CSE

GANGA

THE RIVER, ITS POLLUTION AND WHAT WE CAN DO TO CLEAN IT

A Centre for Science and Environment briefing paper

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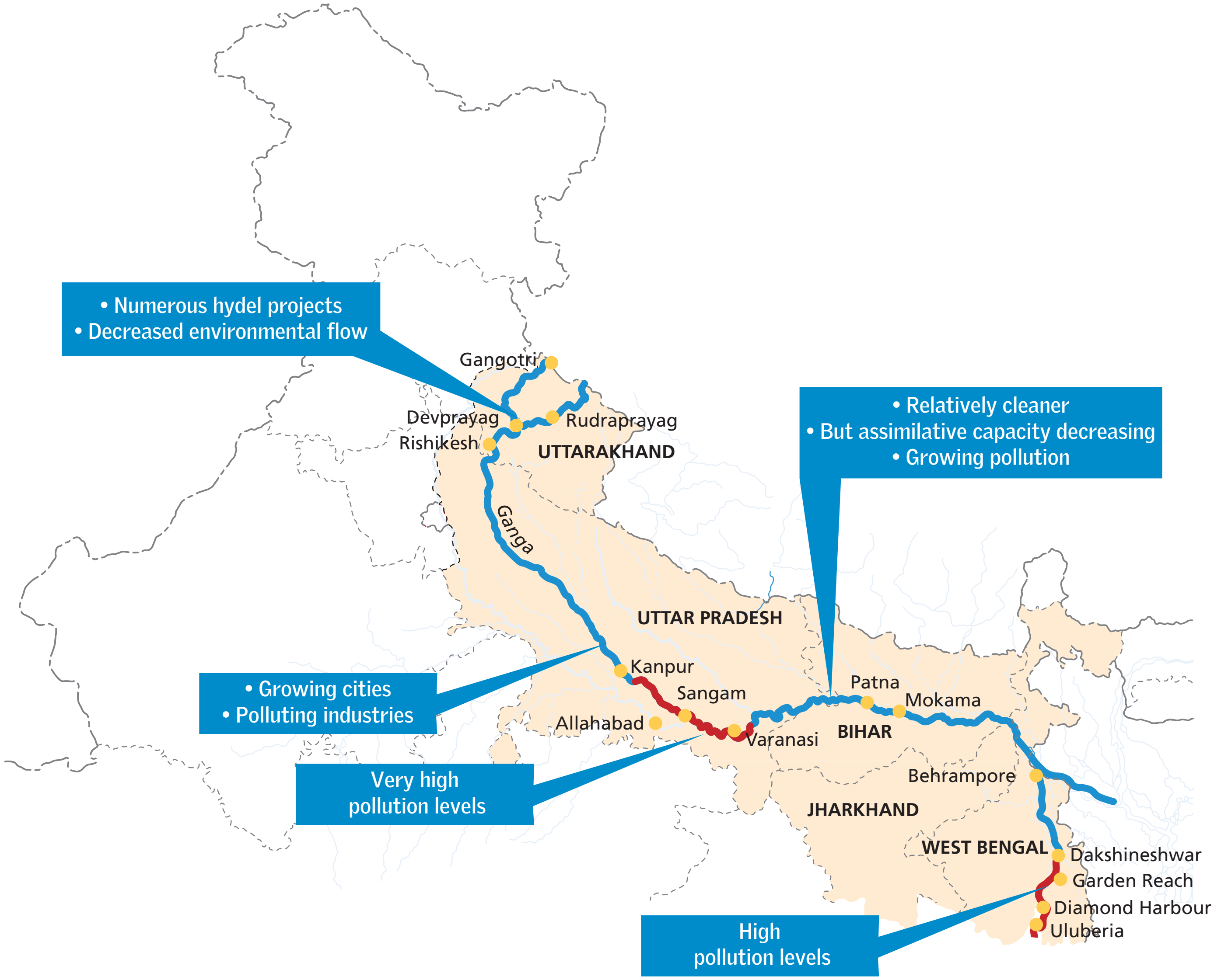
Ganga: the run of the river

Passing through five states, the Ganga covers 26 per cent of the country's landmass. Despite the enormous amounts of money spent on cleaning it, the river continues to run polluted. Worse, the pollution is increasing even in stretches that were earlier considered clean



UTTARAKHAND	UTTAR PRADESH	BIHAR	JHARKHAND	WEST BENGAL
450 km	1,000 km	405 km	40 km	520 km
14 drains	43 drains	25 drains		54 drains
440 MLD	3,270 MLD	580 MLD		1,780 MLD

Note: MLD: million litre per day (the figures refer to the collective discharge from the drains into the river)
Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Ganga is India's largest river basin: it covers 26 per cent of the country's landmass and supports 43 per cent of its population. In 1986, the government of India launched the Ganga Action Plan (GAP). In August 2009, GAP was re-launched with a reconstituted National Ganga River Basin Authority. The objectives in the past 30-odd years have remained the same: to improve the water quality of the river to acceptable standards (defined as bathing water quality standards) by preventing pollution from reaching it — in other words, intercepting the sewage and treating it before discharge into the river. But despite programmes, funds and some attention, the Ganga still runs polluted. Worse, recent studies show that pollution is increasing even in the stretches which were earlier considered clean. What can be done? What is the way ahead?

This paper puts forward the state of the river and the steps that need to be taken to make Ganga 'live' forever.

A. Pollution

Current state, why is it so, and the way ahead

The Ganga Action Plan (GAP-I) had selected 25 towns located along the river in Uttar Pradesh, Bihar and West Bengal. In 1993, the second phase (GAP-II) continued the programme, but included work on four tributaries of the river — Yamuna, Gomti, Damodar and Mahanadi.

In August 2009, the Union government re-launched the Ganga Action Plan with a reconstituted National Ganga River Basin Authority (NGRBA). Under the notification, dated February 20, 2009, the government gave the river the status of a National River. The objective was to ensure abatement of pollution and conservation of the river. The key difference between the first Ganga Action Programme and now, is the recognition that the entire basin of the river has to be the basis for planning and implementation. It is not enough to plan for one city's pollution, without considering the impact of the pollution on the downstream area. It is accepted that the plan for pollution control must take into account the need for adequate water in the river — its ecological flow.

How polluted is the river?

The challenge of pollution remains grim. According to July 2013 estimates of the Central Pollution Control Board (CPCB), fecal coliform levels in the mainstream of the river — some 2,500 km from Gangotri to Diamond Harbour — remain above the acceptable level in all stretches, other than its upper reaches.

Ganga's journey: Gangotri to Diamond Harbour

Fecal coliform levels in 2007 and 2011 – even cleaner stretches are becoming polluted

INSTALLED CAPACITY OF STPS	OFFICIAL SEWAGE LOAD	GAP
1,208 MLD	**2,723 MLD**	**55%**
	MEASURED SEWAGE LOAD	GAP
	6,087 MLD	**80%**

Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Key problems and approaches

There are three problem areas that need to be addressed in order to find a comprehensive solution to Ganga pollution:

- The inadequate flow of water in the river, needed to dilute and assimilate waste
- The growing quantum of untreated sewage discharged from cities along the river
- The lack of enforcement against point-source pollution from industries discharging waste into the river.

But even in these reaches, there are worrying signs as fecal coliform levels are increasing in places like Rudraprayag and Devprayag, suggesting that there is inadequate flow for dilution even in these highly oxygenated stretches *(see Graph: Ganga's journey: Gangotri to Diamond Harbour)*.

The pollution levels are a cause of worry in the hotspots — the mega and fast growing cities — along the river. According to the CPCB's monitoring data, biological oxygen demand (BOD) levels are high downstream of Haridwar, Kannauj and Kanpur and peak at Varanasi. But what is worrying is that in all the stretches, pollution is getting worse. This is not surprising given that all along this heavily populated stretch, freshwater intake from the river is increasing. In this way, water is drawn for agriculture, industry and cities but what is returned is only waste.

Funds have been used up to create infrastructure, without much attention paid to the use and efficacy of this hardware. But with all this done, the cities are still losing the battle with the amount of infrastructure that has yet to be built to convey the sewage and then of course, to treat it and dispose of it.

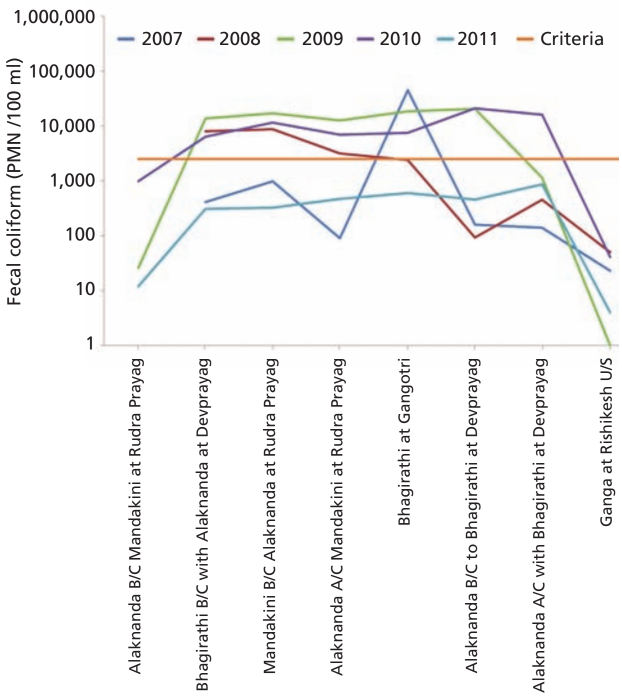
Ecological flow and the need for dilution

Rivers have a self-cleansing ability, which allows for assimilation and treatment of biological waste. But in the current context, where withdrawal from the river is much higher than the discharge of waste, pollution is inevitable.

In the upper reaches of the river, where the oxygenating abilities of the river are the highest, there are growing signs of contamination. This suggests that even here, water withdrawal for hydroelectricity is endangering the health of the Ganga (*see Graph: Annual trend of fecal coliform: the upper reaches*).

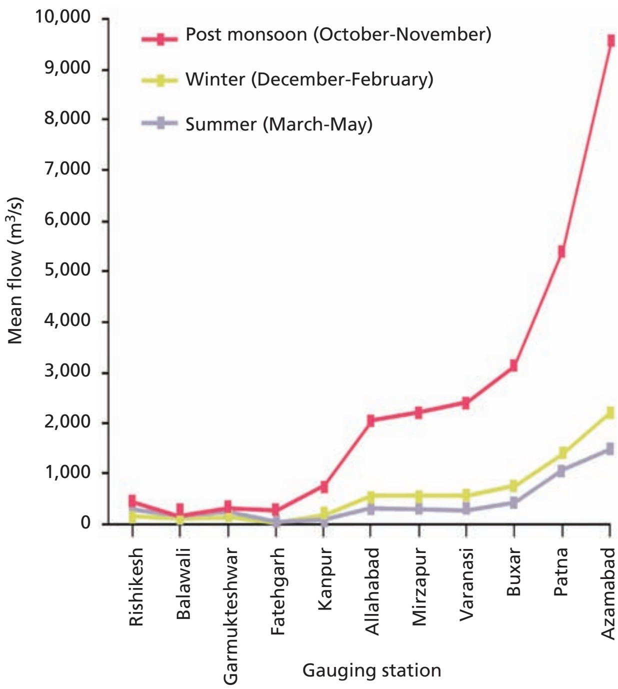
As the river reaches the plains, the water withdrawal peaks for irrigation and drinking water. In this stretch of the river from Rishikesh to Allahabad, there is almost no water during winter and summer months. In other words, the river stops flowing. But the wastewater flow does not ebb. The river then receives only waste and turns into a sewer (*see Graph: Seasonal mean discharge into the Ganga*).

Graph: Annual trend of fecal coliform: the upper reaches



Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Graph: Seasonal mean discharge into the Ganga



Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Domestic sewage and why treatment plants do not solve the pollution problem

Domestic sewage is the major cause of contamination in the river. According to the CPCB, 2,723 million litre a day (MLD) of sewage is generated by 50 cities located along the river, which adds up to over 85 pr cent of the river's pollution load.

The key problem comes from the main cities on the Ganga. The 36 Class I cities contribute 96 per cent of the wastewater generation. Furthermore, 99 per cent of the treatment capacity is installed in these cities. But the problem is that the focus on treatment plants has taken away the attention from cleaning the river. This is what needs to be addressed. But the answers are not just building new sewage treatment plants. The answer lies in the fact that these cities will have to do sewage management differently. Why?

There is a growing gap between installed capacity and treatment

The most recent assessment shows that there is a massive gap between the generation of domestic sewage and treatment capacity in the main stretch of the Ganga. The 2013 CPCB estimate shows that generation is 2,723.30 MLD, while treatment capacity lags behind at 1,208.80 MLD. It is important to compare this with the 2009 estimate *(see Table: Sewage generation and treatment capacity created in the Ganga)*, which shows that even as we invest in sewage treatment capacity, the gap remains the same.

According to this estimate, over half the sewage goes untreated into the river or other water bodies.

Official % gap: treated vs untreated

55%

Unofficial % gap: treated vs untreated

80%

Even the sewage treatment plants (STPs) built are not working

The sewage treatment capacity is poor because of factors ranging from lack of electricity to operate the plant, to the lack of sewage that reaches the plant for treatment. The 2013 CPCB report inspected 51 of the 64 sewage treatment plants (STPs) to find that less than 60 per cent of the installed capacity was utilised, and 30 per cent of the plants were not even in operation *(see Table: Ganga STPs: what works and what does not, as checked by CPCB)*.

Table: Sewage generation and treatment capacity created in the Ganga

	2009	2012
Sewage generation (MLD)	2,638	2,723
Treatment capacity (MLD)	1,174	1,208
Gap (MLD)	1,464	1,514
% gap: treated vs untreated	**55**	**55**

Source: CPCB 2009 and 2013

Table: Ganga STPs: what works and what does not, as checked by CPCB

States	No of STPs inspected	Installed capacity	Actual utilised capacity	Total no of STPs not in operation	STPs exceeding BOD/COD limits
Uttarakhand	4	54	-	0	2
Uttar Pradesh	8	358	287	1	4
Bihar	5	140	100	1	1
West Bengal	34	457	214	13	3
Total	51	1,009	602	15	10

Note: The CPCB inspected 51 out of 64 STPs on the Ganga in 2012-13
Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Measured sewage flow from 138 drains

6,087 MLD

Sewage generation is underestimated and hence the treatment capacity needed is much higher

The actual gap between generation and treatment is grossly underestimated. The problem lies in the manner in which governments estimate pollution load and plan for sewage treatment. The estimation of sewage generation is based on the quantum of water supplied. The assumption is that 80 per cent of the water supplied is returned as wastewater. But as cities do not know how much water is lost in distribution and how much groundwater is used within their boundaries, the waste generation estimate could be wide off the mark *(see Table: Difference between actual and measured sewage generation)*.

This shows up in the most recent data collected by CPCB on Ganga. The actual measured discharge of wastewater into Ganga is 6,087 MLD — which is 123 per cent higher than the estimated discharge of wastewater. In other words, the gap between treated and untreated waste is not 55 per cent, but 80 per cent.

According to this, the estimation is that the BOD load is 1,000 tonne/day in the mainstream of the river.

STPs are ineffective because of lack of connectivity

Most cities along the Ganga do not have any sewage conveyance systems. In Kanpur, Allahabad and Varanasi, 70 to 85 per cent of the city does not have a working underground drainage system. As a result, drains are not connected to STPs. What exist are open drains, which make their way into the river. In Allahabad, 57 drains flow into the river; city officials say 10 of these do not add to pollution as their discharge does not reach the river *(see Table: Connectivity for sewage treatment plants: UP cities)*. But the problem is that this untreated effluent adds to the pollution load by contaminating groundwater.

Therefore, cities must address the underlying problem of lack of connectivity to sewage systems. This is not done and estimates are prepared, which suggest that cities — old and congested — will be able to lay underground sewage and intercept waste before it reaches the river over time. But experience shows that building a fully connected system across the city does not happen. The STP is first built, but the drains to intercept sewage do not get completed and the river continues to be polluted.

Varanasi unsewered

84%

Table: Difference between actual and measured sewage generation

	Official estimate of sewage generation (MLD)	No of drains	Actual measured sewage flow (MLD)	Gap (untreated waste) (%)
Uttarakhand	61	14	440	95
Uttar Pradesh	937	45	3,289	86
Bihar	407	25	579	71
West Bengal	1,317	54	1,779	69
Ganga mainstream	2,723	138	6,087	80

Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Table: Connectivity for sewage treatment plants: UP cities

City	Area of city (ha)	Area with sewerage (ha)	Un-sewered area (ha)	Un-sewered area (%)	Drains
Kanpur	25,810	7,558	18,252	71	37
Allahabad	9,510	2,013	7,397	78	57
Varanasi	10,058	1,635	8,432	84	23

Source: UP government 2010, Presentation made at the meeting of the Executive Committee of the State Ganga River Conservation Authority, Lucknow, *mimeo*

Cities lack funds to build and operate STPs

There are three key costs that need to be estimated during project planning. One, the capital cost of building the STP; two, cost of operating the plant; and three, the cost of intercepting and treating sewage at the plant. Over and above these is the cost of maintaining the drainage network. These costs vary, depending on the quality of sewage generated and the effluent standards.

The capital costs of STPs, in early 2000, had ranged from Rs 30 lakh to Rs 60 lakh per MLD. These costs have now climbed to Rs 1-1.25 crore/MLD, even without the cost of land being included in the project. The operation and maintenance costs, which primarily are electricity, chemicals and labour, are anywhere between Rs 0.60 to Rs 3 per kl, but can increase for tertiary treatment. In the current stretched system, where municipalities are strained to pay for basic services, running a sewage treatment plant becomes difficult.

Also difficult to estimate is the cost of constructing the sewage network, particularly as cities are not greenfield projects; the network needs to be built, or repaired, in already congested areas. If projects under JNNURM-I are used for estimation then the average cost of a comprehensive sewage project, including collection network and treatment plant, is anywhere between Rs 3.33-6 crore per MLD; the per capita cost would be Rs 4,000. But this is widely considered to be an underestimation as the per capita costs are lower than even what is estimated for a comprehensive water supply scheme — Rs 4,500. This lack of clarity is understandable because there are few instances where such comprehensive sewage systems have been built. An analysis of NGRBA projects shows that costs range from Rs 2.4 crore per MLD in Begusarai to Rs 7.8 crore per MLD in Devprayag *(see Table: What sewage projects cost, real-time)*.

The payment for the system — capital and O&M — is a key issue of contest between the Central and state governments. When it began, the programme was funded totally by the Centre. But in early 1990s, states were asked to invest half the funds. Seven years later, there was a reversal in policy: it was then agreed that the Centre would spend 100 per cent of the funds.

This arrangement did not last long. In 2001, a new cost-sharing formula was evolved: 70 per cent funded by Centre and 30 per cent by states. Local bodies were expected to contribute one-third of the state's share. O&M was also the responsibility of the state and the local body. But this too did not work, because of the poor financial state of the municipal bodies.

Under the National Clean Ganga Mission the payment formula has been re-visited. The Centre will build projects through a PPP route, which will require the concessionaire to design-build-operate the plants for five years. The Centre will bear the full costs for five years, after which the plant will be handed over to the state government, assuming that in five years, funds will be available to run the plant. It is unclear how that will work, given the poor financial state of local bodies in all states along the Ganga.

Who will pay?

- STP cost: Rs 1-1.25 crore/MLD
- Running cost: Rs 0.60-3/kl/day

Table: What sewage projects cost, real-time

City	Project cost[1] (Rs crore)	STP capacity (MLD)	Cost (Rs crore/MLD)
Badrinath	11.88	3	3.9
Rudraprayag	12.62	3	4.2
Karanprayag	8.81	1.4	6.3
Devprayag	10.93	1.4	7.8
Moradabad	279.91	58	4.8
Begusarai	65.40	27	2.4
Buxar	74.95	16	4.7
Hajipur	113.62	22	5.2
Munger	187.89	27	7.0

Note: [1]Treatment plant and drainage and pumping stations, under National Ganga Basin Authority: sanctioned projects in 2010-2011
STP: Sewage treatment plant; MLD: million litre daily
Source: Anon 2011, 'List of approved projects under National Ganga River Basin Authority (NGRBA)', MoEF, *mimeo*

Industrial pollution: need for enforcement

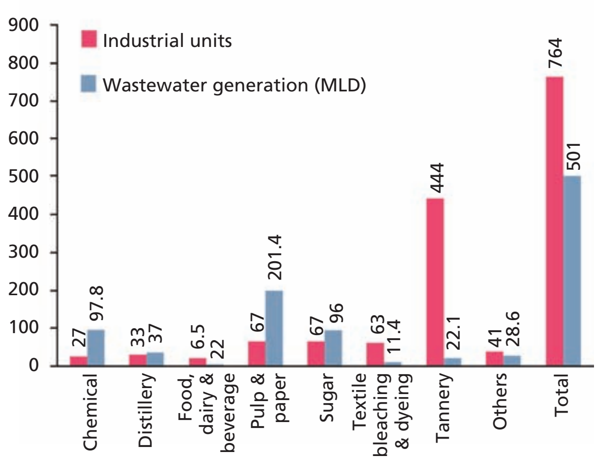
Industrial pollution into the main Ganga has been an issue of attention and focus, but without much success. The problem is that many of the industries that discharge noxious chemical pollutants into the river are small-scale, where technologies for treatment are inadequate or unaffordable.

The 2013 CPCB estimates show that 764 industries in the mainstem of Ganga (and its two tributaries, Kali and Ramganga) consume 1,123 MLD of water and discharge 500 MLD of effluent. The bulk of these industries — 90 per cent — operate in the Uttar Pradesh stretch of the river *(see Box: UP's shame: industries that pollute)*.

The sector-specific industrial wastewater generation forming the bulk of the pollution comes from pulp and paper sector. Tanneries are the highest in number but have a lower wastewater generation in comparison. But the problem is that this waste is both concentrated in stretches of the river where there is no dilution and assimilative capacity and is particularly toxic because of its high chemical load *(see Graph: Sector-specific industrial wastewater generation)*.

Over the past years, many efforts have been made to reduce the pollution impact of these industries, but with little success. As a result, the only real difference is seen when industries are given closure or stop work notices, as seen during the recent Kumbh mela. But as this is not a permanent solution, clearly more will need to be done to find ways to reduce the pollution from these industries, urgently and effectively.

Graph: Sector-specific industrial wastewater generation



Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

UP'S SHAME: INDUSTRIES THAT POLLUTE

This state, which has 1,000 km of the river's length and big cities to boot, also has 687 grossly polluting industries that pollute the Ganga. These tannery, sugar, pulp and paper and chemical industries contribute 270 MLD of wastewater. While tanneries are large in number — 442 — they only contribute 8 per cent of the wastewater but this is highly toxic and concentrated in the Kanpur belt. Sugar, pulp and paper and distillery plants add up to 70 per cent of the wastewater. The inspections by CPCB showed that of the 404 units inspected, only 23 required no action. The rest were non-compliant in terms of the laws of the country. Up to June 2013, enforcement action was in various stages, but this was still to show on the ground. Clearly, enforcement with big teeth is the issue at hand *(see Table)*.

Table: CPCB action against industries polluting the Ganga in UP

Action	No of industries
Direction under Section 5 of Environment Protection Act, 1986	142
Directions under Section 18 (1) (b) of Water Act 1974	12
Letter issued for ensuring compliance	25
Action under process	191
Total	**370**
Found closed during inspection	11
No action required	23

Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

MEETA AHLAWAT / CSE

Kumbh Mela

What was done to clean the Ganga and is replication possible?

Maha Kumbh in Allahabad has perhaps no parallel in terms of the sheer size of the congregation — with over 100 million people visiting the city of the confluence of the Ganga and Yamuna in just two months. At the 2013 Kumbh, the Central and state government's efforts to combat pollution have had an impact. These steps tell us that it is possible to reduce pollution in the Ganga and all other rivers of the country. The steps taken were as follows:

- More water was allowed to flow in the river. The UP government mandated the irrigation department to release 2,500 cubic feet per second (cusec) (71 cubic metre per second/cumec) from January 1 until February 28 to ensure adequate depth and dilution of expected pollution loads at the bathing site in Allahabad. Additionally, two days before and one day after each of the six shahi snan days, the state irrigation department released 11.3 cumec, over and above the minimum stipulated flow.
- Allahabad broke convention in intercepting sewage from open drains to convey to treatment plants. Given that the city does not have underground sewage, the built plants did not ever work to capacity. This changed during the Kumbh as sewage was conveyed and treated, without underground drainage.
- The city tried experimenting with innovative ways of treating sewage — by using bio-remediation techniques. The preliminary reports suggest that this system is working but needs careful scrutiny and constant monitoring. During the project period the Uttar Pradesh Pollution Control Board (UPPCB) took 19 grab samples from the 39 drains, where bio-remediation was being tried. According to their data there was a 40 per cent reduction in BOD using this technology. A report assessing this technology experiment is awaited, which will help review its effectiveness and options for the future.
- The government took tough measures against polluting industries — mainly tanneries and distilleries — discharging into the river. In 2012, the Central and state governments had already directed one-fifth of the tanneries in the upstream city of Kanpur, which were failing to meet the discharge norms, to shut down. During the Kumbh a complete closure of all tanneries in the city was ordered.

What is the solution for Ganga pollution? What should we do?

1. Provide for water in the river for ecological flow and dilution.

Accept that for cleaning rivers in India, where cost of pollution control treatment is unaffordable and unmanageable, the availability of water for dilution will be critical. The available standards for 'acceptable water quality' provide for a dilution factor of 10. This is why discharge standards for waterbodies are set at 30 for BOD, while bathing water quality standard is 3 BOD. The fact is that given the huge unmet challenge of wastewater treatment, the cost of reducing standards will be unaffordable. Instead, what should be provided is water inflow, to build the assimilative capacity in the river for self-cleansing waste.

It is essential to note that rivers without water are drains. It is also a fact that this release of additional water deprives farmers upstream of irrigation; cities and industries of water. The additional water for ecological flow becomes contested. But this flow must be mandated so that it comes from the state government's own allocation of riparian water. The government then has a choice to build storage to collect monsoon water for dilution within its territory or to 'release' water to rivers and make other choices for use in agriculture, drinking or industry. In other words, all users must be forced to plan for water needs based on what the river can spare, not what they can snatch.

Action plan: Ecological flow will be mandatory in all stretches of the river. In the upper stretches, where the requirement is for critical ecological functions as well as societal needs, it will be mandated at 50 per cent for mean season flow and 30 per cent for other seasons. In the urbanised stretches, it will be mandated based on the quantum of wastewater released in the river and calculated using a factor of 10 for dilution.

All Central government funding under the National Mission for Clean Ganga will be conditional on the quantum of ecological flow made available by the state.

Mandate

Ecological flow

Tie funding

To quantum of flow

2. Accept that urban areas will not catch up with the infrastructure to build conventional sewage networks at the scale and pace needed for pollution control.

Therefore, the conveyance of waste must be re-conceptualised and implemented at the time of planning treatment plants. This will then lead to innovative ideas for controlling pollution in drains —

in situ — treatment of sewage as well as local treatment and reuse.

Also, as the plans are premised on the acceptance of non-availability of sewerage networks, the discharge of treated effluent will be carefully reconsidered and designed. The treated effluent will not be 'mixed' with the untreated waste in drains. Instead, all treated effluent will either be designed for reuse or it will be discharged directly into the river.

Action plan:

1. Do not plan for STPs; instead plan for drains that are discharging into the Ganga. Prioritise action based on drains with high pollution load, so that impact is immediate.
2. Make a drain-wise plan, which looks to treat waste without first building the internal conveyance system. Plan for interception and pumping to sewage treatment plant. Also plan for *in situ* drain treatment, as it will bring down pollution levels of discharge that is not intercepted. **Bottom-line, use the open drain for treatment of waste**. This is the reality that we cannot ignore.
3. Ensure that there is a plan for treated effluents — do not treat and put back treated wastewater into open drain, where it is again mixed with untreated waste. Instead, plan deliberately for utilisation or disposal of treated effluent.
4. Plan the reuse and recycling of treated effluent, either for city water use or agricultural use. **Plan deliberately. Implement** this objective.
5. Plan to treat wastewater before it discharges into the river. Either intercept drain before discharge to treatment plant or build treatment plant on the bank of the river for the remaining waste.
6. No untreated waste should be disposed into river. The provision for ecological flow for assimilation of waste will be critical for setting standards for discharge. If there is no water in the river, only waste that is discharged, then standards have to be so stringent that they can meet bathing or even drinking water quality. This will be prohibitively expensive and it makes no economic sense (in a poor country) to clean wastewater to drinking water quality and then not use it for this purpose.
7. If all this is not acceptable, or does not get operationalised, then the only alternative for river cleaning is to ask cities to get their water supply downstream of their discharge points. In other words, they will have to use their wastewater and then invest to clean it to turn it into drinking water for their citizens.

Re-think
Waste conveyance

Plan
Deliberately

Otherwise, we must learn that we all live downstream. Today, each city's waste is fast becoming the next city's water supply.

3. Accept that there is a need to publicly fund Ganga cleaning programmes but simultaneously ensure that state and municipal governments have to contribute either through funds or through release of water for ecological flow.

Even if the current situation requires Central government assistance for capital and operational costs, this is not tenable in the long run or for the scale of pollution control infrastructure that is required to clean the river. As long as states do not have the responsibility to build sewage treatment systems or to maintain these they have no incentive to plan for affordable solutions or even to implement projects. In the current system the Central government will pay full capital cost for infrastructure and even pay for running the plant. There is absolutely no incentive to plan the water-waste infrastructure for affordability and sustainability.

Action Plan: Build clear conditionality in Central government funding, that it will match financial support to the quantum of ecological flow released by the state in the river or payment for capital and operation of infrastructure.

As water utilities do not have infrastructure to charge for operations, build innovative systems for collection of pollution payments at the city/settlement level.

4. Tighten enforcement of industrial pollution norms.

There are no alternatives for this. It is clear that industries must be able to meet discharge standards that have been legally set in the country. In UP, records show that almost all industries inspected by the Central Pollution Control Board in 2013 are in breach of existing standards. It is time for tough action. Nothing less.

B. Ganga in the upper reaches

Dammed and dried. Should there be a policy for ecological flow so that the river is not re-engineered, but hydroelectric projects are?

The Ganga, in its upper reaches (in the state of Uttarakhand), has become an engineer's playground. The Central Electricity Authority (CEA) and the Uttarakhand power department have estimated the river's hydroelectric potential at some 9,000 megawatt (MW) and planned 70-odd projects on its tributaries. In building these projects, the key tributaries would be modified — through diversions into tunnels or reservoirs — to such an extent that 80 per cent of the Bhagirathi and 65 per cent of the Alaknanda could be "affected". As much as 90 per cent of the other smaller tributaries could also be impacted in the same way.

In this way, hydropower would re-engineer the Ganga. It would also dry up the river in many stretches. Most of the proposed projects are run-of-the-river schemes, which are seemingly benevolent as compared to large reservoirs and dams — but only if the project is carefully crafted to ensure that the river remains a river and does not turn into an engineered drain.

Energy generation is the driver of this kind of planning; indeed, the only obsession. On the Ganga, projects would be built so that one project diverts water from the river, channels it to the point where energy would be generated and then discharges it back into the river. The next project, however, would be built even before the river can regain its flow — so, the river would simply, and tragically, dry up over entire stretches. It would die.

The question is what should be the ecological flow (e-flow) — why and how much should be left in the river for needs other than energy. Hydropower engineers argue that 10 per cent ecological flow would be enough, which they say they can "accommodate" in project design without huge loss in energy generation. The Wildlife Institute of India (WII), commissioned to look at ecosystem and fish biodiversity needs, has suggested between 20 and 30 per cent e-flow in different seasons.

Centre for Science and Environment (CSE) prepared an alternative proposal after studying what would be the impact on energy generation and tariff in different e-flow regimes. It found that in the 50 per cent e-flow scenario, there was substantial impact on the amount of energy generated and, therefore, on the tariff. But if this was modified a little to provide for a little extra water for energy generation in the high discharge season, the results changed dramatically.

In this case, the reduction in energy generation was not substantial. Therefore, tariffs were comparable. The reason was simple: the projects actually did not generate much energy in the lean season. The plant load factor, project after project, showed that even in the unrestricted scenario (e-flow of 10 per cent or less) there was no water to make energy in the lean season. CSE suggested that mimicking river flow was the best way to optimise energy generation. The river had enough to give us but only if we put the river first, and our needs next.

Planned hydel projects
70

Bhagirathi affected
80%

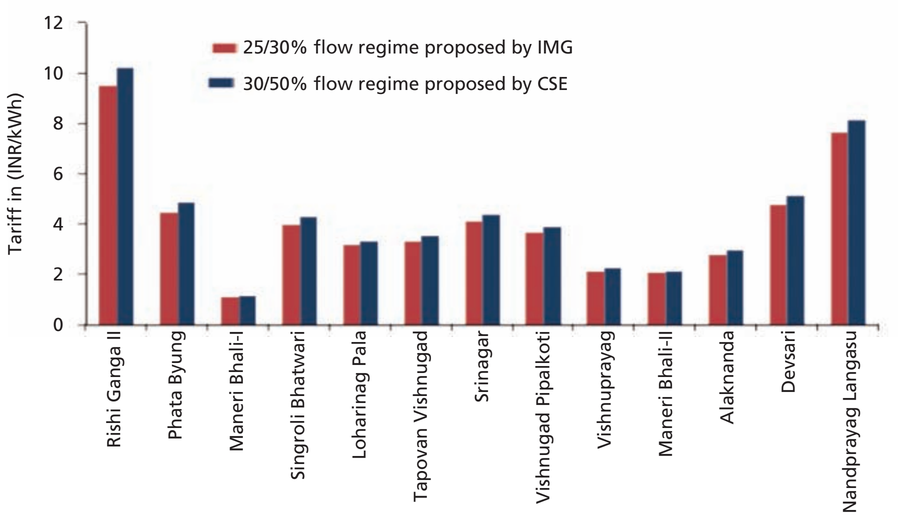
Hydel projects on the Ganga: above 25 MW capacity

	River	Capacity	Commi-ssioned	Under construction	Proposed
Alaknanda basin					
Alaknanda	Alaknanda	300			300
Vishnuprayag	Alaknanda	400	400		
Vishnugad Pipalkoti	Alaknanda	444		444	
Bowla Nandprayag	Alaknanda	300			300
Nandprayag Langasu	Alaknanda	100			100
Srinagar	Alaknanda	330		333	
Kotli Bhel 1 B	Alaknanda	320			320
Malari Jelam	Dhauliganga	114			114
Jelam Tamak	Dhauliganga	126			126
Tamak Lata	Dhauliganga	250			250
Lata Tapovan	Dhauliganga	170			170
Tapowan Vishnugad	Dhauliganga	520		520	
Rishi Ganga I	Rishi Ganga	70			70
Rishi Ganga II	Rishi Ganga	35			35
Gohan Tal	Birahi Ganga	50			50
Phata Byung	Mandakini	76		76	
Singoli Bhatwari	Mandakini	99		99	
Devsari	Pinder	252			252
		3,956	**400**	**1,472**	**2,087**
Bhagirathi basin					
Bharon Ghati	Bhagirathi	381			381
Lohari Nagpala	Bhagirathi	600			600
Pala Maneri	Bhagirathi	480			480
Maneri Bhali 1	Bhagirathi	304	304		
Maneri Bhali II	Bhagirathi	90	90		
Tehri Stage I	Bhagirathi	1,000	1,000		
Tehri Stage II	Bhagirathi	1,000		1,000	
Koteshwar	Bhagirathi	400	400		
Kotli Bhel I A	Bhagirathi	195			195
Karmoli	Jahnvi	140			140
Jadh Ganga	Jahnvi	50			50
		4,640	**1,794**	**1,000**	**1,846**
Total MW in Ganga basin		**8,596**	**2,194**	**2,472**	**3,933**

Note: In addition, there are a large number of small hydel projects below 25 MW in the basin, adding up to 70.

Tariff difference in 30/50 and 25/30 ecological regimes

In the 30/50 ecological flow scenario, tariff does not increase substantially



The CSE proposal is to provide 30 per cent e-flow for six months (May to October) and 50 per cent for the other six months (November to April). The proposal was submitted to B K Chaturvedi-headed Inter-ministerial Group on Ganga. But this course of action was unthinkable for hydropower engineers. They had designed their projects on either zero e-flow or at most 10 per cent. So, in this way, they could generate power with every drop of water even in the low discharge season. They planned deliberately for the river to be sucked dry (*see Box: Reworking ecological flow*).

This issue raises some bigger concerns. Firstly, the question of how we plan the 'potential' of hydropower generation. In this case, the CEA had estimated the hydropower potential way back in the 1980s. This estimation did not account for e-flow, or for the competing needs of society for water needs. This has now become the basis of planning. Any reduction in this 'potential' is seen as a financial and energy loss. Nobody is willing to ask if the potential is realistic, feasible or sustainable.

Secondly, there is the question of cost of generation. Energy planners push for hydro-projects because they say that tariffs are low, and because the source provides for 'peaking' power — for those hours when demand is high. But this discounts the fact there is a cost of raw material, in this case, of water and the necessity of a flowing river. This needs to be accounted for in the tariff.

Thirdly, there is the question of how much needs to be built and where. The way projects are being executed, is making this important source of renewable energy disastrous. If any projects are stopped, compensation is demanded, as Uttarakhand is asking today. This sets a bad precedent as it literally incentivises states to degrade the environment recklessly, and demand compensation. But this happens also because there is no framework which establishes the boundaries for resource use or extraction. In this case, what is necessary is to set sound principles for hydropower development, keeping in mind the ecological flow and distance requirements between projects.

The fact is that rivers cannot and should not be re-engineered. But dams can certainly be re-engineered to optimise on these limits.

CSE's proposal for ecological flow in Ganga

- 30% for 6 months in high discharge season (May-October)
- 50% for 6 months in the lean season (November-April)

REWORKING ECOLOGICAL FLOW

A critique of the recommendations of the Inter-ministerial Group on Ganga

In April 2013, the Inter-ministerial Group (IMG) headed by Planning Commission member B K Chaturvedi submitted its report to the prime minister's office. The report provides for ecological flow of 25 per cent for eight months and 30 per cent for four months. This proposal is a definite advancement over the current situation, where less than 10 per cent is provided as ecological flow in the design of hydropower projects, but it is not sufficient to ensure that the Ganga has adequate water to meet ecosystem and livelihood needs.

The IMG proposal is also inadequate to ensure that the river does indeed flow at all times and in all stretches. Analysis of the 24 projects for which hydrological data is available shows that the lean season flow is less than 10 per cent of the highest monsoon flow. In other words, leaving less than 50 per cent in these dry season months would mean virtually drying up the river.

An alternative option, proposed by CSE, is feasible, which importantly does not have substantial impact on energy generation and tariffs. This is to provide 50 per cent flow for six months (November to April) and 30 per cent for the remaining six months (May to October).

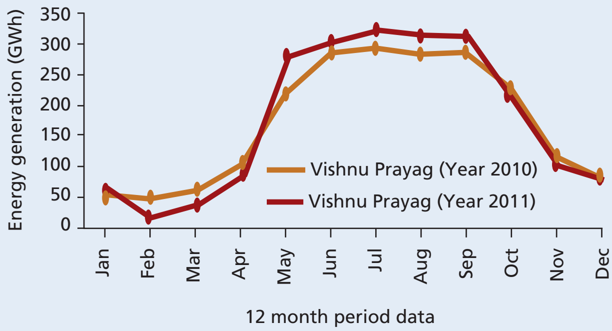
The difference in energy generation between what is proposed by the B K Chaturvedi report and the alternative is a reduction of as little as 6 per cent on an average across the projects. This will mean that tariff will increase by roughly 7 per cent on an average. This is clearly a small price to pay for a flowing Ganga in all seasons.

The reason why the impact on generation and tariff is insignificant is because hydropower projects do not generate much power during lean seasons. Of the annual energy generated by these projects, only 20 per cent is produced during the six-month lean water season. As much as 80 per cent is generated in the six months of high water discharge (May to October).

The future power generation regime would produce when there is water and optimise for this. In this way, we can balance our needs for energy with the requirements of a flowing, healthy Ganga.

Actual monthly energy generated

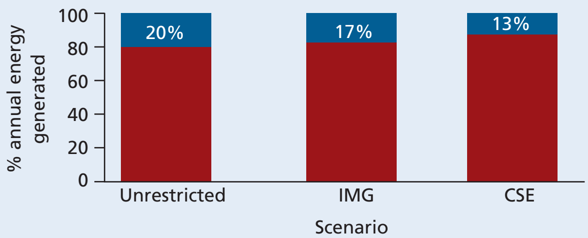
Vishnu Prayag hydropower project



Sources: Central Electricity Authority (CEA) generation data from 2010-12

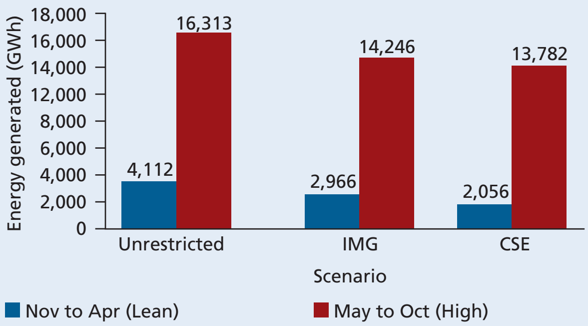
Percentage of annual energy

Generated in unrestricted (10%), IMG (25-30%) and Alternative/CSE (30-50%) ecological flows



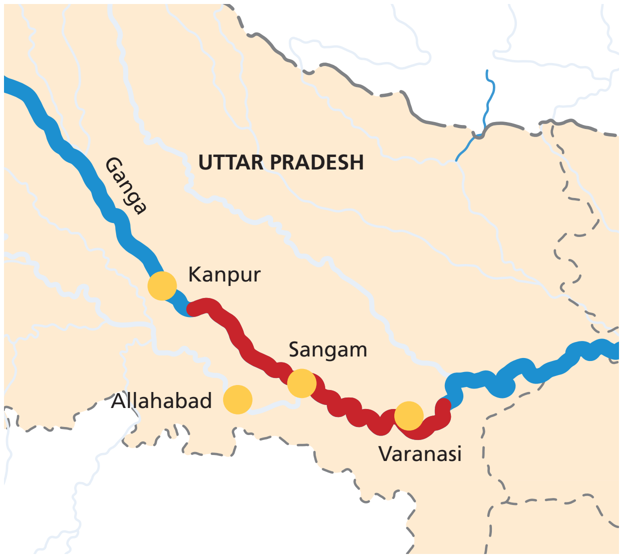
Actual annual energy

Generated in different seasons in unrestricted, IMG and Alternative/CSE e-flows



C. Kanpur-Allahabad-Varanasi

Where Ganga dies many deaths



For Ganga, the journey through the stretch of lower Uttar Pradesh — from Kanpur through Unnao, Fatehpur to Raibareilly and then Allahabad and Varanasi via Mirzapur — is truly killing. The river does not get a chance to assimilate the waste that is poured into it from cities and industries along this course. It is only in Allahabad that some 'cleaner' water is added through Yamuna, which has recovered somewhat since its journey in Delhi.

But this land of Ganga is where the poorest of India live; where urban governance is virtually non-existent; and where pollution therefore thrives.

In the Kanpur-Varanasi stretch, 3,000 MLD of domestic wastewater is discharged into the river — roughly half of its total load. In 2013, the CPCB identified 33 drains with high BOD that flow into the river (*see Table: Drains that discharge into the Ganga, and Map: Polluting pathways*). Out of the 33 drains in this stretch, seven are the worst offenders — they together add up to 94 per cent of the BOD load in the Kanpur-Varanasi stretch.

In terms of the BOD load — which is an indicator of the pollution — Kanpur is the worst. In this stretch, 10 drains discharge 20 per cent of the wastewater but account for 86 per cent of the BOD load of the stretch. Therefore, clearly, this is the city that needs to be cleaned up on a priority basis.

However, every stretch has its priority drains that need action and fast. It is clear that every drain into the Ganga is in danger of carrying only waste, no water.

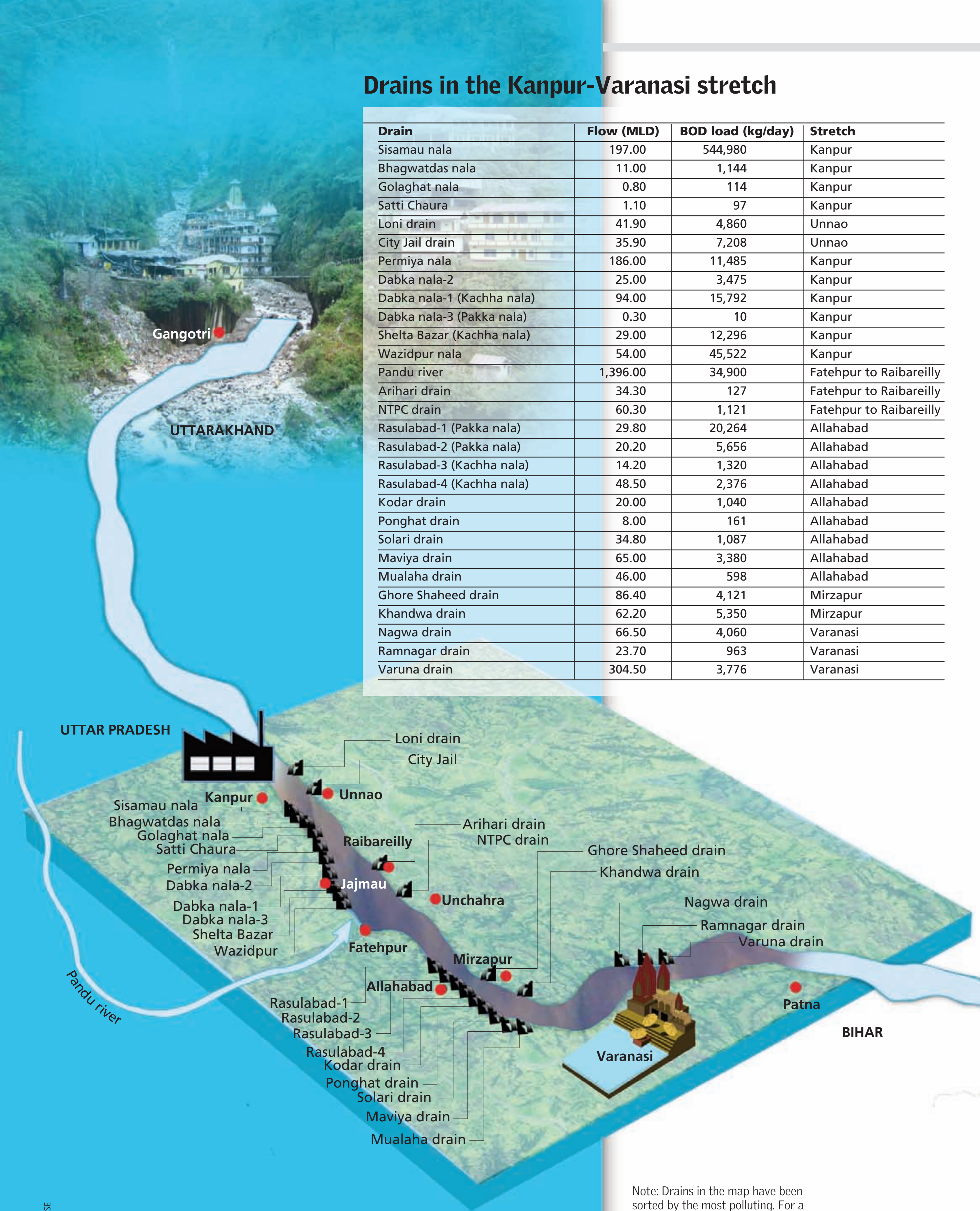
Table: Drains that discharge into the Ganga in the Kanpur-Varanasi stretch

Stretch	Discharge (MLD)	BOD load (kg/day)
Kanpur	600	634,915
Unnao	78	12,068
Fatehpur-Raibareilly	1,491	36,148
Allahabad	294	35,943
Mirzapur	149	9,471
Varanasi	411	9,607
Total	**3,023**	**738,152**

Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Drains in the Kanpur-Varanasi stretch

Drain	Flow (MLD)	BOD load (kg/day)	Stretch
Sisamau nala	197.00	544,980	Kanpur
Bhagwatdas nala	11.00	1,144	Kanpur
Golaghat nala	0.80	114	Kanpur
Satti Chaura	1.10	97	Kanpur
Loni drain	41.90	4,860	Unnao
City Jail drain	35.90	7,208	Unnao
Permiya nala	186.00	11,485	Kanpur
Dabka nala-2	25.00	3,475	Kanpur
Dabka nala-1 (Kachha nala)	94.00	15,792	Kanpur
Dabka nala-3 (Pakka nala)	0.30	10	Kanpur
Shelta Bazar (Kachha nala)	29.00	12,296	Kanpur
Wazidpur nala	54.00	45,522	Kanpur
Pandu river	1,396.00	34,900	Fatehpur to Raibareilly
Arihari drain	34.30	127	Fatehpur to Raibareilly
NTPC drain	60.30	1,121	Fatehpur to Raibareilly
Rasulabad-1 (Pakka nala)	29.80	20,264	Allahabad
Rasulabad-2 (Pakka nala)	20.20	5,656	Allahabad
Rasulabad-3 (Kachha nala)	14.20	1,320	Allahabad
Rasulabad-4 (Kachha nala)	48.50	2,376	Allahabad
Kodar drain	20.00	1,040	Allahabad
Ponghat drain	8.00	161	Allahabad
Solari drain	34.80	1,087	Allahabad
Maviya drain	65.00	3,380	Allahabad
Mualaha drain	46.00	598	Allahabad
Ghore Shaheed drain	86.40	4,121	Mirzapur
Khandwa drain	62.20	5,350	Mirzapur
Nagwa drain	66.50	4,060	Varanasi
Ramnagar drain	23.70	963	Varanasi
Varuna drain	304.50	3,776	Varanasi



VIVEK BHARDWAJ / CSE

Note: Drains in the map have been sorted by the most polluting. For a complete list of all drains flowing into the Ganga, see the Annexure

Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

Kanpur
Where nothing has worked

Kanpur has had a long and rather unsuccessful history of cleaning the river that flows in its midst. It all started in 1985 when under the Ganga Action Plan (GAP-I), it cleaned its drains, expanded its drainage system, built a 130-MLD STP and another 36-MLD plant for treating wastewater from tanneries. It took 18 years to complete the works under GAP I; meanwhile, GAP II was started in 1993. This time the focus was on treatment of the remaining 224 MLD, for which a 200-MLD treatment plant was planned. According to the report of the IIT-Consortiums for the National Ganga River Basin Authority, the schemes under GAP II are still incomplete, some 15 years after the plan lapsed.

In addition, the city has also got funds from the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for drainage and sewage works. If all these funds are put together, the city got the following:

- GAP I: Rs 73 crore
- GAP II: Rs 87 crore
- JNNURM: Rs 370 crore

But the end result is not very encouraging. Pollution is the name of the game in Kanpur. The problems are as follows:

1. The sewerage network does not exist in large parts of the city and so waste is not conveyed to the treatment plants.
2. Under the Ganga Action Plan, the objective was to intercept waste from the open drains and to divert it to STPs. But this did not happen as well because all of the 23 drains of Kanpur were not tapped and so waste still flows into the Ganga.
3. In this period, the city expanded and new growth happened without drainage and pollution control. So, even as some drains were intercepted, waste continued to increase and treatment lagged behind.
4. In 1985, Kanpur generated 200 MLD of waste and had an installed capacity of 171 MLD. By 2013, its 10 drains discharged 600 MLD of waste into Ganga. Its treatment capacity remains the same as in 1985. It has set up two USB technology based plants in Jajmau of 5 MLD and 36 MLD. In addition it has another 130 MLD plant, which is based on ASP technology.
5. The municipality cannot afford to even run the plants, let alone repair and refurbish the old sewage system of the city. There is extensive load-shedding, with hours of power cut the waste is simply bypassed and discharged directly into the river.

As a result, the city with 217 MLD of installed capacity still treats only 100 MLD as the plant does not work or the sewage does not reach the plant. The official estimate of sewage generation is roughly 400 MLD, while the actual measured outfall is 600 MLD. In other words, anywhere between 300-500 MLD of sewage is discharged into the river.

Its biggest and most polluting drain — Sisamau — has now caught the attention of planners and there are many proposals to handle its waste — from trapping the waste upstream to changing its course so that it discharges into the Pandu river and not the Ganga. Then the waste will be treated and wastewater provided to farmers. But for now, all this is on paper. The river continues to suffer and bleed.

Generation (official)
400 MLD

Measured outfall
600 MLD

Treatment
100 MLD

Discharge
300-500 MLD

Varanasi
In penance

The Ganga flows through Varanasi touching its western bank. This is the city Hindus come to, to worship and to cremate the dead. This is the city of Gods. But the river millions worship is still polluted. But not because there has been no attempt to clean it up.

The city's tryst with pollution control started way back in 1954, when the state government started a sewage utilisation scheme, building sewage pumping stations on different ghats to intercept the sewage for diversion to a sewage farm located at the far end of the city in Dinapur. Pumping stations were built at the Harishchandra Ghat, Ghora Ghat (renamed Dr Rajendra Prasad Ghat), Jalasen Ghat and Trichlochan Ghat. This infrastructure was completed by the 1970s and handed over to the Jal Sansthan (the city's water agency) for operation. But little was done beyond this. The works became defunct very soon.

In 1986, with the launch of the Ganga Action Plan these projects were revised. More money was sanctioned and spent to refurbish the pumping stations and build and repair drains. In addition, three sewage treatment plants with a combined capacity of 101.8 MLD were built: 9.8 MLD at Bhagwanpur; 80 MLD at Dinapur; and 12 MLD at the Diesel Locomotive Works.

Then hectic parleys began to spend more money on building new sewage hardware. In March 2001, the National River Conservation Directorate sanctioned another Rs 416 crore for more trunk sewers and interception drains. Tendering started in earnest. But in September 2001 the Supreme Court, listening to a public interest matter on river pollution, halted the process and asked for a review of the plan. In 2002, however, the apex court vacated its earlier order. The plan was ready and cleared for implementation. Everyone forgot the city was already out of money to run the existing plants.

This is when as early as 1997 a city-based group, the Sankat Mochan Foundation, had suggested an affordable variation on the expensive pollution scheme. The city could build watertight interceptors along the ghats that worked on the principle of gravity, so cutting electricity (pumping) costs. Some 5 km downstream of the city, in Sota, the sewage could be treated in advanced integrated oxidation ponds with the help of bacteria and algae. The capital cost of this alternative was projected at Rs 150 crore.

But Varanasi's public water works department has rejected this proposal saying that it is not feasible for it would disrupt pilgrims and damage the historical ghats during excavation.

With the re-launch of the Ganga action programme, the city has sensed a new opportunity. The National Ganga River Basin Authority (NGRBA) and the Japan International Cooperation Agency have agreed to fund another Rs 524 crore worth of projects for beautification of the Assi ghats and sewage infrastructure. By June 2013, for which the last progress reports are available on the NGRBA site, some 12 per cent work had been completed. It is difficult to say if this plan will be any different from the rest as it does more of the same — sewage treatment plants; infrastructure; drains and pumps and pipes. All that has not worked till date in this cash and energy-starved city. Clearly, when there is money to send down the river, cleaning it is not the issue at all.

Will it work?

- Projects worth Rs 524 crore in the pipeline
- Work: STPs, hardware
- Work completed: 12% (2013)

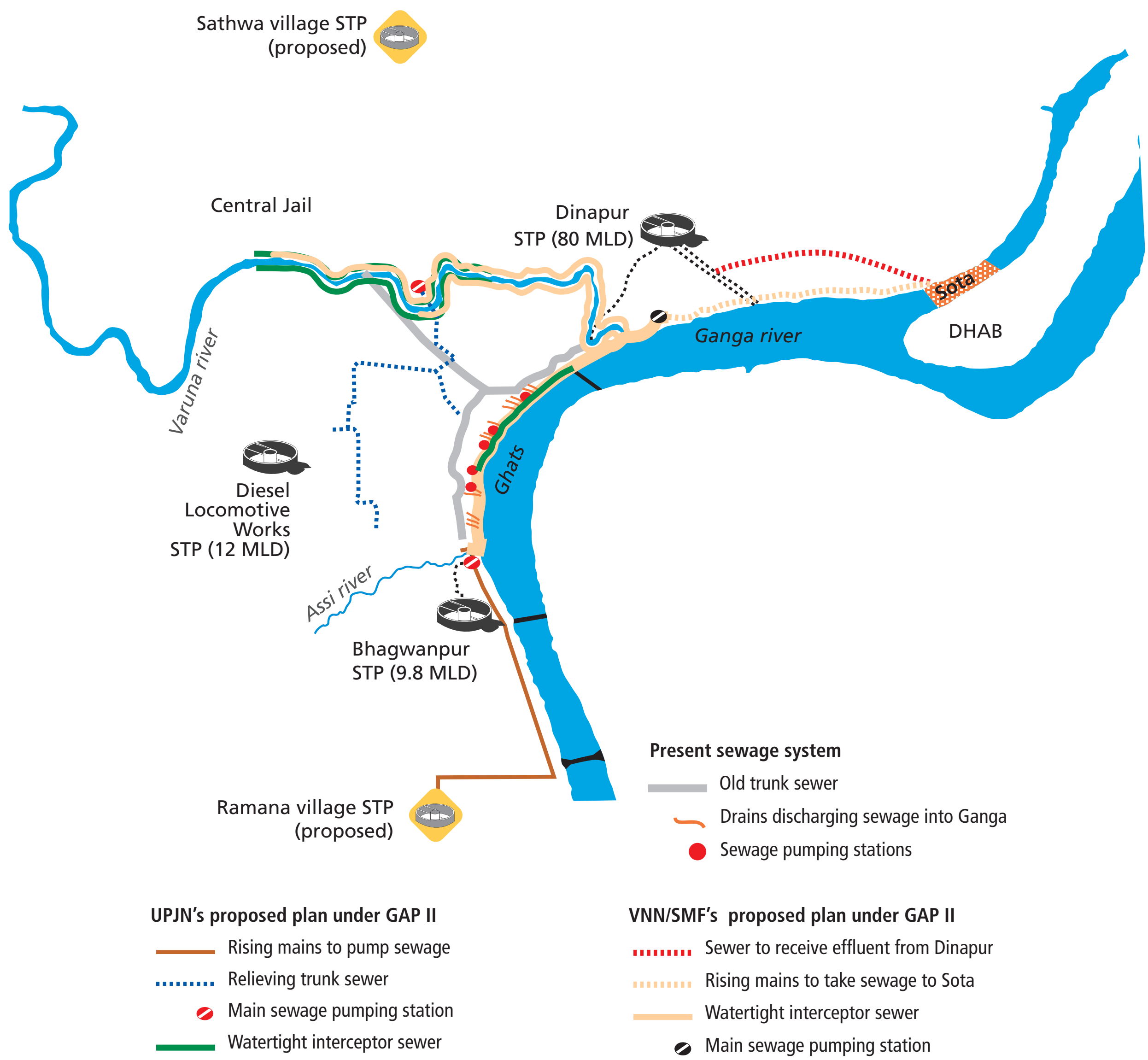
Current status

The city has a heap of problems: First, its current and upgraded sewage network is grossly inadequate. According to the City Sanitation Plan, commissioned by the Union ministry of urban development, the 400 km sewerage network mainly exists in the old city and the ghats area. However, even this is over 100 years old and extremely dilapidated. According to the UP government, over 80 per cent of the city remains un-sewered.

Second, one third of the city lives in slums, with little access to any sanitation and sewerage facilities. The City Sanitation Plan notes that 15 per cent of the city does not have access to toilets and resorts to open defecation (*see Maps on pages 25-27*).

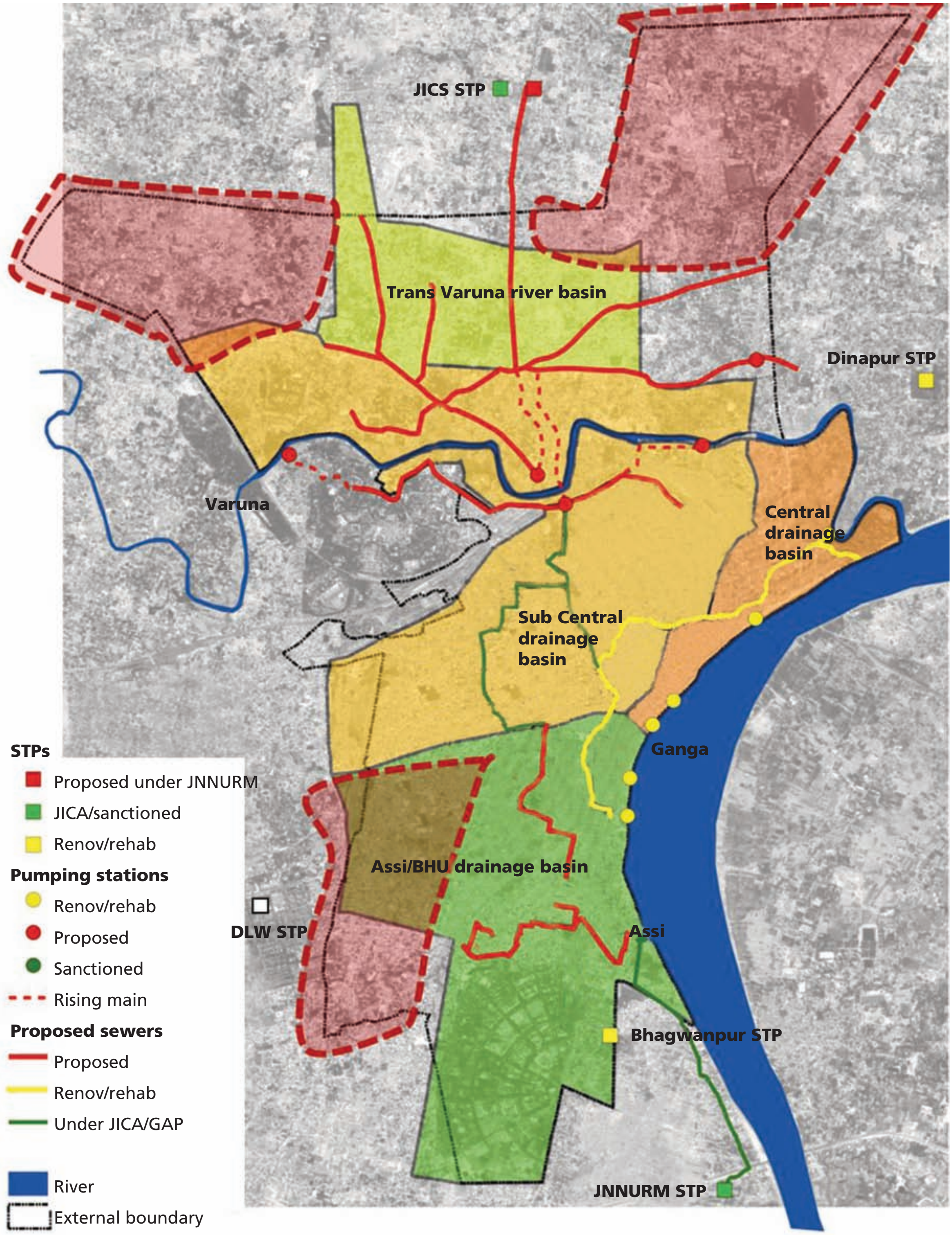
Third, because of lack of sewerage, many parts of the city (particularly the

Varanasi: the river and the sewers



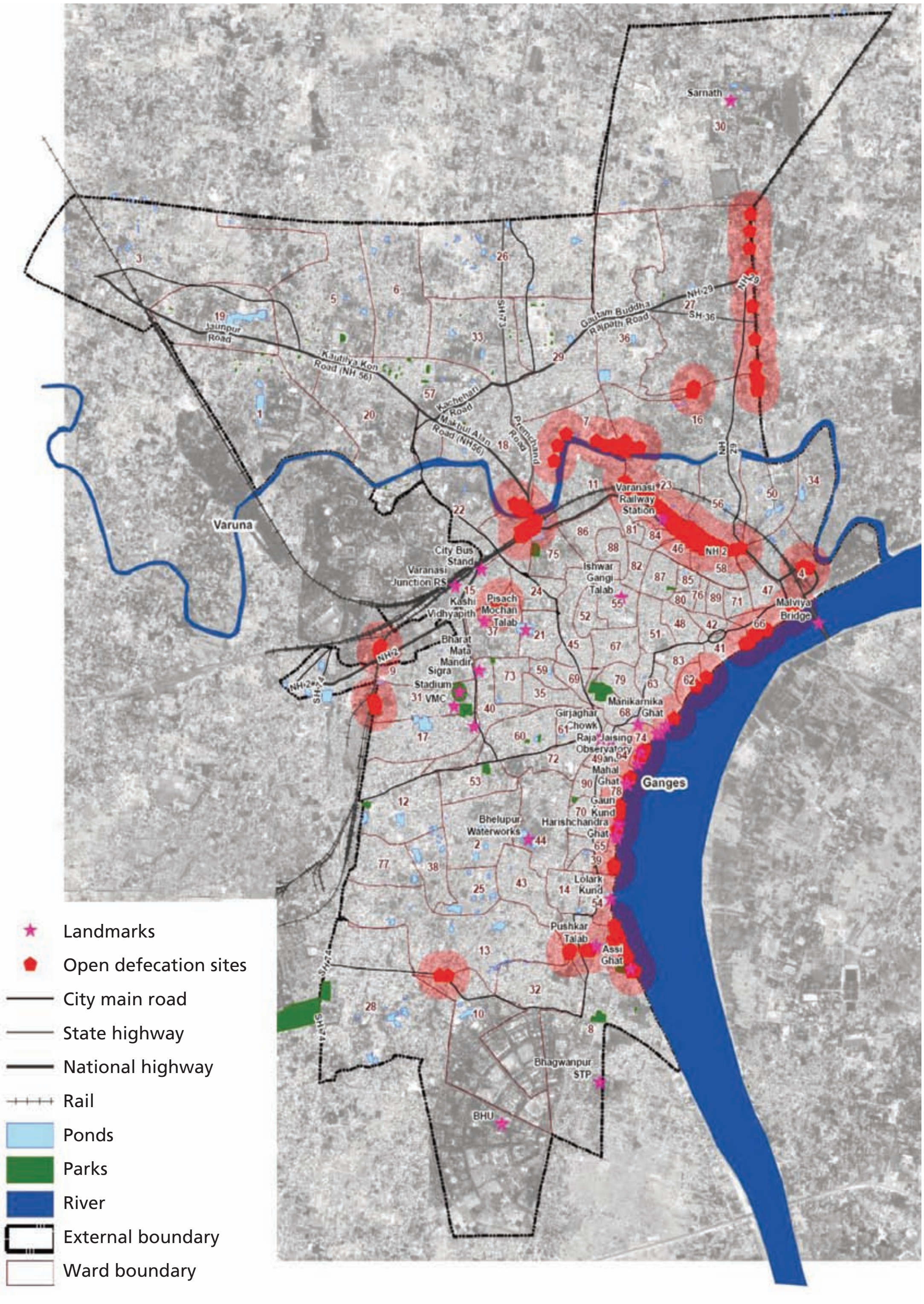
Note: UPJN = Uttar Pradesh Jal Nigam; VNN = Varanasi Nagar Nigam; SMF = Sankat Mochan Foundation
Source: Sankat Mochan Foundation (SMF), Varanasi, and Varanasi Nagar Nigam (VNN)

Coverage of sewage system in Varanasi



Source: Draft City Sanitation Plan for Varanasi, August 2011, Varanasi Municipal Corporation

Open defecation hotspots in Varanasi



Source: Draft City Sanitation Plan for Varanasi, August 2011, Varanasi Municipal Corporation

Generation (official)
233 MLD

Treatment
102 MLD

Untreated discharge
131 MLD

Measured outfall
410 MLD

Treatment
102 MLD

Untreated discharge
308 MLD

peripheral areas) depend on septic tanks. But there is no formalised septage management and tanks overflow into open drains and floods low-lying areas.

Fourth, there is virtually no solid waste management in the city and therefore, this waste also ends up clogging drains and fouls up the river.

In this situation, it is not enough to plan for upgrading the sewage network or building more sewage treatment plants.

Current sewage treatment plants

The official sewage generation of the city is estimated to be 233 MLD. This is based on the calculation that 80 per cent of the water supplied by the water utility (Jal Nigam) is returned as sewage.

However, this is a gross underestimate, because it does not take into account the groundwater usage or the flow of water into the drains from other sources. The CPCB's 2013 measurement of drain outfall shows that the city discharges 410 MLD — double the official sewage estimate.

The current sewage treatment capacity is 101.8 MLD. In other words, only 25 per cent of the waste generated can even be treated and 75 per cent is discharged without treatment into the river. The Jal Nigam maintains that the treated waste of Dinapur and Bhagwanpur STPs is used for irrigation.

Now the city is adding 260 MLD treatment capacity, but the question is if this will provide the solution that is so desperately needed? The question still remains if the city will be able to intercept the waste to take to the treatment plants, without a sewage network. Then, the quantum of discharge from the drains is still much higher and will probably increase over this period as population grows. Therefore, the increased capacity in STP will still not be sufficient. The question also is what will happen to the treated effluent and if it will be mixed with untreated waste in the open drains that discharge into the river. Finally and most critically, where will the city get its electricity and finances to run these plants?

This is why the city needs to a relook at its current sewage treatment strategy. According to CPCB (2013), the city has three key drains — Rajghat, Nagwa, Ramnagar and two rivers (also termed as drains because of their quality) Varuna and Assi. The question is how the waste of these drains can be best intercepted and taken to sewage treatment facilities and then reused and recycled. Two drains are critical because of the high BOD load — Nagwa drain (BOD load is 4,000 kg/day) and Varuna drain (BOD load is 3,888 kg/day).

It is also critical that the drains are developed as *in situ* treatment zones. According to the City Sanitation Plan the wastewater in the drains is diluted because of flow from household septic tanks and therefore, it is possible to clean these drains and to develop them as open treatment facilities.

It is important that the solid waste and sanitation services in the city are vastly improved. In all this the financial strategy will be critical. The Ganga at Varanasi can only be cleaned if the city is cleaned.

Annexure

List of drains flowing into Ganga

Catchment region	Point source	Flow (MLD)	BOD load (kg/day)
Uttarkashi & Devprayag	Storm Water Drain Uttarkashi	1.73	-
Uttarkashi & Devprayag	Kodia nala Devprayag	1.73	-
Rishikesh	Triveni Drain/Saraswati Nala	11.50	828.00
Rishikesh	Rambha River	152.00	152.00
Rishikesh	Lakkar Ghat/ STP Drain	12.00	216.00
Rishikesh	IDPL-STP Drain	3.00	12.00
Rishikesh	Swarg Ashram/STP Drain	2.50	57.50
Rishikesh	Gadhi Shyampur Drain	-	-
Haridwar	Jagjeetpur STP Drain	42.00	2,100.00
Haridwar	Kassavan Drain	11.70	1,357.20
Haridwar	Pandey wala Drain	-	-
Haridwar	Matra Sadan	3.80	76.00
Haridwar	Rawlirao Drain	2.80	2,133.60
Laksar	Laksar Drain	196.00	35,868.00
Sukratal	Banganga River (at confluence with river Ganga)	-	-
Sukratal	Hemraj Drain	-	-
Sukratal	Bijnor Sewage Drain	7.60	440.80
Bijnor	Malan River (at confluence with river Ganga)	16.50	82.50
Bijnor	Chhoiya Drain (at confluence with river Ganga)	124.00	16,120.00
Gajrola and Babrala	Bagad River	1.80	352.80
Garh	Garh Drain	14.00	224.00
Garh	Fuldehra Drain (at confluence with river Ganga)	32.00	3,488.00
Gajrola and Babrala	Bagad River	1.80	352.80
Garh	Garh Drain	14.00	224.00
Garh	Fuldehra Drain (at confluence with river Ganga)	32.00	3,488.00
Badaun	Badaun Sewage Drain	29.90	1,375.40
Badaun	Sot River	42.00	966.00
Anupshar	Anupsahar STP Drain -1	0.85	9.35
Anupshar	Anupsahar STP Drain -2	1.75	49.00
Kanpur	Dabka Nalla-1 (Kachha nala)	94.0	15,792.0
Kanpur	Dabka Nalla-2	25.0	3,475.0
Kanpur	Dabka Nalla-3 (Pakka nala)	0.3	10.0
Kanpur	Shelta Bazar (Kachha nala)	29.0	12,296.0
Kanpur	Wazidpur Nalla	54.0	45,522.0
Kanpur	Satti Chaura	1.1	97.0
Kanpur	Golaghat Nala	0.8	114.0
Kanpur	Bhagwatdas Nala	11.0	1,144.0
Kanpur	Sisamau Nala	197.0	544,980.0
Kanpur	Permiya Nala	186.0	11,485.0
Unnao	Loni Drain	41.9	4,860.0
Unnao	City Jail Drain	35.9	7,208.0
Fatehpur to Raibareilly	Pandu River	1,396.0	34,900.0
Fatehpur to Raibareilly	Arihari Drain	34.3	127.0
Fatehpur to Raibareilly	NTPC Drain	60.3	1,121.0
Allahabad	Rasulabad-1 (Pakka nala)	29.8	20,264.0
Allahabad	Rasulabad-2 (Pakka nala)	20.2	5,656.0
Allahabad	Rasulabad-3 (Kachha nala)	14.2	1,320.0
Allahabad	Rasulabad-4 (Kachha nala)	48.5	2,376.0
Allahabad	Nehru Drain	7.0	61.0
Allahabad	Kodar Drain	20.0	1,040.0
Allahabad	Pongaghat Drain	8.0	161.0
Allahabad	Solari Drain	34.8	1,087.0

Contd...

Catchment region	Point source	Flow (MLD)	BOD load (kg/day)
Allahabad	Maviya Drain	65.0	3,380.0
Allahabad	Mugalaha Drain	46.0	598.0
Mirzapur	Ghore Shaheed Drain	86.4	4,121.0
Mirzapur	Khandwa Drain	62.2	5,350.0
Varanasi	Rajghat Drain	16.2	808.0
Varanasi	Nagwa Drain	66.5	4,060.0
Varanasi	Ramnagar Drain	23.7	963.0
Varanasi	Varuna Drain	304.5	3,776.0
Buxer	Sidhharth Drain	7.50	997.28
Buxer	Sati Ghat Drain	7.70	1,506.16
Buxer	Nath Baba Drain	5.20	303.54
Buxer	Tadka Drain	6.80	16.44
Buxer	Sariupur Drain	6.70	1,583.14
Patna	Danapur Cantt Drain	10.10	1,988.60
Patna	Digha Ghat Drain	9.60	1,907.48
Patna	Kurzi Drain	120.40	31,926.80
Patna	Rajapur Drain	40.70	7,494.80
Patna	Bansh Ghat Drain	6.60	1,135.22
Patna	Collectriate Ghat Drain	14.30	3,998.66
Patna	Mittan Ghat Drain	5.40	980.02
Patna	Mahavir Drain	5.40	1,078.46
Patna	Badshahi Drain	21.40	4,879.04
Munger	ITC Drain	10.13	3,289.40
Munger	Lal Darwala Drain	8.50	2,103.70
Bhagalpur	Jamunia Drain	82.61	17,027.20
Bhagalpur	Adampur Drain	11.75	2,651.30
Bhagalpur	Sarkikal Drain	6.62	1,981.64
Bhagalpur	Saklichand Drain	7.70	1,479.24
Bhagalpur	Hathiya Drain	11.80	2,721.82
Bhagalpur	Chama Drain	10.60	3,072.70
Bhagalpur	Barari Ghat Drain	9.70	2,868.90
Kahalgaon	Kowa Drain	147.28	932.80
Kahalgaon	Kagzi Drain	5.20	1,582.16
Left Bank	Circular Canal adjacent to River Hooghly	320.30	7,045.50
Left Bank	Tolly Nala adjacent to Dahighata	380.20	26,991.30
Left Bank	Dhankheti Khal Near CESE Intake Point	65.20	15,133.80
Left Bank	Akhra Food Ghar Adjacent to Hooghly River	83.40	2,002.50
Left Bank	Khardah Municipal Drain Connected to Hooghly River	63.00	2,330.50
Left Bank	Debitala Pancha Khal, Ichapore (Adjacent to R.N.S. Brick Field)	46.00	229.80
Left Bank	Khal Near Nimtala Burning Ghat	20.70	1,554.90
Left Bank	MuniKhali Khal Asdjacent to Arun Mistri Ghat	19.40	54.21
Left Bank	Kashipur Khal Adjacent to Khamarhati Jute Mill	16.10	6,309.80
Left Bank	In front of S P Bunglow, S N Banerjee Road, MistryGhat, Barrackpore	22.70	3,628.80
Left Bank	Adjacent to Cossipore ferry ghat and gunshell factory	19.80	1,269.04
Left Bank	Chitpur Ghat, Dilarjung Road	15.00	960.00
Left Bank	Majher Char Khal & Kalyani combined waste sewage near brick field with foam near sluice gate	16.50	363.00
Left Bank	Drain Opposite to Fort William, Judges Court Ghat	7.65	76.00
Left Bank	Adjacent to Garifa Rly. Stn., Patterson Road, adjacent to Ram Ghat	7.78	148.20
Left Bank	Adjacent to Garifa Rly. Stn., (North side) on Patterson Road (domestic)	9.68	475.30
Left Bank	Baranagar Khal Adjacent to Ratan Babu Ghat	10.30	990.70
Left Bank	Mohan Misra lane & crossing of Ghosh Para Road, Halisahar, adjacent to Prabhat Sangha playground	10.70	236.10
Left Bank	Bagher Khal, adjacent to Hotel Dreamland, near sluice gate, open pucca drain	11.10	177.00
Left Bank	Drain between Pratapnagar and Rajbari	4.19	729.50
Left Bank	By the side of Alliance jute mill, Jagatdal Jetty, opposite side of bank Chandannagar jetty	4.96	277.70
Left Bank	Adjacent to boundary wall of Gandhighat & near Upashak Social Welfare Organisation, Gandhighat, South gate-I, Barrackpore	3.61	36.10

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Catchment region	Point source	Flow (MLD)	BOD load (kg/day)
Left Bank	Balughat, Manirampur pucca drain	2.28	125.40
Left Bank	Bishalakshmi Ghat, adjacent to CESC Power House, Titagargh	4.01	256.70
Left Bank	Thanar Khal, adjacent to Thana & over tank by Naihati Municipality	5.29	201.00
Left Bank	Sasan ghat	2.92	32.08
Left Bank	Open pucca drain carrying waste for ward nos. 9 & 10	1.20	140.40
Left Bank	Saidabad kunja Bhata (opposie to auto center) ward no. 25	1.26	102.10
Left Bank	Shovabazar Canal near Shovabazar Launch Ghat	0.42	28.97
Left Bank	Open pucca drain flowing adjacent to Diamond club	0.96	2,029.40
Left Bank	Open kuchha drain carrying domestic waste forward 16	0.66	32.30
Left Bank	Adjacent to boundary wall of Jangipur College and B D Office	1.08	49.70
Left Bank	Shasan (burning) Ghat, Bhairabpur, Purbapara ward no.16	0.54	18.90
Left Bank	Radhar Ghat (Old Ichagra shasan Ghat) Bhairabpur, Purbapara	0.48	61.90
Right Bank	Bhagirathi lane, Mahesh, Serampore	41.50	327.63
Right Bank	Hastings Ghat road, adjacent to Hastings jute mill, Rishra, Hooghly	42.00	3,569.18
Right Bank	Najerganj Khal, north side of Shalimar paint, near Hans Khali Poll, Sankrail	326.00	5,216.14
Right Bank	Singhi More Khal (Singhi mara Khal), Manikpur, Sankrail, near brick field	26.10	67.95
Right Bank	Chatra Khal, Beniapara, Serampore, Behind Ganga Darsan, Raja K. L Goswami street, Serampore	28.40	1,445.85
Right Bank	Bagh Khal, border of Rishra & Konnagar Municipality on G T Road	18.40	1,030.58
Right Bank	Telkal Ghat	21.90	3,028.49
Right Bank	Ramkrishna Mullickghat Road	12.20	1,087.40
Right Bank	130 Foreshore Road martin Burn	17.60	2,475.39
Right Bank	Shibpur Burning Ghat	13.30	705.96
Right Bank	Jagannath Ghat Road, opposite to China pharmacy, by the side of Bijoy lakshmi rolling mill	17.30	448.71
Right Bank	Combined of Swarasati Khal and Rajganj Khal, near Sankrail Police station, near Pareshnath Hazra Ghat	2.77	16.62
Right Bank	Champdany Ferry Ghat, opposite nabal garage, Champdany, Poura bhavan road, Pin-712222	4.15	157.59
Right Bank	South side of Dawnagazi Ghat, Bally Municipality, Bally	1.31	36.59
Right Bank	Jagatnath Ghat, Ward No. 14, Lalababu Saha Road., South side of Kathgola Ghat	9.33	133.00
Right Bank	101, Foreshore Road	6.24	167.00
Right Bank	Kuthighat South Side of Belur Math	5.76	946.00
Right Bank	N C Pal Khal, Sankrail	3.87	266.00
Right Bank	Adjacent to bazarpara and Garighat (ward no.18) Kuccha drain	1.20	150.00
Right Bank	Shalimar Coal Deposit No.1 Naresh Kumar Ward	0.16	158.00
	Total	**6,136.90**	**1,003,164.12**

Source: CPCB 2013, *Pollution Assessment: River Ganga*, Central Pollution Control Board, MoEF, July

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