Urban Wastewater Scenario in India

For Prelims: Powers of State legislature and Parliament in matters related to water, Article 246, SDGs and waste water management, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

For Mains: Urbanisation and the problem of waste water management, Challenges and Significance of waste water management and related government initiatives, SDGs and waste water management, Role of technology in wastewater management

What is the Context?

Population growth and **urbanisation**, along with **socio-economic development, have intensified the water supply and demand imbalance,** leading to water shortage conditions, especially in **developing countries** like India.

As cities continue to grow and consume more water, there is **added pressure on agricultural productivity factors** such as water, land, energy, and changing diets, bringing **major challenges to urban and rural** food security.

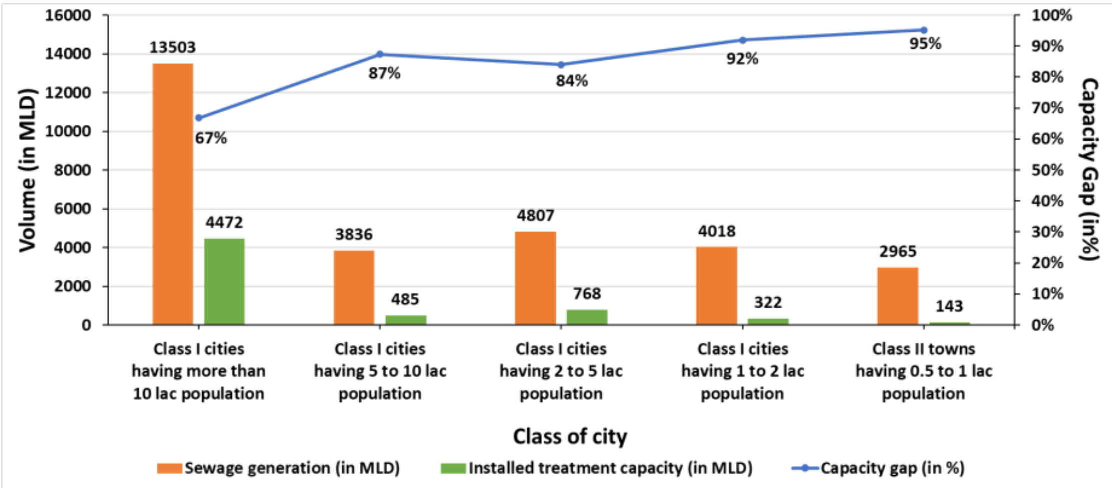
Additionally, **climate change impacts** are affecting the availability and distribution of water resources due to **extreme floods and droughts.** There is an **urgent need to wisely use the water resources available** to us. In this context, **the concept of waste to wealth fits well for** water management **in India.**

Note

- In India, **'water' is a State subject,** according to **Schedule Seven of the Indian Constitution.**
  - The states under **Article 246** are given the **constitutional power to plan, carry out, oversee, and maintain projects related to water** supply and sanitation, as well as to recover costs.
  - The **Public Health Engineering Department (PHED)** is the primary organization in charge of planning and implementing programs for water supply and sanitation at the State level.
- However, **when it comes to interstate waters, Parliament has the authority** to enact laws.
  - The State has the authority to establish policies and legal guidelines on the usage of water inside the State.
- The **74^{th} Amendment to the Indian Constitution in 1993** decentralised the control of water supply and sanitation from the state government to **Urban Municipal Councils (UMC).**
- Although the **Prevention and Control of Pollution Act of 1974** contains laws that report wastewater as a source of pollution, there is **no single Act** in India **that addresses wastewater management** specifically in terms of devoted legislation.

What are the Findings of the Report?

- **Global Findings:**
  - **Wastewater Generation:**
    - It is estimated that **380 billion m^3 of wastewater is generated annually** across the world.
    - Among the global regions, **Asia generates the largest volumes of** wastewater (42% of the global total) and among the **South Asian countries, India has the highest wastewater generation.**
    - **High-income countries (HICs)** generate **42% of global wastewater,** which is almost twice that of **low-income countries (LICs)** and lower-middle-income countries.
  - **Wastewater Treatment:**
    - **HICs collect 82% and treat 74%** of the majority of their wastewater generated, while **LICs collect 9% and treat 4%** of their total wastewater generated.
    - The wastewater treatment is less than 50% for the upper and lower- middle income countries (MICs).
- **India's Wastewater Scenario:**
  - **Urban Wastewater Generation and Treatment:**
    - About 35% of India's total population is concentrated in urban centres, where the **estimated wastewater generation is 72,368 MLD** (million litres per day) for the year 2020-21 (as per **CPCB**).
      - This estimate is **almost double of its rural counterpart** (39,604 MLD).
    - The **current installed sewage treatment capacity is 31,841 MLD,** but the **operational capacity is 26,869 MLD,** much lower than what is generated.
    - Only 28% of the actual quantity of wastewater generated, is treated; **72% of wastewater which is left untreated** is disposed of in rivers/lakes/groundwater. //



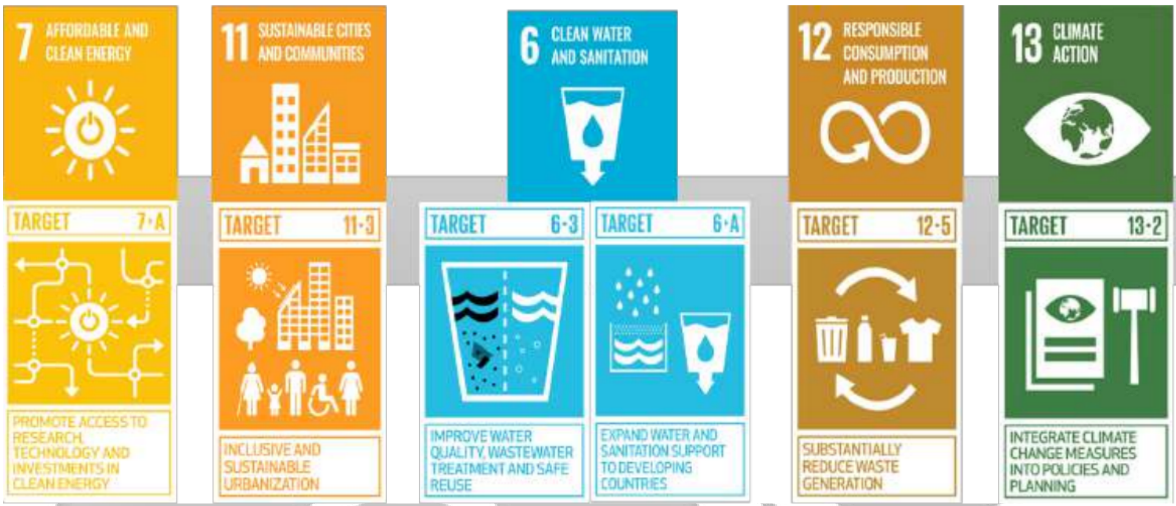
Wastewater generation and treatment capacity gap at city level in India (CPCB, 2022)

  - **Urbanisation and Wastewater Linkage:**
    - More water availability has increased **(a)** the **living standards** in urban cities and **(b)** the **pace of urbanisation**; thus giving rise to the need for immediate attention to managing wastewater.
    - **Rapid and unsustainable urbanisation adds pressure on freshwater resources** to meet the food and water demands in water-scarce areas and areas where expansions occur at an unprecedented pace.
    - Many of these **developing cities are located in important river basin catchments,** consuming large quantities of freshwater and **discharging wastewater back into the catchments,** thus contaminating irrigation water.
      - This has raised serious concerns and challenges for urban wastewater management.
  - **Current Technologies and Practices in UWM:**

- There are two ways to perform **Urban Wastewater Management (UWM)** in India: **on-site systems and off-site systems.**
  - An on-site system **collects wastewater near the toilet in a pit, tank or sludge;** about **60% of the population** is dependent on the on-site sewage management system
  - An off-site system takes wastewater from the area around the toilet for **disposal somewhere else.**
- Different **uses of this treated wastewater** include (a) **irrigation**, (b) **toilet flushing,** (c) **industrial use,** (d) **fish farming**, and (e) **accidental and indirect uses.**

Note

- **Sustainable Development Goals (SDG) target 6.3 is focused on wastewater** and "aims to halve the proportion of untreated wastewater discharged into the water bodies and substantially increase recycling and safe reuse globally".
- The SDG 6.3 is **interlinked with many other SDGs** and targets, which can help in achieving their goals and targets and vice versa. These include - **SDG 6.a, SDG 7.a, SDG 11.3, SDG 12.5 and SDG 13.2.**



What is the Significance of Managing Wastewater?

- **Water Security**: An increasing set of sustainable but unconventional water resources, such as wastewater, holds **immense potential to close the water demand-supply gap and achieve a water-secure future.**
- **Undervalued Resource in India:** In many countries, **wastewater is used as an alternate water source**, especially for **supplying irrigation water** in farmlands. However, **in India, wastewater is considered as an "untapped" and "undervalued" resource.**
- **Alternate Freshwater:** Apart from reuse, the **treated wastewater can also act as a freshwater source** and be useful in **maintaining the river flow during drought situations.**
- **Meeting Industrial Demands:** Wastewater is a highly potential source of water for various purposes and is highly underutilised. For instance, **80% of the untreated wastewater** from 110 cities, if utilised, **can cater to 75% of the industrial water demand** that can be met by 2025

Note

- Diverse **Urban Local Bodies (ULBs)** in India have recently **prioritised the reuse of treated sewage** and started using it for **industrial washing, horticultural irrigation, non-contact impoundments,** and other purposes. For example:

- The **Punjab** govt. announced the **State Treated Wastewater Policy 2017** to promote the recycling and reuse of treated sewage for non-potable uses.
- The **Indian Agricultural Research Institute**, Karnal, examined sewage farming which led to the recommendation of an irrigation method for s**ewage-fed tree plantings.**
- In large condominiums and high-rise apartment buildings in major cities (Delhi, Mumbai, Bengaluru, and Chennai) **treated** grey water **is being used on a trial scale for toilet flushing.**

What are the Existing, Different Approaches for UWM?

- **Decentralized Approach for UWM:**
  - **About:** In areas without sanitation services, the use of **decentralised wastewater treatment systems (DEWATS)** has gained popularity.
    - DEWATS can be categorised as:
      - **Natural Treatment Systems**
        - The most basic method is algal-bacterial interactions in a pond. It is a part of Nature Based Solutions (NBS).
      - **Aerobic Systems**
        - Microorganisms use oxygen to break down organic materials into water and carbon dioxide.
      - **Anaerobic Systems**
        - They are economical, simple, low-energy biological treatment systems that may be utilised to generate energy.
- **Nature Based Solutions (NBS) for UWM:**
  - **About:**
    - **NBS is defined by** IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits".
  - **Different Methods:**
    - The **most basic method is algal-bacterial interactions** in a pond which receives wastewater. **Other common systems use plants and soil as natural filters** for biological processes
    - **Constructed Wetlands (CW),** also known as **reed beds, artificial wetlands, planted soil filters or vegetated submerged beds,** were the first nature-based solution adapted for wastewater treatment.
    - **Floating Treatment Wetlands (FTW)** are an **in-situ treatment option** (among NBS) for the revival of water bodies that frequently receive wastewater.
      - In FTW, the plants are grown on a free-floating mat, and their roots are extended down to the contaminated water that acts as biological filters
    - **Vermifiltration is a novel method** that uses the **combined activity of earthworms and microbes to treat wastewater.**
      - Through ingestion, biodegradation, and absorption through the body walls, earthworms and microorganisms both remove
        - **Biochemical Oxygen Demand (BOD)**
        - **Chemical Oxygen Demand (COD)**
        - **Total Suspended Solids (TSS)**
        - **Total Dissolved Solids (TDS)** from wastewater.
- **Innovative Approaches UWM:**
  - **IoT Based Applications:**
    - Currently, the **Internet of Things (IoT),** coupled with advanced technologies such as **cloud computing, artificial intelligence and machine learning algorithms, and service-oriented architecture,** has led to the development of **Smart Water Quality Monitoring Systems (SWQMSs).**
    - Using data collected through crowdsourcing, instruments, sensors, satellites, photographs, videos, news, and other sources under **SWQMS offers near-real-time awareness and decision-making**

- **GIS-based Approach:**
    - GIS-based (Geographic Information System **based**) approaches are widely used for **various purposes in wastewater management,** including **site selection for the construction of STPs** (Sewage Treatment Plants), **identification of hotspots of pollution,** and **site selection for treated wastewater irrigation.**
    - Various datasets needed for such analysis include topography, land use land cover data, information on geology, distance from major water bodies and environmentally protected areas, climatic data, and required effluent wastewater characteristics.
    - The advantages of **Remote Sensing (RS)** and GIS techniques can be further expanded to analyse the **suitability of treated wastewater for different purposes.**

What are the Challenges Associated to Treating Wastewater?

- **Quality Challenges:**
    - It has been observed that the **quality of wastewater being reused is poor.** The demand for clean water is rising faster than wastewater treatment solutions and quicker than technological advancements in institutions providing safe wastewater access.
    - **One of the biggest hurdles** to clear **while encouraging reuse is to guarantee human health and ecological safety** and ensure that wastewater is of appropriate quality before being used or released into the environment.
- **Institutional Challenges:**
    - In many cases, **ULBs lack the capacity to plan and implement UWM projects,** the plausible cause for which is **deficiencies in planning and financial management of such projects.**
    - The **spatio-temporal data** on the volumes of wastewater generated, collected, treated and reused for different sectors are either **infrequently monitored/published** or are **scattered due to institutional fragmentation.**
    - There have also been instances of **ULBs missing a sewage network** which led to the **untreated wastewater getting discharged into open drains** polluting water bodies in its proximity.
- **Regulatory Challenges:**
    - The major challenges associated with the standard setting of water pollution include:
        - **Diversity of pollutants**
        - **Variety of targeted uses** in which treated/untreated water is being put
        - Amount of **dilution that may occur when the pollution load is released** to a neighbouring water body
    - **Ambient water quality standards are absent** for a surface water body which is on the receiving end of treated or untreated domestic sewage. Such lapses basically **affect the end users, such as downstream farmers.**
- **Economic Challenges:**
    - The **capacity gap** (between the **generated sewage and present treatment capacity)** is very large in all classes of towns and cities in India which **increases even more with the order of decreasing population.**
    - Smaller cities/towns face **difficulty in finding necessary resources** for setting up STPs, due to higher capital expenditure and operation + maintenance costs. **High capital discourages the entry of private players.**
- **Technological Challenges:**
- India has an **over-dependence on older technologies** for handling wastewater. The **limited funds and higher expenditures** push the government to choose **technologies with lower capital costs** despite their poor performance parameters.
- The **knowledge gap,** along with the **ignorance regarding newer technologies,** further leads to the **perpetuation of outdated and inefficient technologies.**
    - The possibilities of alternate nature-based and decentralized technologies are yet to be explored.
- **Social Challenges:**
    - The **citizens are usually not well informed** about either water scarcity or the positive outcomes of water reuse/recycling. In many cases, despite the awareness created, people

are **reluctant to use reclaimed water.**
        - **Recycled water is very less likely to be accepted for drinking purposes** compared to its non-potable purposes like irrigation of parks.
    - The **aesthetic aspects of reclaimed water, s**uch as colour, odour, and taste are other crucial factors that **shape the public acceptance of treated water.**
        - In many parts of the world, schemes related to the reuse of treated water are rolled back due to **public opposition.**

What has the Report Recommended for Better UWM?

- **Shift in Management Approach:**
    - A major shift in the water resource management approach is needed in which **wastewater is considered a "resource"** to meet the water, food and energy requirements **rather than being called "waste".**
    - There is a need to **recognise sewage as a resource that can be treated as needed** and used for non-potable applications and industrial utilities due to the rising load of untreated sewage.
    - **Better-defined water quality standards** need to be met with **rigorous monitoring** in order to detect pollution levels, trace them back to the source and estimate the impacts of the same.
- **Reforming On-Site Treatment:** Along with **technological advancement**, on-site sewage treatment can be improved by:
    - **Periodic Audit of Toilet Facilities:** ULBs must determine the kind of on-site sanitation systems needed in order to guarantee appropriate containment and decrease pollution.
    - **Standardisation of Containment Construction:** As part of the building plan approval process, **ULBs must strictly enforce BIS containment system regulations** in new/reconstructed houses.
    - **Roadside Drains:** In the case where no sewerage system exists, and there is no space for soaking arrangements, as a temporary solution, excess effluent from a septic tank may be collected in well-lined roadside drains.
- **Capacity Building for UWM:**
    - To optimise social equity, efficiency, and environmental sustainability, capacity building is an essential aspect of UWM.
    - **All the stakeholders must be included** in the UWM process, such as executives, technical managers, community committees, and local resident caretakers. **Local health agencies should typically be accountable** for **independent surveillance** of city wastewater activities.
    - **Increasing the number of decision-making actors** or agencies, integrating urban planning, and comprehending trade-offs between many competing aims are all necessary for the implementation of UWM. This becomes far easier if there is an **apex body to coordinate and manage these elements.**
- **Promotion & Adoption of Sustainable UWM Solutions**:
    - **Through Public-Private Partnerships:** PPPs have been common in the urban utility sector, except in the area of water, which is still governed by the state in most cases.
        - PPP should be introduced into the wastewater management sector keeping in mind three fundamentals aspects:
            - **Increasing water tariffs** to a level to guarantee that the **sewage system earns enough revenue** to cover fixed + variable costs.
            - **Intergovernmental cooperation, alignment, and supervision** for the management of political, regulatory, and financial risks.
            - For PPP sustainability, a **credible discretionary regulatory mechanism** must be developed.
    - **Community Partnerships:** Most wastewater treatment initiatives in India follow a top-down approach, with **end-user communities having no influence** on the sort of service they want or how much they are ready to pay for it.
        - **Communities have a larger interest in the results** of wastewater management and are **more devoted to ensuring success when they have influence** and control over choices that impact them.

Conclusion

Urban wastewater management, even though local, requires **globally co-created solutions** including innovations in science and technology **keeping the holistic picture of water-land-people and ecosystems.**

Setting up Apex bodies to manage wastewater treatment systems through extensive collaborations is also essential besides **updating the best management practices** for urban wastewater scenarios.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q1. Biological Oxygen Demand (BOD) is a standard criterion for (2017)

(a) Measuring oxygen levels in blood
(b) Computing oxygen levels in forest ecosystems
(c) Pollution assay in aquatic ecosystems
(d) Assessing oxygen levels in high altitude regions

Ans: (c)

Q. Microbial fuel cells are considered a source of sustainable energy. Why? (2011)

1. They use living organisms as catalysts to generate electricity from certain substrates.
2. They use a variety of inorganic materials as substrates.
3. They can be installed in waste water treatment plants to cleanse water and produce electricity.

Which of the statements given above is/are correct?

(a) 1 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans: (d)

Mains

Q. The effective management of land and water resources will drastically reduce the human miseries. Explain. **(2016)**