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Policy Interventions towards Sewage
Management and Improvement in Water Quality of River Ganga

River Ganga is main sources of livelihood in Gangetic planes as well as holds special sacred value in Indian society. Discharge of untreated sewage in river system is one of the important causes of water pollution, which has emerged as a major socio-economic issue. In 2016, 361 TPD pollution load (in terms of BOD) was being discharged through 154 drains into the river. Till 2017-18, only 68 STP with treatment capacity of 1439 MLD were installed in Ganga front towns. By the dawn of year 2023, 139 STPs have been installed with treatment capacity of 2514 MLD, which shows an increase of 74% in treatment capacity as compared to that in 2017-18. Deployment of appropriate technologies for interception, diversion and treatment of sewage resulted in reduction of pollution load discharge to river Ganga by 252.5 TPD through 516 drains in the year 2022, which is a reduction of 30% in the load as compared to 2016. Noteworthy efforts are made for reuse of treated sewage with improved quality of treatment by adoption of stringent norms for treated sewage. in the 73rd episode of Mann ki Baat (MKB) on 31st January, 2021 Hon'ble Prime Minister (PM) of India underlined the issue of dirty water being used by the farmers for irrigation purpose and need for recycle and reuse of treated wastewater. Measures and interventions to reduce the discharge of domestic wastewater entering into the river have led to significant reduction in pollution. These efforts have ensued improvement in water quality as well as overall health of the river. There has been a significant reduction in length of polluted stretches of the river.

Key words: Wastewater discharge, Sewage management, River Ganga, Sewage treatment plants, Water quality

Mann Ki Baat Reference: Episode 73, aired on January 31, 2021.

Augmentation of sewage management practices in Ganga front towns has led to improvement in water quality of river Ganga.

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Introduction

River Ganga is the main sources of iiveiihood in Gangetic pianes as weii as hoids speciai sacred vaiue in indian society. The river flows through five states Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengai through its journey from origin at Gaumukh, Uttarakhand to Ganga Sagar, West Bengal [Trivedi (2010) and Vidyarthi *et al.* (2020)]. india has witnessed unprecedented rate of urbanisation owing to rapid development. However, this rapid urbanization aiong with fast population growth has caused numerous environmental problems. Similarly, the Ganga River basin, home to 400 million people, is facing environmental challenges, with the progression of economic growth and social development. Demand for water in urban areas is ever increasing, leading to an increase in wastewater generation. Discharge of untreated sewage in water sources, surface and ground water, is one of the important causes of water pollution in India, which may pose risk to public health and environment. Hence, sewage management and sewage disposal become prime concern [Niti Ayog (2022) and MoWR (2017)]. In the 73rd episode of Mann ki Baat (MKB) on 31st January, 2021, Hon'ble Prime Minister of underlined the issue of dirty water being used by the farmers for irrigation purpose and need for recycle and reuse of treated wastewater.

This paper is aimed to assess improvement in sewage management and consequent amelioration of water quality of river Ganga. Significant policy interventions and initiatives has been made towards infrastructure development in sewage management and installation of sewage treatment plants (STPs), employing suitable technologies for interception and diversion drains to STPs. Development of infrastructure projects in tandem with implementation of stricter norms for discharge of treated sewage ensures enhanced quality of discharged treated sewage into the river [Niti Ayog (2020); Schellenberg *et al.* (2020) and CEEPHO (2013)].

Methodology

Central Pollution Control Board (CPCB) with the support from National Mission for Clean Ganga (NMCG) performs quarterly monitoring of STPs in Ganga front towns of five Ganga states, viz. Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal for their performance evaluation. Monitoring of drains discharging into Ganga and its tributaries is carried out on half early basis. Water quality monitoring of river is carried out fortnightly through network of manual monitoring stations (97) and real time water quality monitoring station (76). All analyses were carried out following the Standard Methods [APHA (2017)].

Results and Discussion

Augmentation in sewage treatment capacity from year 2017-18 to 2022- 23

In the year 2017-18 there were 68 STPs installed in the five Ganga states [Uttarakhand (UK)-10, Uttar Pradesh (UP)- 20, Bihar- 4, West Bengal (WB)- 34] with installed capacity of 1489 MLD. Fig. 1 and 2 shows year wise progressive increase in number of installed STPs (2018-19 – 82, 2019-20 – 103, 2020-21- 120, 2021-22 – 136) with corresponding treatment capacity (2018-19 – 1774 MLD, 2019-20 – 1956.68 MLD, 2020-21- 2235 MLD, 2021-22 – 2436 MLD). At advent of year 2023, 139 STPs (UK – 53, UP – 35, BH – 7, JH – 3, WB – 41) with total treatment capacity of 2514 have been installed for treatment of domestic wastewater.

The increase in treatment capacity from 1439 MLD in 2017-18 to 2514 MLD in 2022-23 suggests that an increase of 74% in treatment capacity has been achieved in past 6 years. Further, several sewage treatment infrastructures are under various stages of construction, which will be made operational in near future. This will further enhance the treatment capacity significantly.

It can be observed from the Fig. 3, that a significant improvement in utilised capacity has been achieved. Utilised capacity in year 2017-18 was 605 MLD, which amounted to be only 42% of total treatment capacity. Successive growth in utilised capacity can be seen over the years *i.e.* 1296 MLD in 2020-21, 1628 MLD in 2021-22 and 1652 MLD in 2022-23. This indicates that per cent utilization has increased from 42% in 2017-18 to 66% in 2022-23.

The increase in the utilization *i.e.* actual treatment by STPs is a resultant of employment of suitable technology for tapping of drains and diversion of waste water to STPs. In 2016, 154 drains discharging into river Ganga were monitored by CPCB through which 361.2 TPD pollution load (in terms of BOD) was estimated to be discharged. Table 1 shows progressive increase in the monitoring network on drain by CPCB, *i.e.*, from 154 drains in 2016 to 516 drains in 2022.

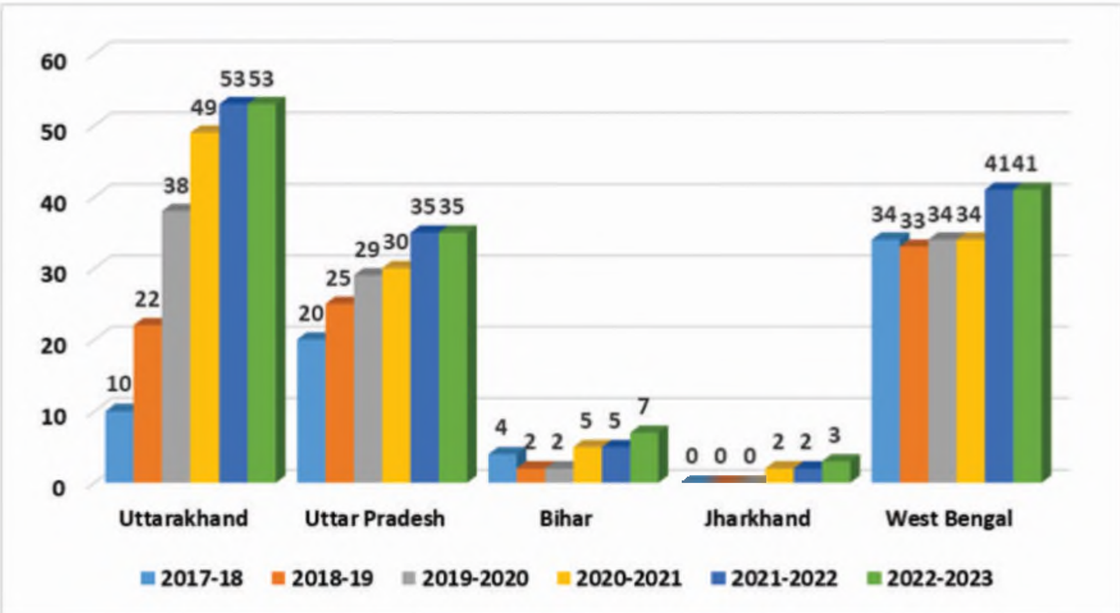

Fig. 1: Increase in number of STPs from 2017-18 to 2022-23

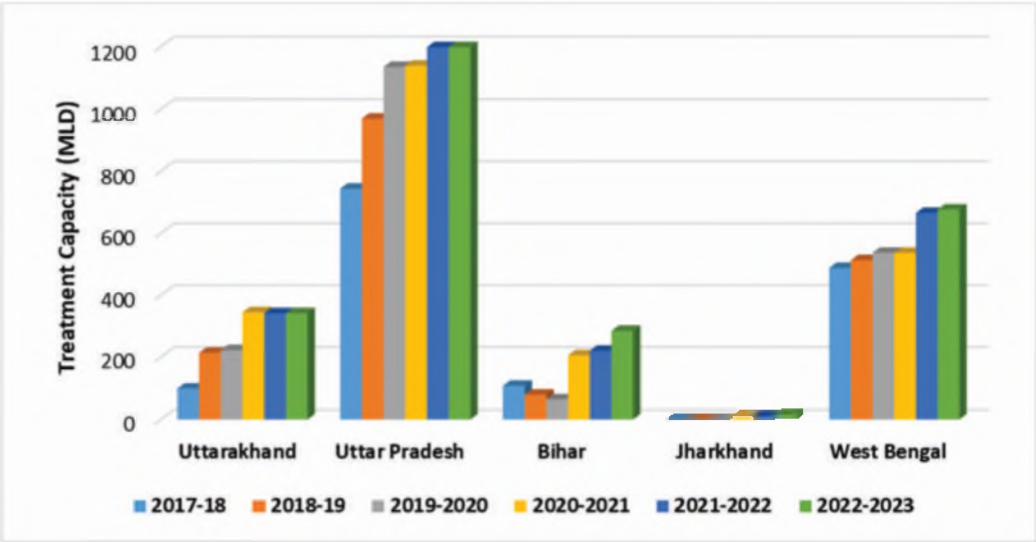

Fig. 2 : Increase in treatment capacity of STPs (2017-18 to 2022-23)

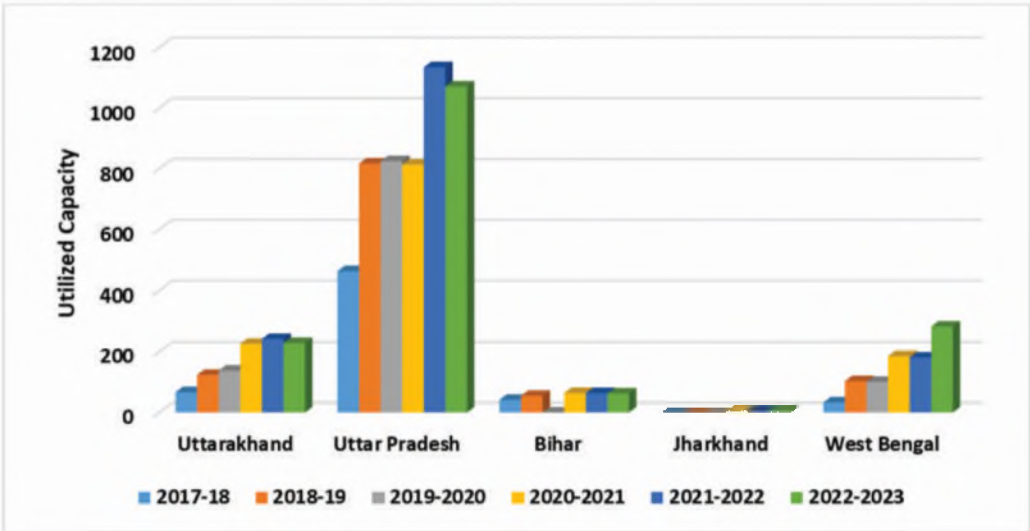

Fig. 3 : Increase in utilised capacity of STPs (2017-18 to 2022-23)

Furthermore, it can be observed that despite progressive increase in number of monitored drains, there is significant decrease in total pollution load (in terms of BOD) discharging into the river system *i.e.*, 361.2 TPD in 2016 to 252.5 TPD in 2022. This reduction in pollution load is owing to significant increase in provision of tapping through interception and diversion of wastewater to STPs. in 2016, oniy 6 drains were found to be tapped out of 154 monitored drains, however by 2022, through the government initiatives, substantial progress in drain tapping has been made *i.e.*, 188 out of 516 monitored drains were found to be tapped (an increase in drain tapping from 4% in 2016 to 36.4% in 2022). Monitoring of tapped drains were also continued for verification of tapping status.

Evolution in treatment technologies

in year 2017-18, employed conventional technoiogies such as series of waste stabilization ponds (WSPs)/ oxidation ponds (OPs) (44%) and Trickling filter (TF) (7%). Other technoiogies used were activated sludge process (ASP) 30%, followed by Sequential Batch reactor (SBR) (7%) and Up-flow Anaerobic Sludge Blanket (UASB) (7%) and Moving bed biofiim reactor (MMBR) (4%).

in the year 2019-20, share of (WSPs)/ (OPs) and (TF) reduced to 25.24% and 4.85% respectively. Besides these, the (ASP) was second most commonly employed technology, which accounts for 22% of installed STPs followed by (SBR) (20%), Eiectro-

Table 1: Year wise comparison of number of monitored drains, flow and corresponding pollution load (year 2016 to 2022)

Year	Drains Monitored	Flow (MLD)	BOD Load (TPD)	Tapped Drains
2016	154	9146.09	361.2	6
2018	151	10720.14	348.71	17
2019	151	11561.87	320.1	32
2020	260	9565.99	236.1	60
2021	503	11031.04	376.7	186
2022	516	10750.84	252.5	188

coagulation (EC) technology (10.68%), Up-flow Anaerobic Sludge Blanket (UASB) (6.8%), Moving bed biofilm reactor (MBBR) (6.8%). However, in 2022, the distribution share of SBR is highest (28%) followed WSPs/OPs + TFs (21%), ASP (17.99%), EC (12.95%), MBBR (8.63%), UASB (5.04%), (FBAS) (1.4%), and Anarobic-anoxic-oxic (A2O) (0.7%).

From this trend, it can be concluded that trend of utilization of advanced technologies for sewage treatment in 2022-23 has increased. And a substantial decline has been observed in utilization of conventional technologies (WSPs/OPs, TFs, and ASP) from 81% in 2017-18, 52% in 2019-2020 to 39.58% in 2022-23. In addition, the gradual increase in the distribution share of advanced treatment technologies (SBR, MBBR, UASB, EC, FBAS, A2O) is observed from 19% in 2017-18, 45% in 2019-20 to 57% in 2022-23.

Conventional treatments such as WSPs/OPs are the low-cost technologies for sewage treatment, however requires huge area. In addition, the performance of these methods is substantially lower in terms of their potential for meeting the stringent discharge standards. Besides, these processes are also less efficient in eliminating biological pollutants (Total Coliform/ Faecal Coliform), generates huge quantity of sludge, and require high maintenance while advanced biological treatment system such as SBR, MBBR, A2O require lesser space and are able to provide better removal efficiency with proper operation and maintenance. The SBR, MBBR based systems can work with automated controls and generally have low hourly retention time (HRT).

Technology wise distribution of STPs in Ganga front towns across the five Ganga states are represented in Table 2.

Rehabilitation of non-operationai STPs

Addressing the issue of discharge of untreated sewage into river system requires multipronged strategies like installation of STPs as well as revamping and restoration of old defunct plants is vital to achieve this objective. It can be observed from the Fig. 4 that share of non-operational STPs has progressively decreased through better operation & maintenance and

Table 2: Technology wise distribution of STPs (year 2017-2018 to 2022-23)

Treatment Technology	2017-18					2019-20					2022-23					
	UK	UP	BH	WB	Total	UK	UP	BH	WB	Total	UK	UP	BH	JH	WB	Total
SBR	4	1	-	-	5	17	3		1	21	21	5	5	3	5	39
ASP	3	9	2	6	20	3	12	2	6	23	3	8	2	0	8	25
MBBR/FAB	2	1	-	-	3	4	3	-	-	7	9	3	-	-	-	12
EC	-	-	-	-	-	11	-	-	-	11	18	-	-	-	-	18
SBT	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	1
WSP/OP	1	4	2	23	30	1	4	-	21	26	0	4	-	-	22	26
UASB	-	5	-	-	5	-	7	-	-	7	0	7	-	-	-	7
A2O	-	-	-	-	-	-	-	-	-	0	0	1	-	-	-	1
CWS	-	-	-	-	-	-	-	-	-	0	-	1	-	-	-	1
FSTP	-	-	-	-	-	-	-	-	-	0	-	2	-	-	-	2
FBAS	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	2
TF	-	-	-	5	5	-	-	-	5	5	-	-	-	-	4	4
Bio-digester	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	1
Total	**10**	**20**	**4**	**34**	**68**	**38**	**29**	**2**	**34**	**103**	**53**	**35**	**7**	**3**	**41**	**139**

SBR – Sequential Batch Reactor, ASP – Activated sludge process; TF – Trickling filter; UASB – Up flow anaerobic sludge blanket; OP-Oxidation pond/WSP-waste stabilization ponds/ Aerated lagoon with or without lining; BD –Biodigester; MBBR/FAB – Moving Bed Bio Reactor/Fluidized Aerobic Bed; SBT- Soil Biotechnology; EC - Electrocoagulation; FBAS- Fixed Bed Biofilm Activated Sludge Process; FSTP- FaecalSludge Treatment Plant; A2O-Anaerobic-anoxic-aerobic; CWS- Constructed Wetland system

UK- Uttarakhand, UP- Uttar Pradesh, BH- Bihar, JH- Jharkhand, WB-West Bengal

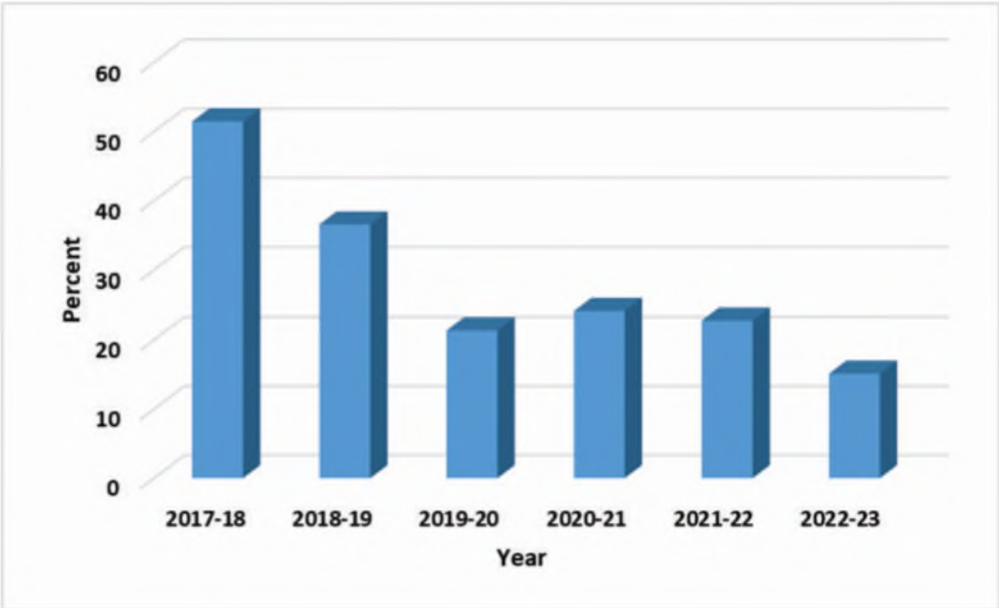

Fig. 4: Percentage decrease in share of non-operational STPs

rehabilitation of defunct STPs. For exampie, 7 defunct STPs in West Bengai have been rehabilitated.

Evolution of standards for treated sewage

Wastewater discharge standards are set at a national level for centralized treatment systems for salient receiving environments. The key feature of a water body from a discharge perspective is its assimilative capacity *i.e.*, maximum amount of pollution that can be diluted or degraded without affecting preliminary defined designated best uses [Schellenberg *et al.* (2020)].

In India, pollution control activities are the joint responsibility of three different institutions: the Ministry of Environment Forest and Climate Change (MoEF&CC), the Ministry of Housing and Urban Affairs (MoHUA), and the recently formed Ministry of Jal Shakti. The MoEF&CC is the nodal agency and together with the Central Pollution Control Board, these bodies are responsible for laying down policies, acts and related standards [Niti Ayog (2022)]. As discussed in section 3.2 on technological intervention, it can be emphasised that efforts are being made to achieve stringent discharge standards.

Different standards for treated sewage notified time to time by different agencies in India is provided in Table 3.

Alternative and decentralized treatment systems

Decentralized treatment system such as Faecal Sludge Treatment Plants (FSTP), phyto-remediation, bioremediation, bio-digesters etc. represents comparatively economical, affordable and ecologically sustainable choices, and also require low maintenance (Rath *et al.*, 2020). Septage treatment is a method for decentralized treatment of faecal sludge from septic tank where STPs are not constructed or no sewerage line is present. Successful implementation of projects by adopting combination of FSTP, co-treatment in STP and cluster approach has resulted in improvement in the water quality of rivers [Parkinson *et al.* (2003); Massoud *et al.* (2009); Libralato *et al.* (2011) and Larsen and Gujer (2013)].

In Uttar Pradesh, two FSTPs are commissioned at Chunar and Nandauli Village, Unnao and one FSTP is under construction at Farrukhabad. In Dehradun, septage is co-treated with sewage at Kargi STP (68MLD) and at 24 MLD STP Bijnor, co-treatment facility for septage has also been started. In West Bengal, FSTP is proposed to be installed considering cluster approach with towns/ urban local bodies (ULBs) with population less than 1 lakh for treatment of septage. Constructed wetlands for in-situ treatment of wastewater is being constructed under CPCB supervision across the length of Phuldera drain, Hapur.

Reuse of treated wastewater

Quality treatment of wastewater and its reuse policy will help to reduce the water stress in the country and also decrease the demand for freshwater (MoJS, 2020). Hon'ble Prime Minister through Mann ki Baat also emphasised on reuse of treated waste water. The extent of wastewater treatment depends on specific reuse applications and their associated characteristics/risks (CPHEEO, 2013). There are two major categories for

Table 3: Different standards notified/directed for treated sewage discharge

Parameters	CPCB direction dated 21.04.2015 to SPCBs under Sec. 18(1)(b) of E(P)A, 1986	Norms as per MoEF&CC notification dated 13.10.2017		Recommended standards of Hon'ble NGT Expert committee				Norms suggested by Hon'ble NGT order 30.04.2019
		Metro cities# & State capitals except Uttarakhand & others*	Area regions other than metros and State capitals	Mega and Metropolitan Cities	Class- I Cities	Others	Deep Marine Outfall	
pH	6.5-9.0	6.5-9.0	6.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
BOD(mg/l)	⩽ 10	20	30	10	20	30	30	10
TSS (mg/l)	⩽ 20	<50	<100	20	30	50	50	20
COD (mg/l)	⩽ 50	-	-	50	100	150	150	50
Nitrogen- Total (mg/l)	⩽**10**	-	-	10	15	-	-	10
Phosphorous- Total (for discharge in lakes& ponds) (mg/l)	-	-	-	1	1	1	-	1
Faecal Coliform(MPN/100ml)	< 100	<1000	<1000	Desirable - 100 Permissible - 230	Desirable - 230 Permissible - 1000	Desirable - 1000 Permissible - 10000	Desirable - 1000 Permissible - 10000	Desirable - 100 Permissible - 230
Ammoniacal Nitrogen (NH4-N) mg/l	<5	-	-	-	-	-	-	-

Metro Cities are Mumbai, Delhi, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad and Pune.

* All State Capitals except in the State of Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, Nagaland, Tripura Sikkim, Himachal Pradesh, Uttarakhand, Jammu and Kashmir and Union territory of Andaman and Nicobar Islands, Dadar and Nagar Haveli Daman and Diu and Lakshadweep

wastewater reuse: (a) potable uses and (b) non potable uses such as: irrigation in agriculture; industrial reuse (e.g., water cooling); aquifer recharge and other urban reuses such as toilet flushing, subway washing, coach cleaning, ground cooling, or building construction [Schellenberg *et al.* (2020)].

Reuse practices of treated sewage in Ganga front towns

Provisions for reuse of treated sewage for irrigation have been made at 36 MLD CETP, Jajmau, Kanpur, 130 MLD STP Jajmau, Kanpur, 43 MLD STP Jajmau, Kanpur, 5 MLD STP Jajmau, Kanpur, 2.25 MLD STP at NAPS Township, Narora, 4 MLD STP at Narora and 68 MLD STP at Haridwar. A Tertiary treatment plant is being installed for reuse of 40 MLD of treated sewage from 210 MLD Bingawan STP, Kanpur in Panki Thermal Power Plant.

Improvement in water quality

The main objective of the policy intervention for sewage management in tandem with initiatives for management of pollution from grossly polluting industries (GPIs) etc., is the restoration of water quality of the river Ganga and its tributaries. Treated wastewater reuse and recycling also provides the desired result in terms of sustainability and overall water quality improvement of river.

As per CPCB report on polluted river stretches 2018 in India (CPCB, 2018), 351 polluted stretches were identified under 5 priority classes with the worst water quality in Priority I stretch. The water quality data has been analysed and monitoring locations exceeding the water quality criteria are identified as polluted locations with respect to risk (Table 4).

Table 4: Priority wise polluted stretches, criteria and numbers in India.

Priority wise Number of Polluted River Stretches	Priority Number of Stretches	Criteria (BOD Level in mg/l)
Priority I	45	exceeding 30
Priority II	16	between 20-30
Priority III	43	between 10-20
Priority IV	72	between 6-10
Priority V	175	between 3-6
Total	**351**	

Due to interventions made over the period, the water quality of river Ganga has significantiy restored or improved in almost all polluted stretches identified in 2018. When compared with 2022 water quality data, the polluted river stretch in Uttarakhand from Haridwar to Sultanpur has been restored.In Uttar Pradesh, the stretch from Kadaghat (Prayagraj) to Sirsa (after confluence Tamas river) and upstream Varanasi has been restored whereas stretches in Kannauj, Kanpur, Rai Bareilly, Pratapgarh, Mirzapur and Varanasi shows improvement from priority III/IV to V. In Bihar, stretch from Buxar to Bhagalpur has been restored. In West Bengal, stretch from Tribeni to Diamond Harbour has improved from priority III to V. In year 2022, major length of river Ganga is pollution free in terms of BOD (Max criteria).

Conclusion

The present study is an effort to assess the policy intervention towards augmentation in sewage management for rejuvenation of water quality of river Ganga. The incessant hard work regarding the management of sewage through the installation of sewage treatment plants, decentralized treatment of sewage and septage management, and adoption of suitable technologies for interception and diversion of sewage from drain to STPs in Ganga front towns have resulted in a significant reduction in discharge of untreated domestic wastewater into the River Ganga. Initiatives are also being taken towards reuse and treated sewage in irrigation, power plants etc which will further alleviate stress on fresh water. Implementing stringent standards through technological interventions like upgradation of sewage treatment plants and adoption of advanced treatment technologies has also helped significantly in the reduction of the pollution load from sewage. The relentless efforts made in the area of sewage management in tandem with pollution load reduction from industries has resulted in improvement in the water quality of river Ganga.

गंगा नदी की जल गुणवत्ता में मलजल प्रबंधन और सुधार की दिशा में नीतिगत हस्तक्षेप

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सारांश

गंगा नदी मैदानों में आजीविका का मुख्य स्रोत होने के साथ-साथ भारतीय समाज में विशेष पवित्र मूल्य रखती है। नदियों में अनुपचारित मलजल का निर्वहन जल प्रदूषण के महत्वपूर्ण कारणों में से एक प्रमुख सामाजिक-आर्थिक समस्या के रूप में उभरा है। वर्ष 2016 में, नदी में 154 नालों के माध्यम से 361 टीपीडी प्रदूषण भार (बीओडी के संदर्भ में) छोड़ा जा रहा था। 2017-18 तक, गंगा की मुख्य धारा वाले शहरों में 1439 एमएलडी की उपचार क्षमता वाले केवल 68 एसटीपी स्थापित किए गए थे। वर्ष 2023 की शुरुआत तक, 2514 एमएलडी की उपचार क्षमता वाले 139 एसटीपी स्थापित किए जा चुके हैं जो दर्शाता है। 2017-18 की तुलना में उपचार क्षमता में 74% की वृद्धि हुई है। मलजल के अवरोधन, मोड़ और उपचार के लिए उपयुक्त तकनीकों की तैनाती के परिणामस्वरूप वर्ष 2022 में 516 नालों के माध्यम से गंगा नदी में प्रदूषण भार निर्वहन में 252.5 टीपीडी की कमी आई, जो कि 2016 की तुलना में प्रदूषण भार में 30% की कमी है। उपचारित मलजल के लिए कड़े मानदंड अपनाकर उपचार की बेहतर गुणवत्ता के साथ उपचारित मलजल के पुनः उपयोग के लिए उल्लेखनीय प्रयास किए गए हैं। 31 जनवरी, 2021 को मन की बात (एमकेबी) की 73वीं कड़ी में भारत के माननीय प्रधान मंत्री (पीएम) ने किसानों द्वारा सिंचाई के उद्देश्य से इस्तेमाल किए जा रहे गंदे पानी के मुद्दे और उपचारित अपशिष्ट जल के पुनर्चक्रण और पुनः उपयोग की आवश्यकता को रेखांकित किया था। नदी में प्रवेश करने वाले घरेलू अपशिष्ट जल के निर्वहन को कम करने के उपायों और हस्तक्षेपों से प्रदूषण में उल्लेखनीय कमी आई है। इन प्रयासों से पानी की गुणवत्ता के साथ-साथ नदी के समग्र स्वास्थ्य में सुधार हुआ है। गंगा नदी के प्रदूषित हिस्सों की लंबाई में भी उल्लेखनीय कमी आई है।

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