop of seasonal monsoon runoff. A **network of channels and stone aqueducts** rerouted rainwater down the mountain slopes and directly into fortified reservoirs.
- ▶ The fort combines **open lakes, stone-lined stepwells (*Baoris*)**, and massive **underground tanks (*Tankas*)** to minimize evaporation loss in the desert heat. Built by Rana Lakha, **Lake Pichola** is the most famous centralized **water reservoir** within the fort, designed to collect massive volumes of surface runoff to act as the primary city supply.
- ▶ Engineers integrated **Persian wheels (*Rahat*)** driven by cattle to efficiently lift water up the steep, multi-tiered slopes into the higher royal palaces, like the *Badal Mahal*.
- ▶ Centuries after its construction, the **UNESCO World Heritage site continues** to serve as an active blueprint for sustainable water management.
- ▶ The **Ganga Canal** is a major irrigation system stretching from the Sutlej River in Punjab to the arid zones of Rajasthan. Commissioned by Maharaja Ganga Singh of the erstwhile Bikaner princely state, the canal was built in **1927** to combat severe regional famines.



- Water conservation at the **Imambara in Lucknow** relies on sustainable historic structures and modern preservation efforts. The monument features the Shahi Baoli, a massive five-story stepwell that acts as a natural water reservoir and catchment system. Modern efforts focus on conserving this legacy while preventing water wastage.
- The historic **Chunar Fort (1029 AD)** utilizes ancient, ingenious water conservation systems, featuring a network of deep, rock-cut reservoirs, underground cisterns, and stepwells. These historic structures are carved into the local sandstone and were designed to harvest monsoon rainwater, ensuring the citadel remained self-sufficient during extended dry spells.
- The fort features three massive, historic wells- Markandeya Kund, Laghu Sagar, and Bavan Khamba. These were designed to tap into groundwater aquifers recharged by monsoon rains.
- The historic **Kalinjar Fort** was not built in a single era; its original foundation dates back to the Gupta period (**3rd to 5th century CE**). The fortress was vastly expanded into a massive military and cultural stronghold during the Chandela dynasty (**9th to 13th century**) and saw final structural additions during the Mughal period.
- The ancient Kalinjar Fort in Bundelkhand is an exceptional example of medieval water harvesting. Its hilltop location utilizes a complex network of rock-cut tanks, natural springs, and reservoirs that capture and store rainwater, allowing the fort to remain self-sufficient even during dry seasons or military sieges.
- The ASI has partnered with private entities (such as *Bisleri International under the Adopt a Heritage 2.0* program) to revitalize the historical water bodies—specifically the **Budha Budhi Pond**—blending sustainable water management with ecological preservation.



**Bara Imambara, The Baoli and (Step Well), Lucknow**



shutterstock.com · 2334460353



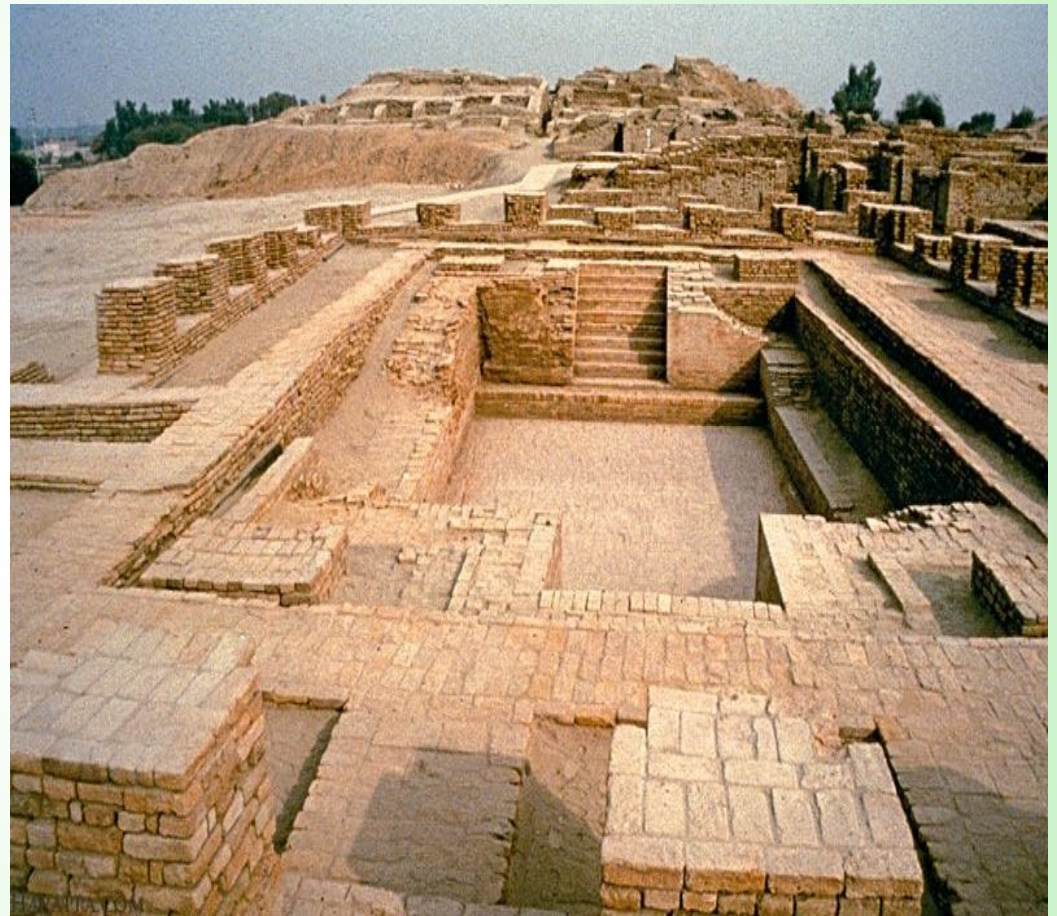
- Maintenance of heritage structures traditionally carried out through guilds, temple trusts, local communities, and customary laws.
- Knowledge transmission occurred through apprenticeships and oral traditions.
- **Indigenous sanitation systems**, drainage networks, and waste reuse practices promoted public health.
- Cities like Mohenjo-Daro and ancient Varanasi demonstrate early urban hygiene planning.
- **Festivals, crafts, performing arts, and local markets** are inseparable from built heritage.
- IKS supports conservation beyond monuments, focusing on living traditions and livelihoods.
- Traditional urban forms were adaptive to floods, heat, earthquakes, and resource scarcity.
- **IKS-based heritage conservation contributes to climate-resilient and low-carbon cities.**
- Integrating IKS into heritage conservation supports inclusive, sustainable, and culturally rooted urban development.
- Provides alternatives to energy-intensive modern construction and uniform urban designs.



# **Indian Knowledge Systems & Urban Sanitation**

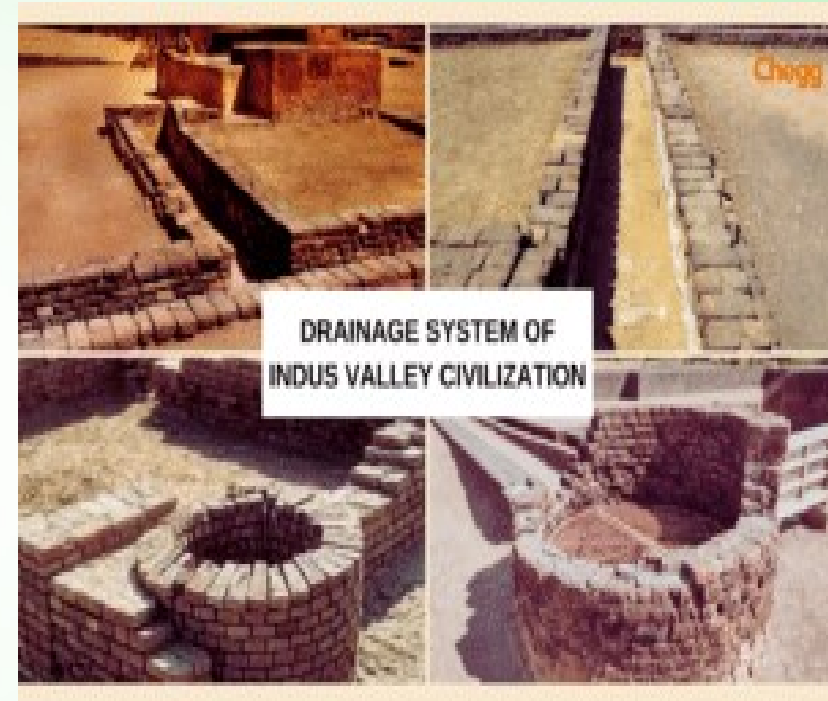
## Indian Knowledge Systems & Urban Sanitation

- ▶ Indian Knowledge Systems contain time-tested practices related to cleanliness, waste handling, and water management in settlements.
- ▶ These practices promote harmony between human health and the natural environment.



## Indian Knowledge Systems and Urban Sanitation

- ▶ Ancient Indian settlements recognised cleanliness as essential for health, social order, and environmental balance.
- ▶ Concepts of *Shaucha* (cleanliness) in Indian philosophy guided personal and community hygiene.
- ▶ Well-planned covered **drainage systems** prevented waterlogging and disease.
- ▶ **Example:** Indus Valley cities such as Mohenjo-daro and Harappa had brick-lined, covered drains running along streets, connected to household outlets.
- ▶ Many houses had **private bathrooms and soak pits**, indicating decentralised sanitation planning.
- ▶ Example: Homes in Indus Valley cities were equipped with bathing areas connected to drainage networks.



## Indian Knowledge Systems and Urban Sanitation

Wastewater was channelled away from living spaces and disposed of safely. **Example:** Use of soak pits and cesspits in Harappan settlements to naturally treat wastewater.

- Community bathing spaces promoted collective hygiene and social cohesion.
- Example: The Great Bath of Mohenjo-daro, designed with waterproofing and controlled drainage.
- Strict separation was maintained to prevent contamination.
- Example: Wells were placed away from drains in Harappan towns; well structures were protected.
- Bricks, lime, gypsum, and natural sealants ensured durability and hygiene.
- Example: Bitumen-lined structures used for waterproofing in the Great Bath.



- Provision of inspection chambers and removable drain covers facilitated cleaning and upkeep.

**Example:** Manholes in Indus Valley drainage systems for periodic desilting.

- Urban sanitation was a collective civic responsibility, supported by local governance structures.

**Example:** Municipal-like planning is evident from standardised sanitation infrastructure across Harappan cities.



Manholes in Indus valley drainage systems for periodic desilting



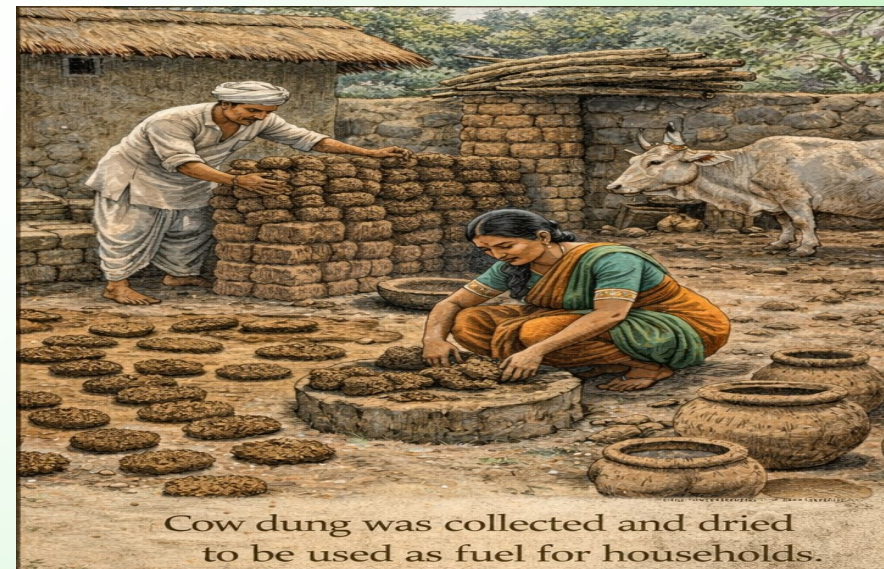
Standardized sanitation Infrastructure in Harappan cities

Ancient rural and urban Indian households utilised backyard composting, turning organic trash into manure for plants.

- ▶ Cow dung was collected and dried to be used as fuel. These insights can inform modern urban sanitation initiatives such as wastewater reuse, decentralised treatment, and community participation.
- ▶ Adopting traditional practices that emphasise reduced consumption and waste-to-value, such as composting and organic waste management, supports sustainability.



Backyard composting organic waste into manure in rural India.



Cow dung was collected and dried to be used as fuel for households.



# **IKS and Urban Water Conservation & Rainwater Harvesting**

## IKS and Urban Water Conservation & Rainwater Harvesting

**Ethical** norms and rituals promoted conservation and careful use of water resources. Ancient cities were designed to capture, store, and reuse rainwater. Rooftop rainwater collection and channelisation into tanks and wells in ancient settlements.

- Multi-storeyed underground structures stored rainwater and groundwater, ensuring a year-round supply. Large water bodies attached to temples collected monsoon runoff and served domestic, ritual, and climatic functions. Temple tanks in **Madurai, Kanchipuram, and Thanjavur**.
- **Rani ki Vav in Patan, Gujarat**, is a masterclass in ancient hydraulic engineering. Built as an "inverted temple" to the sanctity of water, this **11th-century UNESCO World Heritage Site** served as a subterranean reservoir designed to harvest rainwater, manage regional aquifers, and combat the arid climate.
- The stepwell extends up to seven levels underground, acting as a massive cooling and water storage system that mitigated evaporation in the desert heat. Designed to intersect with a fluctuating water table, the vertical shaft and surrounding water channels allowed the structure to collect monsoon runoff and naturally recharge local groundwater.
- **UNESCO recognized in 2014**, as the global importance of ancient water management systems. Modern water conservation in Patan is bolstered by regional state policies like the *Sujalam Sufalam Jal Sanchay Yojana*, which focuses on desilting and recharging aquifers across Gujarat.

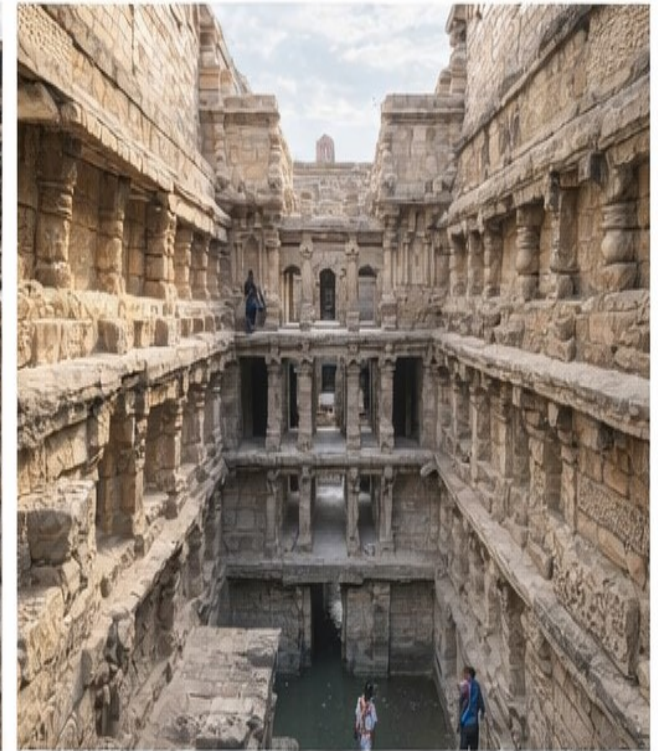
IKS treated water (Jala) as sacred, life-sustaining, and central to settlement planning.



Dholavira (Gujarat): 4,500 year-old, large-scale stone-cut reservoirs



Stepwells store rainwater for year-round supply (Patan, Gujarat)



Stepwells store rainwater for year-round supply (Patan, Gujarat)

## IKS and Urban Water Conservation & Rainwater Harvesting

- Artificial lakes and ponds were integrated into cities for water security and flood control. Examples: **Bhojtal (Upper Lake), Bhopal**; interconnected tanks in ancient South Indian cities. **King Bhoja** established one of the largest artificial lakes in India.
- **Dholavira** (Gujarat) is known for its 4,500-year-old, large-scale **stone-cut reservoirs designed to harvest rainwater on a massive scale**, with a 13-meter drop utilised for water flow.
- **Harappa/Mohenjo-daro** (Indus Valley) engineered precise, gravity-fed sewer systems, covered drains, and public baths, demonstrating early urban water management.
- **Sringaverapura** (Allahabad) utilised a complex, 1st-century-old water harvesting system that used the natural slope to store **Ganga River floodwaters**.



Rooftop rainwater collection  
channeled into tanks, wells

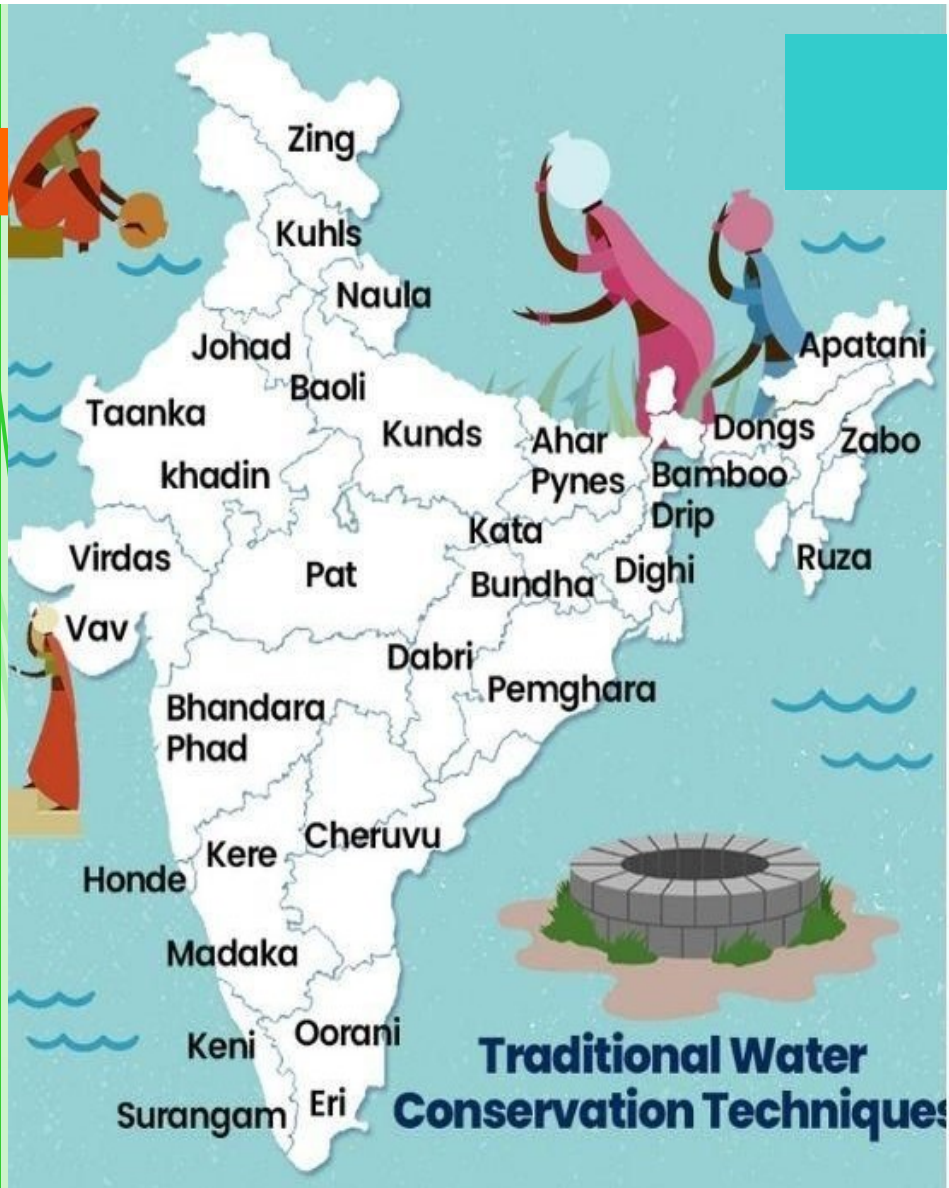


Temple tanks gathered monsoon runoff,  
held cultural importance



Sringeri: Water harvesting using  
natural slope to store Ganga floodwaters

Artificial lakes in cities for water security and flood control (Bhojtal, Bhopal), Bhojtal (Upper Lake)





# **Indian Knowledge Systems and Urban Forestry & Biodiversity Conservation**



# Indian Knowledge Systems in Urban Centres

Humans as an integral part of nature, not separate from it.

## CORE PRINCIPLES

- Concepts like Prakriti, Panchamahabhuta, and Rta emphasised ecological balance and coexistence.
- Forest patches were protected due to religious and cultural beliefs, ensuring conservation within and around settlements.
- Sacred groves, royal gardens and water bodies were integral to urban planning and community life.

## URBAN CONTEXT



Ancient Indian cities integrated nature into their fabric through green spaces, sacred groves, water bodies and gardens—ensuring ecological balance, climate resilience and cultural well-being.

## KEY CONCEPTS IN URBAN APPLICATION

- PRAKRITI** – Living in harmony with nature
- PANCHAMAHABHUTA** – Balance of Earth, Water, Fire, Air, Space in urban design
- RTA** – The cosmic order; aligning human activities with natural rhythms
- DHARMA** – Duty towards nature and community

## SACRED GROVES WITHIN CITIES



- Small sacred groves (Dev Van, Devarakadu, Sarna) protected within urban fabric.
- Preserve native flora, birds, insects and soil biodiversity.
- Act as green lungs and cultural-spiritual anchors.

## BENEFITS

- Urban biodiversity conservation
- Cooler microclimate
- Community well-being and cultural identity
- Ecological balance and resilience

## ROYAL GARDENS IN URBAN FABRIC



## CULTURAL PRACTICES AND PROTECTION



- Rituals, festivals and taboos protect trees, groves and water bodies.
- Community stewardship ensures conservation across generations.

## WATER BODIES AS LIFE CENTRES



- Lakes, ponds, stepwells and tanks (Udyana) maintained as community assets.
- Support groundwater recharge, biodiversity and social gatherings.
- Often integrated with temples, gardens and streets.

## ECOLOGICAL URBAN PLANNING



- Streets aligned with wind and sun for comfort.
- Tree-lined roads and green buffers.
- Built with local materials and climate-responsive architecture.

## INTEGRATING NATURE IN URBAN CENTRES

## INDIAN KNOWLEDGE SYSTEMS SHOW US THE WAY TO SUSTAINABLE CITIES



Nature is not outside the city; it is the foundation of life.



Conservation is a shared cultural and spiritual responsibility.



Balanced urban growth ensures harmony between people and nature.



Ancient wisdom for creating resilient, liveable and sustainable cities.

## EXAMPLES FROM URBAN / NEAR-URBAN CONTEXTS



**SACRED GROVES (DEV VAN, DEVARAKADU, SARNA)**  
Preserved native flora and fauna across regions of ancient India, even within or near urban settlements.



**TRIBAL WORSHIP OF SACRED GROVE**  
Living traditions that continue to protect urban and peri-urban groves.



**UDYANA AT HAMPI, KARNATAKA**  
Ancient water gardens within the urban setting, supporting ecology and community life.



**NANDAVAN AT UNESCO-LISTED PATTADAKAL, KARNATAKA**  
Royal gardens maintained as part of temple-urban landscape.



**OOTY BOTANICAL GARDEN, TAMIL NADU**  
A living example of traditional garden design in a hill urban centre.



*"When cities grow with nature, they nurture both people and the planet."*

## Indian Knowledge Systems and Urban Forestry & Biodiversity Conservation

**Urban** sacred groves are community-protected patches of ancient forests preserved through religious and cultural beliefs. They serve as vital green lungs, offering refuge to rare flora and fauna, mitigating urban heat islands, and acting as critical carbon sinks amidst rapid city expansion in India.

- ▶ The Deorali Chorten (22 hectares) and Enchey Monastery (16 hectares) of **Sikkim** are prime examples. There are several *Gundathopes* (community groves) and temple forests, like those within the campus of the Indian Institute of Science (IISc), Bangalore in **Karnataka**. Traditional *Kovil Kadu* (temple groves) exist in older, temple-centric neighborhoods in **Tamil Nadu** often harboring endangered tropical dry evergreen forest species. Cutting of trees was regulated, and penalties were imposed for ecological damage. *Arthashastra* prescribed fines for harming trees and wildlife, recognising their economic and ecological value.
- ▶ Trees were planted along roads, water bodies, temples, and public spaces to improve air quality and thermal comfort. Shaded avenues and temple groves in ancient towns.
- ▶ Forests around tanks, rivers, and wells were conserved to protect water sources and prevent soil erosion. Protection of forested catchments around temple tanks and reservoirs.

- Urban and peri-urban areas cultivated medicinal plants for healthcare and biodiversity. Example: ***Aushadhi Vanas* (herbal gardens)** are mentioned in **Ayurvedic traditions**.
- Certain animals and birds were protected due to cultural reverence. Example: **Protection of** peacocks, cows, snakes, and specific bird species associated with deities.
- **Local communities and guilds played a role in protecting forests and green spaces.** Example: Village councils and temple authorities managing sacred groves and gardens.
- Religious festivals, rituals, and taboos reinforced conservation behaviour. Example: Seasonal restrictions on tree felling and hunting.
- **Ancient practices offer lessons** for urban forestry, biodiversity corridors, and nature-based solutions.
- Emphasising holistic well-being (Yoga, Ayurveda) encourages sustainable consumption habits that reduce the environmental footprint.

# PANCHAVATI

## The Sacred Grove of Five Trees

### MYTHOLOGICAL SIGNIFICANCE



In Hindu mythology, **Panchavati** translates to “five trees” or a “grove of five banyans”.

According to the Ramayana, **Lord Rama, Sita, and Lakshmana** built their forest hermitage amidst this sacred grove during their exile.

### ORIGINAL LEGENDARY SITE

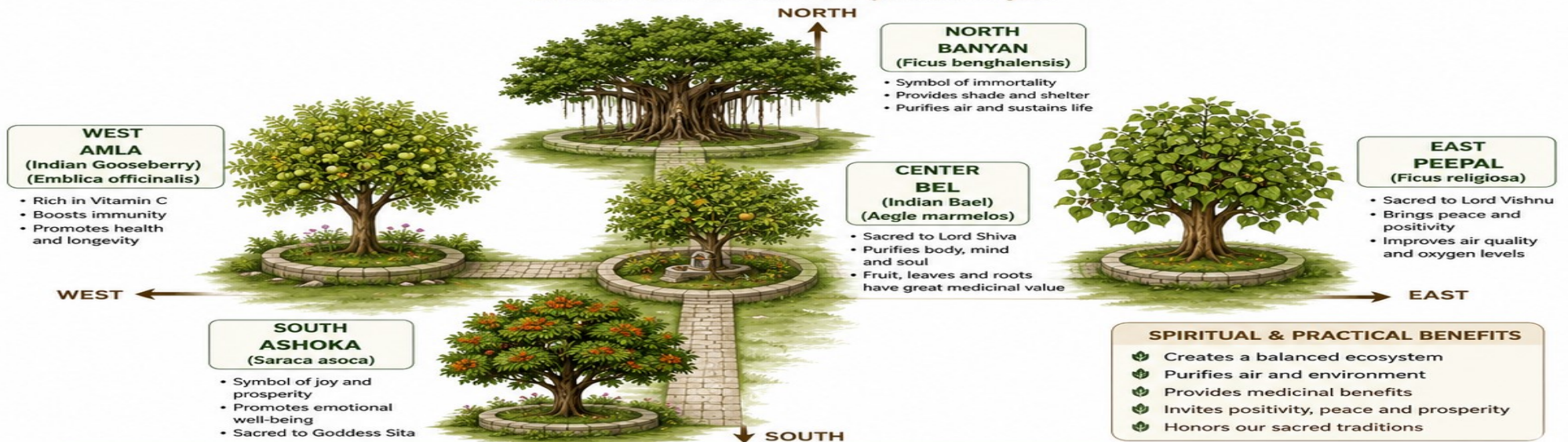
The original legendary site is in present-day **Nashik, Maharashtra**, on the banks of the **Godavari River**.

There, it is defined by a natural grove of five ancient **Banyan trees (Vat Vriksha)** adjacent to **Sita Gufa** (Sita's cave).



### PANCHAVATI VANA – THE FIVE SACRED TREES AND THEIR DIRECTIONS

*In Vastu Shastra and Temple Landscaping, five specific trees are planted in designated cardinal directions to harness their medicinal and spiritual energies.*



Panchavati is not just a grove of five trees; it is a living symbol of dharma, nature, and divine energy, connecting us to our roots and scriptures.

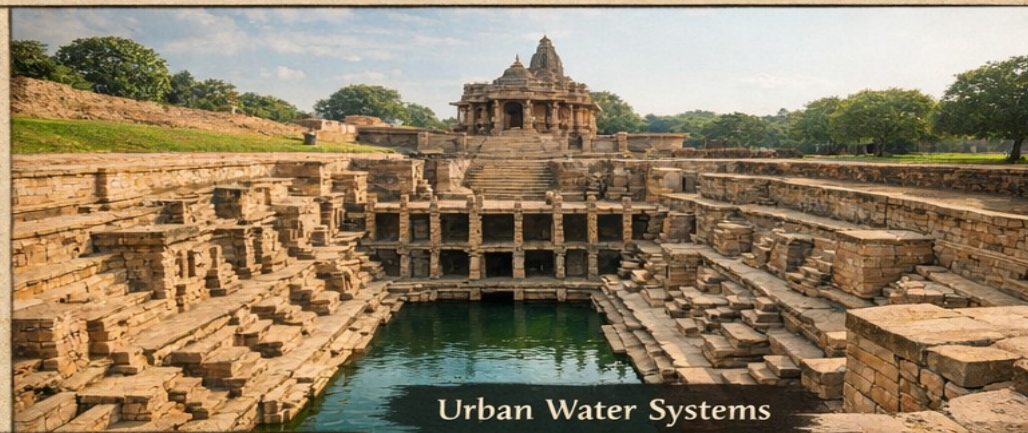


# **Indian Knowledge Systems and Urban Climate Change & Community Resilience**

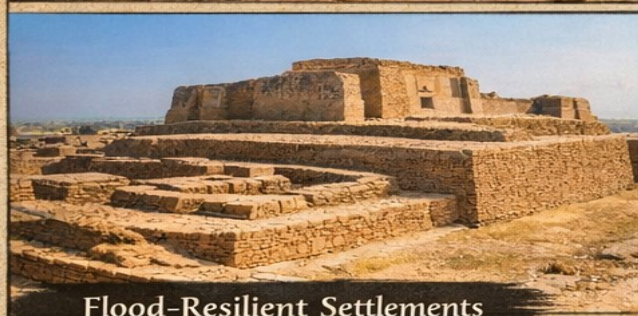
- ▶ Indian Knowledge Systems recognised the interdependence of climate, ecology, and human settlements.
- ▶ Concepts such as *Ritu Chakra* (seasonal cycle) and *Rta* guided adaptive living practices.
- ▶ Cities and houses were designed to reduce heat stress and improve ventilation. Examples: Courtyards, thick walls, high ceilings, shaded streets, and orientation as per *Vastu Shastra* to regulate temperature and airflow.
- ▶ Urban water bodies moderated microclimates and ensured drought resilience. Examples: **Stepwells (*Baolis/Vavs*)**, **temple tanks**, **ponds**, and reservoirs in cities like Ujjain, Patan, and Madurai.
- ▶ Urban settlements were located and designed to minimise flood risks. Examples: Elevated platforms and raised citadels in Indus Valley cities to protect against flooding.
- ▶ Forests, gardens, and tree-lined avenues reduced urban heat and enhanced resilience. Examples: *Nandavanas* (**royal gardens**) and sacred groves within and around cities.



Ritu Chakra & Adaptive Architecture



Urban Water Systems



Flood-Resilient Settlements



## Interconnected Climate, Ecology & Settlements



Green Spaces & Sacred Groves



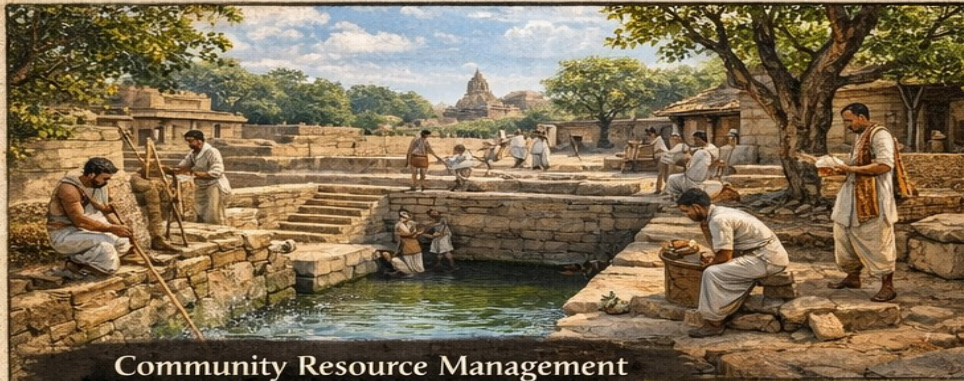
- ▶ Local communities collectively managed resources and responded to climatic stress. **Examples: Community maintenance of water tanks, wells, and drainage systems through guilds (*Shrenis*) and village assemblies.**
- ▶ Mixed cropping, **kitchen gardens**, and storage systems reduced vulnerability to climate shocks. Examples: Urban granaries and household gardens in ancient settlements.
- ▶ Observation of celestial bodies, animal behaviour, and seasonal indicators informed preparedness. Examples: **Agricultural calendars and rainfall predictions mentioned in ancient texts.**
- ▶ Rituals, festivals, and norms reinforced collective responsibility during climatic extremes. Examples: **Seasonal festivals linked to monsoon cycles and harvests.**
- ▶ Decision-making was localised, enabling quick responses to environmental stresses. **Examples: Local councils managing water distribution during drought periods.**
- ▶ IKS offers low-cost, nature-based, and community-driven solutions for climate adaptation.
- ▶ Integrating these practices can strengthen urban climate resilience, disaster risk reduction, and sustainable development in modern India.

## The Blueprint for Indian Urban Resilience

**Green-Blue Infrastructure (Nature-Based Solutions):** Incorporating urban forests, restoring wetlands, and rejuvenating natural drainage networks. This helps mitigate the Urban Heat Island (UHI) effect and reduces pluvial (flash) flooding.

- ✓ **Integrated Heat Action Plans (HAPs):** Pioneered by cities like Bhubaneswar and Ahmedabad, these frameworks provide real-time forecasting, establish early warning systems, and design cool roof programs to reduce extreme heat impacts.
- ✓ **Resilient Infrastructure and Housing:** Constructing climate-responsive, energy-efficient buildings that utilize low-carbon materials.
- ✓ **Early Warning Systems (EWS):** Upgrading meteorological monitoring to allow for better preparedness against heavy monsoons and coastal cyclones.
- ✓ **Sustainable Mobility:** Promoting public transit, pedestrian-friendly infrastructure, and the electrification of urban transport.
- ✓ **Decentralized Governance:** Transition from top-down policies to city-specific Climate Action Plans (CAPs). Local bodies must be empowered to outline their adaptation priorities based on their unique geographical and hazard risks.
- ✓ **Vulnerability Mapping:** Adopt tools like the Climate Hazard and Vulnerability Assessment (CHVA) to identify hotspots and protect the urban poor who are disproportionately affected by flooding and heatwaves.

- **Urban Greening:** Scale up urban forests (e.g., Miyawaki method) to counter the Urban Heat Island (UHI) effect and improve air quality.
- **Water Resilience:** Implement water-sensitive urban design, restore urban wetlands, and establish secondary riverfront rejuvenation to mitigate flood risks and prevent waterlogging.
- **Permeable Surfaces:** Replace concrete with permeable materials to encourage groundwater recharge and reduce runoff.
- **Integrated Mobility:** Expand and transition public transportation fleets to electric vehicles, promote non-motorized transport (cycling and walking infrastructure), and establish green mobility zones.
- **Waste & Water Management:** Upgrade to decentralized sewage treatment plants (STPs) for wastewater reuse, and transition to zero-waste, scientific solid waste management (e.g., Bio-CNG plants).
- **Energy-Efficient Buildings:** Retrofit public and residential buildings to meet green building standards, reducing overall energy consumption and carbon footprints.
- **Unlocking Finance:** Tap into green municipal bonds (e.g., Pune's municipal bonds model), Verified Carbon Standard programs, and blended finance.
- **Training Urban Bodies:** Build the capacity of Urban Local Body (ULB) officials in climate vulnerability assessment, data utilization, and climate finance mobilization.



### Community Resource Management

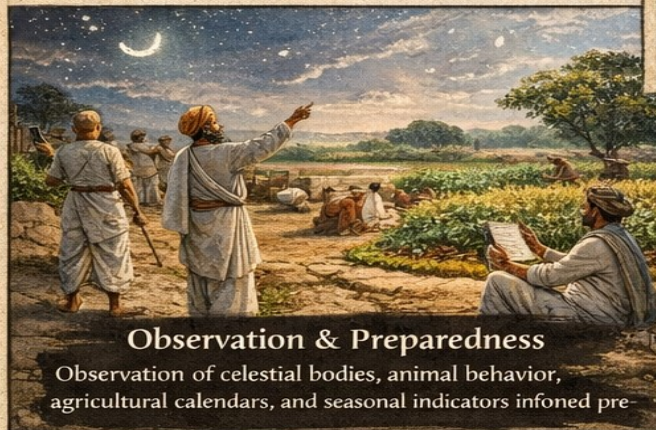
Collective maintenance of water tanks, wells, and drainage systems through guilds (shrenis) and village ex-



### Mixed Cropping & Kitchen Gardens

Urban granaries and household gardens reduce vulnerability to climate shocks

## Local Communities & Climate Resilience



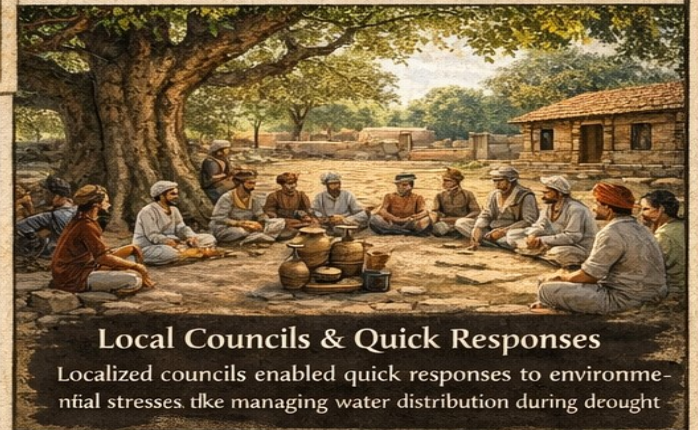
### Observation & Preparedness

Observation of celestial bodies, animal behavior, agricultural calendars, and seasonal indicators informed pre-



### Rituals & Seasonal Festivals

Rituals, seasonal festivals linked to monsoon cycles and harvests reinforced collective responsibility.



### Local Councils & Quick Responses

Localized councils enabled quick responses to environmental stresses like managing water distribution during drought

**IKS offers low-cost, nature-based, and community-driven solutions for climate adaptation. Integrating these practices can strengthen urban climate resilience, disaster risk reduction, and sustainable development in modern India.**



# **Indian Knowledge Systems and Circular Economy**



IKS is rooted in the principle of “*nothing is waste*” (*Aparigraha* and *Prakriti-Samanvaya*).

- **Circular economy** aligns with traditional Indian practices of **reuse, repair, regeneration, and sharing**.
- **Use of biodegradable materials** such as clay, bamboo, jute, wood, and leaves.
- Long life-cycle of products through repair, repurposing, and local craftsmanship.
- **Organic waste reused as compost, manure, or fuel** (cow dung cakes, biogas).
- **Agricultural residues** converted into fodder, mulch, or building materials.
- **Rainwater harvesting**, stepwells (*baolis*), tanks (*talabs*), and ponds ensured reuse and recharge.

# Sustainable Urban Systems in Urban Centres

Nature-based practices supporting urban livelihoods  
and circular material flows in cities

## URBAN WISDOM APPLIED IN CITIES



### WATER SENSITIVE URBAN DESIGN

- Rainwater harvesting, recharge wells, bioswales, permeable pavements to restore urban hydrology.



### URBAN AGRICULTURE & GREEN COVER

- Rooftop gardens, vertical farming, community gardens for food, health and green spaces.



### ORGANIC WASTE MANAGEMENT

- Decentralized composting, biogas from wet waste and leaf litter management.



### COMMUNITY ENGAGEMENT

- Shared decision-making, festivals, clean-up drives and public space management.



### CULTURAL HERITAGE & SKILLS

- Revive traditional crafts, local art and knowledge in modern urban livelihoods.

## ADAPTING TRADITIONAL WISDOM TO MODERN CITIES

Urban centres can integrate time-tested, nature-based systems to build resilient, inclusive, low-carbon and self-reliant cities.



### GREYWATER REUSE FOR URBAN USE

- Treat and reuse greywater for flushing, gardening and cooling.
- Reduces freshwater demand and sewage load.



### MIXED CROPPING & URBAN FARMING

- Community gardens, terrace farming and vertical farms.
- Enhances food security, reduces heat and improves air quality.



### BIO-INPUTS & SEED SAVING

- Use compost, bio-fertilizers and botanical extracts.
- Community seed banks preserve local varieties and biodiversity.



### WASTE TO RESOURCE – CIRCULAR FLOW

- Segregate organic waste and compost locally.
- Convert waste to compost, biogas and useful by-products.



### NEED-BASED CONSUMPTION & LOCAL ECONOMY

- Support local producers, artisans and services.
- Promote repair, reuse and mindful consumption.



### TRADITIONAL OCCUPATIONS & URBAN LIVELIHOODS

- Support traditional skills, crafts, building with natural materials.
- Create dignified, sustainable livelihoods in the urban economy.



### COMMUNITY SHARING & URBAN COMMONS

- Protect and manage lakes, ponds, parks, streets and commons as shared assets.
- Encourage community participation and stewardship.

## BENEFITS FOR URBAN CENTRES



### Environmental Resilience

Improves air quality, reduces urban heat island effect and restores biodiversity.



### Resource Efficiency

Conserves water, reduces waste and promotes circular material flows.



### Social Well-being

Strengthens community bonds, cultural identity and equitable access to resources.



### Economic Sustainability

Supports local jobs, traditional skills and low-carbon, nature-based solutions.



### Climate & Disaster Preparedness

Enhances urban resilience to floods, droughts, heat waves and extreme events.

## PRINCIPLES FOR URBAN APPLICATION



**Work with Nature**  
Design with local ecology and natural cycles.



**Local & Context Specific**  
Use local materials, knowledge and community strengths.



**Reduce, Reuse, Regenerate**  
Minimize waste and regenerate resources continuously.



**Community Ownership**  
Enable active participation and shared responsibility.



**Balance Development  
& Ecology**  
Plan cities that are productive, livable and regenerative.



Cities that live with nature are future-ready, inclusive and resilient.

Sustainable today. Resilient tomorrow.



- 
- 
- Greywater reuse for irrigation in traditional settlements.
  - **Mixed farming** integrating crops, livestock, and trees.
  - Use of crop residues, animal waste, and bio-inputs (**panchagavya, jeevamrit**).
  - **Seed saving** and indigenous seed systems promoting regeneration.
  - Community sharing systems (**common grazing lands, water bodies**).
  - Emphasis on need-based consumption rather than excess accumulation.
  - Village-level production systems reduced transportation and resource loss.
  - Traditional occupations (**potters, weavers, metal workers**) supported **circular material flows**.

Recyclable and reusable building materials (**mud bricks, lime plaster, stone**).

- Climate-responsive architecture reducing energy demand.
- Sacred groves (***Dev Van***), community forests ensured natural regeneration.
- Knowledge transmitted through generations ensuring continuity of circular practices.
- **Community participation** and collective responsibility for resources.
- IKS offers scalable models for waste management, sustainable cities, and climate resilience.
- Integration of IKS can strengthen India's transition to a circular and green economy.

## Mainstreaming Climate Change Adaptation in Urban Planning

| Sector                                                                                            | Example Interventions       | Impact             |
|---------------------------------------------------------------------------------------------------|-----------------------------|--------------------|
|  Land Use         | Climate-sensitive zoning    | Reduced exposure   |
|  Water            | Rainwater harvesting        | Water security     |
|  Urban Design     | Cool roofs, green corridors | Lower urban heat   |
|  Infrastructure | Climate-proof roads         | Reduced disruption |
|  Disaster Mgmt  | Early warning systems       | Faster response    |

# Building Urban Resilience in India

## Urban Resilience Framework

### Physical Resilience

- Flood-resilient infrastructure
- Heat-resilient buildings
- Reliable energy and water systems

### Environmental Resilience

- Urban forests
- Wetland restoration
- Blue-green infrastructure

### Social Resilience

- Community preparedness
- Public health systems
- Protection of vulnerable populations

### Institutional Resilience

- Data-driven governance
- Climate-informed decision-making
- Multi-stakeholder collaboration

# Way Forward – Climate-Resilient Urban India

## Strategic Actions for the Future

### ■ Governance

- • Climate budgeting at city level
- • Climate risk assessments for all major projects
- • Integration of climate indicators into urban plans

### ■ Infrastructure

- • Green and blue infrastructure investments
- • Climate-resilient transport systems
- • Nature-based stormwater management

### ■ Technology

- • GIS-based climate risk mapping
- • Smart sensors and early warning systems
- • Digital twins for urban planning

### ■ Community Participation

- • Citizen-led climate action
- • Ward-level resilience planning
- • Awareness and capacity building



**Thanking You**