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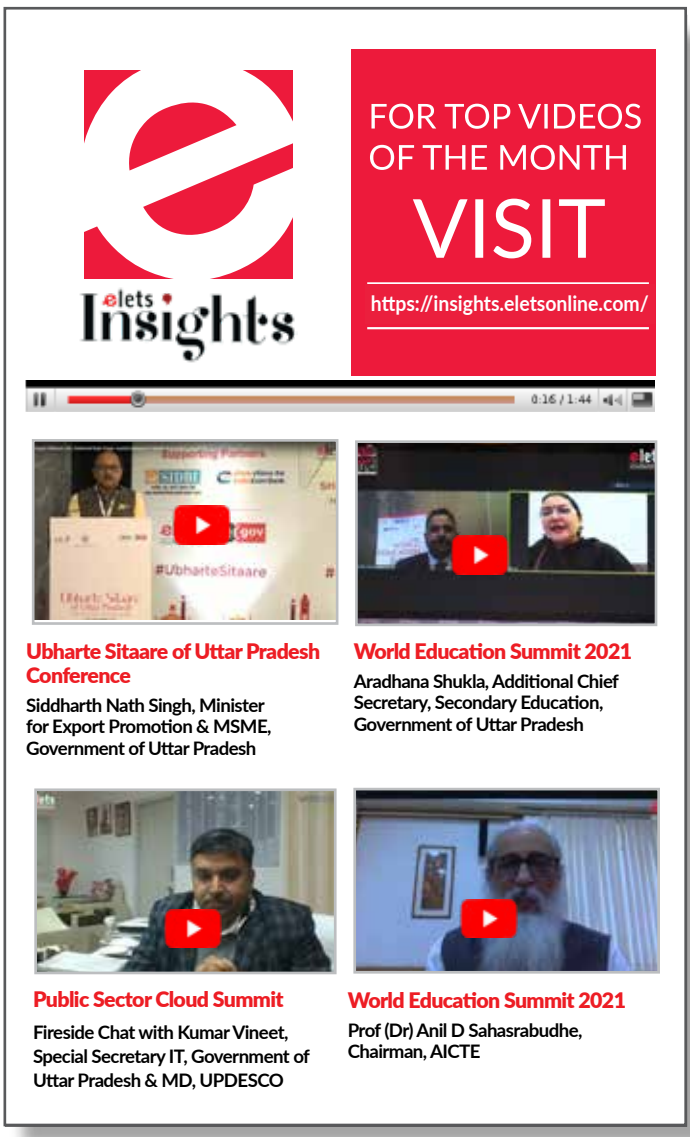

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Assessing wastewater management in India and its water reuse potential

Billions of people around the world lack adequate access to one of the essential elements of life: clean water. Although governments and aid groups have helped many living in water-stressed regions gain access in recent years, the problem is projected to get worse due to global warming and population growth.

India is among the most water-stressed countries, in part due to its population, pollution, and the exploitation of groundwater. Due to these factors, wastewater management has become a serious issue. A report issued by NITI Aayog in 2019 mentions that India is placed 120th among 122 countries in the water quality index, with nearly 70 per cent of water being contaminated.

However, over the past few years, the recycling and reuse of wastewater has gained momentum in the country due to the initiatives taken by several urban local bodies (ULBs). The use of treated wastewater for various non-potable purposes such as industrial use, car washing, gardening and construction has been encouraged.

The National Mission for Clean Ganga (NMCG) has been assigned the task of developing a circular economy model focused on reclaiming, reusing, and recycling water. The government is planning ways to monetise treated sewage water by selling it to power plants along the river. This move is one of the several endeavours of the six verticals identified under Arth Ganga.

This issue of the eGov Magazine, in partnership with the National Institute of Urban Affairs (NIUA), is an attempt to draw the spotlight on how India is faring on the global Sustainable Development Goal (SDG) 6.3 which says 'by 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.'

It is a compilation of enriching articles and insightful interviews on the theme from senior policymakers, experts and academia.

Do keep a copy of this collector's edition!

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DR RAVI GUPTA
Editor-in-Chief, eGov magazine, and
Founder, Publisher & CEO,
Elets Technomedia Pvt Ltd

From the Desk of Director-NIUA

SDG 6.3—Water Quality and Waste Water

HITESH VAIDYA
Director, National Institute of Urban Affairs (NIUA)

Globally, around 80 per cent of wastewater from cities is discharged directly into the natural environment without adequate treatment. This results in deterioration of quality of water bodies and turn a significant threat to both human and environmental health. In the context of India, this is a significant cause of concern as most cities do not have functional wastewater management infrastructure. This raises the question—how Indian cities can grow sustainably in the absence of wastewater management and reuse solutions?

Sustainable Development Goal (SDG) 6.3 sets the target 'to improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globallyby 2030'.

Wastewater is an untapped reservoir of resource, therefore, various missions under the Government of India such as Swachh Bharat Mission-Urban (SBM 2.0), National Mission for Clean Ganga (NMCG) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT 2.0) have placed equal emphasis on wastewater treatment and reuse as part of developing a water secure India. This contributes directly towardsachieving the target under SDG 6.3.

This edition on SDG 6.3 – **Water Quality and Waste Water** - is a compilation of thirteen uniquely articulated articles related to the theme of urban water quality and wastewater management. The prime objective of this edition of the magazine is to capture and disseminate the perspective of experts on different aspects of urban water quality and wastewater management relevant for Indian cities. It takes a comprehensive approach to wastewater management, focusing on topics such as the wastewater management scenario and challenges in urban India, urban drain management, wastewater management in unauthorised colonies, reuse and recycling of treated wastewater, innovations and capacity building as part of wastewater management, and so on.

NIUA is committed to helping Indian cities improve their performance against each SDG Indicator. In addition to leveraging our internal resources, we partner with media houses, academic institutions and other government and non-government organisations, for research, capacity-building and advocacy outcomes. The collaboration of NIUA and eGov Magazine is a demonstration of the same. To come up with this special edition, teams at NIUA and eGov have enthusiastically worked together, to collate a diverse range of knowledge-base on the themes of wastewater management and ambient water quality of waterbodies. My sincere thanks to all the authors who have contributed to this special edition and shared their knowledge to make this possible.

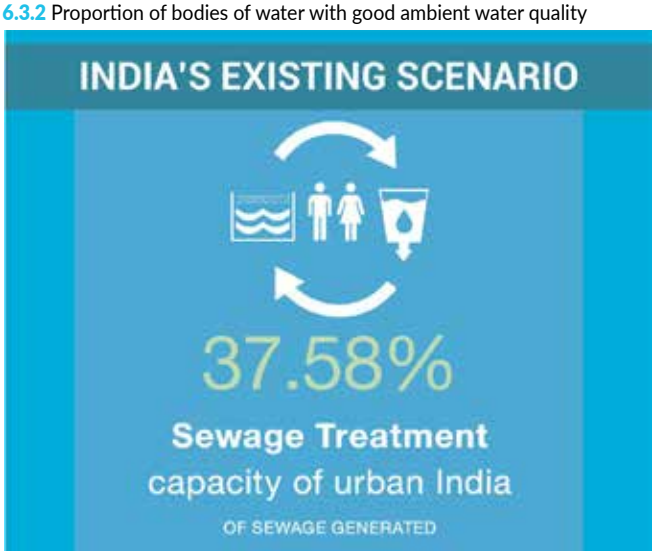
SUSTAINABLE DEVELOPMENT GOAL 6

By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

UN Indicator for SDG 6.3

6.3.1 Proportion of domestic and industrial wastewater flows safely treated

6.3.2 Proportion of bodies of water with good ambient water quality



Ministry of Statistics and Programme Implementation Indicator for SDG 6.3

6.3.1: Percentage of sewage treated before discharge into surface water bodies.

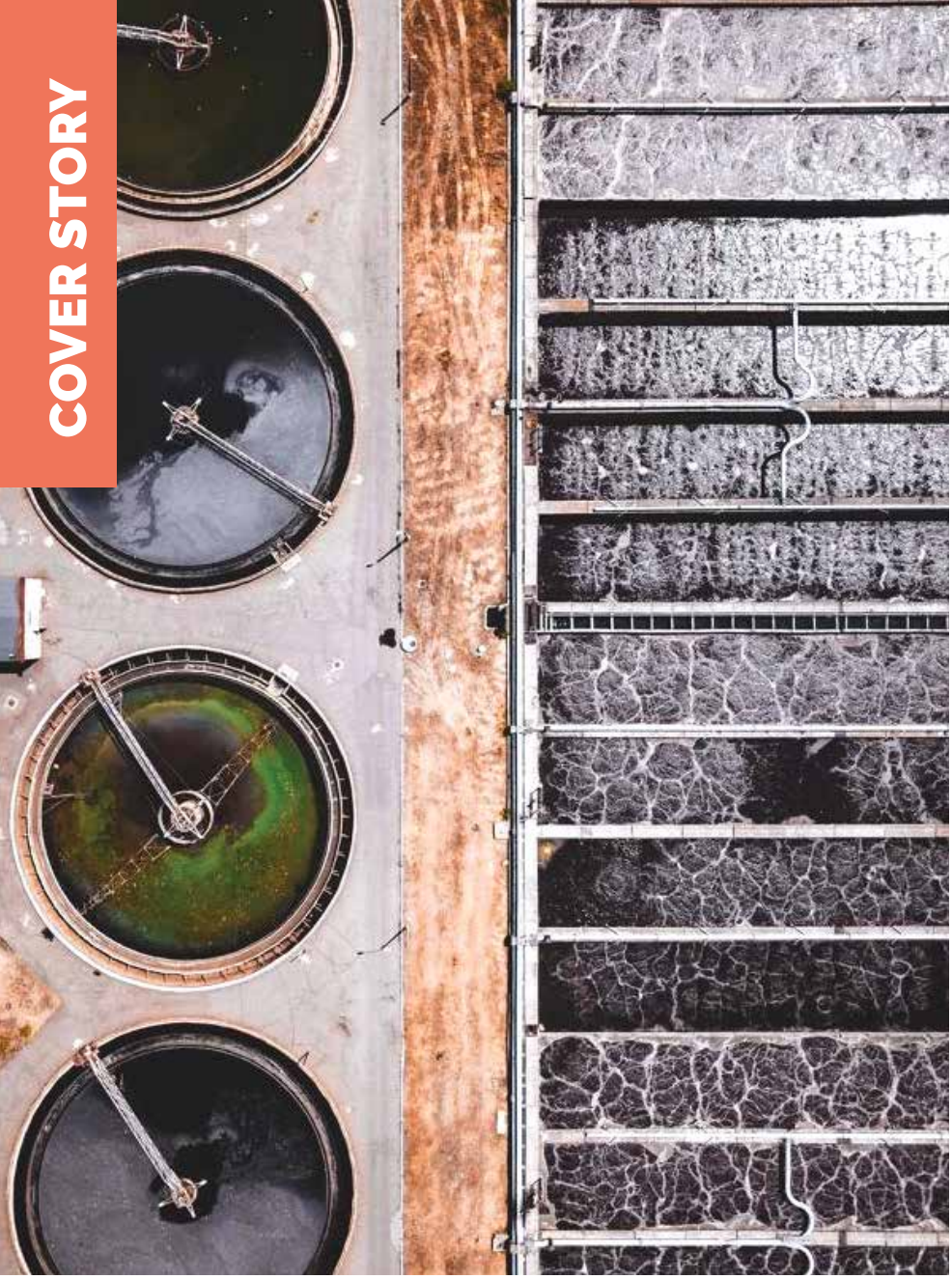
6.3.2: Percentage of industries (17 category of highly polluting industries/grossly polluting industry/red category of industries) complying with waste water treatment as per CPCB norms.

6.3.3: Proportion of waste water treatment capacity created vis-à-vis total generation.

351 River stretches in India are polluted as per CPCB report (2018).

The **Swachh Bharat Mission, AMRUT, Namami Gange mission** are primary focusing on treatment of wastewater flows aiming at achieving SDG 6.3

Source: National Institute of Urban Affairs. (2021). Handbook of Urban Statistics, NIUA, New Delhi. Retrieved from https://www.niti.gov.in/sites/default/files/2020-07/SDX_Index_India_Baseline_Report_21-12-2018.pdf



India is ranked as the world's 13th most water-stressed country by the World Resources Institute's Aqueduct Water Risk Atlas[1]. According to the NITI Aayog's report[2], India is placed 120th amongst 122 countries in the water quality index, with nearly 70 per cent of water being contaminated. Both surface water and groundwater in India are highly exploited; it is no surprise that the country's water challenges are multifaceted and diverse. In this article, **Hitesh Vaidya**, Director, National Institute of Urban Affairs (NIUA) brings to light the aforementioned subject and the government's efforts to achieve SDG 6.3.

WASTEWATER MANAGEMENT IN URBAN INDIA

Source: Economic and Political Weekly

Water pollution is a significant factor contributing to India's water crisis. With rapid expansion of cities, and domestic water supply, the quantity of wastewater is also increasing rapidly. The biggest deficit in urban sanitation has been the inadequate treatment of wastewater. Anywhere between 80 and 90 per cent of wastewater in urban India is let out untreated into the environment, causing considerable public health impacts (the economic impacts of which were estimated at Rs 2,180 per capita per annum, the equivalent of about 6.4 per cent of India's GDP in 2006[3]).

Untreated sewage-waste is one of the major causes of surface water and groundwater pollution in India. Raw waste material dumped in a water body usually cleans itself through a natural action of stream and self-purification. However, rapid urbanisation and the resulting rising population has led to an increase in sewage discharge that far exceeds the speed of natural purification. Wastewater is let out untreated due to the lack/unavailability of sewerage network and discharged into the natural drainage system causing pollution downstream. Owing to lack of or improper treatment facilities, wastewater carrying toxic effluents is often discharged into surface water bodies, resulting in pollution. Wastewater should be treated efficiently to avert adverse health risk to the user of surface water resources and the aquatic ecosystem.

As per the recent National Inventory of Sewage Treatment Plants published by Central Pollution Control Board (CPCB) in 2021, there are 1,631 STPs (including proposed STPs) with a total capacity of 36,668 MLD covering 35 states/UTs. Out of these 1,631 STPs, 1,093 are operational, 102 are non-operational, 274 are under construction and 162 STPs are proposed for construction. When compared to the previous inventory of STPs (2014), it is discovered that sewage treatment capacity has increased by 50 per cent; however, the gap remains enormous, as sewage generation is estimated to be 72,368 MLD, capacity utilisation is only 20,235 MLD, and the remaining quantity of 52,133 MLD is let-out as untreated sewage. Various missions under the Government of India such as Swachh Bharat Mission-Urban (SBM 2.0), National Mission for Clean Ganga (NMCG) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT 2.0) have been taking initiatives

UN Indicator for SDG 6.3

- 6.3.1 proportion of domestic and industrial wastewater flows safely treated
- 6.3.2 Proportion of bodies of water with good ambient water quality

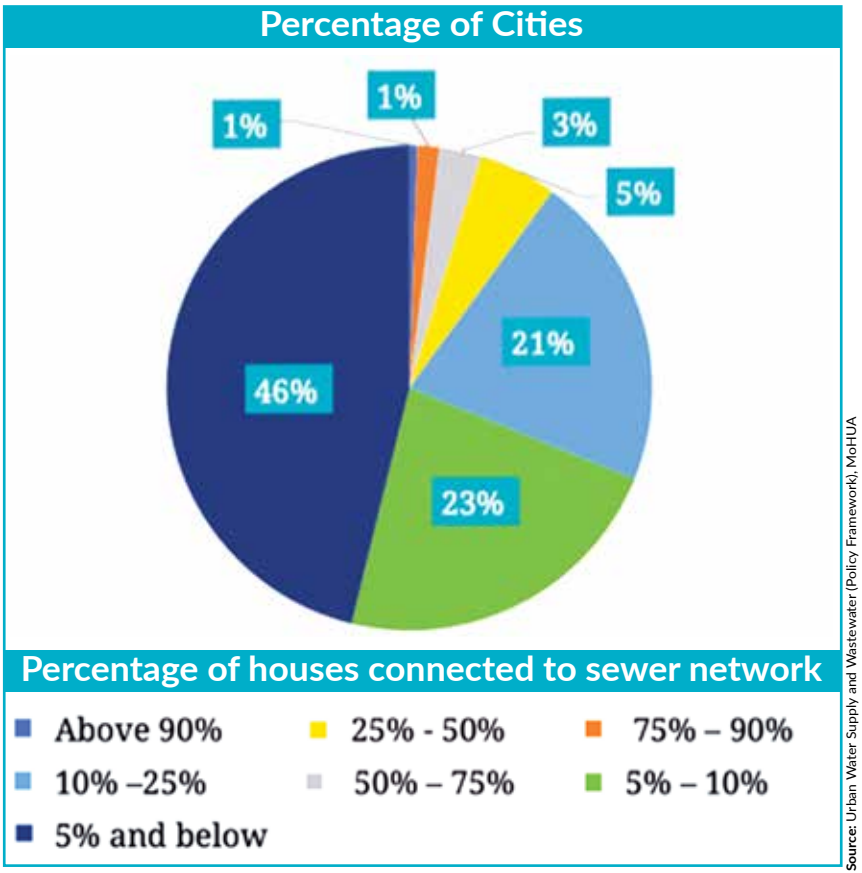
1. Earth, D. t., 2019. India, world's 13th most water stressed country:WRI, New Delhi: Down to Earth.
2. Aayog, N., 2019. Composite Water Management Index, New Delhi: NITI Aayog.
3. Wankhade, K., n.d. Operationalising SDG 6 in Urban India, Bangalore: IIHS Bangalore

to reduce the sewage generation and treatment gap and also putting equal emphasis on reuse of treated wastewater as part of developing a water secure India. Currently, only a few states in the country have implemented wastewater management policies, including Gujarat, Maharashtra, Rajasthan, Chhattisgarh, Karnataka, and Madhya Pradesh. In the absence of a blanket national mandate and standard regulations throughout states to manage the untreated wastewater pouring into bodies of water, the initiatives of a few states to control water pollution are not enough.

India's urban population is projected to grow rapidly and generate mounting volumes of urban wastewater, driving the need for increased investments in developing wastewater systems centralised, decentralised or nature-based solutions to manage flows and protect downstream areas.

With only 30 per cent of wastewater treated before discharge (and a small amount is reused), India has an immense opportunity to capitalise on projects that treat wastewater for recycling and reuse. Widespread water recycling and reuse offers a reliable, long-term water supply source for helping meet both potable and non-potable demand. By reusing treated wastewater, India can significantly bridge the supply-demand gap.

Reclaimed water/treated wastewater could also represent a key source for meeting the country's vast agricultural demand, reducing the strain on depleted groundwater resources. Further non-potable uses of reclaimed water include irrigation, toilet flushing, fire protection, dust control, and air-conditioning. In industry, reclaimed water treated to higher qualities can be used for cooling applications, as boiler feedwater, or to help meet a variety of industrial process water needs. In addition, reclaimed water purified to drinking standards can be used to recharge aquifers, augment reservoirs and potable supplies.



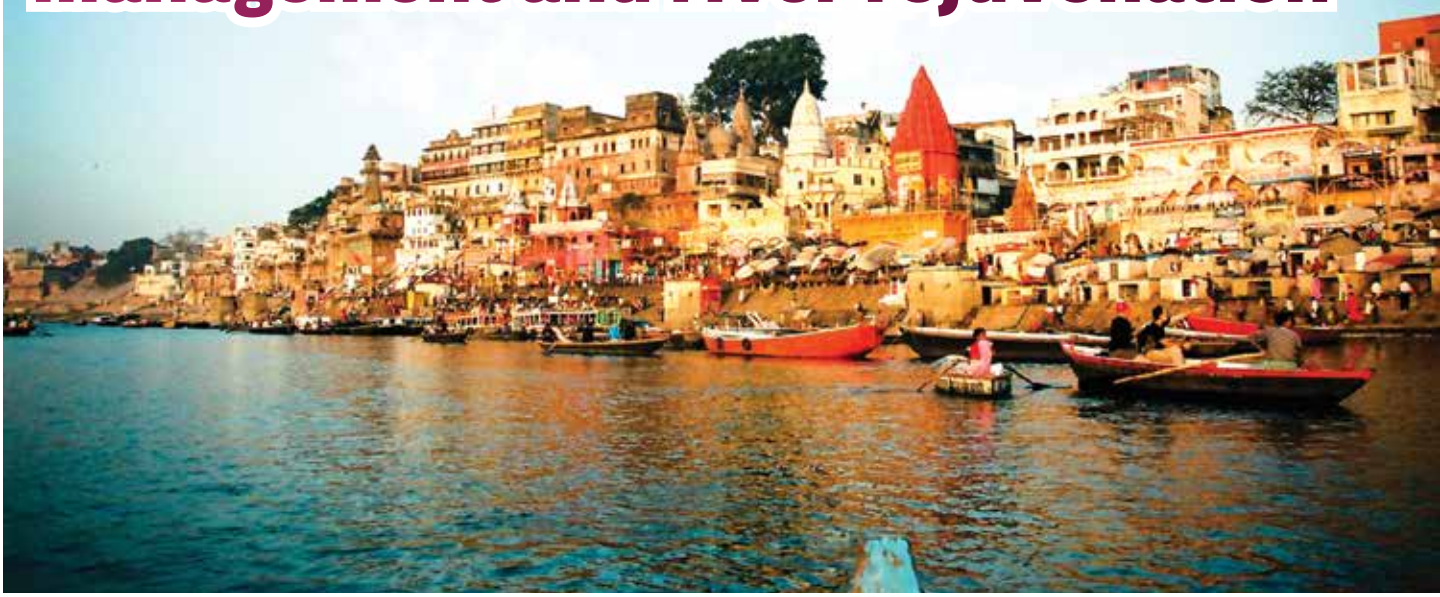
Source: Urban Water Supply and Wastewater (Policy Framework), MoHUA

Distribution of cities by sewer connections

Reuse of treated wastewater can play an important role in maintaining sustainable use of water resources. India needs to take timely measures to avoid a series of associated problems, ranging from health issues due to poor sanitation and conflicts over water access to food security and climate change. Regulatory/ policy interventions by the Central and state governments, further to the existing ones, are needed for encouraging innovative reuse projects. The interventions will need to focus on incentivising the use of reclaimed water, and developing institutional support mechanisms. Another aspect to manage the treated wastewater is the monitoring of the treated wastewater coming out of the treatment plants. Innovation in the field of automatic data monitoring systems in the form of dashboards can help the cities in making definitive decisions. Capacity building of cities is another such area where cities need the handholding from the state, Central government and experts in the field of wastewater management.

NIUA is nudging states and cities through several initiatives like creation of River Cities Alliance (RCA), capacity building of ULB officials on wastewater management & reuse of treated wastewater, waterbody diagnostic tool etc. to catalyse progressive action in the water and wastewater management sector through the adoption of improved management solutions. The objective of NIUA is to strengthen the policy interface, create innovative guidelines, networking and plug capacity building in the wastewater management sector. NIUA is devoted to assisting states and cities in aligning with the SDGs and initiating a conversation for future orientations in India's wastewater sector through substantial research, policy advisory, data solutions, technology, and capacity building.

Namami Gange: Sustainable solutions for wastewater management and river rejuvenation



» G ASOK KUMAR, IAS
Director General, National Mission for Clean Ganga

NMCG has always strived to keep the people at the centre of the Namami Gange Mission and its efforts have led the mission to be transformed into a Jan Andolan today. With concerted efforts and practice-oriented policy interventions, Namami Gange is successfully moving towards management of wastewater through a sustainable approach and protecting, conserving, and rejuvenating Ganga river basin, writes **G Asok Kumar**, IAS, Director General, National Mission for Clean Ganga.

For our continuous economic growth and prosperity, it is essential for cities to focus on sustainable management of water resources and provide access to safe water and sanitation. Without access to safe water and sanitation, both mankind and nature experience the detrimental effects, which will be magnified multi-fold due to the phenomenon of climate change. In 2015, the United Nations General Assembly (UNGA) declared 17 Sustainable Development Goals (SDGs) to call for action by all countries – poor, rich and middle-income – to promote prosperity while protecting the planet, to be achieved by 2030.

Of these, the Sustainable Development Goal 6 pertains to 'Clean Water and Sanitation' and includes eight targets, which are - access to clean water and

sanitation, protection and restoration of entire water related ecosystems, universal and equitable access to safe and affordable drinking water, improved water quality by reducing pollution, substantially increase water-use efficiency across all sectors to ensure sustainable withdrawals and supply of freshwater, etc.

The Government of India has undertaken several initiatives to achieve SDG 6 and its targets. The Ministry of Jal Shakti's 'Catch the Rain' campaign from March 22, 2021 till December 31, 2021, became a people's movement. It encouraged states and stakeholders to create appropriate rainwater harvesting structures suitable to climatic conditions and subsoil strata, through participation of people. This campaign is continuing this year as well.

The Namami Gange Mission was launched by GoI in 2014-2015 with a holistic vision of protecting, conserving, and rejuvenating the river Ganga. The mission now comprises of five major verticals namely 'Nirmal Ganga' with focus on pollution abatement, 'Aviral Ganga' with focus on ecology and flow of river Ganga, 'Jan Ganga' with aim of people participation, 'Gyan Ganga' with focus on research, policy, and knowledge management and 'Arth Ganga' for sustainability with river-people connect using economic bridge. Out of the eight sub-targets, SDG 6.3 is defined as "By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally."

National Mission for Clean Ganga (NMCG) as the implementing agency of the mission is responsible for undertaking the pollution abatement measures for river Ganga and its tributaries. To cater the industrial and residential pollution abatement, emphasis is laid on developing sewerage infrastructure which comprises sewerage treatment by construction and rehabilitation of STPs, integrated sewerage network and projects focusing on interception & diversion works.

Despite previous interventions to revitalise the Ganga and address gaps in the sewage treatment systems, these attempts failed to deliver the expected treatment services due to a variety of factors such as lack of ownership, less support for asset sustainability, and suboptimal performance of the treatment infrastructure, among others. Hence, to develop a reliable and sustainable solution, NMCG introduced a paradigm shift in the Indian sewerage sector, which included innovative best practices such as Hybrid Annuity Mode (HAM) under Public-Private Partnership (PPP), wherein 40 per cent of the capital cost is paid during construction, and the remaining 60 per cent is paid over a period of 15 years as annuities with interest on outstanding balance, along with operation and maintenance expenses and One City One Operator Model to increase accountability in water infrastructure and service delivery.

Namami Gange Mission has undertaken various policy driven initiatives for sustainable wastewater management in Ganga basin. NMCG has framed the National Framework on the Safe Reuse of Treated Wastewater, which will serve to guide the implementation of reuse projects across India. Urban Local Bodies (ULBs) are also encouraged to reuse treated wastewater for revenue generation and conversion of sludge into usable products such as manure, pavers, bricks etc. NMCG has signed Memorandum of Understanding (MoU) with the Ministry of Railways regarding use of non-potable water released after treatment from STPs located in Ganga and Yamuna River Zones for railway purposes.

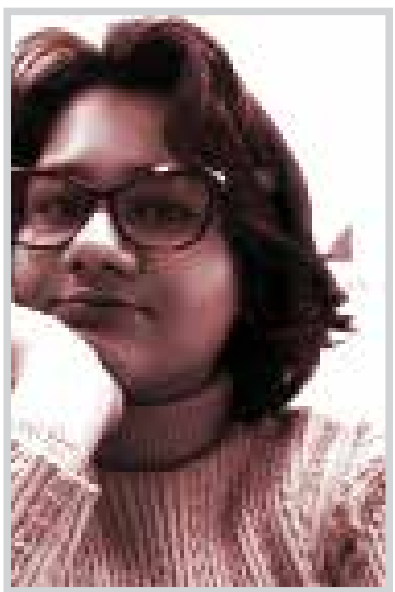
Additionally, in collaboration with the Ministry of Power, NMCG has mapped STPs located within 50 km radius of Thermal Power Plants (TPP). Consequently, it has released an advisory to the TPPs which mandates the conveyance of wastewater from STPs to Tertiary Treatment to be borne by TPPs. NMCG is encouraging its stakeholders to adopt a circular economy approach in the water sector by promoting concepts like Zero Liquid Discharge in Ganga basin cities at various national and international platforms. NMGC has also set up a Centre of Excellence on water reuse in association with TERI, which also aims to support and provide policy interventions focusing on water reuse at state and national level.

Over the years, concerted efforts made by NMCG are beginning to find success in restoring the pristine glory of the river. Under Arth Ganga, NMCG is focusing on promotion of Zero Budget Natural Farming (ZBNF) along 10 kms of either side of river Ganga, which will eliminate pollution from agricultural land and generate income for farmers. NMCG is conducting workshops with different stakeholders including farmers, for adoption of zero budget natural farming. NMCG has also signed an MoU with Sahakar Bharati for setting up 75 Sahakar Ganga Grams for promoting natural farming. Additionally, NMCG is in process of signing an MoU for promoting formation of cooperatives for Arth Ganga.

NMCG has always strived to keep the people at the centre of the Namami Gange Mission and its efforts have led the mission to be transformed into a Jan Andolan today. Along with this, 131 DGCs have been constituted to support and strengthen the participation of local communities in improving water and sanitation management to align with the vision of Namami Gange Mission. In April, DGC Dashboard was launched and it was mandated to conduct DGC meetings, which are to be held on the 2nd Friday of every month. With these concerted efforts and practice-oriented policy interventions, Namami Gange is successfully moving towards management of wastewater through a sustainable approach and protecting, conserving, and rejuvenating Ganga River basin. egov

Effective management of wastewater is the key to managing urban rivers

India has 18 per cent of the world's population, but only 4 per cent of its water resources. A large number of Indians face high to extreme water stress. This highlights the importance of addressing the issue of pollution of freshwater, write **Banibrata Choudhury**, Senior Research Associate and **Shilpi Chakraborty**, NIUA.



» **BANIBRATA CHOUDHURY**
Senior Research Associate, NIUA

» **SHILPI CHAKRABORTY**
Intern, NIUA

Introduction

Although urbanisation is now a global phenomenon, its effects are more apparent in developing nations. However, rapid and uncontrolled urbanisation and development activities have an ill effect on the precious water resources, both in quantitative and qualitative terms. Water resources are also directly associated with the impacts of climate change. The SDGs were adopted to allow for this growth and development to occur in a sustainable way. Also, India has 18 per cent of the world's population, but only 4 per cent of its water resources. A large number of Indians face high to extreme water stress.[1] This highlights the importance of addressing the issue of pollution of freshwater.

It is estimated that around 70 per cent of surface water in India is unfit for consumption.[2] Also, the health and economic impacts of water pollution are quite critical. Annually, about 37.7 million Indians are affected by waterborne diseases, 1.5 million children die of diarrhoea and 73 million working days are lost leading to an economic burden of $600 million a year.[3] Also, as per the latest assessment by the Central Pollution Control Board, number of polluted river stretches in the country are 345, out of which 45 are critically polluted. Both these numbers have gone up from their last assessment. Against this backdrop, India needs to take serious actions towards sustainable urban development focusing on the SDG target 6.3, which focuses on improving water quality by reducing discharge of untreated

1. World Bank Group- Brief on World Water Day 2022: How India is addressing its water needs (2022)
2. Water pollution is killing millions of Indians. Here's how technology and reliable data can change that, World Economic Forum (2019)
3. Water contamination and pollution - A growing challenge for health and biodiversity by Aarti Kelkar Khambete (2021)

wastewater, increasing recycling and reuse of treated wastewater and restoration and preservation of water bodies.

India: Urbanisation and river system

India is one of the fastest growing economies in the world, aspiring to become a $5 trillion economy by 2026 and $40 trillion by 2047, when India marks 100 years since its independence. In this process, the country is urbanising at a rapid pace. The number of inhabitants in Indian cities is estimated to have increased almost fourfold between 1970 and 2018, from 109 million to 460 million.[4] Rapid urbanisation in the country is evident from the fact that urban population in India has increased from 10.8 per cent in 1901 to 31.2 per cent in 2011 and similar is the case with the number of cities in India.[5] Historically, cities have grown over the banks of rivers. India is home to more than 400 rivers, which either drain into the Arabian sea or the Bay of Bengal. Hence, every city of the country lies on the basin of one river or the other. Almost 60 per cent of the class I cities and 80 per cent of the million plus cities in India are river cities. This highlights the importance of maintaining healthy rivers for improved quality of life in these urban centres.

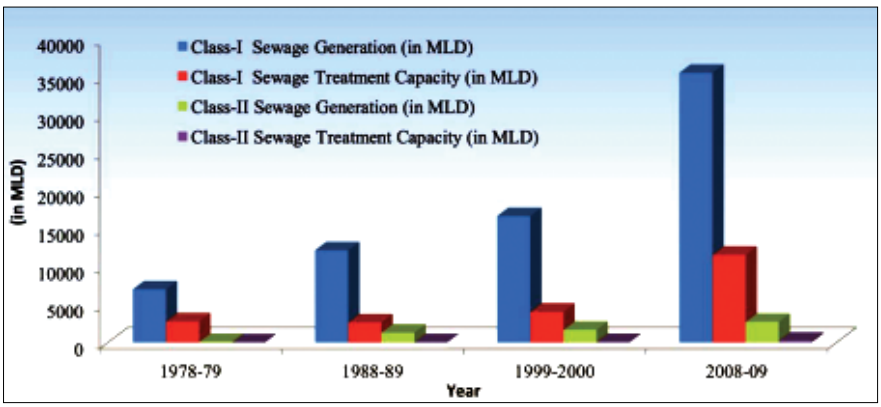


Figure 1 Decadal trend of sewage generation and treatment capacity in Class-I cities and Class-II towns

India generates approximately 62,000 MLD of domestic sewage from its urban centres. There are approximately 1400 sewage treatment plants (STPs) operated primarily by municipal corporations, with an actual treatment capacity of close to 27,000 MLD, i.e., merely 37 per cent of generation.[6] Remaining part of this wastewater generated ends up being drained into rivers and waterbodies. Other important issues in this context are that many of the existing sewage treatment plants are either non-functional or not being utilised to their installed capacities.[7,8] Approximately 40 per cent of the capacity of STPs is not functional.[9]

As per the 2008-09 estimates of CPCB, out of 38,254 MLD of sewage generated in class I cities and class II towns, only 11,787 MLD was treated. But different cities are also slowly moving towards the utilisation of treated wastewater. Apart from using treated wastewater for irrigation, landscaping, horticulture, construction etc, cities like Chennai, Delhi, Jamshedpur, Nagpur, Surat etc are using this water in industries, thermal power plants, washing of vehicles etc. Though government missions like NMCG, AMRUT and some others have facilitated construction of STPs and several water rejuvenation programmes, most STPs do not operate on adequate efficiency.

Key gap areas

Monitoring is the key to addressing the issue of pollution of rivers. As per the online database of CPCB ENVIS, more

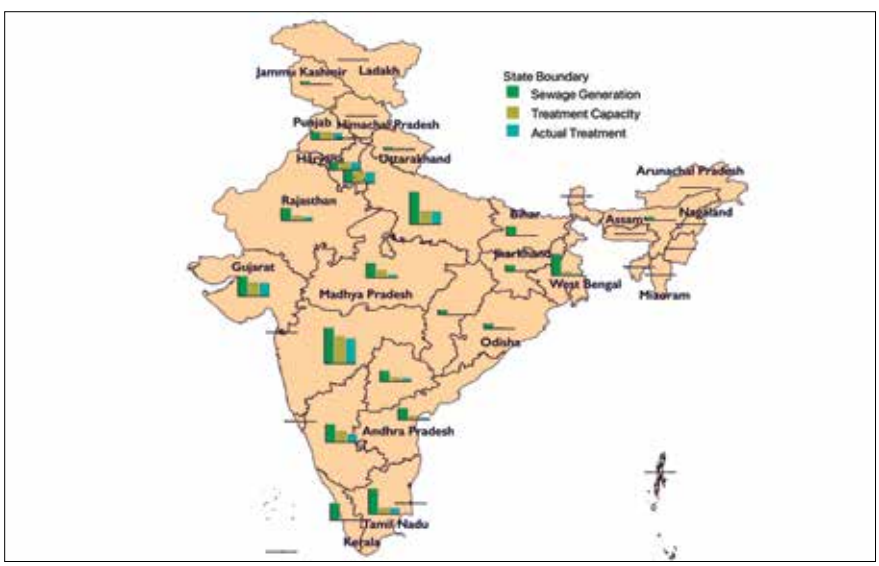


Figure 2: Million-plus cities and their sewage treatment scenario

4. Cities as Engines of Growth- Executive Summary by NITI Aayog and Asian Development Bank (2022)
5. India's Urban System: Sustainability and Imbalanced Growth of Cities by Abdul Shaban, Karima Kourtit and Peter Nijkamp (2020)
6. Mitali Nikore and Mahak Mittal, "Arresting India's Water Crisis: The Economic Case for Wastewater Use," ORF Issue Brief No. 453, March 2021, Observer Research Foundation
7. National Inventory of sewage Treatment Plants by CPCB (2021)
8. http://www.sulabhenvis.nic.in/Database/STST_wastewater_2090.aspx
9. National Framework on the Safe Reuse of Treated Water by National Mission for Clean Ganga (2021)

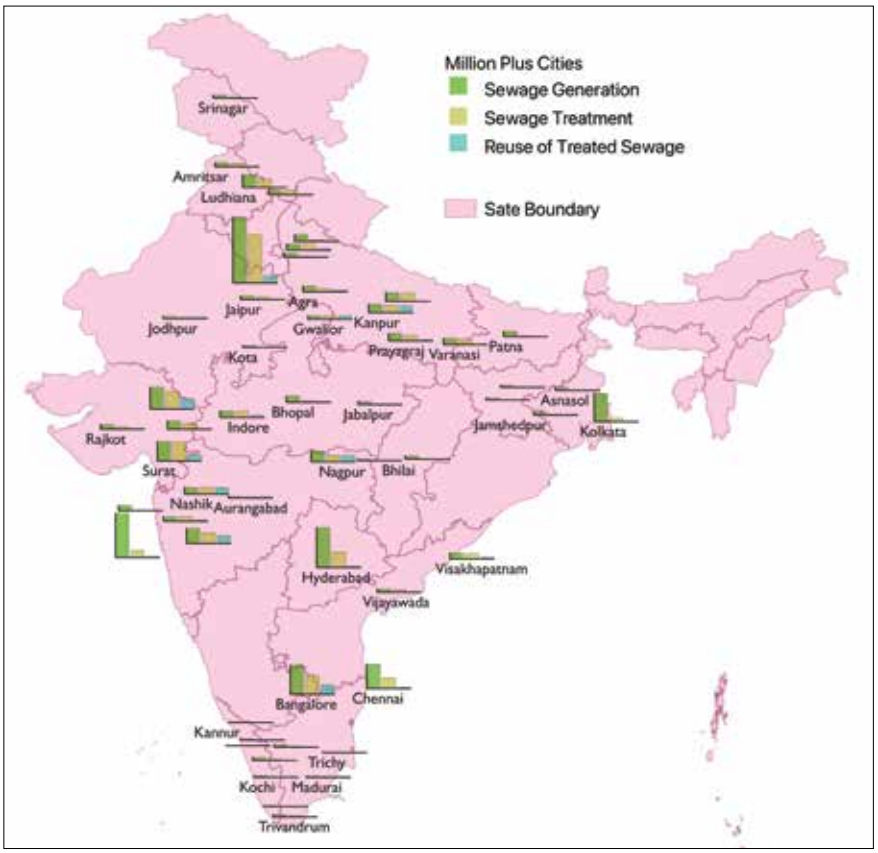


Figure 3: Map showing the state wise waste-water treatment scenario in urban centers in India

than half of the metropolitan cities do not have regular and periodic monitoring of the water quality of their rivers. Another important issue in this context is that water quality is monitored mostly for the major and some of the medium rivers. But at present, no monitoring mechanism exists for many smaller rivers. For instance, in Kanpur city, water quality is monitored for river Ganga, but river Pandu, a tributary of Ganga, does not have any water quality monitoring station. Similarly, Varanasi, the spiritual centre of India, lacks information on the river's water quality despite having its second syllable derived from the Assi. The city only monitors water quality of the rivers Ganga and Varuna. But most of these smaller rivers, being tributaries of some or other major rivers, become equally important to be monitored and in most cases, these are the ones which are under tremendous pressure of pollution, reduction in baseflow, floodplain encroachment etc.

India is home to more than 400 rivers, which either drain into the Arabian sea or the Bay of Bengal. Almost 60 per cent of the class I cities and 80 per cent of the million plus cities in India are river cities. This highlights the importance of maintaining healthy rivers for improved quality of life in these urban centres.

Urban lakes and waterbodies are also an important source of surface water (e.g. for cities like Bhopal, Udaipur etc.) But urban water bodies are also being harmed by the ill effects of pollution due to improper management of both solid and liquid wastes. In many cases, urban water bodies also become hotspots for solid waste dumping, making them vulnerable to encroachment. For instance, the municipal corporation has been disposing of solid garbage in Guwahati's Deepor Beel since 2006. Solid trash is dumped even in Chennai's Pallikaranai wetland. Heavy metal concentration can be found in lakes in Nagpur and Bhopal and the Hussainsagar lake in Hyderabad after idol immersion every year.[10]

Also, regarding pollution prevention, the focus has mostly been on construction of STPs and laying of sewer networks. But the operational efficiency of these critical infrastructures has always been a matter of question. Also, in lines of the SDG 6.1 and 6.2, India is striving hard towards provision of universal access to safe drinking water and sanitation for all. Under Jal Jeevan Mission (Urban), universal coverage of water supply to all households through functional taps in all 4,378 statutory towns and providing coverage of sewage/septage management in 500 AMRUT cities have been targeted.[11] But with the current gap in wastewater generation and treatment infrastructure, situations are going to be more challenging. Although India's policy and regulating frameworks acknowledge the necessity of wastewater recycling and reuse, there hasn't been much in the way of detailed benchmarks.

10. https://www.downtoearth.org.in/news/urbanisation/two-sides-of-the-same-coin-shrinking-water-bodies-and-urban-floods-72702
11. https://pib.gov.in/PressReleasePage.aspx?PRID=1694420

What is India doing for sustainability?

The government has been actively developing policies and supporting initiatives to move the nation toward a circular economy recently. A number of policies and regulations have been announced in the domain of municipal solid and liquid waste in order to promote scientific waste processing and resource recovery. With the introduction of Swachh Bharat Mission-Urban (SBM-U) in 2014, the circular economy agenda for municipal solid & liquid waste gained major impetus at the national, state, and local levels. The Mission has been effective in raising urban India's solid waste treatment capacity from 18 per cent in 2014 to 68 per cent today, thanks to the 3R principles (reduce, reuse, recycle) (including recycling).

Water resource protection is one of the main benefits of recycling water, since it lessens water pollution discharges and the need to extract water from natural practices. Out of the more than 54 million communities, 32 have successfully recycled and reused wastewater for commercial, irrigational, and agricultural reasons, whereas the remaining 22 have not done so. The National Water Policy-2012 promotes the reuse and recycling of treated water in accordance with established requirements. The Ministry of Housing and Urban Affairs (MoHUA) has also released a variety of recommendations for urban cleanliness, including wastewater recycling and reuse. Water recycling and reuse is extensively covered in the 2013 Manual on Sewerage and Sewage Treatment Systems (CPHEEO 2013), and its rules serve as national standards.

The Ministry of Power, under its 2016 Tariff Policy, requires thermal power plants located within 50 km radius of a sewage treatment plant (STP) of a ULB to mandatorily use treated wastewater. Also, various states like Gujarat, Chhattisgarh, Madhya Pradesh, Punjab etc have developed state-specific policies for reuse of treated wastewater. National Mission for Clean Ganga has developed frameworks on Urban River Management Plan, Safe Reuse of Treated Wastewater. Key focus of these plans is to improve the quality of the urban rivers, majorly through management of liquid waste of the city. But cities need to proactively come forward to adopt these frameworks. A National Water Framework, which serves as an overarching set of basic principles managing water concerns by the Central government, the state governments, and the local governing bodies, must be integrated into the current water and wastewater policies and programmes. This ought to pave the way for crucial legislation on wastewater governance throughout the nation.

> *"Although India's policy and regulating frameworks acknowledge the necessity of wastewater recycling and reuse, there hasn't been much in the way of detailed benchmarks."*

Keeping up with innovations

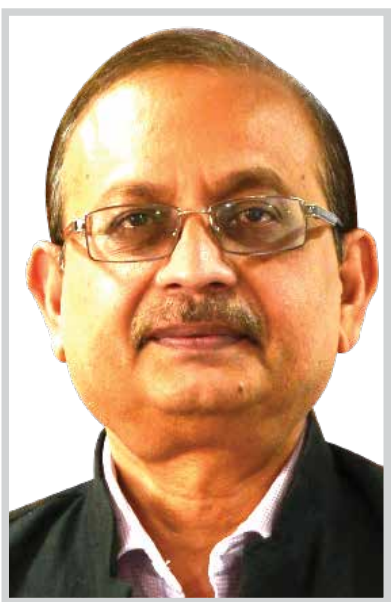
The processing of wastes may be restricted by convectional wastewater technology, which would exacerbate the already existing issues with potable water across the world. Therefore, it is imperative to create innovative techniques to lessen the impact of wastewater on the ecosystem, which is already deteriorating. It cannot be overlooked how some cities in India are also taking unique and innovative approaches to manage their river pollution. For example, RENEU technology for bioremediation of drains developed by NEERI, vertical STP by the Namami Gange in Rishikesh, and nature-based/ blue green solutions for treatment of wastewater.

Way forward

Access and treatment are only the beginning and conclusion of the problem of urban sanitation. Even though it isn't stated explicitly in the SDGs, securing the whole cycle of urban sanitation, including safe and dependable collection and conveyance is necessary, if the targeted goal is enhanced public health. While more treatment facilities are required, there are also other improvements that must be made at every stage of the cycle, such as the safe containment of untreated excreta and the prevention of leaks into the open, routine and safe septic tank emptying and desludging, a switch to mechanical equipment for emptying (preventing manual handling), safe conveyance, plugging of exfiltration in the sewerage networks, and so on.

The most typical method of wastewater management in Indian cities has been to dump the pollutants and garbage onto surrounding peri-urban and rural regions in order to relocate them. Urban India will need to take on the issue of planning and executing waste management innovations utilising regional (urban-to-rural continuum) frameworks over the future years, as increasing citizen awareness, judicial monitoring, and improved enforcement have indicated in many regions.

Inclusion of private sector in wastewater management



RAJIV RANJAN MISHRA
Chief Technical Advisor, NIUA.

According to a report of the Observer Research Foundation, the water and wastewater sector in India is developing at a rate of 10-12 per cent each year and is likely to exceed $4 billion due to rising demand for water and wastewater treatment plants in the country. There will be a significant investment gap in this industry, which the private sector may cover through technology selection, fund rotation, and execution, writes **Rajiv Ranjan Mishra**, Chief Technical Advisor, NIUA.

The majority of Indian cities/ towns lack basic sewerage infrastructure, and those that do have partial sewerage systems operate at sub optimal capacities. This leads to discharge of most of the wastewater into water bodies with partial or no treatment, causing serious environmental degradation. In sanitation sector, while much has been achieved for providing access to toilets to all the households, mainly through Swachh Bharat Mission, supported by missions like AMRUT etc., the largest gap remains in the development of sewerage infrastructure with adequate treatment capacity, along with a network to transport wastewater to sewage treatment plants, where treated wastewater can be reused or discharged after adequate treatment, as per stipulated standards.

According to the latest report of Central Pollution Control Board (CPCB) for 2020-2021, the estimated sewage generation from urban areas is 72,368 MLD, with total treatment capacity from 1,631 STPs (including proposed STPs) being only 36,668 MLD covering all 35 states/UTs. Out of these STPs, 1,093 are functional, 102 non-operational, 274 under construction, and 162 slated for construction. When compared to the previous inventory of STPs (2014), it is discovered that sewage treatment capacity has increased by 50 per cent. The gap in treatment capacity, however, remains enormous, as seen from the above statistics and even out of this existing capacity, the actual capacity utilisation complying with prescribed standards is only 20,235 MLD, and the remaining quantity of 52,133 MLD is let-out as untreated/ improperly treated sewage to water bodies and rivers.

The poor performance of existing service providers in the sector and non- compliant STPs as well as suboptimal capacity utilisation is caused by a combination of improper planning, lack of funds and technical capability, along with traditional lack of attention by decision makers. These factors and the massive investment requirements anticipated in this sector has led to the exploration of Public-Private Partnership (PPP) models in the sector as a panacea for the aforementioned problems. According to a report of the Observer Research Foundation, the water and wastewater sector in India is developing at a rate of 10-12 per cent each year and is likely to exceed $4 billion due to rising demand for water and wastewater treatment plants in the country. There

will be a significant investment gap in this industry, which the private sector may cover through technology selection, fund rotation, and execution.

SDG 6.3 aspires to improve water quality, reduce pollution and untreated wastewater load and substantially increase recycled and safe reuse of treated wastewater. This demands substantial investment in new sewerage infrastructure, rehabilitating and upgrading the existing infrastructure, developing and practicing new and suitable technologies and an optimal mix of solutions for centralised as well as on site and in situ treatment, promoting nature-based solutions etc. Long term operation & maintenance (O&M) need to be embedded for sustaining the benefits of capital investment. The huge financial requirements to expeditiously bridge the huge gap between the generation and treatment capacity, while ensuring high quality standards, would require private investment in addition to public funds. Inadequate sanitation leading to huge social and economic costs on account of poor health and hygiene further makes a case for such investment.

The main policy governing the urban sanitation and sewerage sector is the National Urban Sanitation Policy (NUSP) of 2014. This also emphasises on wastewater reuse for conserving water and also improving environmental standards. It is suggested that at least 20 per cent of the generated wastewater be utilised promoting the prospect of income generation from the sale of treated wastewater. It also recognises the role of public-private partnerships (PPPs) in this sector, in terms of investments, cost recovery through wastewater reuse mechanisms, and improved management of sewerage treatment facilities and networks.

Most sewerage projects in India are apparently not financially viable for

Build, Operate and Transfer Model (BOT)

The end user or consumer itself is the private operator, hence owns and takes responsibility for the project.

BOT Third Party PPP (Annuity)

Third party operator is hired by Concession Granting Authority (CGA) to provide wastewater collection, treatment and discharge/ reuse services to the end users and is paid an annuity by the CGA to cover capital and O&M costs.

BOT Third Party PPP (User Charge)

Third party operator is hired by the CGA to provide wastewater collection, treatment and discharge/ reuse services to the end users and collects user charges in return from end-users itself

Design, Build, Operate Model (DBO)

The ULB or parastatal meets the capital costs for the project, and uses the private sector to bring in technology and managerial skills to operate and maintain the assets for a period of 5 to 10 years.

PPP models that are in use in wastewater management

usual PPP because current user charges do not cover O&M expenses, let alone capital requirements. As a result, commercial financing of these projects, completely through the bank loan or bond markets, is not a viable alternative at present without the adequate backing from government. The majority of sewage projects in the country have been funded by a combination of subsidies from national/state governments and multilateral/bilateral loans guaranteed by the Government of India. The major sources of funding for sewage projects in the government sector include grants from the central government, grants and loans from state governments, loans from multilateral/ bilateral agencies, and taxes and user charges, including one-time connection fees from ULBs.

Alandur, an urban local body in Tamil Nadu, first attempted a PPP initiative in this sector. Between 2000 and 2005, approximately six PPP projects were attempted, including Alandur, Tirupur, and four projects in Chennai. Between 2006 and 2011, the number of PPP projects attempted in the sector expanded due to the availability of financial support from centrally sponsored schemes and several urban missions. A major boost came from the Namami Gange mission which systematically developed PPP through Hybrid Annuity Model for wastewater sector. AMRUT 2.0 and SBM have also incorporated PPP and the national policy level push on PPP in the infrastructure sector has made it percolate to state and city level. Many of them now have projects with PPP initiatives and are gaining experience in the design of concession agreements, balanced risk sharing mechanisms which are essential for the success of PPP projects.

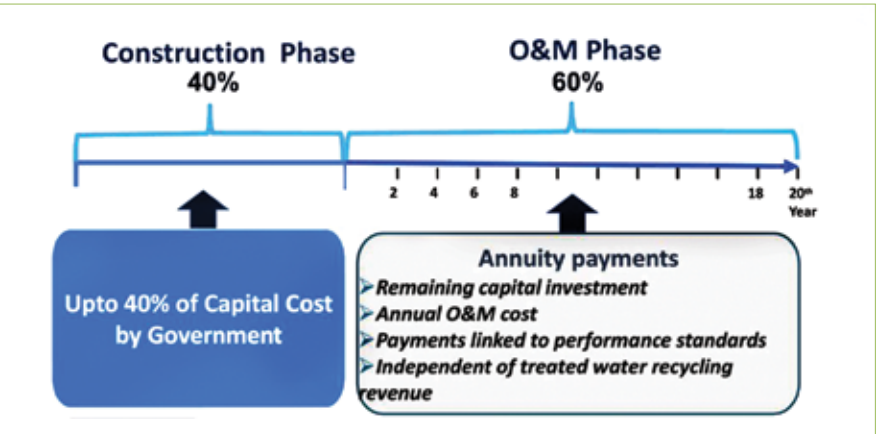
An analysis of these PPP models in India show that the BOT End-User PPP and the DBO model were the two most successful ones. The DBO Model is a success if private operators are given some type of guarantee on O&M payments. However, because the private operator is the end user, the BOT End-User PPP model is successful even without payment assurances.

Another approach to address revenue risk concerns of the private sector and government's own desire to ensure that the private sector has some "skin in the game" to ensure commitment

and performance of private sector over the duration of concession is to combine the BOT Annuity and the DBO models, which is Hybrid Annuity Model (HAM). National Mission for Clean Ganga (NMCG) introduced the HAM model in wastewater management under the Namami Gange Mission. HAM had its origin in the highways sector.

In a funds-stressed situation and lack of sufficient toll income, National Highways Authority of India (NHAI) was exploring alternatives to the conventional Design, Build, Finance, Operate and Transfer (DBFOT) model that relies on Grant/Premium or Annuity modes. NMCG modified the road sector HAM bringing innovative features for building confidence of private players and held extensive market and stakeholder consultations. By now, NMCG has 30 projects with a sanctioned cost of more than Rs 11,000 crore for 1700 MLD new capacity, along with rehabilitation of older assets and O&M for 15 years. Under the HAM, a significant portion of the capital cost of the project is required to be financed by the private developer. This amount is paid by the government to the developer in equal installments over the term of the concession, subject to sustained performance. 40 per cent of the capital cost for the project is paid by NMCG during the construction period, and balance 60 per cent along with interest paid as quarterly annuity along with Operation & Maintenance (O&M) cost during a period of 15 years.

This is a paradigm shift from payment for construction to payment for performance. One City-One Operator (OCOP), next innovation was conceptualised and implemented by NMCG for improving citywide governance in wastewater management. OCOP has led to the paradigm shift in managing sewage treatment in a city by integrating the development of new STPs with the existing treatment infrastructure in the city/town, with their rehabilitation/ upgradation as needed and O&M of all assets-new and old for 15 years under HAM, with an aim of achieving "no untreated sewage shall enter in to the river Ganga". OCOP ensures singular accountability of the entire sewage treatment issue in a city.



Overview of HAM Model

With the significant potential for scaling-up, it is important that the perception risk should be mitigated through alternative cost-effective Payment Security mechanisms, which is sustainable, consumes less capital and be more cost effective for the whole program. Wastewater, in many cases, is rich in recoverable materials. This may be the nutrient value of domestic wastewater or indeed a particular fraction of an industrial discharge. In many regions, the use of wastewater in agriculture is well understood, albeit in a way that carries significant health risks and hence, safety standards are important. What is needed is a better matching of available treated wastewater to the different reuse requirements in different purposes such as agriculture, industry, city needs, recharge of water bodies etc.

A national framework for safe reuse of treated wastewater is under development and many states have now come up with state policies. Gujarat and Tamil Nadu have several successful models for such reuse and Surat has significant income out of this. Hyderabad has also taken up major STP projects on HAM. The Mathura sewerage project under Namami Gange is a successful example of integrating the HAM model, OCOP approach and reuse of treated wastewater.

This project at a cost of Rs 437.95 crore integrates both the construction of new STPs (30 MLD) and rehabilitation & maintenance of existing assets (37 MLD) under one operator for the whole city. This has a capstone component of a 20 MLD Tertiary Treatment Plant (TTP) for reuse of treated wastewater by Mathura Refinery of Indian Oil Corporation Ltd (IOCL) for non-potable purposes. It saves 20 MLD fresh water from Yamuna for the refinery.

In order to ensure quality in delivery of urban wastewater management services, performance based contracting either through HAM or any other PPP mode should be adopted as a matter of policy. This will also support the implementation of polluter pays principle and help in achievement of sustainable development goals in the long run. Sector would flourish, mature in terms of reduced cost of treatment, assured quality of treatment & sustainability once more and more states adopt this approach.

Managing urban drains for citywide wastewater management

To treat wastewater, cities often rely on costly grey infrastructure, but they are continuously looking for innovative, cost-effective, and easy-to-manage options. Nature-based Solutions (NbS) provide a range of possibilities for treating municipal waste and is gaining traction among governments, writes Jyoti Verma, Senior Research Specialist, NIUA.

» JYOTI VERMA
Senior Research Specialist, NIUA.

Rivers and drains are integrated aquatic ecosystems in many Indian cities facing environmental degradation by untreated municipal waste and are key concerns for city administrators. While the agriculture and industrial effluent are complex in their distribution and composition; the municipal waste remains uniform. With rapid urbanisation and changing lifestyles, xenobiotic compounds like organic petroleum hydrocarbons, pesticides and other agrochemicals, pharmaceutical products (Elekwachi C. et al. 2014) not only increase load on treatment systems but jeopardise aquatic ecosystems in cities. According to a UN assessment, cities' wastewater treatment capacities range from 8 per cent to 70 per cent, resulting in large amounts of wastewater being released untreated into aquatic systems, posing a major threat to the environment and public health (UNHABITAT, 2019).

Increased surface runoff from cities' growing paved surfaces changes the urban water cycle, quickly transporting contaminants to rivers via drains. To treat wastewater, cities often rely on costly grey infrastructure, but they are continuously looking for innovative, cost-effective, and easy-to-manage options. Nature-based Solutions (NbS) provide a range of possibilities for treating municipal waste and is gaining traction among governments (WWAP, 2018). Sustainable NbS provides options to strengthen cities' resilience in the face of rising climate change concerns, exacerbated by unsustainable grey infrastructure-oriented pollution abatement measures.

Bioremediation is one of these NbSs, and it is quickly gaining traction as a safe, effective, low-cost, and ecologically acceptable long-term option for controlling aquatic pollution (Akta F. 2013). Bioremediation technology is presented in this article as a novel and complementary stop-gap method for pollution abatement. Overall, the bioremediation technology can significantly contribute in achieving SDG target 6.3, which is to improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater.

Bioremediation: Innovative NbS for pollution abatement

Only 37 per cent of total daily wastewater from entire Indian cites is treated and remaining ends in rivers and other water bodies, imposing threats to public health and environment (CPCB 2021). Several studies have highlighted significant pollution of rivers and loss of water bodies. The wastewater treatment gaps and delay to implement sewerage infrastructure in cities demands immediate stop gap arrangements to prevent pollution of rivers and local drains.

Though most cities aspire for centralised treatment options which have proven costly, limiting potential re-use of treated wastewater the decentralised treatment options catering to limited areas, adopted

from household to institutional scale are cost-effective and provide avenues for reuse of treated wastewater. NbS which mimic the natural processes are now gaining attention in India due to their potential to prevent pollution of rivers, and ecosystem services they offer through the Blue-Green infrastructure like urban forests and wetlands in cities.

In dense urban areas provisioning sewerage networks, space and access to polluted sites for cleaning is a challenge. Amongst many promising decentralised technologies, bioremediation seems techno-economically feasible and rapidly implementable in complex urban settings with minimal infrastructure, ease of operation, and cost-effectiveness. The technology is also recommended by the National Green Tribunal as a stop gap arrangement until STP and other infrastructure is available in unserved areas.

Bioremediation process

This innovative approach uses microbes which are introduced into the target sites to reduce pollutant load, rehabilitate polluted areas and increase self-cleansing capacity. The microbes consume contaminants like organic matter (waste food) oil, and convert them and expel carbon dioxide and water (EPA,2012). The process employs naturally occurring bacteria, fungi, or plants to degrade substances hazardous to human health or the environment. Most of the time, the microorganisms used in the process already exist in nature, preventing any environmental harm.

Since the mid-nineteenth century, it has been used to cleanse domestic wastewater. It was originally used to minimise industrial pollution and can be aerobic (with oxygen) or anaerobic (without oxygen). The procedure aids in the decrease of sewage's Biochemical Oxygen Demand (BOD) as well as stink. Microorganisms' breakdown organic molecules in wastewater often, using oxygen in the process. This is envisioned as ecotechnology for the 21st century, since it has few environmental and health dangers and uses few chemicals. This method could be immensely advantageous in a country like India, where inadequate sewage collection and treatment efficiency is polluting the environment.

Implementations approaches

To successfully execute bioremediation, a feasibility analysis in terms of viability, types of alternatives, CAPEX and OPEX, and institutional capabilities to oversee implementation and monitoring are recommended. Before its implementation, it is vital to determine the type of pollutants present (biological or chemical), and level of contamination. This will help to choose one of the two technology solutions available. The first is in-situ solution, which is applied to polluted water directly at site with minimal disruption, and the second is an ex-situ solution, which is applied to polluted water that has been pumped away from a site with minimal disruption.

Drain cleaning

Drains or nullas follow local terrain through the cityscape before merging with higher-order streams or larger rivers. Wastewater from places without sewerage infrastructure is discharged straight into drains, which might be lined or unlined. Unlined drains carrying dirty rivers have the potential to harm groundwater. To cure dirty drain water, bacteria are cultivated in large batches and applied to the running sewage with variable dosages from the beginning until the pollutants are gone. It usually does not involve any extra building or large drain or flow diversion improvements. This approach is less expensive, easier to

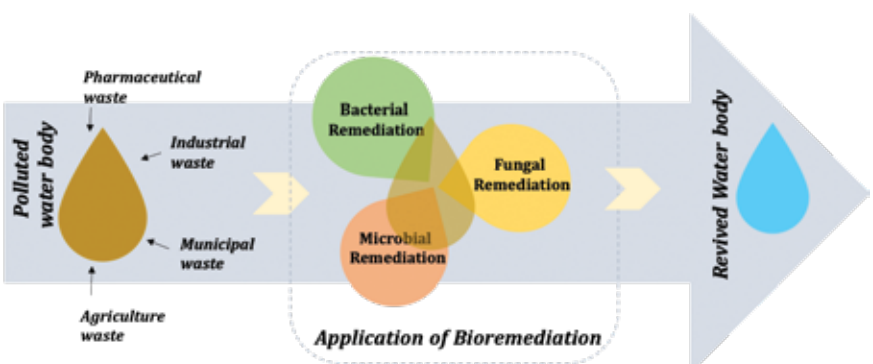


Fig1: Bioremediation application for reviving polluted waterbody

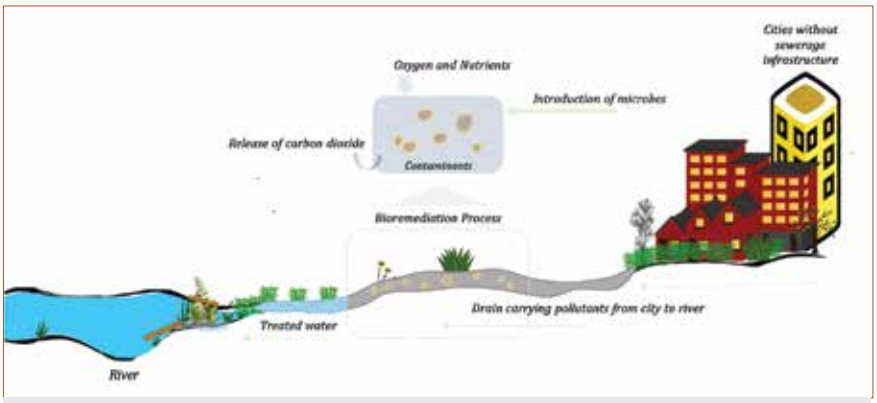


Fig2: Schematics showing application of Bioremediation for drain cleaning

operate, and, most significantly, reduces pollution load in STPs located downstream.

The Ganga river is India's most respected river, and it attracts vast crowds to its banks throughout the year. The Kumbh Mela, for example, attracts millions of pilgrims who take a holy dip in the river. The National Mission for Clean Ganga used bioremediation technology with the support of the National Environmental Engineering Research Institute to reduce 2 MLD pollution entering the Ganga river from six major drains in a short period of time. The NEERI developed an in-situ treatment called RENEU (REstoration of Nullahs with Ecological Units) that employs the natural attenuation concept in combination with engineering instruments to treat sewage drain water as it travels down the drains. The results fulfilled the discharge norms with a 40 per cent reduction in BOD and COD in all drains. Bacterial load was found to be reduced by a factor of 10, sometimes even more.

Limitations & recommendations

In India, bioremediation is becoming more popular, with more pilot projects being conducted. This has brought to light a few drawbacks that must be considered before implementing this technology. The first is that it is slower than mechanical treatments and can be used in shallow streams, drains, soil, and groundwater. Toxic element concentrations that are too high can injure the aquatic plants used in this procedure. The less turbulent site conditions are extremely important for success. Biological processes are frequently very specialised. The availability of metabolically competent microbial populations, proper environmental growth conditions, and optimum quantities of nutrients and pollutants are all important site considerations.

Fig3: RENEU application in Kumbh Mela; Souce: NEERI

Because of the continuous flow of wastewater, disinfection of wastewater is essential to minimise the faecal coliform load in the drains, which is challenging to accomplish in bioremediation, even with check bunds and other measures. Not all substances can be completely degraded in a short period of time. Finally, extrapolating pilot-scale studies to full-scale field operations is problematic. Bioremediation systems that are acceptable for sites with complex combinations of pollutants that are not evenly disseminated in the environment and may be present as solids, liquids, or gases need to be developed and engineered.

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Tackling water pollution through emerging technologies

Water pollution causes millions of fatalities worldwide each year, with more than 90 per cent of these deaths happening in low- and middle-income countries, demonstrating uneven access to essential infrastructure that exists even to date. As the globe prepares to embrace the industrial revolution 4.0, emerging technologies provide effective solutions that are both time and cost-efficient while being less prone to error, writes **Muddukrishna A.S**, Urban Planner, Associate, Centre for Urban Governance, Haryana Institute of Public Administration (HIPA, State ATI of the Government of Haryana).

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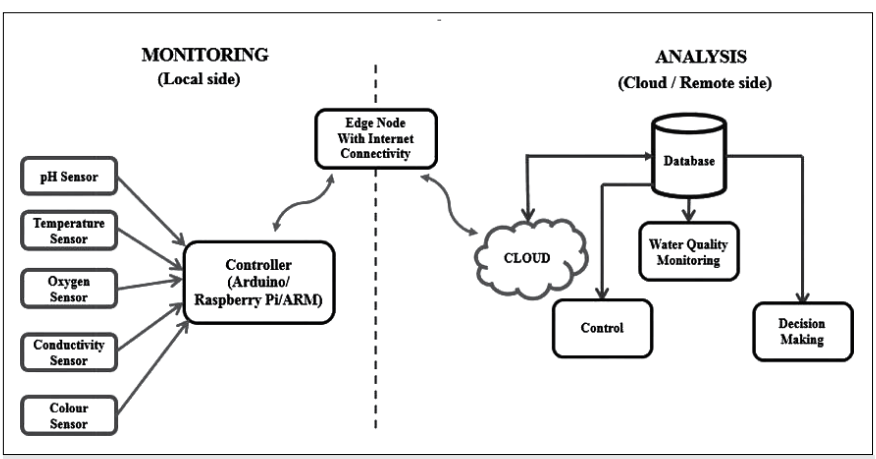
Water pollution causes millions of fatalities worldwide each year, with more than 90 per cent of these deaths happening in low- and middle-income countries, demonstrating uneven access to essential infrastructure that exists even to date. The manual nature of the current approaches to combat water pollution makes the disparity even more pronounced, due to the time and money-consuming nature of these manual methods. As the globe prepares to embrace the industrial revolution 4.0, emerging technologies provide effective solutions that are both time and cost-efficient and less prone to error. These data-driven solutions would not only aid in bridging the gap but also offer effective & efficient tools to address the water pollution problem. Several of which are discussed below:

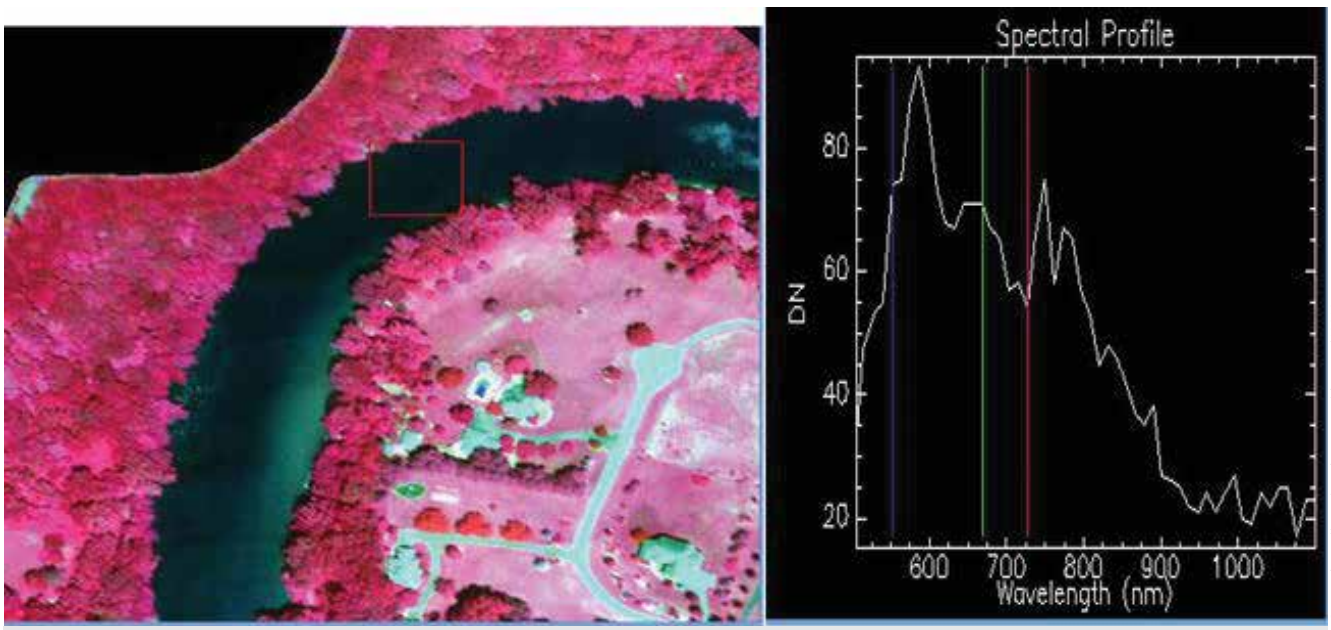


Source: https://www.researchgate.net/figure/General-Architecture-of-IoT-based-water-quality-monitoring-and-control-system_fig8_342278197

The general architecture of IoT-based water quality monitoring and control system.

IoT-based water quality monitoring

"Internet of Things" often known as the IoT, is a network of connected digital, mechanical, and computer objects that have been given special



Source: https://www.intechopen.com/chapters/69219

Hyperspectral Imagery

identification numbers (UIDs). What makes them special is their ability to transfer data over a network in real-time without requiring human-to-human or human-to-computer interaction. It enables the sensors to capture and transmit real-time water quality in terms of pH, conductivity, dissolved oxygen, temperature, biochemical oxygen demand, total dissolved solids, and conductivity etc. The IoT facilitates the administration to make effective data-driven decisions. At the same time, demonstrating the effectiveness of initiatives in real-time to the public, inducing the factor of transparency in governance.

Geospatial analytics based on hyperspectral imagery for water quality analysis

Hyperspectral imaging is a remote sensing technique that uses reflectance in spectral bands, based on which water quality parameters like sediment, dissolved organic carbon (DOC), carbon concentration etc can be measured. The fact that this technique can cover enormous areas and multiple water bodies without being on the field makes it unique. The geospatial data can be used to identify sources of pollution and areas of concern, enhancing the monitoring and decision-making capability to address the issue of water pollution.

Clean water AI is an example of a deep neural network model that uses IoT-based high-definition microscopic cameras which can track harmful microbes and effluents in real-time.

Artificial Intelligence (AI) & Big Data

With enormous volume, velocity and variety of data being generated through various sources in different forms (structured, unstructured and semi-structured data), it becomes a near impossible task to transform this data into wisdom for taking actionable decisions in real-time. Since 'data not converted into wisdom and wisdom not being transformed into actions are simply useless', the need for artificial intelligence emerges.

AI emerges from the thought process that human thought can be mechanised, and is defined as the ability of machines to learn, act, sense, and comprehend rationally. It is due to this very nature that it can be used to:

Monitor and inspect water quality through pattern recognition and machine learning

AI can be used to detect biological and chemical contaminants in the water. Clean water AI is an example of a deep neural network model that uses IoT-based high-definition microscopic cameras which can track harmful microbes and effluents in real-time. The application denotes the hazardous locations on the map.

Simple test devices like this would significantly aid in disease prevention and save thousands of lives across the globe, where access to clean water is a persistent problem.

Detect untreated sewage spills

Untreated sewage spills can be detected in near to real-time. AI systems compare real-world circumstances to expected water levels based on past data using data from the IoT-based devices, remote sensing data, discovering discrepancies and notifying operators in advance using predictive modelling techniques.

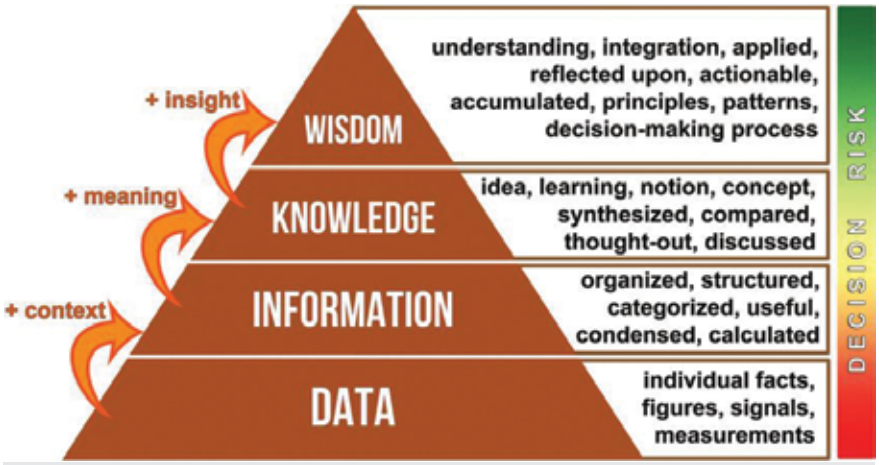
Identify contamination and leaks in the pipeline

An integrated AI based on sensing, communication, analytics and reporting would be an ideal way forward, as it would not only help in tackling the issue of contamination in pipelines, but would also help address the issue of Unaccounted-for-water (UFW) based on advanced Hydraulic models. These Hydraulic models can be used to develop:

- Forecasting tools: This can be used to develop a "what if" scenario for the design and operation of the water distribution network.
- Explanation and prediction tools for what occurred and prediction for what would happen in the water distribution network/ sewer network, based on which problems like network blockages could be identified before they happen. This would enable a quick investigation of the predicted blockage and prevent it from developing into an issue.
- Prescriptive tools for decision support platforms can advise on the best solutions to specific problems.

Industrial effluents

With India set to leap forward to the future as a manufacturing powerhouse with a staggering growth rate[1], it becomes essential to channel this growth into development through the funnel of social, environmental and economical sustainability. Despite strict regulations, untreated industrial effluents still remain to be one of the prominent factors of water pollution[2]. In this context, effective monitoring of industrial effluent becomes a need of the hour, as also pointed out by NGT in its directions given to CPCB[3].



DIKW model

Source: https://www.researchgate.net/figure/The-data-information-knowledge-wisdom-DIKW-hierarchy-as-a-pyramid-to-manage-knowledge_fig6_332400827

AI-based IoT solutions offer a ray of hope to the problem of scale, where IoT-based sensors can be imbibed industries, based on which effluents can be monitored through AI in real-time. Wherein using predictive analysis, problems can be identified and addressed prior.

Way forward

With India aspiring to lead the Industrial revolution 4.0[4] driven by AI, machine learning, 5G technology, Internet of things, robotics, biotechnology, quantum computing, etc., reorienting its strategies in manufacturing, supply chain, logistics etc.

Due to this, it becomes essential for the developmental sector also to realign its approach to tackling the fundamental issues, where emerging technologies can be used as an effective tool to achieve Sustainable Development Goals.

The article explores the scope of emerging technology through the lens of challenges that exist in the water sector. Like any other developmental sector problem, it was observed that the solutions never work in an isolated view. Implementation can be effective only when they are approached comprehensively. egov

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Management of used water and SDG 6.3 - Challenges and Opportunities for India

The availability of water in India is under pressure due to increasing population, urbanisation and the impact of climate change. The situation is further exacebated by water pollution caused by anthropogenic and geogenic factors. Among the anthropogenic factors, inadequate treatment of used water is a major concern in India. Approximately 70 per cent of used water being untreated is one of the main sources of pollution in surface and groundwater, writes **Mary Abraham**, **Nathaniel B Dkhar** and **Girija K Bharat**, Mu Gamma Consultants, Gurugram.

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Background

Improved wastewater treatment capacities and their safe reuse can curb environmental pollution, make fresh water sources available for higher hierarchy uses, and support a circular economy in the water sector. This contributes towards the achievement of the global Sustainable Development Goals (SDGs) and more specifically the achievement of SDG 6.3. It is evident that the Indian government has initiated policies to recognise the need for used water treatment and effective management of this resource. The Prime Minister's endorsement of the National Ganga Council confirms the country's commitment to used water treatment and reuse.

Current scenario

Used water from households, commercial establishments, industries, runoff from urban and agricultural land are the main sources of pollution in many parts of India. It is estimated that 72,368 million litres per day (MLD) (CPCB, 2021) of wastewater is generated throughout the country. However, the installed capacity of the STPs is only 31,841 MLD, with actual treatment only 20,236 MLD due to the fact that several STPs are inoperative[1] (CPCB, 2021). A total of 29,129 million litres of sewage are expected to be produced from Class I and Class II cities, while treatment capacity is only 6190 million litres, resulting in a shortfall of 22,939 million litres (78.7 per cent). Despite significant expansions in treatment capacity over the past five years, a deficit remains. The mixing of industrial-used water adds to the challenge and poses a serious risk to both human health and the environment.

The solid waste scenario is compounding to the challenges associated with used water. It is estimated that approximately 1,50,847 tons of solid waste are generated in

India each day, with only 47 per cent being treated[2]. Rivers ultimately discharge much of the untreated solid waste into the ocean. Several urban local governments are still struggling with low technical and managerial capacities in dealing with waste management, which has been further aggravated by the COVID-19 pandemic.

Wastewater and SDGs

The Sustainable Development Goals (SDGs) are generally interconnected and mutually reinforcing. While India has made substantial progress toward achieving SDG 6.1 and 6.2 in terms of access to water and sanitation, SDG 6.3 (to improve water quality, reduce pollution, halving the proportion of untreated wastewater, increase recycling and safe reuse by 2030) still has a long way to go. SDG 6.3 and 11.6 (urban waste and promoting urban sustainability and resilience) are closely linked in terms of lowering pollution into water bodies.

Issues and challenges

Despite the growing consensus to reduce pollution by treating wastewater, and to reduce freshwater demand by reusing treated water, several issues and challenges persist. As elaborated below, the challenges include setting up of a regulatory and institutional framework for safe reuse, conveyance of treated water to potential users, coordination and convergence between various aligned departments, funding mechanisms, public perception, monitoring, compliances and quality control in wastewater treatment plants, public health safety aspects.

Implementation challenges

The implementation of national and state-level legislation on the reuse of treated wastewater is a great challenge as misinterpretation of guidelines and policies can result in further issues. Public perception of reuse can pose a major challenge in terms of acceptability and willingness-to-pay. Reuse in industry is a very important option, but depends upon the geographic vicinity, conveyance of treated used water and a viable business model. In the agriculture sector, it is very safe for reuse in non-edible food crops, urban forestry, urban greening but raises concerns about the safety of the food crops and the irrigation techniques. Therefore, enhancing infrastructural, technical and managerial capacities of the urban local bodies (ULBs), awareness among the industry as well as the farmer and other stakeholder groups is essential.

Governance challenges

The regulations governing the reuse of wastewater for various end-user groups as well as release of the treated water into the environment complying with the discharge standards need regular

1. https://cpcb.nic.in/status-of-stps/
2. https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZX MvMTQwM18 xNjU1MzU0NzkxX 21IZGIhcGhvdG8xNjQ3MS5wZGY=

monitoring and evaluation. Decentralised treatment systems have the potential to complement large-scale treatment plants, especially in small cities, peri-urban areas, and regions with no access to sewers. However, these decentralised systems need to be adequately integrated within the governance framework. Capacities need to be built to plan, collect and integrate wastewater data in order to report on the progress towards SDG 6.3.

Funding challenges

Several urban regions have been concerned about the availability of funds for mobilising reuse of treated wastewater. These costs need to be allocated in the budget for a viable business model. The capital cost (CAPEX) and the operational cost (OPEX) need to be factored in. There is also a need to adjust the water supply pricing plan, sewage cess and have incentives/disincentives for uptake of treated water by industries and other stakeholder groups. The cost recovery of wastewater treatment systems from sale of treated used water is very high in some of the ULBs such as the Surat Municipal Corporation (SMC), while it is very low in many others.

Opportunities

The circular economy's main principle of sustainable waste management provides numerous opportunities. The fundamental benefit of sustainable waste management is low environmental impact with improvement in air and water quality. Safe reuse of treated water has a higher potential for cost recovery for the services provided and the products such as treated water for fit-for-purpose. The sludge generated in the process is a soil conditioner and manure.[3] The Draft National Policy on Safe Reuse of Treated Water (SRTW), supported by NMCG and GIZ under the India-EU Water Partnership, presents an array of business models and a framework for the states to develop their respective SRTW policy. Many of the potential end uses except potable uses have been discussed here.

The Government of India's flagship programs such as Swachh Bharat Mission (SBM -2.0) and AMRUT -2.0, emphasise achieving 'water secure' urban regions. Several Indian cities are working towards wastewater treatment and reuse. The various actions taken by the Chennai Municipal Water Supply and Sewerage Board have led to Chennai becoming the first Indian city to have successful large-scale recycling of wastewater and reuse. They are using around 60 and 75 per cent of the city's wastewater for industrial and indirect potable reuse. Surat has also pioneered the implementation and augmentation of treated wastewater reuse under the Gujarat State Policy for reuse of wastewater and the Surat Municipal Corporation Action Plan for Reuse & Recycle of Treated Wastewater, 2019.

The Service Level Benchmarks (SLBs) of the Ministry of Housing and Urban Affairs (MoHUA) mandate the extent of reuse and recycling of sewage in urban areas as 20 per cent. The states are expected to introduce mandatory reuse targets appropriate to the local context as a regulatory measure or as part of incentive programmes. This will help improve the livability index of the cities, hedonic pricing, and the ranking of cities in Swachh Survekshan.

Way forward

The Government of India's initiatives in implementing related programs has significant political support, both at the Central and at several state levels with crucial policies such as the Policy on Safe Reuse of Treated Water, the National Urban Sanitation Policy (NUSP), and other actions towards realising SDG 6.3. In SBM 2.0, there is a strong emphasis on the inclusion of the entire sanitation value chain, including the collection, containment, treatment, disposal, and recycling of faecal wastes and wastewater.

The Central, state governments, and ULBs need to work together to promote circularity in wastewater management and reuse. Cities should have a plan in place for the safe reuse of urban wastewater to safeguard themselves from threats to their water quality and water availability. Evidence-based decision making tools regarding wastewater treatment options to invest in (based on expected CAPEX and OPEX, benefits, cost recovery, sustainability, human resource capacity, etc.) can help reduce complexity around financing, acceptance, operation, and maintenance, amongst others. Given the paucity of water and the pollution caused by wastewater in most Indian towns, wastewater reuse plans and their stringent implementation are the need of the hour.

Wastewater management should not only be the responsibility of the government but also of all stakeholders, including industry, farmer groups, and citizens. While the circular economy approach towards wastewater management can provide a framework on how to solve some of the issues that are plaguing our environment, an integrated approach involving all stakeholders will support the quest to achieve the SDGs.

Acknowledgements:
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Wastewater management in unauthorised colonies

One in every six of the Indian population lives in unauthorised colonies, and almost 95 million people live in these colonies. Out of the 93 million habitants, 80 per cent have inadequate access to sanitation, as per the 2008-09 National Sample Survey Organisation (NSSO), writes **Lovlesh Sharma**, Senior Water and Infrastructure Expert, W&E Vertical, Sector Coordinator Infrastructure, Master Plan Delhi (MPD-2041), NIUA.

Figure 1: Slum in Mumbai, India

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The existence of unauthorised colonies

The uncontrolled migration of rural population in Urban centres has been a basic cause for the formation of unauthorised settlements in Indian cities. One in every six of the Indian population lives in unauthorised colonies, and almost 95 million people live in these colonies. The major locations of these settlements are unutilised space of the city like river flood plains, edges of railway tracks etc. As per Un-Habitat 2008 report, almost half of the world's slum population resides in Asia, while in India, approx 45 per cent of urban households are classified as slums.

Surprisingly, out of the 93 million habitants of unauthorised colonies in India, 80 per cent have inadequate access to sanitation, as per the 2008-09 National Sample Survey Organisation (NSSO). Interestingly, Delhi is a peculiar case in this regard, even being the capital of India, more than 40 per cent of its population still lives in unplanned colonies. However, the unauthorised colonies are, in a way, possible solutions to the homeless households in urban areas. At the same time, the unplanned nature of these settlements leads to most critical issues

including access to clean water, inadequate sanitation and lack of other basic amenities.

Difficulty in infrastructure provisioning for urban local bodies

The basic challenge in unauthorised colonies is the absence of basic amenities required for the liveability. The very unplanned nature creates the first issues, as the formation of these settlements has been inorganic and unplanned, no civic amenities could be planned timely. In most of the cases, the provisioning of basic services in unauthorised colonies is an afterthought or remedial attempt. The unavailability of space to put the trunk and branch infrastructure is the core issue. As far as the drinking water supply is concerned, the household somehow gets access to it. This may be through the community taps, ground water withdrawal or access to tankers supply. The criticality arises when it comes to the sanitation facilities to these households. The inadequate facilities for sanitation make these pockets more vulnerable and challenging. For the Urban Local Bodies, the main issue is the unavailability to provide sanitation facilities.

Poor state of basic services in unauthorised colonies

Poor access to sanitation facilities in these unauthorised colonies make the situation worse not only due to inadequate provisioning, but the impact of the improper wastewater management. The sewage generated from these colonies add to the local drains making them full with untreated sewage. The vector borne diseases and the mixing of untreated sewage in ground water causes many health hazards to the habitants of these colonies. Moreover, the improperly-constructed toilet blocks have led to the health issue of several people in the unauthorised colonies across the country. The local bodies at times try their level best to arrange for the community toilet access, but considering the population density in Indian cities, it is again a tough task. Most of the households in unauthorised colonies have a system of septic tank base sanitation. This is a regular practice in rural as well as unauthorised colonies. Many planned areas in urban centres also have septic tank-based sanitation system.

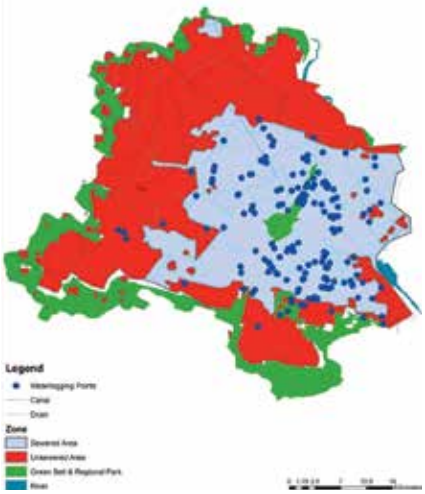
The universal myth that the sewered system is the only correct way for sanitation is questioned well in the Indian context. A big chunk of Indian cities still function well with septic tanks. There are two big challenges with septic tank-based sanitation. First is the improper and incorrect design of septic tanks and the unavailability of Faecal Sludge Management System (FSSM) in the cities. Unauthorised colonies too majorly rely upon poorly

designed septic tanks base sanitation. The wrongly designed septic tanks are a threat to the health of residents in many ways. The vector borne disease due to contamination of groundwater is most critical.

The kind of diseases poor sanitation leads to is scary, for instance diarrhoea, water diseases, parasitic worms/ infestation and faecal oral diseases etc, are really a big threat to life for the habitants. It is widely mismanaged in India and it might be the worst sanitation country in the world for unauthorised countries. Moreover, the children are the most affected ones and because of these epidemics, the mortality rate of children is huge.

Case of Delhi

More than 45 per cent of Delhi residents live in unplanned colonies, and most of them face serious sanitation crisis from exposed drains to rampant open defecation. A study conducted by the Delhi government in 2012 revealed that close to 56 per cent of children in unauthorised settlements defecate in the open, exposing them to a greater risk of contracting infections and contagious diseases. Intermittent strikes by sanitation staff have severely affected the regular cleaning of the drains which have, over time, turned



into community health hazards, compounding the crisis further. It has been recorded that while 36.6 per cent of households had open drainage systems in the national capital, 4.2 per cent households had no drainage at all.

However, Master Plan Delhi envisages laying of sewer lines in a length of about 10,500 km, which is a lengthy process. Hence, the work is to be carried out in a phased manner, prioritising areas where sewer lines can be made functional, immediately after being laid, because of availability of outfall sewers and wastewater treatment plants. The unavailability of proper sanitation system in Delhi's unauthorised colonies has created several health hazards for the residents and the various reports indicate huge loss of lives due to the same cause.

Recommendation

However, the Swachh Bharat Abhiyan (Clean India Mission) has resulted in major improvements in access to safe potable water, sanitation, and hygiene facilities, especially in urban India. But still, the city administrations in India need to plan the hybrid sanitation system especially for unplanned pockets. The areas where sewerage lines are difficult to lay down, the septage management has to be made foolproof. The community toilet system can also be a useful way to maintain the health and hygiene of these areas. Moreover, the improved knowledge of proper design of septic tanks and its benefits. Most of the planned urban areas witness the improper septic tank designs. The other issue with non-sewered areas is irregular de-sludging. The local bodies need to create an ecosystem for the scheduled and demand de-sludging of septic tanks. The app-based system as adopted by many Indian cities can be a game changer. The health and hygiene of the habitants of unauthorised colonies can be best managed by the proper facility of drinking water and sanitation services.

The redevelopment of unplanned colonies is a long term process, city administration has to plan basic services to these urban-poor strategically, so as to reduce the case of water borne diseases and health hazards. The hybrid of sewerage and septage has changed the fabric of many unplanned colonies across the world. Awareness about safe sanitation practices is also a key factor which cities need to target upon. The knowledge of right practice and behaviour about correct sanitation practice will also offload the pressure of local bodies.

Living with subsurface pollution by wastewater irrigation

Even if the communities choose a low-cost system for primary treatment, the existing wastewater does not undergo advance treatment for considerable reduction in biodegradable organic material, pathogens, nutrients, etc., from the wastewater. When such a large amount of wastewater remains untreated, it is certainly catastrophic for the subsurface and obviously for health, writes **Pankaj Kumar Gupta**, PhD, Co-founder, Society of Young Agriculture and Hydrology scholars of India (SYAHI).

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Wastewater can be simply defined as the commercial and household discharge of used water, which is a complex matrix containing significant concentration of solids (350-1200 mg/l), dissolved and matter (chemical oxygen demand 250-1000mg/l) microorganism (up to 109 number/ml) nutrients, heavy metals and micropollutants. Households and industrial discharge of untreated/ partially treated wastewater into the environment severely affects soil water health and induces lethal toxic effects in living beings. Industrial discharge of water contains diverse organic and inorganic pollutants, PPCPs and pathogens.

CPCB report of 2009 states that out of 38 billion L/day of sewage/wastewater generated; treatment capacity exists for only 12 L/day in India, and a 2019 study reported that total volume of sewage generated by households in urban India was 61,754 MLD, which amounts to an annual volume of 22,540 billion cubic meters or about 5.6 times the annual rainfall in the country, notwithstanding operational capacity for collection and treatment is restrained around 24 per cent, of which only a small proportion is reused. When such a large amount of wastewater remains untreated, it is certainly catastrophic for the environment and obviously for health.

A low-cost primary treatment such as waste stabilisation ponds, the existing wastewater does not undergo secondary treatment for considerable reduction in biodegradable organic materials, PPCPs, pathogens and nutrients etc, hence a huge mass suffers from pathogen-related health issues. The water (prevention and control of pollution) Act, 1974 emphasises on maintaining and restoring the wholesomeness of aquatic resources by not discharging sewage or pollutants into water bodies including lakes. Most states mandate the usage of Treated Used Water (TUW) in agriculture, only if surplus quantity is available after meeting the demands of mandatory usage for other purposes. Nevertheless, altered climatic conditions and depleted groundwater has eventually corrupted the ideal policies and now a large amount of untreated wastewater is used in irrigation. Kinley et al reported that the application of treated wastewater gains more attention due to water scarcity across the globe, and water conservation being the need of the hour, and the largest source of

marginal water for agriculture is treated wastewater in many areas.

Be it the controlled or uncontrolled usage of wastewater in agriculture, both impose adverse effects. We have substantial evidence to show how this untreated or partially treated wastewater, after entering into the subsurface environment, kills the natural microflora of soil and enters into the food chain system, causing shocking damage to health. Treated wastewater contain nutrients, microelements, pharmaceutical and personal care products, nanoparticles, and pathogens higher than that of fresh water. This happens because of ineffectiveness of traditional wastewater treatment plants in treating PPCs, which leads to recurrent occurrence of pharmaceuticals and their derivatives in wastewater effluents.

Wide range of adverse environmental impacts such as masculinisation or feminisation of fish by hormones or xenoestrogens, antibiotic resistance in bacteria and synergistic toxicological effects are evident in several studies. A review suggests that possible adverse health effects of chronic exposure to pharmaceuticals via drinking water and food chain systems could result in allergic reactions, carcinogenic effects, genotoxicity, effect on reproduction and foetal development, eventually arresting overall health in different ways.

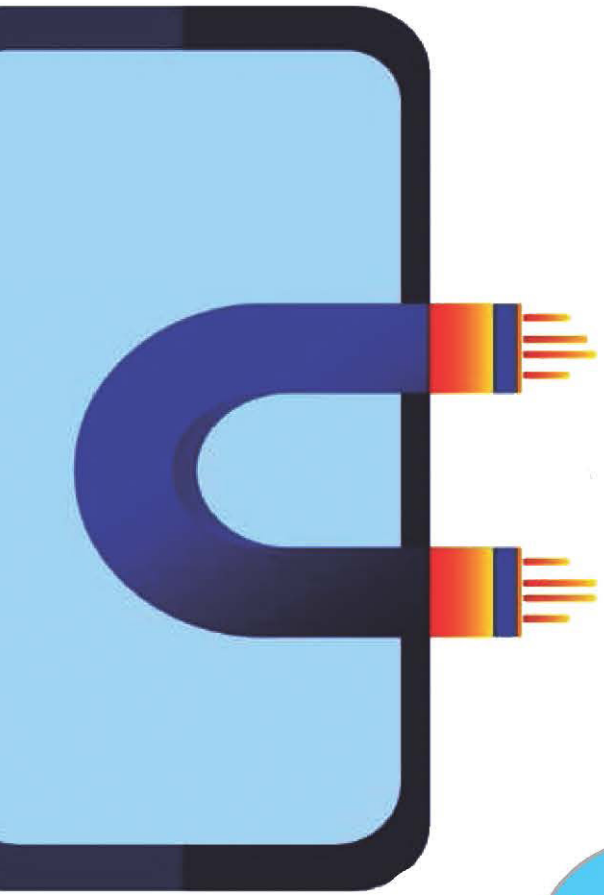
Disease like amoebiasis is now very common, and neurotoxic effects of BTEX compounds like benzene, toluene and a host of others have been found to cause lesion to central nervous system, resulting in increased number of patients with headache, light-headedness, fatigue etc. Subsurface pollution is now a global concern and predominantly in developing nations, the discharge of untreated wastewater is the root cause of widespread pollution of surface and groundwater resources, since there is a large gap

between generation and treatment of wastewater. The land irrigated with untreated wastewater containing biosolids and petroleum hydrocarbon during fertigation has deteriorated large volumes of soil and groundwater due to the spread caused by advective-dispersive mechanism and biological treatment cannot effectively treat the effluent from petroleum industries.

Viruses and the protozoa are major ecological threats and viruses are the most critical for the groundwater among the microbiological contamination. The continuous irrigation by treated wastewater causes accelerated advective dispersive flux, which increases pore water velocities in vadose zone. Groundwater table fluctuations along with high pore velocities can enhance the mobilisation of pollutants. Land irrigated with treated wastewater contains a significant amount of nanoscale emerging pollutants like viruses and protozoa. Fate, transport of these pollutants in a subsurface environment depends upon their interaction with solids to be the result of differences in the electrical charge and hydrophobicity of the pollutants surface. Thus, attach and detachment scale pollutants control the reuse potential of treated wastewater. Land application of treated wastewater results in more vulnerability of underlying subsurface resources due to inefficient treatment capacities of wastewater treatment plants.

Climatic variables affect the solubility of different pollutants present in treated wastewater. In situ bioremediation technique is required to decontaminate the polluted soil water resources under variably changing climatic conditions. Preventive measures should be taken, awareness towards the environment must be fostered through awareness activities programs, the committee forming the laws and legislation for environmental components must comprise residents of the concerned area. Integrated waste management approaches must be incorporated for better coordination to avoid effort gap assessment and meet the Sustainable Development Goals (SDGs). Achieving (safe use of treated water) SRTW targets requires the synergistic alignment of interest and incentives among the key stakeholders, identifying areas of demand supply, selecting the most appropriate business model where risks are shared equitably, and designing support programs that are efficient in time and resources.

IGNITING MINDS IMPACTING LIVES



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Treating pollution the natural way: Riparian Buffers

There is a need to look at alternatives for pollution abatement other than hard-engineered solutions. These include exploring nature-based solutions to minimise the pollutant load entering rivers, drains and other water bodies. Designing an appropriate riparian buffer is a great example of mitigating pollution entering rivers and other water bodies, writes **Vishakha Jha**, Senior Environmental Specialist, NIUA.

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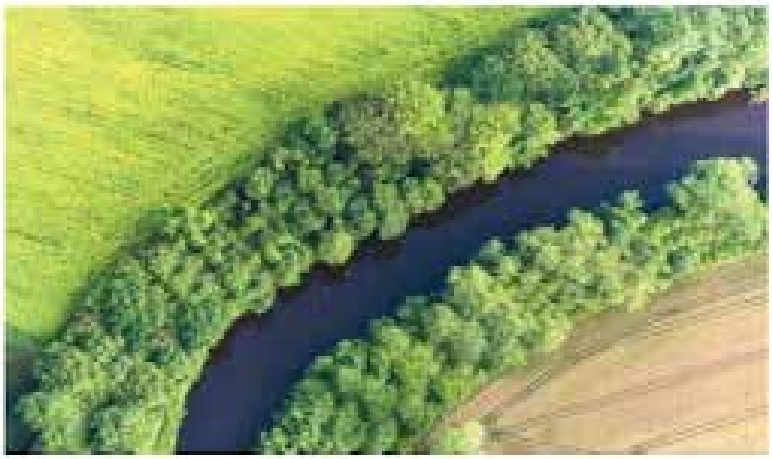
The wastewater, when left untreated in all probability, ends up polluting rivers, water bodies, drains and groundwater. All these years, cities have looked at wastewater treatment through typical engineered solutions such as sewage treatment plants, both centralised and decentralised, designed to improve waste water quality before it gets discharged into surface waters. But let alone being cost intensive, these treatment systems often due to lack of proper effluent treatment or sustained treatment, can further add to the problem. For instance, the effluent discharge of nutrients leads to deterioration of receiving waters, excessive algal growth and potential eutrophication of water bodies, thus impacting the aquatic ecosystem.

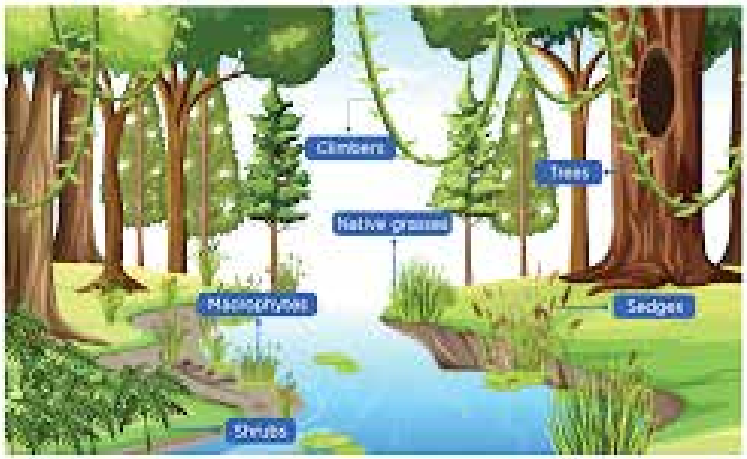
There is a need to look at alternatives for pollution abatement other than hard-engineered solutions. These include exploring nature-based solutions to minimise the pollutant load entering rivers, drains and other water bodies. Designing an appropriate riparian buffer is a great example of mitigating pollution entering rivers and other water bodies.

The word riparian in Latin refers to the riverbank. In other words, it is an interface between land and river, or any other water body, an area where land meets the natural river course. Typically, it is a longitudinal stretch of vegetation on either bank of the river or drain or around water bodies. Vegetation in this buffer can include native grasses, macrophytes, sedges, climbers, shrubs and trees amongst other vegetation. Even though these buffers can be developed for water bodies or along drains, their nature, design and features may vary from those developed for rivers.

These riparian buffers are not just any vegetative stretches. They act as shock absorbers for the river or natural drain and its ecosystem against various detrimental developmental activities. In the process, they also help restore and maintain the physical and biological integrity of the river. It is this wide range of co-benefits that make them so unique.

The lack of any filter between the land and river would imply mixing of pollution on the land with the river water. Moreover, river edge, when left unregulated in urban areas,





often become susceptible to human activities such as uncontrolled farming, grazing, and industries adding to the pollution. A healthy riparian stretch can help protect the rivers from such human land-use practices and forms of encroachment. The vegetation additionally enhances river water quality, capturing the surface run-off, trapping pollutants and providing protection from solid waste elements.

Other than the environmental benefit of improving water quality, such riparian stretches also offer manifold co-benefits. First, it serves as a source of food and energy for the aquatic ecosystem and therefore, enhances biodiversity. Second, it also helps reduce soil erosion. Soil erosion of stream bed and banks amalgamated channel instability leads to preponderance of sedimentation in most rivers. A healthy vegetated riparian buffer reduces the levels of sediments. They slow down overland runoff, filter out sediments, nutrients, pathogens, and toxins. To put it simply, by creating roughness along the surface of the ground, the vegetation decreases the water velocity, allowing time for water to infiltrate the soil and for sediments to drop out. Third, it helps reduce the impact of flooding, especially through the thick vegetative strips that help absorb excess water. Fourth, it also influences the temperature of the river water and the microclimate. The trees of riparian buffers shade the water of the river, moderating water temperature. The protection, management and restoration of the functions and values of riparian buffers is a unique cost-effective approach to improving wastewater quality, sedimentation and nutrient reduction goals of the river ecosystem.

The protection, management and restoration of the functions and values of riparian buffers is a unique cost-effective approach to improving wastewater quality, sedimentation and nutrient reduction goals of the river ecosystem.

Another unique aspect of these buffers is they will not just vary city to city but may vary from one area to another, even within a city. This is because every watershed is unique, and thus, riparian buffer projects will vary having its own goals. In fact, this is one of the major reasons why there are no set guidelines for riparian stretches that will fit all cities. Cities such as Colorado, Victoria, New York, Nashville have dedicated riparian management plans and guidelines but those are contextualised only for their own cities.

Given that every city has different needs, developing riparian buffers may not feature on top priority for all cities. There are several socio-economic factors and other drivers that will influence how cities need to approach developing riparian stretches and for which purpose. The foremost driver would typically be identification of suitable riparian stretches in the city. In most cases, from a pollution abatement perspective, these stretches should be developed close to polluting industries, pollution hotspots, and areas with presence of solid waste

dumping sites. Other drivers would include establishing the width of a riparian buffer, its profile, activities permissible or restricted within these buffers amongst others.

Ideally, the riparian buffer for a river should be a continuous stretch with a width of twelve to fifteen metres, in some cases even extending to 30 metres. This width will depend on the slope, depth of the river, soil conditions and so on. Therefore, it varies from city to city. For example, the state of Oregon in the USA has guidelines for riparian buffers indicating a width of 15-30 metres, while Victoria city in Australia has riparian buffer guidelines of 10-20 metres. Some Indian cities are also adopting riparian guidelines. For example, Kanpur, which is the first city to prepare an Urban River Management Plan, has adopted a riparian buffer of 30 metres. Delhi, on the other hand, in its Draft Master Plan 2041, has proposed riparian vegetation of 25-30 metres along the identified stretches of river Yamuna.

The planting strategy, for a riparian buffer, is critical for it to achieve its intended purpose. For instance, the dominant purpose of the streamside zone, the zone closest to the river, is to slow down runoff, reduce erosion, and create a habitat for invertebrates and other wildlife. Therefore, the plants in this zone should typically include trees with dense root systems. Similarly, the purpose of the middle zone is to remove pollutants from the subsurface flow of water. And for the outer zone, it is to remove pollutants from the groundwater. Consequently, the plantation for each of these zones may vary. Other than accounting for soil conditions, water depth, nature of ground profile and its surrounding uses, the use of native plant species cannot be overemphasised. These types of plant species naturally occur in a region or habitat and have co-evolved over geologic time with other plants and animals, serving vital ecological roles and creating a balanced plant community that supports indigenous wildlife. Thus, it is very critical for the sustenance of the riparian ecosystem.

While nature-based solutions such as riparian buffers are unsung heroes of healthy rivers, it cannot be a plant and walk away activity. To maximise its benefits and ensure its health, cities also need to plan for its maintenance and monitoring consistently.

The riparian buffers are also being used globally in combination with soft engineering solutions such as constructed wetlands that use wetland vegetation, soils, and their associated microbial assemblages to treat wastewater. Another hybrid yet naturalised variation to riparian is developing rip-rap edges that constitute boulders or large crushed stone lining along with natural edge, enabling many ecological interactions to take place while also protecting the river from pollution and erosion. While nature-based solutions such as riparian buffers are unsung heroes of healthy rivers, it cannot be a plant and walk away activity. To maximise its benefits and ensure its health, cities also need to plan for its maintenance and monitoring consistently.

"G-Governance: An aid to Ganga rejuvenation to achieve SDG objectives"

» **ER. PEEYUSH GUPTA**
Real Time Information Specialist, National Mission for Clean Ganga, Ministry of Jal Shakti.

E-governance is a popular terminology today. It basically involves the use of technology to reform government work. Increasingly, geospatial technology is becoming the core to many IT programmes in the government. Geospatial Governance or g-Governance can be treated as a geospatial plug-in to e-Governance. Altogether g-Governance acts as an extended module of e-Governance with the additional functionality of geospatial technology, writes **Er. Peeyush Gupta**, Real Time Information Specialist, National Mission for Clean Ganga, Ministry of Jal Shakti.

Geospatial technology essentially provides a framework for integrated problem solving. To solve a problem, we need to first understand it. Geospatial technology enables us to understand problems better because it presents issues visually, in a more understandable manner. To move towards g-Governance, we need to see how e-Governance programmes can get geospatial data.

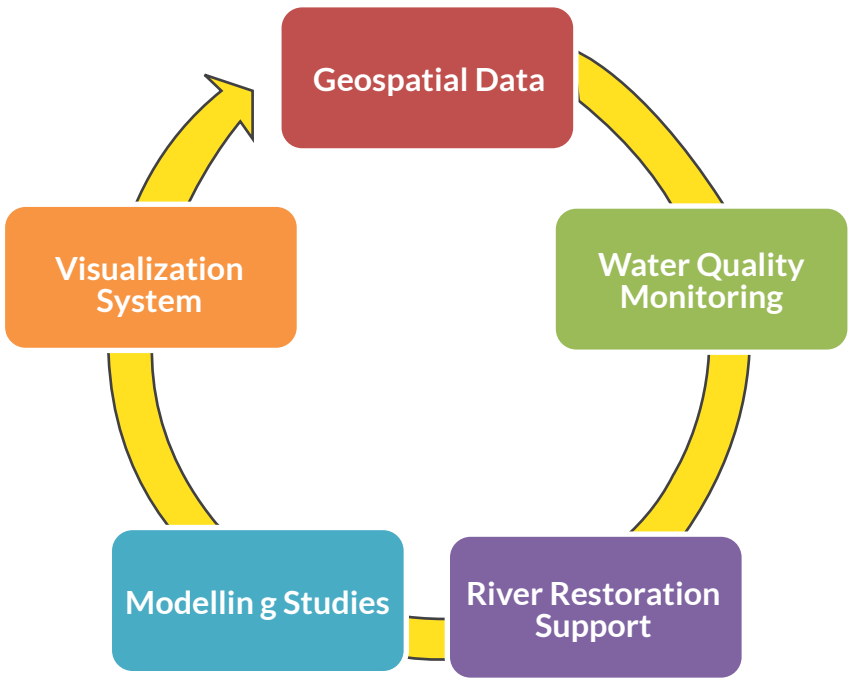
Water is a vital natural resource without which life would cease to exist. Water conservation and resources management represent some of the most critical environmental issues currently facing humankind. With the planet's second largest population at 1.3 billion, and expectant growth to 1.7 billion by 2050, India is struggling to serve the vast majority of that population with safe and potable drinking water. Bringing clean water, toilets and hygiene to 1.3 billion people is a massive challenge. Waste discharge or surface runoff from urban, industrial, or agricultural areas is degrading the quality of surface or groundwater vital for human needs, ecosystem needs, and business operations. Effluent management is a way of reducing water quality impacts at a system or catchment level. Actions include managing effluent from the source prior to discharge, developing waste treatment and water reclamation systems, protecting affected aquatic ecosystems, supporting water sanitation projects, or providing financial resources for waste treatment. Water quality management may also include water quality rehabilitation, such as Namami Gange flagship program.

Namami Gange is a flagship programme of the Government of India for the rejuvenation of Ganga and its tributaries. National Mission for Clean Ganga (NMCG) is the implementing authority of this program. It was constituted under the provisions of the Environment Protection Act (EPA) 1986, and is a part of the Ministry of Jal Shakti. The vision is to restore the wholesomeness of river Ganga in terms of Aviral Dhara (continuous flow) and Nirmal Dhara (unpolluted flow), along with preserving its ecological and geological entity.

In December 2019, the first National Ganga Council meeting was convened under the Chairmanship of Honourable Prime Minister Narendra Modi. The concept of Arth Ganga is based on the symbiotic relationship between nature and society, which strives to strengthen the people river connect. Arth Ganga will channelise economic activity along the banks of Ganga river. Six key verticals for interventions viz; zero budget natural forming, monetisation & reuse of sludge & wastewater, livelihood generation opportunities, public participation, cultural heritage & tourism, and institutional building is defined under the Arth Ganga.

During the course of river Ganga's journey from the Himalayas to the Bay of Bengal, municipal sewage from urban centres along its banks, effluents from industries, municipal solid wastes and polluting waste from several other non-point sources including agriculture get discharged into the river, resulting in its pollution. Large scale abstraction of water from river Ganga for different purposes, most substantial being for agricultural use, leads to depletion of flow in certain stretches. NMCG authority order mandates the use of geospatial information and technology in river rejuvenation, there lies an opportunity for the technology solution providers and decision-makers to tap onto the true potential of geospatial information and technologies.

Namami Gange has been recognised as India's leading programme in using geospatial technologies towards river basin management and regulating the proposed protected and regulatory zones along the banks of the river. The flagship programme has high priority for research and evidence-based decision making and has a special place for the use of satellite information, Internet of Things (IoT), big data, digital twins, Machine Learning (ML), Blockchain technology and Artificial Intelligence (AI).

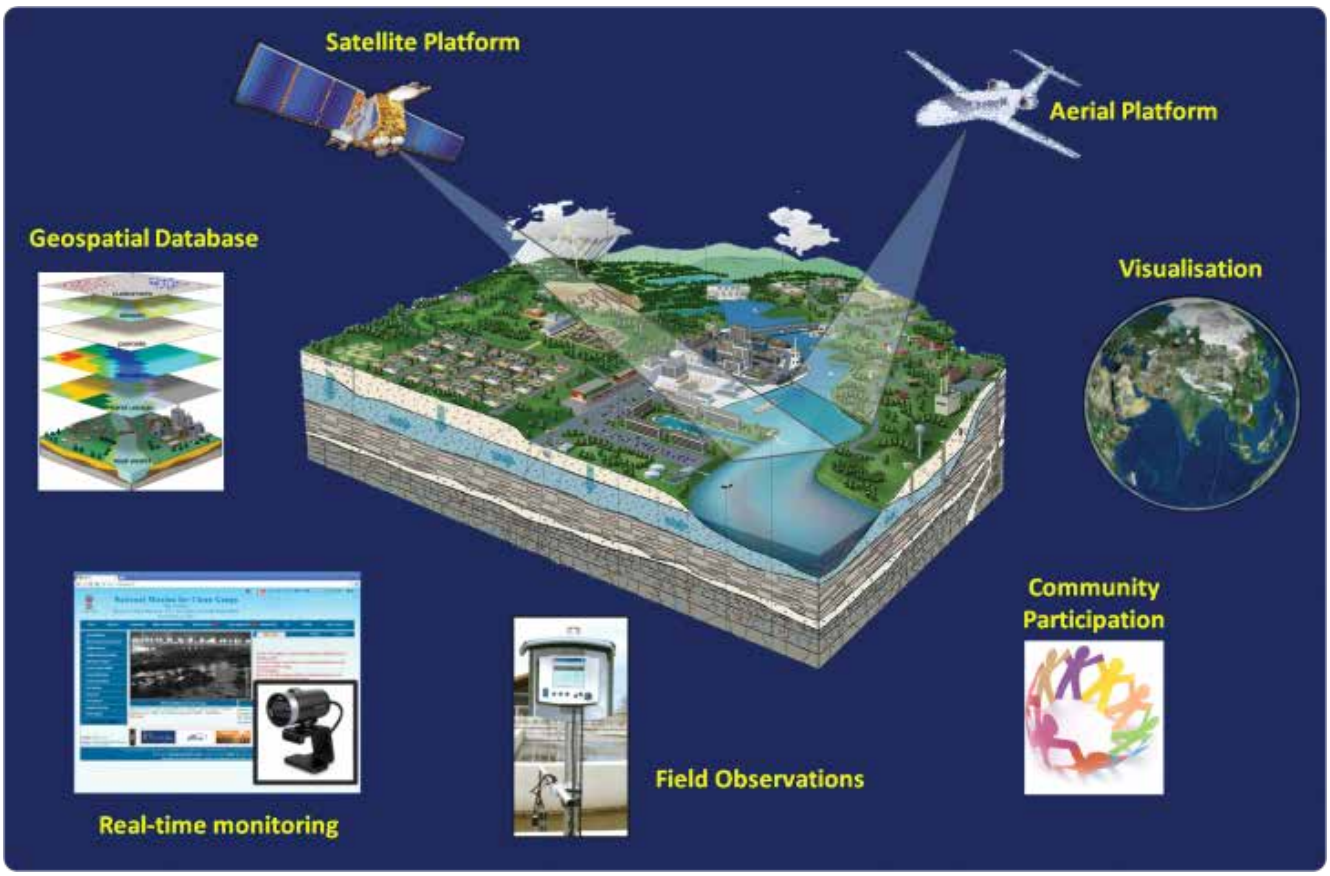


Role of Geospatial data in River Restoration

To overcome these issues, NMCG has sanctioned different GIS-based research projects touching different aspects of river rejuvenation to use geospatial data in a wide variety of areas, including legislative and policy development, allocation and management of water resources, river system spatial planning, and monitoring and basin management. Only a few of them are mentioned here.

Real time data networks for water quality management are crucial to provide an estimate of the spatial and temporal variability in water quality at a particular site. Real time data transmission from Grossly Polluting Industries through Online Continuous Effluent Monitoring System (OCEMS) is established for compliance verification. Till 31st December, 2021, 959 GPIs (out of 1080 GPIs) in river Ganga and 293 GPIs (out of 1660 GPIs) in river Yamuna basin have the connectivity of OCEMS. Water quality of river Ganga is also carried out through a network of 36 Real Time Water Quality Monitoring Stations (RTWQMS) since 2017, of which 18 stations are on main stem of river Ganga, 9 stations on tributaries and 9 stations on drains discharging into river Ganga. Real time water quality data from these stations is displayed on a web portal for visualisation. These real time stations measure water quality of river Ganga on 24x7 basis for 17 parameters, through sensors which include temperature, pH, turbidity, water level, colour, total suspended solids, conductivity, nitrates, dissolved oxygen, chemical oxygen demand, ammonia, chloride, fluoride, potassium, TOC, biochemical oxygen demand and BTX. The calibration on regular intervals is witnessed that ensures quality assured data assessment of river water quality. Recently, additional 40 real time stations have also been set up in Ganga basin. Significance of the GIS framework had brought a paradigm shift in visualisation of all crucial spatial and non-spatial information of Ganga basin to adopt accurate and transparent decisions.

Aquifers in the Ganga-Yamuna doab play an important role in sustaining the flows in these rivers. Ganga River Basin Management Plan recognises the



Power of Geospatial Technology in G-Governance

importance of interplay between groundwater and surface water. Aquifer mapping project- Data generation for aquifer mapping with focus on paleo-channels in parts of Ganga-Yamuna Doab in Kaushambi-Kanpur stretch for tracking the existing paleo-channel further northwest ward for engineered ground water recharge/ augmentation, Uttar Pradesh is executing by National Geophysical Research Institute (NGRI), Hyderabad. This project will be helpful for development of a plan for managing aquifer recharge which may help in increasing the flow of river Ganga during lean season. Nature of project is tracking the inferred paleo-channel further north-west ward., 3D mapping of Principal Aquifer system, establishing linkages between aquifer system including paleo-channel with river system, estimating age profile of paleo river and climate conditions, development of a plan for Managed Aquifer Recharge.

The pilot project on 'Satellite Image-derived Water Quality Research (SIWAR)–River Ganges' was executed by World Resources Institute (WRI) India, to understand if satellite image-derived water quality measurements can effectively supplement in-situ water quality monitoring.

Way forward

G-Governance plays a key role in understanding global water cycles, mapping water courses, and monitoring and mitigating the effects of floods and droughts etc. In order to overcome these challenges, we are tapping into the power of technology. The new-gen of 'smart' and 'intelligent' technology has the ability to monitor and analyse water usage in different fields. These technologies include smart water metering, effective desalination, wastewater management through Supervisory Control and Data Acquisition (SCADA), laser seeding treatment and so on, making water systems more efficient, secure and reliable.

Namami Gange programme is adopting progressively the state of art technology like, use of space technology over cloud-based GIS platform, LiDAR technology, geo statistical analysis, big data, IoT, machine learning, blockchain, deep learning, artificial intelligence, various data collection platform such as IoT, drone etc are going to be integrated ecosystem of digital transformation and empowerment. GIS platforms are going to be used as a service for visualisation at all levels of g-Governance for rejuvenation of Ganga basin to achieve the target of SDG 6.3.

Breakthrough in industrial and municipal wastewater treatment

To achieve UN SDG 6.3 and make the National Missions truly successful, we have to make wastewater treatment and management highly resource and energy efficient, much more sustainable, affordable, robust and future ready with augmentation of capacities within existing infrastructure. Thus, it is required to integrate in current systems, novel approaches and advanced technologies which could help achieve these requirements, writes **Dr. Nupur Bahadur**, Senior Fellow & Head, NMCG-TERI Centre of Excellence on Water Reuse, Water Resources Division, TERI.

» **DR. NUPUR BAHADUR**
Senior Fellow & Head, NMCG-TERI Centre of Excellence on Water Reuse, Water Resources Division, TERI.

Background

UN SDG Target 6.3 sets out to improve ambient water quality, which is essential to protecting both ecosystem health (target 6.6 and SDGs 14 and 15) and human health (recreational waters and drinking water sources, target 6.1), by eliminating, minimising and significantly reducing different streams of pollution into water bodies. The main sources of pollution include wastewater from households, commercial establishments and industries (point sources), as well as run-off from urban and agricultural land (nonpoint sources). Thus, it becomes imperative for Industries and Urban Local Bodies (ULBs) to adequately treat wastewater and reuse. However, the current wastewater treatment faces the following issues, gaps and challenges:

(i) use of a large amount and large number of chemicals, which leads to secondary problems associated with toxic sludge generation, disposal and management, (ii) almost all kinds of effluents are treated with a similar approach, without understanding the matrix, composition and requirement of treatment, (iii) high dependence on biological treatment systems, which involves large footprint, prone to shock loads and inadequate treatment especially in case of industrial effluent treatment, (iv) inadequately treated coloured water when goes as the feed to tertiary systems, involving RO/MEE/MVR etc. leads to choking and biofouling of membranes and create associated problems leading to higher CAPEX and OPEX and make the overall wastewater treatment and management highly unsustainable, unacceptable, unaffordable and non-compliant.

Further, in the National Missions like the 'Namami Gange', the primary requirement is to curb the point source pollution across the ETPs and STPs, so that the objectives of 'Nirmal Dhara' (unpolluted flow) is achieved. The missions like SBM 2.0 and AMRUT 2.0 require the stringent treated water quality for reuse to be having COD<30 mg/L and BOD<5 mg/L, which our existing wastewater treatment technologies fail to achieve. Large industrial houses could afford tertiary treatment systems to achieve Zero Liquid Discharge (ZLD) compliance from CPCB, Government of India, whereas the MSME sector is left with limited choice of discharging the inadequately treated coloured water to drains and to natural water bodies.

Thus, in order to support and make the UN SDG 6.3 and these National Missions truly successful, we have to help all sectors of industries to be water secure and compliant, and provide safe and secure water and sanitation to rural and urban areas. We have to make wastewater treatment and

management highly resource and energy efficient, much more sustainable, affordable, robust and future ready with augmentation of capacities within existing infrastructure. Thus, it is required to integrate in current systems, novel approaches and advanced technologies which could help in addressing these gaps and challenges.

TERI's TADOX® technology

It is in this pursuit, The Energy and Resources Institute (TERI), New Delhi, has developed a novel technology called TERI Advanced Oxidation Technology (TADOX®), which provides treatment of wastewater stream containing high colour, COD, BOD, TOC, dissolved organics, micropollutants, non-biodegradable and persistent organic pollutants (POPs) in effluents from grossly polluting industries and municipal wastewater. TADOX® is under TERI's Patent (grant awaited) and also under various categories of trademark with the Trademark Office, Government of India. TADOX® involves UV-Photocatalysis as

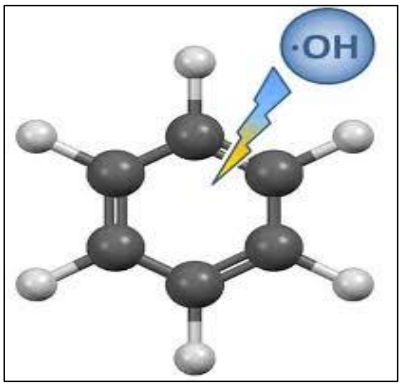


Fig. 1. Breaking of bonds of pollutant molecule by UV induced hydroxyl radicles

an Advanced Oxidation Nanotechnology (AON), leading to oxidative degradation and mineralisation of targeted pollutants. Also, it involves novel approaches which make very less use of chemicals in the overall treatment leading to much reduced quantum of sludge, preventing secondary pollution and providing highly resource and energy efficient treatment.

This technology has been developed under DST Water Mission, Water Technology Initiative (WTI), Program of Ministry of Science & Technology, Government of India, during July 2017-2020 and the outcomes have been announced through its press release on 25th August, 2021: https://pib.gov.in/PressReleasePage.aspx?PRID=1748888

TADOX® technology for industrial wastewater treatment

Figure 2 depicts successful case studies in Industrial Wastewater Treatment in different sectors and how it could be retrofitted at different stages of treatment as per the need. The TADOX® treated colourless and high-quality water going to subsequent tertiary system involving RO may prevent biofouling of membranes, enhance life span and efficiency of RO systems and reduce overall load on subsequent evaporators like MEE and MVR etc., enabling sustainable and affordable ZLD compliance with 85-90 per cent enhanced water reusability. Further, having small footprint, few hours treatment time and together with resource & energy efficiency, the overall treatment is

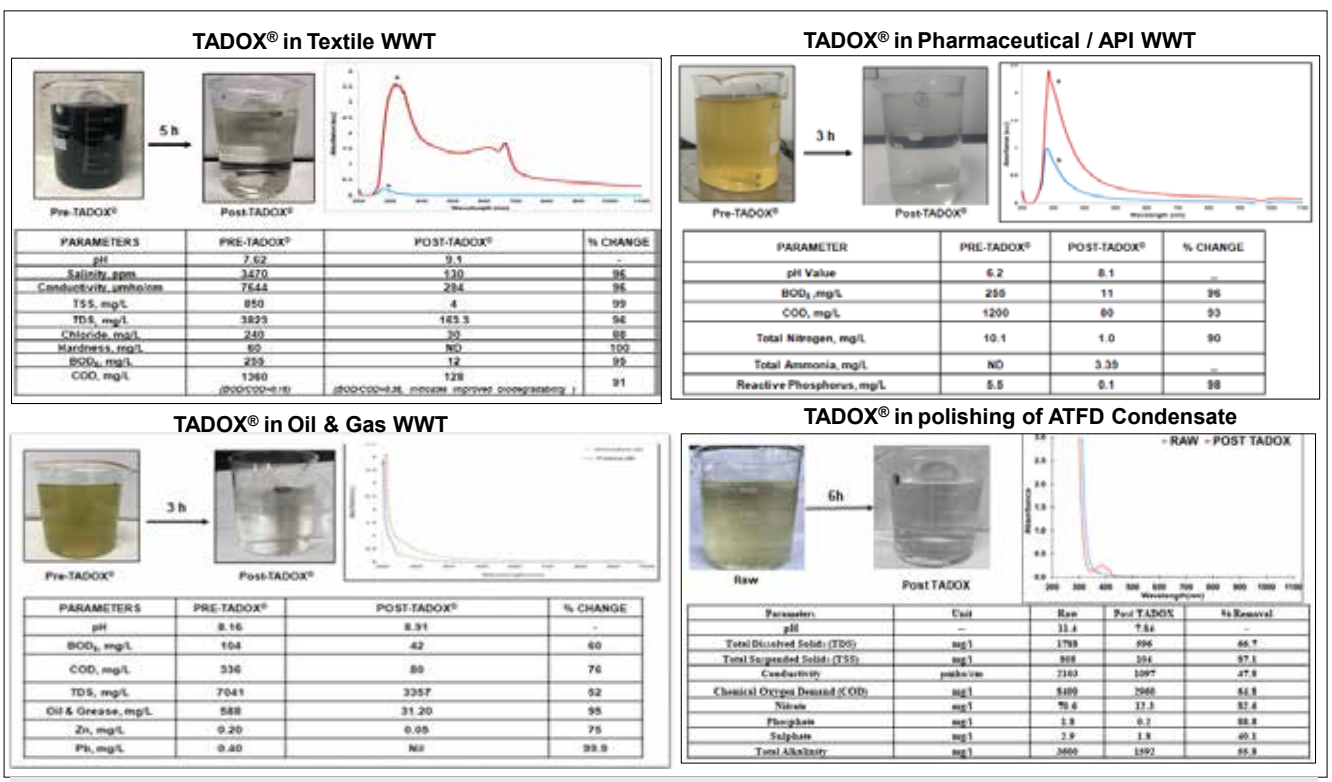
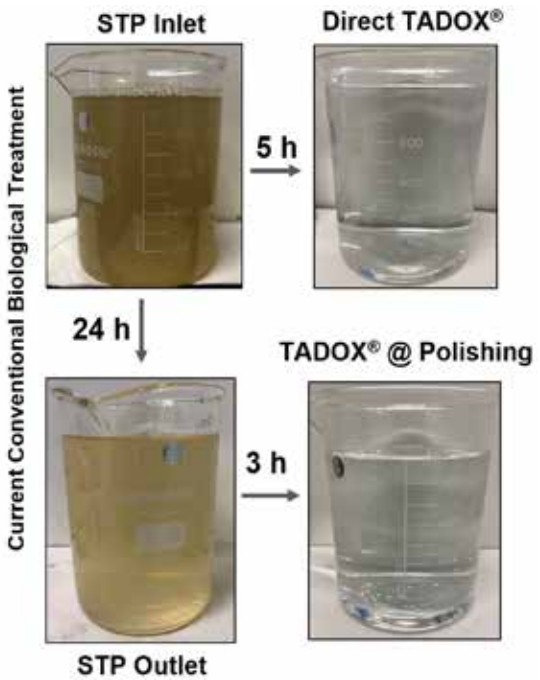


Fig. 2. TADOX® Treatment of Industrial Wastewater

STP INLET	
pH	7.9
Colour, (Pt- Co) (CU)	185
COD, mg/L	650
BOD, mg/L	261
TSS, mg/L	380
Total N, mg/L	32.0
Total P, mg/L	81.2
E. coli, MPN/100 ml	1.02×10^5
Total Coliform bacteria, MPN/100 ml	6.12×10^6
Total count, CFU/100 ml	5.24×10^5

STP OUTLET	
pH	8.2
Colour, (Pt- Co) (CU)	125
COD, mg/L	400
BOD, mg/L	78
TSS, mg/L	110
Total N, mg/L	30
Total P, mg/L	13
E. coli, MPN/100 ml	1.21×10^4
Total Coliform bacteria, MPN/100 ml	1.13×10^5
Total count, CFU/100 ml	1.84×10^4



DIRECT END-TO-END TADOX®	
pH	8.0
Colour, (Pt- Co) (CU)	8
COD, mg/L	64
BOD, mg/L	7
TSS, mg/L	<5
Total N, mg/L	1.9
Total P, mg/L	<1
E. coli, MPN/100 ml	16
Total Coliform bacteria, MPN/100 ml	1.16×10^2
Total count, CFU/100 ml	28

TADOX® AT POLISHING STAGE	
pH	8.1
Colour, (Pt- Co) (CU)	5
COD, mg/L	46
BOD, mg/L	<3
TSS, mg/L	<5
Total N, mg/L	1.7
Total P, mg/L	<1
E. coli, MPN/100 ml	<8
Total Coliform bacteria, MPN/100 ml	3.13×10^2
Total count, CFU/100 ml	11

Fig. 3 - TADOX® Treatment of Sewage

expected to bring down OPEX by 30-40 per cent than current values. Further, TADOX® could be integrated and retrofittable in existing treatment systems depending on the nature and constitution of the matrix; e.g. for streams having high COD, it could be integrated at pre-biological stage to enhance biodegradability; for streams having high BOD, at post-biological or polishing stage to remove recalcitrant and dissolved organics.

TADOX® technology in sewage and municipal wastewater treatment

Case study

Following is the case study of treatment of raw STP Wastewater from the 10 KLD TADOX® WWT Plant, operational in TERI Gurugram campus. This plant is treating wastewater coming directly from a collection sump, having wastewater from various research laboratories, hostels, canteens, laundry, toilets, etc. No stream segregation of any kind is required and two approaches could be there (i) directly treating the Inlet water and (ii) further treating or polishing the currently treated outlet. Since in both cases, the quality of treated water is the same, therefore, direct treatment is best as it saves the time, resources and footprint as compared to existing treatment technologies.

Way forward

In case of Sewage and Municipal wastewater treatment, TADOX® having Advanced Oxidation is sufficient for direct treatment, without any kind of biological treatment or additional disinfection technology, not even requiring any kind of grey and black water stream segregation. With total treatment time of 4-5 h, together with point of use water quality, which makes it an excellent choice in improving current efficiencies in wastewater treatment together offering augmentation of capacity within existing infrastructure. Also it could serve as Decentralized Wastewater Treatment system and micro-STP in upcoming and existing infrastructural projects, townships, commercial complexes, Green Buildings, AMRUT and Smart Cities Project. Also under SBM 2.0, where the requirement is to enhance treated water reuse, this technology could be used at the polishing stage of the current STPs.

Currently the technology is at TRL-7 and ready for commercialization and invites participation of Industry and Governmentto adopt and deploy technology at field scale. It holds great potential for point source pollution abatement across ETP and STPs and thus preventing Industrial effluent and sewage being discharged to open drains and pollute riverine ecosystem.

Innovation is the key to achieving SDGs and the technological interventions like TADOX®isparticularly required to meet the SDG 6.3.

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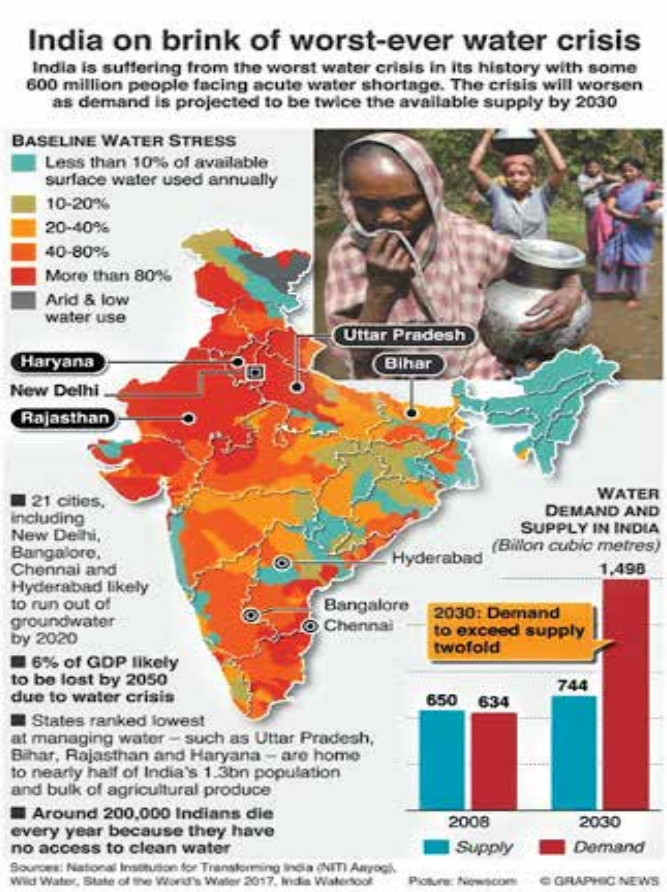
Wastewater a resource: Plugging water supply and demand gap

» **DR. MAHREEN MATTO**
Program Manager, Sanitation Capacity Building Platform (SCBP), NIUA.

India is on a move to rapid increase in urbanisation with an estimate of 590 million people to start living in cities by 2030, going up to 820 million by 2050. However, demand for a rapidly urbanising society comes when Indian cities are spiralling - climate is changing, making cities more prone to extreme rain events and floods while water scarcity and pollution continues to grow, writes **Dr. Mahreen Matto**, Program Manager, Sanitation Capacity Building Platform (SCBP), NIUA.



India's Water Crisis

Ground water, lakes and rivers are exhaustively overdrawn, yet no city is able to meet the service level benchmark of water supply.[1]

According to the Niti Aayog, Composite Water Management Index (CWMI) report, 100 million people are on the frontline of a national water crisis and many major cities are facing an acute water shortage.[2] The CWMI report also highlights that by 2030, the country's water demand is projected to be twice the available supply, implying severe water scarcity for hundreds of millions of people and an eventual 6 per cent loss for the country's GDP.

Indian cities practise the colonial conventional water

1. Shah, M. (2016). Urban water systems in India: a way forward (No. 323). Working Paper.
2. Aayog, N. I. T. I. (2018). Composite water management index. National Institution for Transforming India, GOI.

management approach, which focuses on supply of water. Furthermore, there is an increased dependence on long distance sources; pumping and piping the water means both loss in distribution as well as high costs of energy and infrastructure. Thus, focuses on hardware solutions and neglects future spatial development of cities. This approach is unsustainable, given that more water supply leads to more wastewater generation, which in turn increases the cost of treatment.[3]

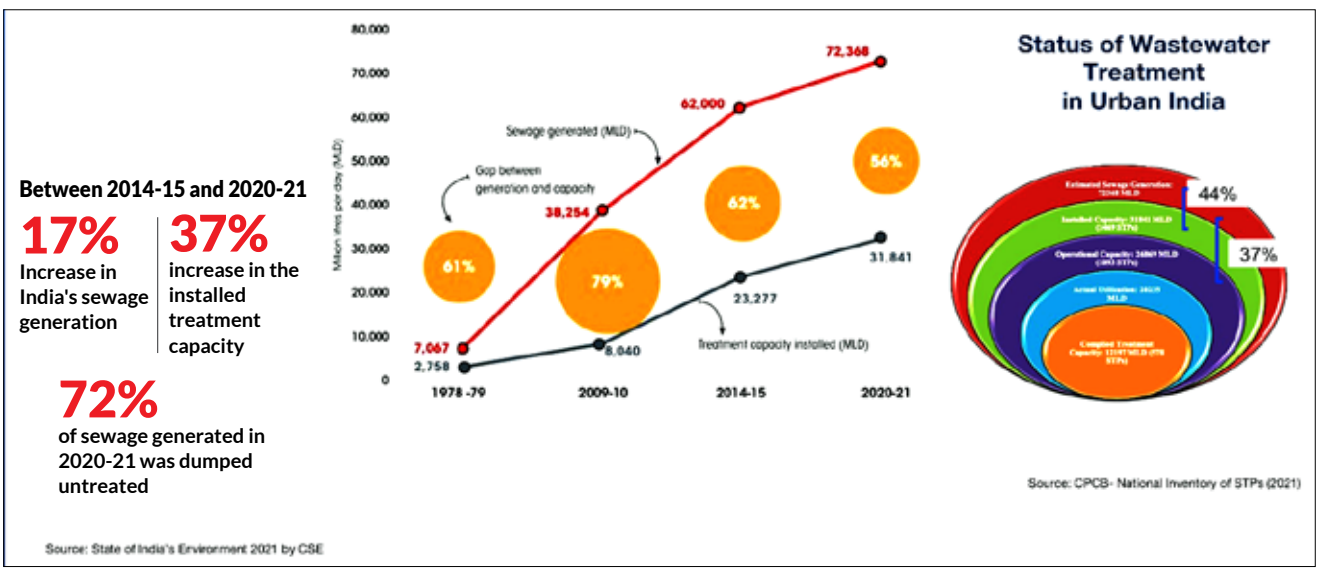
About 80 per cent of the water that reaches households leaves as waste. In urban areas of the country, treatment of sewage/domestic wastewater is a big challenge. Since 2009, the pace of implementing Sewage Treatment Plants (STPs) has surpassed the pace of sewage generation. However, the statistics can be quite often misleading, because the gap between sewage generation and installed and actually treated, that implementation and operation and maintenance of the sewerage network is cumbersome and financially unsustainable. As a result, most of the cities do not have fully functional wastewater management systems. Further, the growing pollution and the increasing demand exacerbates the inadequacy of treatment capacity which causes the disposal of untreated wastewater directly or indirectly into the water bodies. Thus deteriorating the quality of water bodies which poses a significant threat to human and environmental health.

However, the question arises, how will Indian cities grow, without creating solutions for wastewater and practice recycling and reuse? The challenge is to reinvent the wastewater management system that reuses every drop of water discharged, at affordable cost for all.

cellulose, rare earths and other resources can be extracted.[4]

According to estimates, if 80 per cent of urban wastewater is treated by 2030, there will be around 400 per cent more treated wastewater available, which is equivalent to nearly 75 per cent of the anticipated industrial demand in 2025 and nearly a quarter of the country's projected total drinking water needs.[5]

The National Missions such as Swachh Bharat Mission-Urban (SBM 2.0), National Mission for Clean Ganga (NMCG) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT 2.0) have prioritised wastewater treatment, along with the reuse of treated wastewater as key environmental interventions towards a more water secure India. According to MoHUA, it is now called 'used water' which recommends a used water management



capacity was still 56 per cent in 2021. In the year 2020-21, 72 per cent of the sewage generated was discharged into the environment without treatment. This clearly indicates that there is a huge gap between the wastewater generated

Research shows that wastewater is increasingly being considered an untapped resource to augment water supply that can ultimately reduce water stress. It is a valuable resource from which energy, water, organics, phosphates, nitrogen,

approach based on the Citywide Inclusive Framework. Few states like Gujarat, Jharkhand, Haryana, Punjab, Rajasthan, Maharashtra, Chhattisgarh, Karnataka, Jammu and Kashmir and Madhya Pradesh have announced wastewater treatment policies.[6] In states such as Delhi, Bengaluru, Gujarat, Chennai, Haryana, Maharashtra etc, the used water is used for horticulture, irrigation, construction and rejuvenation of lakes and waterbodies. Against this background, many

3. Rohilla, S. K., Matto, M., Jainer, S., Kumar, M., & Sharda, C. (2017). Policy Paper on Water Efficiency and Conservation in Urban India. New Delhi: Centre for Science and Environment.
4. Connor, R., Renata, A., Ortigara, C., Koncagul, E., Uhlenbrook, S., Lamizana-Diallo, B. M., ...& Hendry, S. (2017). The United Nations world water development report. Wastewater: The untapped resource. The United Nations World Water Development Report.
5. https://www.downtoearth.org.in/blog/water/covid-19-the-need-is-to-decentralise-how-we-manage-wastewater-70991
6. Government of Gujarat (2018) Policy for Reuse of Treated Waste Water; Government of Karnataka (2017) Policy for Urban Waste Water Reuse: Enabling Environment for Urban Wastewater Reuse; Government of Punjab (2017) The State Treated Waste Water Policy

municipalities across the country have started to pursue reuse projects:

- In 2014, Surat Municipal Corporation built a 40 MLD reuse plant to supply reclaimed water to Pandesara Industrial Estate
- In 2016, Chennai Metro Water Supply and Sanitation Board awarded a PPP based reuse project to develop 45 MLD reuse capacity on the design, build, and operate (DBO) model to supply used water to industries
- Bengaluru's water utility has built a 10 MLD tertiary treatment plant at Yellahanka to supply used water to Bengaluru international airport
- Maharashtra Generation Company and Nagpur Municipal Corporation have jointly invested in a reuse project where used water from an STP is used as cooling water
- In 2016, New Delhi Municipal Council started promoting decentralised STPs to deal with the wastewater load in the city and promote recycling of used water for horticulture and irrigation

While policy and guiding frameworks recognise the need for recycling of wastewater, there has been little in terms of detailed guidance on the treatment standards, types of reuse applications, design and O&M considerations for management of wastewater recycling projects and tariff structures for sale of recycled wastewater for various applications. Such projects, while being undertaken by various states and cities in India, are largely structured individually and developed in isolation at the local level.

In the absence of specific standards and guidelines, the wastewater reuse for irrigation is practised informally in India. Local governments and industries in several parts of the country earn income by selling treated or untreated wastewater to local farmers. However, a lack of comprehensive standards and policy framework is hindering the development of a formal market, appropriate technology and sustainable business/financial models.[7]

From a resource perspective, sustainable wastewater management requires to overcome following challenges:[8]

i) Lack of knowledge about the concept of water resource recovery and considering wastewater as a resource.
ii) Need for policies and regulations that support and incentive used water.
iii) Lack of regulatory frameworks and guidelines for used water, biosolids and energy generation from treatment plants.
iv) Lack of coordination and convergence for the implementation of measures to align local activities, strategies and policies with those at a regional and national level, to initiate the dialogue between various government institutions and stakeholders and eventually transfer experiences and good practices for scaling up and integrating in corresponding policies and plans.
v) Tailored technologies that enable fit-for-purpose treatment to optimise resource utilisation.

Application of the resource recovery concept as well as planned wastewater management programmes of the Centre and states would be integral to achieving a Swachh Bharat in the complete sense. Such a nationwide comprehensive model will not only rejuvenate water bodies and help recharge groundwater to provide a safer and cleaner access to water, but also a healthier ecosystem.

7. Banerjee, A. Legal And Policy Framework For Wastewater Treatment And Reuse In India: A Background.
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Raising Awareness: A key to accomplish sanitation

In its endeavour to plan and execute decentralised sanitation solutions, Sanitation Capacity Building Platform (SCBP), a platform designed by National Institute of Urban Affairs (NIUA), facilitates knowledge sharing among cities on decentralised sanitation and assists states and cities to move beyond open defecation-free status by addressing safe disposal and treatment of human faeces.

Aiming to raise awareness around India's urban sanitation scenario and its importance for urban development among the Indian youth, SCBP organised 'Urban Sanitation Photostory Competition' from mid-April to mid-June 2022. The competition, which revolved around three important themes, saw massive participation of students across India. The three themes were focused on sanitation and climate change, innovative practices for achieving a circular economy in sanitation, and inclusive sanitation. The participants submitted photographs along with a nuanced abstract on respective themes.

With six participants emerging out as winners – two winners per theme – the event ended on a very high note.

The winners under Theme 1, titled Sanitation and Climate Change, were **Swapnil Dewangan** and **Samiksha Singh.**

Swapnil Dewangan - AAFT University, Raipur

"Because of natural calamities, the temperature is too high and the soils are dried out. The lady in the first frame collects the little water left in the pond after the soils are dry. In the second frame, the lady boils the water to use it as drinking water. In the third frame, she strains the water in another utensil and gives it to her son to drink in a glass in the last frame. The whole story in these frames is to maintain the sanitation and hygiene when the climate is changed."

Samiksha Singh - Nazareth Academy, Gaya

"The name of my city reflects purity. Some seek enlightenment and peace for their departed beloved ones, and I always took pride in the same until an 8 am temple town area visit shifted my perspective. The stroll during the long streak of heatwave in the city was nothing but an eye-opener on how lakes that bring food to 30 per cent of the area's households are nothing but dumping yards in the off-season. Welcome to the land of Buddha and Vishnu"

The winners under Theme 2, titled Innovative Practices for Achieving Circular Economy in Sanitation, were **Akash Verma** and **Mananya Chaudhary.**

Akash Verma - AAFT University, Kharora

"If milk is 'white gold' in India, then dung is also called 'green gold'. Because, just as different types of enterprises can be set up by processing milk, similarly many types of enterprises can be started with cow dung. In the last few years, government organisations as well as the general public have started paying attention to this. That is why now, many different things are being made from cow dung as manure for the fields, biogas for the kitchen, and also for the stove."

Mananya Chaudhary - Mira Model School, Janakpuri

"Climate change is the reality of life today. Increasing population pressure has led to increasing consumption of power and fuel, contributing enormously to the climate change crisis. Unexpected rise in temperature is one such parameter. However, green cover on earth has potential to negate this effect. Recycling of dry leaves and other urban degradable waste into manure has great potential, which has the dual benefit of cleanliness as well as supply of plant nutrients. This practical solution of converting urban waste into manure has successfully been implemented in a DDA run nursery in Dwarka, New Delhi."

The winners under Theme 3, titled Inclusive Sanitation, were **Hemanshi Jain** and **Noella Horo.**

Hemanshi Jain - AAFT University of Media and Arts, Raipur, Chhattisgarh

"In the spirit of education's cloud, the sun of literacy is hidden somewhere. The country has made a bold statement by making sanitation a national issue. Having toilets at home and public toilets nearby, still there is a large proportion who prefer to defecate outside. Understanding the consequences of contamination of land, water, and transmission of diseases, this story is about a young girl who understands and educates his friend to use public toilets instead of defecating in the open. One day the mission of Swachh Bharat Abhiyaan will be successful."

Noella Horo - Dahisar

"What is the condition of the nameless workers who toil on the streets at 47 degrees? Well they smile for our pictures, and send us off with bowed heads and muttered thank-yous when we pass by clicking sympathy pictures. As we walk away, they wipe their sweat and step into the sewers feet first, wading through toxic waters. We owe them safety gear, not only appreciation. How have we reached the moon, when we still haven't installed mechanical desludgers? At the end of the day, there is just one question to answer: hygiene for all or hygienic for some?"

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ASIA'S FIRST MONTHLY MAGAZINE ON E-GOVERNANCE

Knowledge Exchange

27-28 August 2022

Caravela Beach Resort, Goa

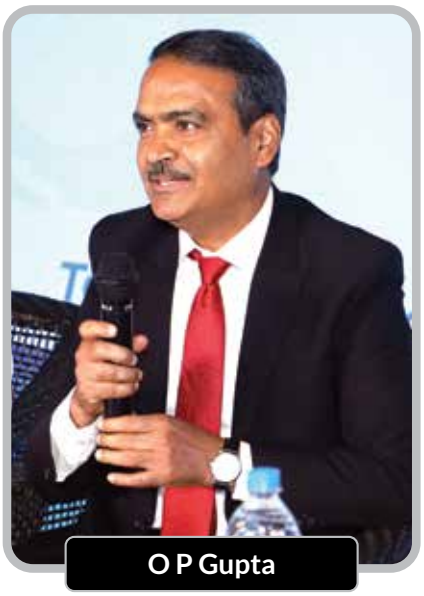
Elets Technomedia and eGovernance magazine organised the 11th edition of 'Knowledge Exchange Summit' on August 28, in Goa, on the theme 'Technology Accelerating Dynamic Transformation'. The summit was aimed at encouraging and celebrating cutting-edge innovations transforming governance in today's fast-paced digital era. Presented by IBM, with the support of National e-Governance Division (NeGD), Ministry of Electronics and Information Technology (MeitY), Government of India and Digital India, the conference saw a robust participation from senior policymakers from the Centre as well as state governments and industry experts.

India @75

The IT Industry has been instrumental in transforming the whole Indian economic and governance landscape. Highlighting this, **O P Gupta**, Principal Secretary (Expenditure), Finance Department, Government of Maharashtra; **Baldeo Purushartha**, Joint Secretary, Department of Economic Affairs, Ministry of Finance, Government of India; **Sumnesh Joshi**, Deputy Director General, Unique Identification Authority of India (UIDAI) and **Lalit Jain**, Director, Department of Environment, Science & Technology and Member Secretary, HIMCOSTE , Government of Himachal Pradesh spoke at the Knowledge Exchange Summit, Goa.

Talking about the IT-enabled intervention in the financial sector, **O P Gupta**, Principal Secretary (Expenditure), Finance Department, Government of Maharashtra, said "Maharashtra, today, does not really have paper stamps for high value transactions. Till now, you were supposed to pay through the bank, but now you can pay online and get the stamp delivered to you, which is verified." He said that the whole process has taken a few years, but that was the initial step, which according to him, was the IT-enabled intervention in the financial sector.

Talking about India's growth and development, he said, "India, in a way, is probably one of the few economies who has moved from agriculture to service sector in a transformative way.



O P Gupta

When we got independent 75 years back, our major part was agriculture and today, our service sector probably provides around 50 to 60 per cent of our GDP. Rather than going with a three-step process from agriculture to manufacturing and then to the service sector, India has gone directly from agriculture to the service sector."

Highlighting employment opportunities for the youth, Gupta said that the government's main focus is to make sure that the young generation gets enough gainful employment and help take India to the developed stage. Prime Minister Narendra Modi had also said that Information Technology plus Indian talent is India Tomorrow.

Talking about IT and its impact, Gupta gave an example of the kind of social unrest IT may bring in future. "When I was incharge of the state electricity distribution company, we talked about introducing smart metres. These metres are chip-based and you just drive a vehicle around and it takes the reading from all the buildings, so you don't really need a metre reader. Our second option is that the owner himself just takes a photo and uploads it. Now this creates a problem. The

employees who have been doing metre reading work become jobless. How do you retrain and re-employ them?"

Gupta concluded by posing three major questions- "How do we tackle the social unrest. How do we make sure that the people who are getting jobless or losing work are retrained and re-employed and what are the things we are doing today, which will remain relevant in 10 years 20 years down the line?"

Talking about technology, **Baldeo Purushartha**, Joint Secretary,

Baldeo Purushartha

Department of Economic Affairs, Ministry of Finance, Government of India, said, "We have done quite well but there are still miles to go. Technology is a very dynamic process, it never ends. It always keeps reinventing and developing itself. So, we have to be on our toes and find out the newer ways, because one of the problems of technology is that it is also a tool of exploitation."

"So, whoever controls the technology is in a position to exploit other countries and Indian experience is that we have been exploited by developed countries in terms of technology in many areas," he added. Purushartha said that the pace of technological change will make almost 99 per cent things irrelevant. "Would there be a requirement for a self-owned car? There are driverless cars, you can just summon a car and go," he said.

"The way AI and machine learning is developing, 50 per cent of US calls of booking, asking for a service or purchasing anything is answered not through a human being, but through AI. So, half of the job is gone. These are part and parcel of technological development," he further said.

Talking about what the future would be, Purushartha said that "the general understanding is that within next 10-15 years, a real conscious AI would be in place, an AI having self-awareness. And if a self-aware AI is there, then there is no difference between a human being and AI," he said.

He said that video conferencing technology was hardly of any use before the pandemic. But now, with the pandemic, everyone is doing VC. "In government also, we used to do VC three or four times a day," he said. "Five to seven years from now, I doubt if we will require travel from one place to another to conduct meetings. We can have a virtual meetings with the same kind of sensation and feeling which we have today, in a holographic simulation," he concluded.

Sumnesh Joshi

Talking about Aadhaar, **Sumnesh Joshi**, Deputy Director General, Unique Identification Authority of India (UIDAI) said, "Direct Benefit Transfer (DBT) using Aadhaar has really made a difference in our country. We have saved Rs 2.2 lakh crore of subsidy (estimated by DBT Mission under Cabinet Secretariat) under DBT using Aadhaar."

> **Technology is a very dynamic process. It keeps reinventing itself. So, we have to be on our toes and find out the newer ways, because one of the problems of technology is that it is also a tool of exploitation. — Baldeo Purushartha**

"We have to reach the poorest of the poor. Earlier, in the absence of identity and the cost of acquisition or giving a service in the rural area was very high, now with an IT system in place, and using Aadhaar as a Know-Your-Customer (KYC), people are reaching and giving the services on the ground."

Financial transactions require a bank account. "Earlier, many people did not have a bank account, but due to Aadhaar as a KYC, over 40 crore accounts were opened under Pradhan Mantri Jan Dhan Yojana and that has made a difference as everyone now has a bank account."

Talking about ease of doing business, Joshi said, "Earlier, both lessee, lessor and witnesses had to visit the registrar office to get the live-in licence registered, but with Aadhaar, both lessee and lessors are getting authenticated online. There is no requirement of witnesses, as both are getting authenticated."

Joshi also talked about JAM (Jan Dhan-Aadhaar-Mobile) trinity concept. "This trinity is really changing the way we are delivering the services. The states are also working towards getting all the services on JAM trinity. So, in a nutshell, what I can say is that everyone is working to inward the pyramid. Initially, the citizens were applying for the services, now the government is reaching out to the citizens. Transformation is taking place in the ecosystem," he said.

UIDAI has launched face authentication. "All our senior citizen pensioners have to visit the bank for the life certificate once in a year. Now, they can simply call the postman and get the Jeevan Praman Patra through fingerprint auth or can do face authentication," he said. "A successful pilot of this has already happened in the COWIN platform. And now we are working with banks and state governments to adopt it," he concluded.

Talking about the impact of information technology, **Lalit Jain**, Director, Department of Environment, Science & Technology and Member Secretary, HIMCOSTE , Government of Himachal Pradesh said, "One thing which has brought the most disruption in the government is IT. There may be talk about changing laws, removing old laws, bringing various amendments in laws, but it is IT which has unleashed a great development vis-a-vis the governance."

Jain talked about his time when he was the Director of Rural Development, Government of Himachal Pradesh. "Having to deal with over 300 villages where there is no connectivity of telephone and with COVID, I think we were saved primarily because of IT, as we were able to reach and convey our messages to the people and also hold video conferencing with the various stakeholders like the pradhans of the panchayats," he said. "We could get their feedback, tell them what the government is doing. We held over 100 video conferences from our department. So that was the biggest impact which I saw," he added.

Highlighting another initiative during COVID which became a great success, Jain said, "In every 15 days, we would fix to hear public grievances online. So we would float a zoom ID, which would be well publicised to everybody and any citizen of Himachal Pradesh could join that video conference and convey his grievances to us."

> **Everyone is working to inward the pyramid. Initially, the citizens were applying for the services, now the government is reaching out to the citizens. — Sumnesh Joshi**

Lalit Jain

Emphasising the importance of IT, Jain said, "When we talk about India, it is IT that has had the most important impact as far as governance and the growth and development of the country is concerned. It's also true that for future years to come, it is going to be IT that is going to be the cheerleader."

Talking about the future of technology, Jain said that there will be a time when everything will be done by AI, robotics. "Even physical things - managing a godown of a civil supply corporation will be by the use of robots, who are going to sort out the material and then deliver it," he concluded.

Education and Skilling for New India

India, a fledgling democracy, continues to invest heavily in the education system, the results of which can be gauged from the dramatic rise of its IITs or IIMs. Today, it boasts of 23 IITs, 20 IIMs and 19 AIIMS which has made India a leading nation in delivering of education. But to make it truly meaningful, India must work in the direction of harnessing the massive demographic dividend. Highlighting this, **Dipak Desai**, Director, Directorate of Skill Development and Entrepreneurship, Government of Goa; **M Nagarajan**, Commissioner Higher Education, Government of Gujarat; **Anju Sharma**, Principal Secretary, Labour, Employment and Skill Department, Government of Gujarat and **Rajiv Rattan**, Director, Department of Higher Education, Government of Haryana shared their thoughts at the Elets Knowledge Exchange Summit, Goa.

Edited excerpts:

Using technology, India can further excel on its transformational journey in education and skilling, said **Dipak Desai**, Director, Directorate of Skill Development and Entrepreneurship, Government of Goa. Highlighting that vocational education and skilling are the need of the hour, he said "When I took over in the skill development and entrepreneurship department, there were various technical challenges prevailing in the state. Most of the Central government schemes were either not implemented or had been in a poor state. So, we started a private training partnership in Prime Minister Kaushal Vikas Yojana (PMKVY) and made all our ITIs training partners in PMKVY. The model became so effective that it is now being followed at the pan-India level."

Dipak Desai

Highlighting the various initiatives being undertaken in this regard, he said, "Unlike other states where state skilling programs like Chief Minister Kaushal Vikas Yojana (CMKVY) exists, Goa had no such scheme. So, we are soon going to launch CMKPY - Chief Minister Kaushal Path Yojana. Another thing is, though ITIs are run and managed by the government, there are certain regulations and compliances which act as hindrances to the proper implementation of the skilling program. Therefore, through CMKPY, we aim to bypass such stumbling blocks. Under Sankalp women entrepreneurship, they arranged a program at the taluka, districts, and state levels which turned out to be very successful. As a result, people in Goa now know about such schemes and departments, which was not the case earlier." Giving greater emphasis on apprenticeship, he concluded, "Apprenticeship plays an important role in this regard. Many organisations had no knowledge about it. Through our awareness drive, today 70 per cent of the companies in Goa engage in apprenticeship programs."

In order to make skilling drive a success, there is a need to break all the silos and comfort mentality, and at the same time, a multidisciplinary approach to problem

M Nagarajan

solving has to be encouraged. The gap between haves and have nots has to be bridged in education, said **M Nagarajan**, Commissioner Higher Education, Government of Gujarat.

He said that a lot of steps have been taken in the direction of education and skilling, especially with regard to upskilling and partnership. "We are supporting college students to come up with their ideas for innovations. Once these ideas are presented to the panel at the university, the IDR (Incentive Distribution Rights) level funding is provided to the students," he said, adding that these kinds of opportunities provide youth a platform to work for their future and take a career-oriented recourse. He also said that there is a need to look at education and skilling in tandem and together. "With these mindsets, we can plan strategically in making our skilling aspect in education more viable," Nagarajan said.

He further added that in the last five years, more than 6,000 ideas had been funded and over 800 patents had been filed. "We also did a large-scale certification program for college faculty. So now, at least one of the two faculties in each and every college or university is qualified, and is knowledgeable enough to guide the students. We have also implemented supportive and enabling initiatives which are called the Gujarat state IP guidelines for a group of teachers to mentor the students," he said, adding that only startup, entrepreneurship and IT are sunrise sectors, rest all are sunset. "We can teach and train our students more holistically in alignment with emerging opportunities in the sunrise sector," he said.

He further added that in Gujarat state student innovation hub, they worked on co-creation with big corporates like Mahindra, Nestle and state level public sector units like GUVNL, whose problems statements were identified and spe\cial hackathons were proposed to the college students. So, this has created a culture of ideation, innovation and entrepreneurship. In regard to higher education, he said that they are promoting embedded internships and they also converge with other departments so that students are exposed to different ideas and skills. "We must do away with the departmental mentality where one department refrains from engaging effectively with other departments, as it is really detrimental for making effective strides," Nagarajan said.

Highlighting the various initiatives being undertaken in Gujarat, he said, "We have undertaken pioneering initiatives in regard to technical skillling in the innovation club programs where students of different fields are taught about Artificial Intelligence (AI), 3D printing, Machine Learning (ML), and block-based coding. We have also implemented block-wise coding in Gujarati language for tribal students or the students in the interior areas, to have a glimpse of technologies coming up."

> **"We started a private training partnership in PMKVY (Prime Minister Kaushal Vikas Yojana) and made all our ITIs training partners in PMKVY. The model became so effective that it is now being followed at the pan-India level." - Dipak Desai, Director, Directorate of Skill Development and Entrepreneurship, Government of Goa.**

Technology has transformed the entire functioning of the education department. It has made education more tech oriented and digitally enabled, said **Anju Sharma**, Principal Secretary, Labour, Employment and Skill Department, Government of Gujarat. "Through NEP, the entrenched biasness of various streams viz., Arts, Commerce and Science which existed not only at school level but also at a society level will now be done away with," she said.

"At the district level, we have reinvigorated the team officials and the entire ITI system has now been centralised into one portal for the students to apply for the ITI (Industrial training Institute) admission. Their marks will also be verified by the board members. If they fail to get ITIs of their choice, they can reapply," she added.

Anju Sharma

She further added that there is need to take into consideration the market dynamics to take a gauge of the fact as to which ITI is doing best and which one is lagging behind, so that effective reassessment can be made accordingly. To make ITI education and output more effective, she highlighted three points- remove, reduce and improve, using which the Gujarat government has turned around the image of ITIs in the state. She said those IITs, where courses were not getting registered or were attracting least students, were removed. Those ITIs where students were coming in less numbers, their numbers were reduced. And those IITs which were doing excellent work were further improved.

Sharing concerns on the shortage of skilled manpower in the IT sector, she said, “If IT does not get the kind of manpower it wants, India as a nation will suffer badly. So, we must make sure that a regular pool of skill talents always remains at the disposal of the IT sector.”

Speaking on the importance of skilling, she said that the education system has to be upgraded and be more in line with career aspirations of contemporary times. Emerging technologies like AI, ML, robotics are creating huge job opportunities because of the enormous amount of analysis and demands it's throwing on the market. Concluding her speech, she said, "Growth of the current economy is now going to be predominantly in the service sector, so the rate of increase in the service sector is very high. The Service sector offers a lot of potential for jobs and even the manufacturing sector requires the need of having a service oriented mechanism in its offerings."

The National Education Policy (NEP) 2020 is a transformational step in making education more aligned with the contemporary demands of time, said **Rajiv Rattan**, Director, Department of Higher Education, Government of Haryana. With the view to help in the overall development of a child, the 16 deliverables in the NEP 2020 viz., quality, multidisciplinary approach, optimal learning, internationalisation of education, teachers-training, and ethics among others are going to make major strides in rendering education more practical and future-oriented.

"Aligning our plan with the objectives

Rajiv Rattan

envisioned in the NEP 2020, we are soon going to set up an 'Institute of Emerging Technologies' in Gurugram, which will function under the aegis of Gurugram University. The institute will delve into the study of emerging technologies in the IT or science field because, in government, people often tend to focus only on the prevailing technologies and not others. So, through this, the study related to the emergence of technologies will be taken care of," he said.

He further added that they are also proposing research and innovation in 6 multidisciplinary fields which are mentioned in vedas too, like prithvi (land), jal (water), vayu (air), agni (fire), van (forests) and vatavaran (environment). "Not only will it generate a sense of competition among the various public and private universities in the state to excel further in the field of innovation, but will also help in getting maximum or optimal grants from the state," Rattan said.

"To make education more inclusive and accessible in Haryana, we have made sure that there exists a college within a 20-kilometre radius of any particular area. With a small population of only 3 crore people, Haryana today has 178 government colleges, 97 engineering colleges, and more than 200 self-financed colleges," said Rattan.
“With 10 universities in higher education and four in technical education, the state also has 20 private universities in higher and technical education. We also have one skill university named Vishwakarma Skill University in Palwal, which focuses on mainstreaming skilled workers by helping them get good income and recognition. Almost all universities in Haryana collaborate with international universities through student exchange, teacher exchange and content management programs,” he added.

“So, we are doing everything possible to transform the education system in the state," he concluded.

Digital India: Making governance future ready

India, since its independence, has travelled a long distance in terms of developing its economy. By bringing robust policies and laws, it has effectively tried to address the ambition and aspirations of India and make its economic outlook more aligned with contemporary demands. India, in the 21st century, is more agile and active and is blessed with skilled talents whose works are recognised worldwide. Highlighting this, **Arvind Kumar Chaudhary**, Special Secretary (IT), Government of Bihar; **Dr. B. R. Mamatha**, Additional Mission Director, SAKALA Mission, Department of Administrative Reforms, Government of Karnataka; **Shilpa Nag**, Commissioner, Rural Development & eGovernance, Government of Karnataka; **Abhishek Sharma**, Chief Executive Officer, Jammu & Kashmir eGovernance Agency (JaKeGA) and **Mirant Parikh**, District Development Officer, Junagadh, Gujarat spoke at the Elets Knowledge Exchange Summit, Goa.


Arvind Kumar Chaudhary

Arvind Kumar Chaudhary, Special Secretary (IT), Government of Bihar, said that India, as a nation, has made great strides everywhere. "From analog in 20th century to digital in 21st century, first and second generation communication before 2000 to fifth generation communication in 2020, offline to online dissemination of public service and information, and from cash to booming digital transactions," he stated.

Elaborating on the transformational role played by low data tariffs in India, he said, "Data has become the most basic need of today. Total telecommunication connections today have grown to 118 crores. With 150 crore GB per month of mobile data consumption, India is now the world's number one mobile data consuming country, leaving behind China and USA altogether. This data flow shows how exponentially digital communication has grown in the country. India at 75 is entering the fifth generation of the communication era with revolutionary services to advance the digital India vision."

"The introduction of 5G in blend with the Internet of Things and Artificial Intelligence will bring further revolutionary digital transformation to the nation. 5G will provide a new dimension to Digital India. As far as the contribution of the IT industry to the Indian economy is concerned, it accounts for more than 8 per cent of India's GDP. It is one of the highest employment-providing sectors in the country with a 4.8 million IT workforce. The use of digital technologies brings governance closer to people. A report said that Digital India has helped government machinery in enhancing the country's revenue to save Rs 2.2 lakh crore from going into the wrong hands in the last 8 years," Chaudhary said.

He further said that the outbreak of

the COVID pandemic at the beginning of this decade has further underlined the importance of digital technologies and accelerated the digital movement. "Today, India's digital transformation is itself in its full momentum. It is now self-driven. All the departments of the government are now adopting digital solutions for good governance," he concluded.

Effective coordination and collaboration between various departments of the Central government as well as of the state governments or between various states are imperative to make governance and administration smooth and efficient in the economy. **Dr. B R Mamatha**, Additional Mission


Dr. B. R. Mamatha

Director, SAKALA Mission, Department of Administrative Reforms, Government of Karnataka, said, "Collaboration is the future because every state is taking some initiative or other to enhance the governance in its own way. What the future calls for, is a collaboration among the states and departments within the state."

Speaking on governance, she said, "As the need advances, comes the assessment, using which we can figure out what we can do and how we can do it. We also understand that with all the initiatives behind this, we need to know whether the citizens are satisfied with what we are providing them. When we talk about citizen-centricity, we should look at easy access to citizens, affordability must be there and with less invasive technology."

"We also need to make sure that all the data we have collected is secure. This is the most important thing for the future. Data is the key and it is important to ensure that data sharing among ourselves is safe and secured," she concluded.

To make the governance future ready to meet the challenges and aspirations of contemporary times, effective leveraging of emerging technology like AI&ML, robotics, and drones becomes extremely crucial. **Shilpa Nag**, Commissioner, Rural Development & eGovernance, Government of Karnataka, said "The happiness of the king lies in the happiness of his people - so is the concept of governance! Governance should take into account people-centric approaches.


Shilpa Nag

There is also a lot of learning management system-related activity going on, such as giving information to people through the citizen information portal. We have created multiple portals for faster dissemination of public services. Today, the risk is non-repetitive," she said.

"In the governance process, whenever a fund is available before executing any work – planning, monitoring, implementation, and evaluation are the primary steps that need to be performed so that revenue is not squandered unnecessarily and there is a check on corruption," she further said.

Abhishek Sharma, Chief Executive Officer, Jammu & Kashmir E-governance Agency (JaKeGA) said that Jammu & Kashmir was quite new to the digital ecosystem


Abhishek Sharma

and most of the initiatives have been taken post reorganisation i.e., after 2019. "Going digital has helped us in a lot of ways. We have two capitals – Jammu and Srinagar – and every year, more than 300 trucks are used to carry documents

and files from Jammu to Srinagar in summers and then back from Srinagar to Jammu in winters. This movement of files alone used to cost us Rs 300 crore annually," he said.

Post reorganisation, the first task given to JaKeGa, an IT department, was to onboard an eOffice. In 45 days, all administrative secretaries and HODs went on eOffice, resulting in a cost saving of Rs 300 crore annually, he said. "Right now, we have 15,000 users on eOffice. Even the CS office is in the eOffice. So, we could finally be done with the need of cumbersome physical file movement. We have also given awards to the officers who have done files in the shortest time possible. All this has helped us in achieving accountability in the system," he said.

"In J&K, the target of the government is to make the system more accountable, and transparent and there is no other alternative other than going digital," Sharma said, adding that "earlier in the fund flow, nobody knew where the funds were going. But in J&K, there is a process called Budget Estimation Accounting and Monitoring System. In this process, everything is online. And you must link it with proof, so if any DDO is releasing the budget, it can't be done without entering the portal of the work. Funds get released in exchange for some work and that work must get uploaded in the form of a photograph. Not a single penny can be spent without going digital," he said.

"With the intention to go digital and make the process even deeper, we have launched an online billing system, in which contractors are registered online. We are very new to this system and there is no baggage. So our philosophy is to promote transparency and accountability through this," he concluded.

"Overall concept of e-governance brings to us four to five main facets of governance. The major one is the concept of accountability. The second is the concept of transparency. The third is public service delivery, especially at the grassroot level. And the fourth point is the elimination of discretionary powers that we had at different stages," said **Mirant Parikh**, District Development Officer, Junagadh, Gujarat.

On the overall concept of e-governance, he commented, "Adding the letter E into the concept of governance entails the overall transformation of governance. Minimum government and maximum governance must be the norm." He further said that all sorts of loopholes that have existed for a long time are being addressed and eliminated in Gujarat, rendering the state the best tech-driven state in India.

Stressing upon the superb role played by the Finance Commission, he said, "The 15th finance commission, a constitutional body set up to maintain fiscal federalism in India, whose core responsibility is to evaluate the state of finances of the Union and state governments, recommend the sharing of taxes among states. In its recent reports, it gave greater emphasis on allocating resources for rural development, especially at panchayat level. So, the aspect of decentralisation in administration is paramount in transforming the governance at the grassroots level in India."

"Overall concept of e-governance brings to us four to five main facets of governance. The major one is the concept of accountability. The second is the concept of transparency. The third is public service delivery, especially at the grassroot level. And the fourth point is the elimination of discretionary powers that we had at different stages," said Mirant Parikh, District Development Officer, Junagadh, Gujarat.

He concluded by saying that Gujarat has made major strides in that regard. The e-governance system is being made more robust and resilient in the state.

Silvassa moving towards seamless urban mobility

In line with the objective of the smart city mission, the city of Silvassa has set its vision for a smart city as a vibrant growth centre that offers an optimal balance between industrial prosperity and quality of life, while promoting its rich private heritage. Highlighting the initiatives the city has taken, **Charmie Parekh**, Chief Executive Officer, Silvassa Smart City, spoke at the Elets Knowledge Exchange Summit.

Silvassa smart city has been taking path-breaking initiatives to address the mobility challenges of urban habitats. Talking about urban mobility, **Charmie Parekh**, Chief Executive Officer, Silvassa Smart City, said, "We have been looking at the urban mobility aspect in an integrated manner by providing e-buses, which are environment friendly. We are providing transport services at a very reasonable cost to people."

Silvassa is an industrial town, so many people who are commuting to work require public transport, she said. "People are also coming from the far-flung areas of Dadra and Nagar Haveli, as well as the nearby industrialised towns of Vapi and Daman. So, we have kept our buses in a way that it reaches all three industrialised towns," she added.

Apart from providing mobility and transport to these people, the city is also targeting the school and college students and has come up with a policy for them.

Looking at the industries and corporates of Dadra and Nagar Haveli and Silvassa, Parekh said that they have started an initiative along with Bangalore smart city, which is 'Cycle2Work'. "We are taking it to the next level – pan Silvassa – where people are being encouraged by the companies to take up cycling to reach industries," she said. The Ministry of Housing and Urban Affairs has also backed the initiative.

The campaign calls for employees to reconsider their every mobility choice—to shift from cars and motorbikes, and cycle to their workplace instead, building health while saving the planet. "Cycle2Work will probably be carried forward in the other smart cities of India too," she concluded.

Technology transforming Indore

With the launch of the Centre's flagship Smart Cities Mission, the urban development and city planning in India has seen a transformation, opening arms to adopt technology interventions to optimise city operation and services. Highlighting Indore's development, **Rishav Gupta**, Chief Executive Officer, Indore Smart City Development Limited, spoke at the Elets Knowledge Exchange summit, Goa.

In the Swachh Survekshan 2021, **Rishav Gupta**, Chief Executive Officer, Indore Smart City Development Limited, said that Indore, the commercial capital of the state of Madhya Pradesh, became the first city to attain the 'Water Plus' status. 'Water Plus' status is accorded to cities under the Swachh Survekshan survey on the basis of their performance in tapping the polluted water and preventing its flow in the rivers and other freshwater bodies of the region.

Talking about sludge disposal solution, Gupta said the only solution for sludge disposal is to use it as manure. But this sludge contains a lot of pathogens which are typhoid, cholera causing and due to this, there have been many incidents of epidemics and diseases. "Bhabha Atomic Research Centre came up with a technology, in which, by using the radioactive cobalt 60, we can have gamma radiations which can then be used to treat the sludge, making it innocuous and a perfect substrate, upon which we can add bio NPK fertiliser and then use the final product as a commercially viable fertiliser," he said.

"That technology has been adopted in the past year by Indore smart city," he further stated.

Highlighting another initiative by Indore Smart City Development Limited, he said, "Indore smart city has been the first city in the whole South-Asia to have earned carbon credits and by selling those credits, we have earned revenue on the tunes of around Rs 10 crore, per year."

Gupta said that Indore smart city has come up with a business aggregator model. It is inviting all the cities which are having some eco-friendly projects. "We are clubbing these to make a single project and the projects which were not economically viable initially, to be participating in such kinds of markets, now by the means of aggregation, are becoming economically viable," he said.

Talking about technology interventions, Gupta said, "GIS-based property tax collection has been a hallmark of Indore smart city. Just by the click of a button, we can know what is the expected amount of revenue that we will be getting from every zone." He further said, "Just by this technology intervention, we have increased the revenue of Indore's municipal corporation tax collection by more than Rs 100 crore."

> **Indore smart city has been the first city in the whole South-Asia to have earned carbon credits and by selling those credits, we have earned revenue on the tunes of around Rs 10 crore, per year.**

"Technology is really proving beneficial in governance of cities like Indore," he concluded.

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