Credits:

Ahmedabad:
Sabarmati river rejuvenated with accessible river front, 2012.
Pravin Indrekar at CC BY 2.0 (https://bit.ly/3uvvosg)

6

Water Management

Water Management

The stresses on natural resources and access to basic services like water is intensifying with the growing urban population. Unplanned urbanization leads to encroachments and disposal of untreated sewage and industrial waste into water bodies leading to pollution of urban water resources. Further, cities are adversely impacted by extreme events like heat waves, increased precipitation and flash floods triggered by extreme weather. Most cities are unable to tackle the twofold challenges of increasing demand for potable water during sumer time and management of excess water during extreme precipitation events mainly due to ageing infrastructure, inadequate monitoring, improper management and lack of holistic planning.

Achieving the SDG Goal 6 will require adopting various measures such as recycle, reuse of water and reducing loss in transmission. An effective water and waste water management plan can reduce the stress on existing water resources. Guidelines and initiatives undertaken by the Ministry of Water Resources includes Repair, Renovation & Restoration (RRR), river basin management, ground water irrigation etc. can help cities ensure the conservation of existing water resources and help meet future demand. Cities can also follow the guidelines provided in the Urban River Management Plan (URMP) framework for enhancing river management and conserving the quality of water. Conversely, embedding energy efficiency in pumping and treatment plants can help cities contribute towards mitigating GHG emissions.

This particular theme supports cities to better understand their water challenges, and infrastructure and management gaps. The indicators allow cities to revisit their water resource management plans, consider conserving and reviving water resources to cater future demand, address loss of water, increase recycle and promote efficient reuse of recycled water.

Dr. Panagiotis Karamanos
Urban Development Expert
International Urban & Regional Cooperation India

"The CSCAF is a thoroughly conceived, all-inclusive and truly valuable initiative for Indian cities. We appreciated the cooperation and motivation of Mayors and cities during the fact finding process and believe that Indian cities will play a key role addressing the climate change challenge. The CSCAF is an essential step forward towards more sustainable, healthy and livable cities"

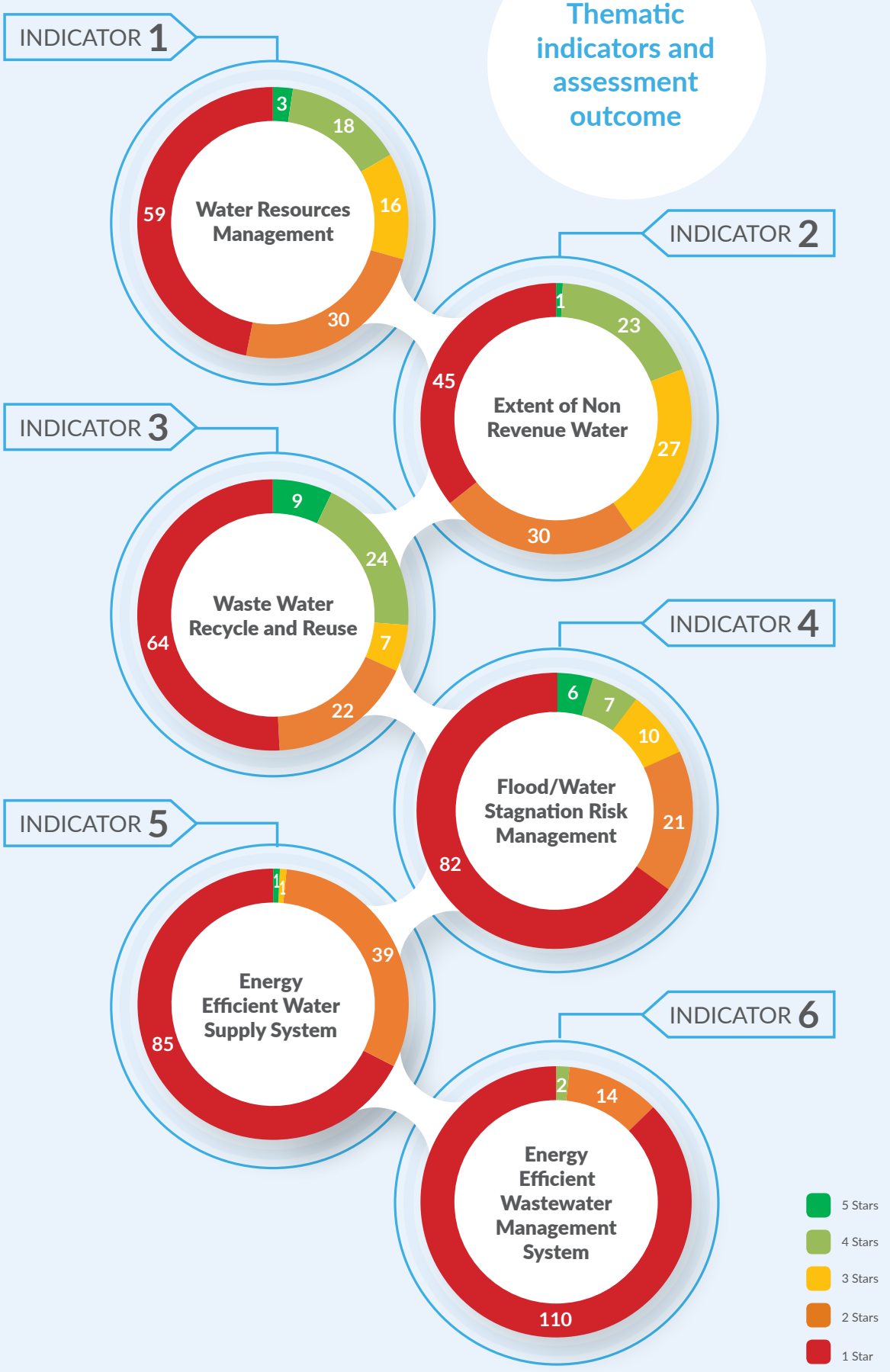
"Water resources must be managed with respect and highest degree of responsibility both individually and collectively. Climate change is a factor which is impacting it in and around us. Hence more engineered and scientific ways of managing our resources are the need of the day. CSCAF is a one step forward."

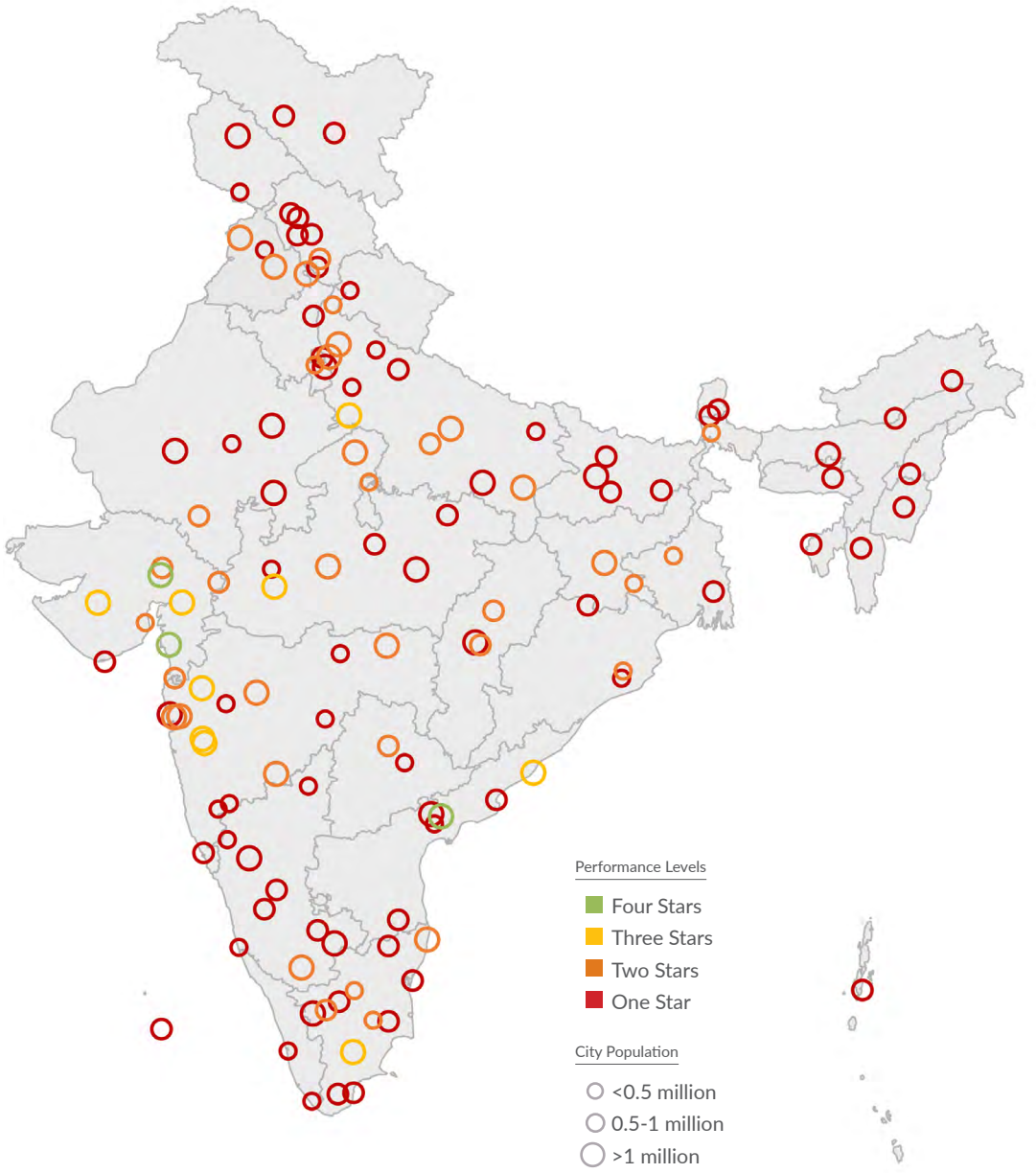
Mr. Manzoor Khan
Consultant- Urban Specialist
World Bank Group

Dr. Victor Shinde
Sector Coordinator for Water and Environment
National Institute of Urban Affairs

"Water is the primary medium through which the effects of climate change are manifested. Invariably these effects are more pronounced in cities. A sound and holistic water management strategy is, therefore, at the heart of any robust climate change adaptation mechanism that a city develops. The CSCAF can serve as a very useful tool in informing the design of such strategies."

Thematic indicators and assessment outcome





Performance of 126 Cities

Overall, 3 metropolitan cities from Gujarat (2) and Andhra Pradesh (1) have emerged as *Four Stars*. These cities have considered the climate change aspect in water management and are in the process of implementing it. 46 cities that are *Two Stars* and *Three Stars* are at various stages of water management plan preparation and have potential for addressing the climate change challenges within the plans.

25 out of 126 participating cities are at high water risk as per the WWF Water Risk Filter. Out of these, only 2 cities, namely, Ahmedabad and Surat are performing well. The rest of the 23 cities in high risk states of Maharashtra, Gujarat, Tamil Nadu, Uttar Pradesh, Rajasthan, Madhya Pradesh, Punjab and Jammu & Kashmir need to take initiatives to enhance water security in their respective cities.

77 *One Star* cities are mostly from the cold or hot-dry climatic regions. 21 out of 77 *One Star* cities from mostly small and medium sized cities belonging to the Northern and North-Eastern regions are most vulnerable to the climate change impact with respect to water management.

0
5 Stars

3
4 Stars

9
3 Stars

37
2 Stars

77
1 Star

★★★★

- **Ahmedabad**
- **Surat**
- **Vijayawada**

★★★

- **Agra**
- **Indore**
- **Madurai**
- **Nashik**
- **Pimpri Chinchwad**
- **Pune**
- **Rajkot**
- **Vadodara**
- **Visakhapatnam**

★★

- **Amritsar**
- **Aurangabad**
- Bhavnagar
- **Bhopal**
- Bilaspur
- Chandigarh
- **Chennai**
- Cuttack
- Dahod
- Durgapur
- Gandhinagar
- **Ghaziabad**
- Gurugram
- **Gwalior**
- Jamshedpur
- Jhansi
- **Kalyan Dombivali**
- **Kanpur**
- Karimnagar
- **Lucknow**
- **Ludhiana**
- **Meerut**
- Mysore
- **Nagpur**
- Naya Raipur
- **Ranchi**
- Saharanpur
- Salem
- Shimla
- Siliguri
- Silvassa
- Solapur
- **Thane**
- Tiruchirapalli
- Tiruppur
- Udaipur
- **Varanasi**

★

- Agartala
- Aizawl
- Ajmer
- Aligarh
- Amravathi
- Amravati
- Barielly
- Belagavi
- **Bengaluru**
- Bhagalpur
- Bhubaneshwar
- Bihar Sharif
- **Coimbatore**
- Davangere
- Dehradun
- Delhi
- Dharamshala
- Diu
- Erode
- **Faridabad**
- Gangtok
- Gorakhpur
- Gulbarga
- Guntur
- Guwahati
- Hamirpur
- Hubli Dharwad
- Imphal
- Itanagar
- **Jabalpur**
- **Jaipur**
- Jalandhar
- Jammu
- **Jodhpur**
- Kakinada
- Kargil
- Karnal
- Kavaratti
- Kochi
- Kohima
- Kolhapur
- **Kota**
- Leh
- Loni
- Mandi
- Mangalore
- Mira Bhayandar
- Moradabad
- Muzaffarpur
- Namchi
- Nanded
- New Town Kolkata
- Palampur
- Panaji
- Pasighat
- **Patna**
- Port Blair
- **Prayagraj**
- Puducherry
- **Raipur**
- Rourkela
- **Sagar**
- Sangli Miraj & Kupwad
- **Satna**
- Shillong
- Shivamogga
- Solan
- **Srinagar**
- Thanjavur
- Tirunelveli
- Tirupati
- Tiruvanantapuram
- Toothukudi
- Tumakuru
- **Ujjain**
- Vellore
- Warangal

Smart and AMRUT cities ◈ Smart cities ◆ AMRUT cities ○ Other cities *Million + population cities

INDICATOR 1

Water Resources Management

More than 40% of the world's population is estimated to live in water stressed river basins, and by 2025, about 1.8 billion people will be living in regions or countries with absolute water scarcity.[1] By 2030, a gap of 40% in global water demand and availability is expected. In India, more than 40% of the annually available surface water is being consumed and the growing demand from urbanization and the industrial water needs are further leading to the exploitation of ground water resources.[2]

India is at higher risk of water challenges as per WWF Water Risk Filter about 30 Indian cities, mostly metropolitan cities have been identified as cities that will face increasing water risks in the next few decades.[2] States like Andhra Pradesh, Chhattisgarh and Tamil Nadu are already experiencing water shortages due to changing rainfall patterns.[3] India holds only 4% of global freshwater and the projected climate trends impact water availability along with the growing demand.[2]

Performance of 126 cities

- ✓ The participating cities from Gujarat, Madhya Pradesh and Jharkhand have performed well by ensuring timely preparation and implementation of actions to augment existing water resources through recharge, rejuvenation and storage including rain-water harvesting, developing demand management plan and reviewing existing WRM plan to include climate considerations.
- ✓ 27 cities have WRM plans. Of these, 3 cities have emerged as *Five Stars* (Surat, Ranchi and Indore) and have considered the climate change factor in the existing WRM Plans and are in the process of implementing climate sensitive actions with notable impacts.
- ✓ 30 *Two Stars* and 16 *Three Stars* cities have provided partial data for three sub-indicators namely existing water resources, demand management and information on augmentation of the existing water resources.
- ✓ 59 *One Star* cities do not have or are not able to provide the WRM plan for their cities
- ✓ Among the cities in hilly areas, only Namchi and Shimla are able to perform relatively better in this indicator. All the participating small towns (except Namchi) have not performed well in this indicator. The North Eastern cities (except for Namchi which is *Four Stars*) are yet to initiate substantial measures.
- ✓ Cities with 10 million+ population especially from the states of Bihar, Rajasthan, Madhya Pradesh and Uttar Pradesh need to conserve their surface & ground water resources, alongside assessing the availability of existing water resources to meet the current and future water demand.

Actions

VIJAYAWADA

Vijayawada has prepared a Water Resource Management Plan highlighting the assessment of current water resources including both ground and surface water. The plan has taken into consideration the future water demand and water availability for at least five years.

Recognizing this significance, the National Water Mission is working towards conserving water, minimizing wastage and ensuring more equitable distribution is achieved both across and within states. The Jal Shakti Abhiyan by the Ministry of Jal Shakti is campaigning for water conservation and water security and promoting interventions like rainwater harvesting, renovation of traditional and other water bodies/tanks, reuse, bore well recharge structures, watershed development and intensive afforestation. With a focus on river management, Namami Gange has developed river centric planning framework and urban river restoration mechanisms that is currently benefitting cities along the Ganges. While setting a path towards improved water resources management, cities face various challenges in planning and implementation due to institutional overlaps and lack of man power in managing water bodies and area around it. Further, gaps in local capacity is a challenge in formulating strategies and implementing the same.

In this indicator, the cities are assessed based on progress made on aspects, ground water management to mitigate water stress, development of a water resources management with short, medium and long term actions, and revision of the same aligning to projected climate trends to address future water demand. The latter also contributes to SDG 6 where cities can contribute towards implementing Integrated Water Resource Management (IWRM).

Way forward to improve water resource management

- 59 *One Star* cities need to establish a water resource management committee to guide them in the process of development of city/ catchment wide water management plans. This committee can include representatives from the water utility department/ water board, ULB, ground water department, SPVs, and technical experts like engineers and infrastructure experts.
- Cities can refer to the guidelines for Integrated Water Resources Development and Management for detailing out the functions of the team. Cities can initiate a study along with mapping of ground and surface water to assess the status of existing water resources. Further, assessing the availability of water considering the future demand can be conducted.
- 30 *Two Stars* cities can initiate the development of demand management plan to support improved utilization of water resources and adopt measures to rejuvenate water resources and replenish groundwater. This particular initiative also aligns with an indicator in the theme of urban planning, green cover and biodiversity. Cities can focus on preparing the water resource management plan wherein short, medium and long-term actions can be identified. Cities can follow the 2014 guidelines for improving water use efficiency in irrigation, domestic and industrial sectors to develop the plan.
- 16 *Three Stars* cities that have already developed water management plans can start allocating budget for implementing some of the actions identified and institutionalize monitor review verification for the activities performed. These cities can also think about dovetailing some of their planned initiatives through the central government and state government funded schemes.
- 18 *Four Stars* cities can review and update their WRM plan as per the climate trends for a return period of 10-30 years. They can conduct studies on assessing future water availability in various climate change scenarios and drawing out plans to safeguard the availability of water.

1. Guppy, L., Anderson, K., 2017. Global Water Crisis: The facts. United Nations University Institute for Water, Environment and Health. Available at: https://inweh.unu.edu/wp-content/uploads/2017/11/Global-Water-Crisis-The-Facts.pdf [Accessed 23 March 2021]
2. WWF India, 2020. [Online] Available at: https://www.wwfindia.org/news_facts/pres/?19602/Cities-across-the-globe-face-an-alarming-rise-in-water-risks#:~:text=About%2030%20Indian%20cities%20including,Dr. [Accessed March 2021].
3. NITI Aayog, 2019. Composite Water Management Index. Ministry of Jal Shakti and Ministry of Rural Development. Available at: http://social.niti.gov.in/uploads/sample/water_index_report2.pdf [Accessed 23 March 2021]

INDICATOR 2

Extent of Non-Revenue Water

Non-Revenue Water (NRW) is a broader estimate of water loss, which includes loss of revenue not only from physical leakages of treated water but also from metering inaccuracies, unbilled consumption, and unauthorized connections. The estimated NRW in developed countries like the United States and the United Kingdom varies between 15-16% whereas in Asia, there is a broad variation between 4-65%.[4] In addition, it is estimated that 30% of global water abstraction is lost due to leakages[5] whereas in developing countries, one-third to a half of the pumped water is lost due to leakages.[5] Considering the amount of water loss, addressing NRW can be one of the key aspects for securing water availability.

Water loss is one of the key challenges faced by cities in India. The NRW loss varies from 40-50% and 50-60% in large metropolitan and smaller cities respectively.[5] Water loss in cities happen mainly due to old pipes used for

Performance of 126 cities

- ✓ 24 (23 *Four Stars* and 1 *Five Stars*) cities have performed relatively well in this indicator. These cities have conducted NRW study including strategies to reduce and achieve a minimal NRW percentage.
- ✓ Participating cities from Gujarat, Jharkhand, West Bengal and Andhra Pradesh have performed relatively well. Some of the measures undertaken by the cities include replacement of the existing assets, GIS mapping, metered connections, establishment of District Metered Areas (DMA) and Supervisory Control And Data Acquisition (SCADA).
- ✓ As per WWF Water Risk Filter, 25 out of 30 high risk cities have undertaken this assessment. 8 cities out of 25 have performed well in this indicator.
- ✓ The results from the assessment indicate that 45 *One Star* cities and 30 *Two Stars* cities with more than 40% NRW are still at an early stage of targeting their NRW reduction. 45 *One Star* cities have not submitted NRW study reports or have not secured the data. Cities that do not have metered water connections may pose a challenge in assessing NRW.
- ✓ All small cities (except Mandi) and cities in hilly and coastal regions (except Shimla and Surat) are yet to initiate measures to reduce their NRW considerably.
- ✓ The *One Star* million+ cities from Bihar, Haryana, Jammu & Kashmir, Rajasthan and Madhya Pradesh with an increasing population, expanding service areas can focus on reducing water loss for efficient water utilization and limiting revenue expenses.

Actions

SURAT

Surat has established a NRW cell to take up dedicated actions. A comprehensive NRW study along with leakage mapping has been conducted. A scheme of 24 x 7 water supply with 100% metering has been in operation since 2015. This scheme has helped to monitor NRW by assessing the quantity of water treated versus the quantity of water supplied. Through metering and levy of water charges, the city has not only been able to monitor NRW but also improved revenue income.

transmission and distribution due to broken or corroded pipes. These conditions are also not favourable to maintain the quality of ground water as there are chances for the sewage seeping into the ground water. In order to guide states and cities in addressing NRW reduction and efficient management, a toolkit was developed under JnNURM. The toolkit also provides guiding principle for auditing water supply and calculating losses at various stages that cities can follow. Various measures for leak detection to minimize leakages and reducing other unaccounted water losses are also captured in the draft general guidelines for Water Audit and Water Conservation released in 2017 that can inform enhanced management. However, lack of technical manpower and funds to conduct NRW study and inefficient coordination and management across various departments involved at the city and state levels pose challenges in identifying priority areas of water loss and adopting relevant measures.

As recognized in SDG 6, NRW is a powerful demand management instrument to reduce stress on existing water resources and aligning to the same this indicator assessed cities based on the extent of water loss due to NRW. This comprises consumption which is authorized but not billed, such as public stand posts; apparent losses such as illegal water connections, water theft and metering inaccuracies; real losses which are leakages in the transmission and distribution networks. Cities provided data on the amount of water put into the distribution system after treatment and the amount of water sold (billed) to the consumers for calculating water loss due to NRW in this indicator.

Way forward to improve monitoring of Non-Revenue Water

- Majority of the cities can start understanding the gaps by identifying problem areas, leakage points and reduction of illegal connections.
- Cities can prepare Non-Revenue water study or conduct a water audit in order to understand the real losses, apparent losses and unbilled authorized consumption.
- 45 *One Star* cities can conduct NRW study through specialized and experienced agencies/experts. This will enable cities to understand the gaps and plan for its reduction. Initiatives such as water supply audit and assessment, locating problem areas, implementing supply monitoring system through supervisory control and data acquisition (SCADA) , etc., can be explored.
- Cities which have conducted the NRW assessment may continue to monitor the leakages and loss of water in the existing water supply system and focus on reducing the percentage of loss. This can include preparation of GIS database of water resource infrastructure and preparation of strategy and action plan for NRW reduction. Measures such as Tariff revision and organizing public awareness programs can lead to larger participation of stakeholders in water resource management.

4. Kumar, P., Matto, M. & Sharda , C., 2017. Policy Paper on Mainstreaming Energy Efficiency in Urban Water and Wastewater Management in the Wake of Climate Change, Centre for Science and Environment, Ministry of Urban Development. https://tinyurl.com/to995kgp [Accessed 23 March 2021]
5. Guppy, L., Anderson, K., 2017. Global Water Crisis: The facts, United Nations University Institute for Water, Environment and Health. https://inweh.unu.edu/wp-content/uploads/2017/11/Global-Water-Crisis-The-Facts.pdf [Accessed 23 March 2021]
6. Never, B., 2016. Wastewater systems and energy saving in urban India. https://www.researchgate.net/publication/305308932_Wastewater_systems_and_energy_saving_in_urban_India [Accessed 23 March 2021]

INDICATOR 3

Wastewater Recycle and Reuse

Globally, only 20% of the total wastewater generated is treated[8]. Two-third of the sewage from urban areas globally is let into water bodies untreated[9]. In the case of India, 32% of urban households have piped sewer systems and only 10% of the overall sewage generated is treated[10]. Around 62% of total urban sewage generated in India is directly discharged into nearby water bodies[11]. This is a key reason for water pollution that is impacting the water quality and the overall water ecosystem.

SDG 6 goal for sustainable management of water and sanitation identifies the need for strengthening city wastewater management and increasing the reuse of recycled waste water. Recycle and reuse of wastewater are an important part of the sanitation cycle and critical for water conservation, especially in conditions with decreasing freshwater availability and increasing costs for delivering safe water, often from far distance. Moreover, adopting recycle and reuse of water for non-potable domestic use, horticulture, agricultural, power plants and industrial use can reduce water pollution and the stress on water availability which is expected to be adversely impacted by climate change.

At the national level, the National Water Policy, 2012 encourages cities to increase the recycling and reuse of wastewater after treatment and has set preferential tariffs to incentivize the reuse of treated wastewater.

Performance of 126 cities

- ✓ 40 cities are in the category of *Three Stars*, *Four Stars* or *Five Stars* category among which 9 cities are currently recycling and reusing more than 20% of their wastewater. 29 of the 40 cities are from western region, having either composite or hot-dry climatic or warm-humid zones and are benefitting from the reuse of recycled water.
- ✓ The relatively better performing cities are mostly metropolitan cities (except Gandhinagar and Udaipur)
- ✓ Majority of the coastal cities and all cities in the hilly areas are yet to establish wastewater treatment facilities and increase their capacity to cater to the current and future demand.
- ✓ 64 *One Star* and 22 *Two Stars* cities are in the early stages of development with less than 5% of their wastewater being recycled and reused.
- ✓ All the cities in the north-eastern region are in the *One Star* category.

Actions

BENGALURU

Bengaluru has conducted studies on the wastewater treatment and reuse for establishing a Decentralized Wastewater Treatment and Reuse Unit (DWTRU) using small-scale on-site sewage treatment plants. They have also incorporated the concept of zero liquid discharge and urban wastewater recycling, an attractive solution for addressing the problems of water pollution and scarcity.

The National Urban Sanitation Policy, 2008 has also set a minimum of 20% reuse of waste water for cities. Further, Smart Cities Mission, AMRUT mission and Namami Gange supports cities with financial and technical resources respectively for enhancing waste water treatment and management.

In this indicator, cities are assessed based on the extent of treated water being recycled wherein cities provided data on the quantum of wastewater recycled and reused for various purposes for the last 12 months.

Way forward to increase Wastewater Recycle and Reuse

- Cities which are in the initial stage of assessment, with or without the wastewater management system can initiate assessment of existing wastewater scenarios of the city and strategize the immediate measure to be considered for managing the wastewater.
- All the cities, which are located along coastal regions and situated along river stretches; impacting the water bodies and water ecosystem most, need to strengthen their wastewater management system with the help of national programs as mentioned above.
- Cities can explore sustainable measures for recycling the wastewater, such as biogas, biofiltration, combined heat and power (CHP) technology, decentralised wastewater system, and many more.
- Cities can plan to re-evaluate the water demand sectors and explore the possible avenues for treated wastewater use within or nearby the city such as irrigation, horticulture, green belts within the transport network.
- Cities can formulate the plans for reuse of wastewater for the different purposes, such as selling it to industries, for landscaping at municipal roads, selling it to nearby housing societies for gardening etc. Accordingly, required infrastructure such as laying of pipes etc., can be budgeted in development projects.
- The efficiency and effectiveness of wastewater treatment plants can be enhanced as per CPHEEO guidelines and also monitor to increase the quantum of recycled/ reusable water.

7. Guppy, L., Anderson, K., 2017. Global Water Crisis: The facts, s.l.: United Nations University Institute for Water, Environment and Health. https://inweh.unu.edu/wp-content/uploads/2017/11/Global-Water-Crisis-The-Facts.pdf [Accessed 23 March 2021]
8. UNEP, UN-Habitat, 2005. Coastal Area Pollution, The roles of city.
9. Never, B., 2016. Wastewater systems and energy saving in urban India. https://www.researchgate.net/publication/305308932_Wastewater_systems_and_energy_saving_in_urban_India [Accessed 23 March 2021]
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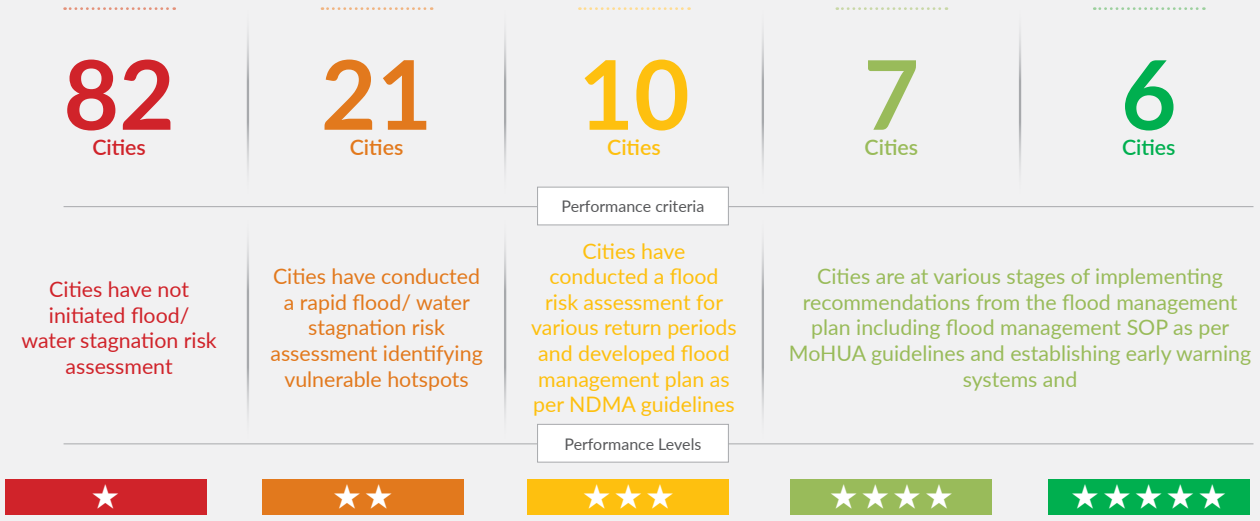
11. Shrivastava, M., Ghosh, A., Bhattacharyya, R. & Singh, S., 2018. Urban Pollution in India. In: Urban Pollution: Science and Management. Available at: https://www.researchgate.net/publication/328216636_Urban_Pollution_in_India

INDICATOR 4

Flood / Water Stagnation Risk Management

Globally, urban flooding[13] events impacting large urban populations have increased in frequency and intensity. Rise in sea levels and changing rainfall patterns due to global warming is a key reason for this. In addition to flooding, many cities also experience water stagnation[14] due to various urban development patterns such as increasing impervious surfaces deterring ground water absorption, inefficient storm water network, growing development activities in flood plains and decreasing green cover that has the potential to slow down stagnation. Further, lack of adequate flood management makes cities vulnerable to floods.

India experienced the highest monsoon rainfall in 2019 when compared to previous 25 years.[15] Every year, around 75 lakhs hectares of land is impacted by floods resulting in loss of more than 1,600 lives and damages to houses and public utilities exceeding over Rs.1,800 crores.[16] Understanding the increased frequency in major floods due to climate variability, the National Disaster Management Authority (NDMA) along with MoHUA has developed Standard Operating Procedures (SOPs) for urban floods. Many states have also improved their State and District Disaster Management Authority (SDMA/DDMA) for taking up prevention, mitigation, preparedness and capacity building for addressing disasters. The Central Water Commission (CWC) along with the Ministry of Water Resources has implemented a flood forecast program to set up a network of forecasting stations covering all important flood prone river areas supporting with early warnings.



Performance of 126 cities

- ✓ 6 *Five Stars* cities have implemented more than one key measures for flood management plan, SOPs and have established the urban flood alerts and early warning systems. The relatively better performance is evident in Metropolitan cities. 5 (Ahmedabad, Nagpur, Nashik, Pimpri Chinchwad and Pune) are from western and 1 (Vijayawada) is from the southern region.
- ✓ Of 6 *Five Stars* cities, 3 cities (Ahmedabad, Pune, Vijayawada) have implemented all 3 measures and 3 cities (Pimpri Chinchwad, Nagpur and Nashik) have implemented at least 2 measures.
- ✓ Only 10 *Three Stars* cities are able to provide information on detailed flood/water stagnation risk assessment and flood management plan.
- ✓ Out of 21 *Two Stars* cities, only 7 cities (Bhopal, Bilaspur, Delhi (NDMC), Ghaziabad, Ludhiana, Silvassa, Toothukudi) were able to provide data on flooding hotspots, reasons of floods, level of floods etc.
- ✓ 82 *One Star* cities are at very early stage and have not conducted flood/water stagnation risk assessment. These cities are currently referring to their District Management Plans and have not yet started preparing city level management plans.

Actions

CUTTACK

Cuttack, located at the confluence of Mahanadi and Kuakhau rivers is highly vulnerable to floods and water stagnation. The city has prepared an integrated city level disaster management plan which consists of vulnerability & exposure analysis at ward-level, resource inventory and capacity analysis, preparedness plan, response plan, reconstruction & rehabilitation measures and mitigation plan. The ULB has also setup a city control unit to monitor the water logging and blocking of drains. The existing drainage infrastructure has been improved by adopting structural measures such as building retaining walls, barrages and diversion channels etc.

However, with growing cities and increasing floods, the need for city level flood management plan in alignment to the district disaster management plan is becoming critical. Conducting assessments, identifying vulnerable hotspots, ensuring SOPs can be followed during a flood and establishing end-to-end Early Warning Systems (EWS) are important for the cities that experience flooding and water stagnation. Aligning to these pertinent measures, the indicator assessed cities based on the initiatives taken to mitigate flood and water stagnation for becoming flood resilient. In the merged levels of *Four Stars* and *Five Stars*, cities were marked based on initiatives implemented towards mitigating flood risk and establishing early warning systems.

Way forward for flood and water stagnation risk management

- 82 *One Star* cities do not have any plans and are likely to be affected in extreme weather events. As an initial step, these cities can initiate the process of interdepartmental consultation for collecting data on flood events and conduct Hazard Risk Vulnerability (HRV) assessments to understand reasons for flooding. WRM team can be mobilized to create a departmental rapid risk assessment report and action plan. Spatial mapping of hotspots along with attributes such as frequency, impact level, and damage/loss, etc may be carried out.
- 21 cities are in the *Two Stars* category where there is evidence of increased awareness of the impacts due on recent extreme events. These cities may ensure that all departments have their departmental level flood management plans. As an initial step, drainage master plan or the storm-water management plan can be aligned with the flood management plan. The flood management plan of the city can include structural and non-structural strategies which may entail the designs and implementation methodology in accordance with parallel development plans. Cities can refer to the district level disaster management plan and detail out city level actions in alignment with the existing district level disaster or flood management plans.
- Establishing an end-to-end EWS will help cities prepare better for the disaster. Cities can also enforce building bylaws and development codes to address building vulnerabilities to floods. This entails updating DCRs and bylaws regularly as per 2015 national level guidelines.
- The cities which have advanced to the level of *Four Stars* and *Five Stars* may continue to monitor the implementation of actions mentioned within the flood management plan. These cities may consult technical agencies to a strong GIS database for drainage and storm water networks overlaid with historical and projected flood data. They can also coordinate with the local training institutions and community based organizations to establish a volunteer network and trained task force for disaster response.

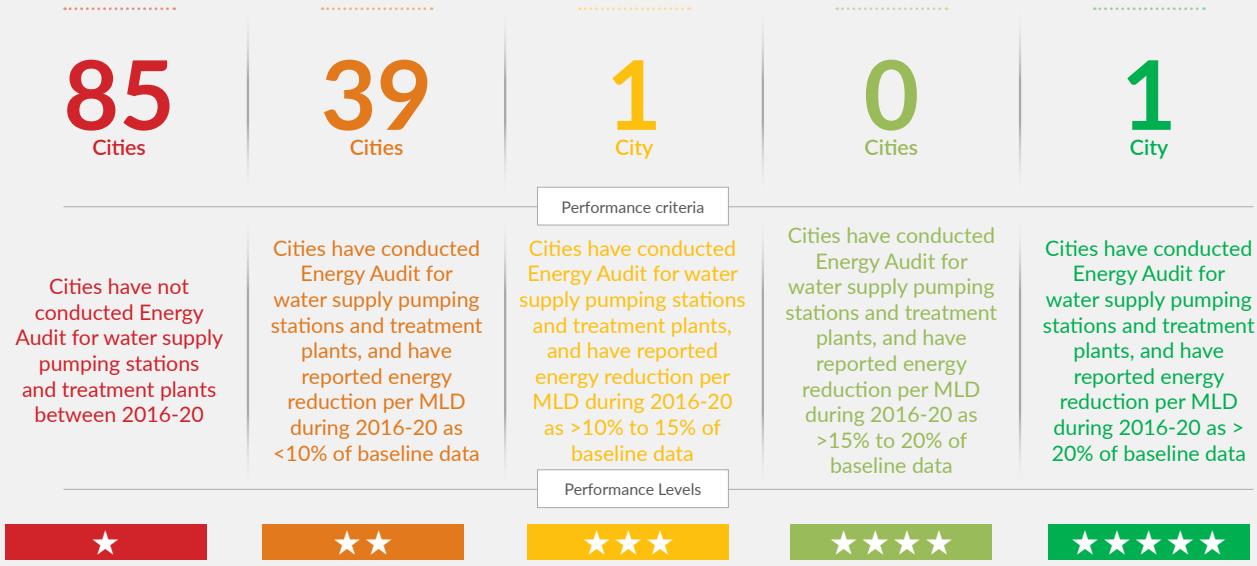
13. Urban flood is the submergence of usually dry area by a large amount of water that comes from sudden excessive rainfall, an over-flowing river or lake, melting snow or an exceptionally high tide.
14. Water accumulated for more than four hours with a depth of more than six inches.
15. Masih, N., 2019. The Washington Post. https://www.washingtonpost.com/world/2019/10/01/more-than-have-people-have-died-heavy-rains-india-heres-what-flooding-looks-like/ [Accessed 23 March 2021]
16. National Disaster Management Authority, [Online]. Available at: https://ndma.gov.in/. [accessed on 23 March 2021]

INDICATOR 5

Energy-Efficient Water Supply System

Water supply system includes the entire process of water extraction from source, treatment to meet standard quality, storage as required and supply to the end users. This system has a number of electro mechanical equipment that consumes energy, however, water pumps account for the maximum usage. The expanding urbanization increases the demand for electricity consumption that is required for the water supply system. With estimates for municipal water and wastewater utilities demand in developing countries increasing by 40% by 2030,[17] emphasizing the focus on energy efficient water supply system is of significance for reducing energy consumption and indirectly mitigating GHGs emissions.

Cities in India spend around 30-40% of their annual expenditure towards energy charges for pumping, storing, transporting and distributing water.[18] With almost 50% of municipal budget spending[20] and expanding urban areas that demand higher energy for water supply system, cities have the opportunity to cater the rising need in an energy efficient manner. Cities in hilly areas leveraging the slopes can benefit in conserving energy, however, cities that are pumping up water experience increased municipal expenditure and can focus on installing an energy efficient system. BEE has indicated the potential for energy saving across municipal services wherein energy efficient water supply can lead to substantial cost reduction and savings



Performance of 126 cities

- ✓ Only 2 cities, Ahmedabad (*Five Stars*) and Indore (*Three Stars*) have managed to showcase regular audits being conducted and energy efficiency improvements achieved over the years. Both of these are metropolitan cities.
- ✓ 39 *Two Stars* cities have conducted an energy audit in the last 5 years but have not monitored the same regularly. Majority of the cities that managed to conduct these studies are from the states of Gujarat, Karnataka, Maharashtra, Tamil Nadu and Uttar Pradesh.
- ✓ 85 *One Star* cities have not provided evidences/ requisite supporting documents for this indicator. All the cities from north-eastern region, and majority of the participating small towns are in the *One Star* category. None of the coastal and hilly cities are performing well in this indicator.

Actions

AHMEDABAD

Ahmedabad has conducted the energy audit report where potential energy saving and cost saving has been highlighted with possible measures. The city also has provided the trend for energy consumption from 2016 to 2020. It is evident that around 26% of energy consumption has been reduced from 2018 to 2020 after taking appropriate measures proposed in the energy audit report.

for the ULBs. Further, the Investment Grade Energy Audit (IGEA) conducted around 2007 for municipal services in 134 cities estimated the potential to save 120 MW through energy efficiency projects.[19]

In India, the Section 18 of Energy Conservation (EC) Act requires all states to regulate energy consumption and drive energy efficiency for water and waste water management.[20] The AMRUT mission is also encouraging cities to conduct an energy audit that can support in identifying inefficient equipment such as pumps and replacing the same. This particular indicator in the assessment focuses on bringing energy efficiency in the water supply system with a two-fold benefit of reducing municipal expenditure and reducing energy demand. Cities are assessed based on the energy audit conducted and extent of measures taken to reduce energy consumption.

Way forward to improve energy efficiency in water supply system

- The first step for the 85 cities which are in the *One Star* level is to conduct an energy audit. Central schemes such as BEE facilitated energy audits and situational surveys to identify suitable projects to save electrical energy under as per MuDSM guidelines can be leveraged.
- 39 Cities which are in *Two Stars* level can make plans for improving their efficiency by replacing their old pumps. These cities can also ensure that all new and upcoming water supply systems may adhere to energy efficiency systems and standards. Cities can also plan to install solar pumps and motors, BE rating pumps and motors, auto operation and control systems to reduce the energy consumption and O&M cost.
- Maintain the monthly energy consumption records of the water supply pumping stations, electro mechanical equipment such as pumps, motors, aerators and other equipment in the entire water supply system, and prepare plans for making them more energy efficient. These cities can also plan to introduce design innovation for the energy efficiency of water supply system such as network analysis, supply flow moderation and terrain 3D modelling to use the gravitational force can be explored.

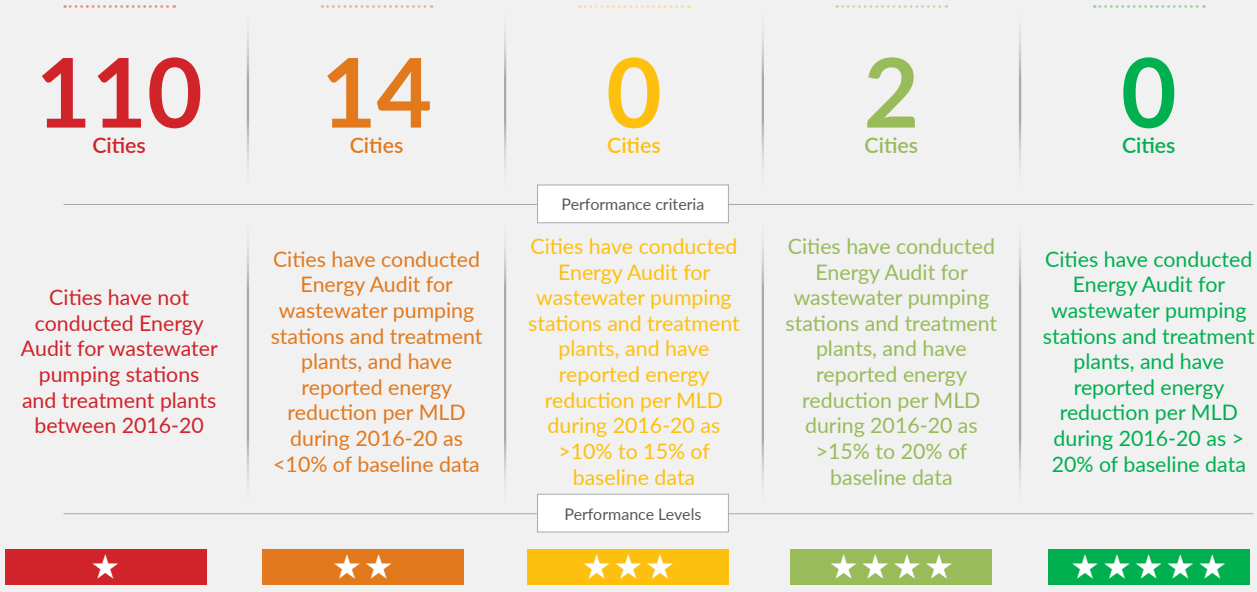
17. Kumar, P., Matto, M. & Sharda , C., 2017. Policy Paper on Mainstreaming Energy Efficiency in Urban Water and Wastewater Management in the Wake of Climate Change, Centre for Science and Environment, Ministry of Urban Development. https://tinyurl.com/to995kgp
18. Kumar, P., 2013. Energy and Water Efficiency in Municipal Water Supply System. Guwahati: CSE India. http://cdn.cseindia.org/user-files/pradeep_kumar_director.pdf
19. BEE India, n.d. Municipal Demand Side Management Programme. [Online] Available at: https://beeindia.gov.in/content/municipal-dsm. [Accessed 20 03 2021]
20. AEEE, 2019. State Energy Efficiency Index, Ministry of Power, GoI. https://beeindia.gov.in/sites/default/files/State-Efficiency-Index-2019.pdf [Accessed 23 March 2021]

INDICATOR 6

Energy-Efficient Wastewater Management System

Cities in India spend 50% of their municipal budget for the energy charges of water supply and waste water management[21]. With increasing urbanization, the amount waste water is bound to increase and energy consumed to treat and manage the same will also increase. Further, around 10% of the waste water generated in India is estimated to be treated using old pumping and electro-mechanical equipment that consume high amounts of energy[22]. Focusing on energy efficiency waste water management is key for reducing energy demand and hence reduced municipal expenditure. Reduced energy demand also provides a co-benefit of mitigating GHGs emissions.

BEE has indicated the potential for energy saving across municipal services wherein energy efficient can lead to substantial cost reduction and savings for the ULBs. The Investment Grade Energy Audit (IGEA) conducted around 2007 for municipal services in 134 cities estimated the potential to save 120 MW through energy efficiency projects[23]. The Section 18 of Energy Conservation (EC) Act requires all states to regulate energy consumption and drive energy efficiency for water and waste water management[24]. The AMRUT mission is also encouraging cities to conduct an energy audit that can support in identifying inefficient equipment such as pumps and replacing the same. This



Performance of 126 cities

- ✓ Only 2 metropolitan cities namely Surat and Indore have performed well with respect to bringing energy efficiency in their waste water management. They are able to demonstrate lower energy consumption in the last year based on the audit conducted.
- ✓ In total, 16 cities (14 *Two Stars*, 2 *Four Stars*) are able to assess the energy efficiency of their existing electromechanical equipment used in wastewater management system and are gradually shifting towards energy efficient water supply system which will help to mitigate GHG emissions. Majority of these cities are from Gujarat, Karnataka, Punjab, and Uttar Pradesh.
- ✓ 110 *One Star* cities have not provided evidences/ requisite supporting documents for this indicator. All the cities from eastern and north-eastern regions, and majority of the participating small towns are in the *One Star* category. All coastal cities (except Surat) and hilly cities are also not performing well in this indicator.

particular indicator in the assessment focuses onbringing energy efficiency in the wastewater management system where cities are assessed based on the energy audit conducted and extent of measures taken to reduce energy consumption in wastewater management.

Actions

INDORE

Indore has replaced the traditional electro-mechanical equipment of the existing wastewater management system with a solar energy system that has helped in 22% reduction in the energy consumption. The use of clean energy has resulted in the municipal expenditure savings on electricity bills.

Way forward to improve energy efficiency in waste water management

- Cities can conduct energy audits annually to understand energy usage trend in the waste water management system wherein potential areas to reduce energy cost and consumption can be identified. 110 cities that are in the very early stages of bringing energy efficiency can follow MuDSM guidelines and leverage central schemes such as BEE facilitated energy audits and situational surveys to identify suitable projects to save electrical energy.
- 14 Cities which are in *Two Stars* level and have conducted energy audits can focus on bringing in efficiency based on the identified priorities in the audit. They can consider installing solar pumps and motors, BE rating pumps and motors, auto operation and control systems to reduce the energy consumption and O&M cost.

Mr. Sanjay Seth
Senior Director – Sustainable Habitat Programme
The Energy and Resources Institute (TERI)

> With increasing frequency of erratic and extreme weather events, it is necessary to improve urban resilience through use of innovative & data-driven solutions and systems that are dynamic & adaptive. The climate-sensitive approach of CSCAF provides cities with a roadmap to integrate such considerations and solutions in their resilience building processes across priority sectors.

21. Kumar, P., 2013. Energy and Water Efficiency in Municipal Water Supply System. Guwahati: CSE India. http://cdn.cseindia.org/user-files/pradeep_kumar_director.pdf
22. Kumar, P., Matto, M. & Sharda , C., 2017. Policy Paper on Mainstreaming Energy Efficiency in Urban Water and Wastewater Management in the Wake of Climate Change, s.l.: Centre for Science and Environment, Ministry of Urban Development., https://cdn.cseindia.org/attachments/0.73120800_1505297784_Policy-Paper-Mainstreaming-Energy-Efficiency-in-Urban-Water.pdf
23. BEE India, n.d. Municipal Demand Side Management Programme. [Online] Available at: https://beeindia.gov.in/content/municipal-dsm. [Accessed 20 03 2021]
24. AEEE, 2019. State Energy Efficiency Index, Ministry of Power, GoI. https://beeindia.gov.in/sites/default/files/State-Efficiency-Index-2019.pdf [Accessed 23 March 2021]

Credits:

Chennai:
Ongoing lake rejuvenation in the city, 2020

by NIUA

Actions in the cities

Namchi

Integrated water supply management, augmentation of existing distribution network & strategy for water conservation & reuse

Namchi has implemented a strategy for water conservation & reuse using co-polymer based rain water harvesting technology. The city aids towards the greater objective of water management and conservation and to increase recharge of groundwater by capturing and storing rainwater. Rainwater harvesting from rooftop run-offs and natural waterbodies augment the community development.

Bhubaneshwar

Assessment and implementation for NRW reduction

The city has planned to expand the network to achieve universal coverage by providing every household with water supply service connection. One of the key municipal reforms under AMRUT programme, is to reduce NRW from current levels to 20% providing the following benefits: Ensuring equitable water supply and reduce demand/supply gap; Improvement in network efficiency by reducing water losses; Improvement in water supply coverage, reliability and quality of service; Improving cost recovery from water supply operations.

Surat

Reuse & Recycle of Treated Wastewater Action Plan 2019

The city of Surat has prepared an action plan which promotes the reuse of treated sewage for different purposes of gardening, industrial reuse, tanker filling, lake restoration, flushing and construction with a vision to maximize the collection & treatment of generated sewage and reuse of treated wastewater on a sustainable basis, thereby reducing dependency on freshwater resources. Also, the reuse of treated wastewater can become a source for revenue generation.

67 cities

have initiated water resource assessment

44 cities

have initiated flood/ water stagnation risk assessment

41 cities

conduct regular (annual) energy audits of their water supply system

Pune

Standard Operation Procedure for Flood Control (SOP)

The city of Pune has prepared a SOP for taking timely action, systematic co-ordination among department and public, streamlining communication and decision making. The core objectives include identifying hazard potential on downstream of the dam, warning about probable floods in advance, taking preventive actions in advance, monitor flood situation, protection of human lives & infrastructure, restore damaged infrastructure due to floods.

Durgapur

Investment grade energy audit report

The city of has conducted an energy audit of the water supply system to carry out a performance evaluation of pump sets. Based on the energy audit, the pump and pump set efficiencies for all the pumping stations have been estimated. Along with estimation of efficiency of pump sets, performance indicators such as specific energy consumption were also evaluated for the city. The energy saving has been calculated on the basis of energy audit activity conducted, where the estimated energy saving has a potential of 32%.

Saharanpur

Investment grade energy audit

The city has conducted an energy audit of the waste water management system to carry out a performance evaluation of pump sets. Based on the the energy audit, the overall pump efficiencies for each running pumps of borewells, sewage treatment plant and sewage pumping station have been estimated. Along with estimation of efficiency of pump sets specific energy consumption was also evaluated for pump. The energy saving calculated on the basis of energy audit estimates an energy saving potential of 48%.

16 cities

conduct regular (annual) energy audits of their wastewater supply system

62 cities

have instituted mechanisms for promoting recycle and reuse of waste-water