Dirty Flows the Ganga

Why Plans to Clean the River Have Come a Cropper

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One of the first announcements of Prime Minister Narendra Modi pertained to cleaning the Ganga. But this is not the first time an attempt has been made to clean the river. River cleaning schemes initiated in 1974, 1985, 1993, 1996 and 2008–09 have been monumental failures. While the Prime Minister's announcement was followed by a lot of rhetoric and initial moves towards the goal were frantic, two years later, there has been little improvement in the state-of-affairs. This article looks at some of the problems that have dogged programmes designed to clean the river and suggests measures to address the pitfalls.

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After winning the parliamentary constituency elections, Narendra Modi ensured the river Ganga would be cleaned and restored to its glory, to be *nirmal* Ganga, *aviral* Ganga. The task is, no doubt, onerous and challenging. Initial moves towards the goal have been frantic; there is plenty of rhetoric; all forms of protagonists have jumped into the fray. The charge has been assigned to Uma Bharti, the minister of water resources, who is advocating a "compact plan" to be executed, and has, in turn, involved other relevant ministries such as the Ministry of Road Transport and Highways, the Ministry of Shipping, the Ministry of Tourism and the Ministry of Environment, Forest and Climate Change as well as the respective state governments. It is imperative that this flurry of attention and activities is deftly sustained, implementation is duly coordinated, and a stringent timeline maintained. More than two years have gone by, with little to demonstrate that the project is really followed through on a war-footing.

Modi would not be unaware that, way back in 1979, the then Prime Minister, Indira Gandhi had a comprehensive survey conducted by, what is now, the Central Pollution Control Board (CPCB), leading to the Ganga Action Plan (GAP) to clean up the river. For the implementation of GAP, ex-Prime Minister Rajiv Gandhi set up the Central Ganga Authority, in February 1985 (renamed as the National River Conservation Authority in September 1995). The government also established the Ganga Project Directorate (GPD) in June 1985, as a wing of the department of environment, to execute the project. It was renamed as the National River Conservation Directorate (NRCD) in June 1994, setting on track the GAP at Varanasi on 14 June 1986. Nothing tangible came about in more than two decades.

During a visit to the Banaras Hindu University, Varanasi in March 2008, the then Prime Minister Manmohan Singh promised that the government would accelerate the pace of cleaning the Ganga. Typically, the promise remained unfulfilled. The river has become shallower and dirtier now.

Ganga was declared a national river, and yet another new body—the National Ganga River Basin Authority (NGRBA) was constituted on 23 September 2009, bringing curtains down on earlier two tranches of GAP. A sum of ₹7,000 crore was approved in April 2011 for the Clean Ganga project, including a share of ₹1,900 crore by state governments of Uttarakhand, Uttar Pradesh (UP), Bihar, Jharkhand and West Bengal.

As the Ganga Meanders

Notwithstanding the river being named Ganga only after the Bhagirathi is joined by the Alaknanda and Mandakini at Devprayag, the Hindu mythology recognises Bhagirathi river to be the actual Ganga. The origin of the Bhagirathi itself is traced to glacial waters flowing from a cave at Gaumukh on the southern slopes of the Himalayas. The Ganga receives over 60% of its discharge from its tributaries; originating over 150 km east of the Bhagirathi, the Yamuna flows parallel to the Ganga and a little to the south for most of its course before merging with the Ganga at Prayag or Allahabad. In the plains, Ganga is joined by Ramganga, Yamuna, Sai, Gomati, Ghaghara, Son, Gandak, Kosi and Damodar along with other smaller rivers.

Some 23 km far from Gaumukh, the river reaches Gangotri, the first town on its path before emerging into North Indian plains at Haridwar. Gangotri forms one of the celebrated *Chaar Dhaam,* including Badrinath, Kedarnath and Yamunotri. At an annual average of 23 m, the Gangotri glacier is one of world's most rapidly retreating glaciers. Reported to have been receding since 1780, its retreat quickened post-1971, its recession amounting to 76 m during the period 1996–99 itself. Increased activities endanger the glaciers further.

Beginning with Rishikesh, Ganga gets to be contaminated by municipal and industrial effluents. At Rishikesh itself, industrial waste from the Bharat Heavy Electricals Ltd (BHEL) and the Indian Drugs and Pharmaceuticals Ltd (IDPL) and sewage drains flow into the river. With its relatively small population of about 1,50,000, Haridwar gives rise to only about 42 million litre per day (mld) of sewage, but pollution is accentuated sharply every six years during *Ardh Kumbh* when up to five million devotees descend on the town for a holy dip.

The river meanders thence through the plains, which are the worst polluted. A large part of the Ganga flow is abstracted for irrigation just as it enters the plains at Haridwar, from where it flows as a trickle for a few hundred kilometres until Allahabad, winding its way to Ganga Sagar in the Bay of Bengal, covering 2,525 km through Uttarakhand, UP, Jharkhand, Bihar and West Bengal, passing along 29 Class–I cities (population over 1,00,000), 23 Class–II cities (population between 50,000 and 1,00,000), and 48 towns having less than 50,000 population each, in addition to thousands of villages.

Kanpur with its hundreds of tanneries, distilleries, cotton, jute, paper chemical and fertiliser units emerges as the most polluting centre, daily discharging over 200 million litre of waste water, toxic and hazardous materials. UP has around 700 industrial units, mainly small scale and many illegal—tanneries, sugar, pulp, paper and chemicals, which contribute 270 mld of waste water. While a cluster of some 400 tanneries around Kanpur generate 8% of the industrial discharge, what they spew is highly toxic effluent into the river. The 2013 CPCB inspection showed that only 23 of the 404 scrutinised industrial units complied with the law, notwithstanding clear directions issued and closure notices served!

Much of Allahabad town has no sewer facilities. Thirteen sewer drains, a major source of pollution in the city, the venue of the Maha Kumbh Mela every 12 years, are choked. While the 13 drains at Allahabad discharge about 120 mld of sewage, Naini industrial area and Phulpur fertiliser factory compound the problem with their industrial effluents. The annual Magh Mela and 12-yearly Kumbh Mela exacerbate the situation, when millions of devotees congregate.

The Varanasi city, accounting for as much as one-fourth of UP's pollution load for the Ganga, is struck with a heap of problems. According to the City Sanitation Plan commissioned by the Union Ministry of Urban Development, the 400 km sewerage network mainly existing in the old city and the ghat area has remained dilapidated and choked since around 1920. Over 80% of the city remains unsewered. One-third of the city lives in slums, with little access to any sanitation and sewerage facilities; 15% of the city does not have access to toilets and resorts to open defecation. Because of lack of sewerage, many parts of the city (particularly, the peripheral areas) depend on septic tanks. There is no formalised septic management; tanks overflow into open drains and flood low-lying areas.

Some reports indicate the upstream end of the 6.5 km stretch of the ghats in Varanasi contains 60,000 bacteria per ml, while the downstream of the ghats, where some 60,000 people perform daily ablutions and 32 streams of raw sewage empty into the river, the figure goes up to a whopping 1.5 million. "In places, the Ganges becomes septic: tar-black, stinking, without life" (*Economist* 2008).

The next major city downstream is Patna, where new areas have been built up without adequate civic facilities. The city is estimated to generate 100 mld of waste water, of which 87 mld from nine major outfalls in the city were tapped in GAP–Phase I. Sandwiched between the Son and the Ganga, Patna expanding mostly along the Ganga, gets increasing volumes of the garbage that gets dumped into the river. The city is blessed with high discharge even during dry weather as the Ganga is augmented upstream by Ghaghra and Son, while Gandak joins it downstream. As it enters Bihar near Buxar, Ganga is fed by tributaries—Ghaghra, Gandak, Bagmati, Son, and Kosi on its 445 km course through the state, to be choked by urban sewage, industrial waste at Mokama and oil refinery at Barauni, among others, besides rampant, illicit sand-mining and brick kiln waste dumped by some 6,000 kilns sprouted along its bank. According to a report in 2013, over 671 mld of untreated waste water goes into the Ganga in Bihar.

The main source of pollution in Kolkata is the waste generated in its metropolitan area, with its population of 14.1 million (2011 Census), comprising three corporations, 38 municipalities, and 527 small towns and villages. It was reported to add as much as 1,350 mld of sewage into the Hooghly/Bhagirathi. In addition to around 150 large industrial units along the riverbank in the city belching effluents, most of the around 325 drains (such as the Howrah Drainage Canal) carry sludge into the river.

A Paradox: Faith and Reality

Most rivers in the country today are just fetid sewers. A symbol of the country's culture, an abiding source of its legends and

literature, India's most sacred, and one of world's most important rivers, the Ganga water has been acclaimed in ancient treatises on medicine and dietetics from the *Charaka Samhita* (first century AD) onwards as clear, wholesome, sweet and digestive. The Ganga directly sustains more than 150 million people, affects the lives of more than 450 million in emotional or economic terms; and has an estimated catchment area of 9,07,000 sq km. About 47% of India's total irrigated area located in the Ganga basin, the river irrigates about 18 million hectares. It carries the world's highest silt load of any river, in turn, leading to the world's largest river delta—400 km north to south and 320 km east to west.

Millions of devotees from all walks of life, from all corners of the country and beyond, congregate to bathe in the river during religious festivals, especially the Kumbhs of Haridwar and Allahabad. It is a great paradox that, while the Ganga is hailed as verily the cradle of civilisation, revered and worshipped for centuries, Ganga *jal* used as sacrament by countless dying devout Hindus, the people as much as governments have let the river, among most rivers, remain so polluted and unwholesome. How come, they contribute, and remain passive witness, to so much of filth heaped on her?

For the millions on the banks of the Ganga, with the world's most heavily populated river basin, the river is a watering hole, a bathroom, a septic tank, a laundromat, a cleansing pool, also a garbage dump. A large number of devotees who throng the river ghats and banks daily abuse the river. Not only has the pristine purity of the Ganga water deteriorated, but the entire ecology of the river system has been degraded. Fishing fields of commercial importance collapsed, the monoculture of pollution tolerant species like tubifex became common, especially near city outfalls; pollution-intolerant species disappeared; community respiration increased; and primary productivity of the river adversely affected, resulting in the decline of not only the fish population, but of other vertebrates as well.

Three-fourths of pollution in the Ganga emanates from municipal sewage from the cities, towns and villages located along its banks. The total sewage generated in 25 Class I towns in 1985 was estimated to be 1,340 mld, which prima facie appears to be an underestimation. The stretches between Rishikesh in Uttrakhand and Rajmahal in Bihar pose major problems, as also the stretch lying between Kannauj and Varanasi, where hundreds of factories and tanneries discharge toxic wastes into the river without any treatment. The Class I and II cities alone along the river generate about 2.7 billion litre of sewage, at least two-thirds of which flows—untreated—into the Ganga.

A report prepared by the UP's irrigation department shows more than 40,000 km long drains and subsidiaries stretched over 5,000 km carry hazardous industrial and urban waste, while directly falling into the 1,300 km long stretch of the Ganga that chokes the river.

The Ganga River, like many rivers of the world, sustains diverse flora and fauna, which has helped the river maintain purity of its water. Indiscriminate use of pesticides in agriculture has posed new threats and resulted in accumulation of these hazardous chemicals in the tissues of fish as well as of other higher vertebrates due to bio-magnification. Rampant killings of Ganga turtles, especially the soft-shelled turtles by fishermen, have reduced the scavenging capacity of the river system, thereby affecting its self-purifying capacity. Direct and accidental trapping and habitat destruction due to various developmental activities, besides pollution, pushed the only cetacean in the Ganga, the Ganga River Dolphin, to the verge of extinction.

It is the ceaseless influx of noxious pollutants from human settlements and riverbank industries that have added to the river's woes, distorting the natural dynamic of its equilibrium and affecting its biodiversity. Nearly all the sewage in addition to considerable quantity of garbage and human/animal excreta go directly into the river, along with the run-off from the 6 million tonne of fertilisers and 9,000 tonne of pesticides used in agriculture within the basin, besides large quantities of solid waste, including thousands of animal carcasses and hundreds of human corpses released into the river every day.

GAP: An Evaluation

Launched in 1985 and extended in two phases over more than two decades, the GAP focused primarily on urban waste water and funded a large number of waste water treatment plants and related urban waste water infrastructure. The GAP was fully financed by the central government, with the assets created by it to be used and maintained by the state governments. Efforts to clean the Ganga concentrated on a few highly polluting towns and centres and addressed "end-of-the-pipe" waste water treatment, without adequate attention to developing a basin-level, multi-sectoral approach.

The major problem of pollution from domestic municipal sewage (1.34×106 m^3 d-1) arising from the 25 selected towns was handled directly by financing the creation of facilities for interception, diversion and treatment of the waste water, and also by preventing the other city wastes from entering the river. Of the 1.34×106 m^3 d-1 of sewage assessed to be generated, 0.873×106 m^3 d-1 was intended to be intercepted by laying 370 km of trunk sewers with 129 pumping stations as part of 88 sub-projects. The laying of sewers and the renovation of old sewerage was restricted only to that required to trap the existing surface drains flowing into the river.

About 100 industries were identified on the main river itself, including 68 of them considered "grossly polluting"—discharging 260×103 m^3 d-1 of waste water into the river. Under the Water (Prevention and Control of Pollution) Act, 1974 and Environment (Protection) Act, 1986, 55 of such units (generating 232×103 m^3 d-1) are reported to have complied and installed effluent treatment plants.

For all the larger sewage treatment plants, the well-accepted activated sludge process was adopted. For other plants trickling filters were considered more appropriate. In smaller towns, where land was available and the quantity of waste water was less, other options such as oxidation ponds were chosen. Unconventional technologies like the rope bound

rotating biological contactors, sewage irrigated afforestation, upflow anaerobic sludge blanket (UASB) technology and plants for chromium recovery from tannery waste water were tried out.

Most of these works were carried out by the same agencies which were eventually responsible for maintaining them as part of their primary functions such as the city development authority, the municipality, or the irrigation and flood control department of the state. Involvement of the external aid agencies was initially useful in introducing new technologies, such as chrome recovery plants for tannery waste waters, low energy input technologies like the UASB and in situ sewer rehabilitation technology. The involvement of aid agencies, with their associated mandatory procedures, added to the complexities of decision-making, especially in large sewage treatment plants (STP) projects. The procedural delays experienced with mid-project decisions on some issues of these turnkey contracts afforded the contractors grounds to justify their own shortcomings. The project schedules had to be relaxed several times.

The NGRBA sanctioned a number of projects which, in real terms, have yielded little. For creating a 3,600 km sewer network and sewer treatment capacity of 700 mld, some 80 projects were sanctioned, involving an expenditure of ₹6,400 crore for the UP, Uttarakhand, Bihar, Jharkhand and West Bengal. A ₹500 crore project was sanctioned specially for Varanasi itself.

The GAP aimed to tackle 2,794 mld of sewage: 882 mld under GAP–I and 1,912 mld under GAP–II. The NRCD records put the estimates of total sewage generation in towns along Ganga and its tributaries as 5,044 mld. The project commenced with an initial budget allocation of ₹350 crore. GAP–I envisaged to intercept, divert and treat 882 mld out of 1,340 mld of waste water generated in 25 Class–I towns in three states, Uttar Pradesh (six towns), Bihar (four towns) and West Bengal (15 towns); 261 schemes of pollution abatement concerning municipal activities were sanctioned, including 88 schemes of interception and diversion, 35 of sewage treatment plants, 43 of low-cost toilets, 28 of electric crematoria, 35 of riverfront development, and another 32 of miscellaneous category. Of these, 259 schemes were claimed to have been completed, the remaining two STP schemes being in Bihar. The NRCD had scheduled GAP–I for completion by March 1990, but extended it progressively up to March 2000.

The principal thrust of GAP–I was immediate reduction of the Ganga's pollution load and establishment of treatment systems which were technically and financially self-sustaining. Class–I cities were proposed to be taken up first. While GAP–I was still in progress, the Central Ganga Authority decided in February 1991 to take up GAP–II, covering pollution abatement works (left out in Phase–I) on the Ganga tributaries, viz, Yamuna, Damodar, Gomati and Mahananda. The Cabinet Committee on Economic Affairs approved GAP–II in various stages during the period April 1993–October 1996. UP, Bihar and West Bengal were to implement GAP–II by treating 1,912 mld of sewage, scheduled for completion by December 2001.

The Japan Bank for International Cooperation signed an agreement with the Government of India for providing a loan for taking up the pollution abatement schemes of the Ganga in Varanasi at an estimated cost of ₹540 crore (Yen 13.248 billion). The final feasibility study reports for the remaining three towns of Allahabad, Kanpur and Lucknow envisaged an estimated cost of ₹1,105 crore (Allahabad ₹305 crore; Kanpur ₹425 crore and Lucknow ₹375 crore).

Operation and Maintenance Bottlenecks

With the completion of the GAP-I, bottlenecks appeared in respect of operation and maintenance (O&M) of the assets created under the programme. Expenditure towards O&M facilities like sewage treatment plants and main sewage pumping stations were fully met by the centre up to September 1989, and thereafter, shared equally with the respective state governments from October 1989 onwards till March 1997. The programme under NRCP was initially approved on 50:50 cost sharing between central and state governments. The National River Conservation Authority (NRCA) at its 9th meeting held on 12 July 1997 decided to convert this scheme into a 100% centrally-funded programme on the lines of GAP–I. In November 1998, the central government decided to bear the entire expenditure on schemes effective from April 1997, as the states found it difficult to provide for their matching share.

An evaluation of GAP–I by experts from the Roorkee University, Aligarh Muslim University, Indian Institute of Technology Kanpur, and All-India Institute of Hygiene and Public Health, Kolkata concluded that the reduction in discharge of organic matter—a necessary first step in restoring the water quality—had been achieved to a fair level. They recommended an appropriate intervention to reduce the microbial pollution of the river, rigorous qualitative and quantitative characterisation of the sewage for adopting the most appropriate technology of treatment completed with resource recovery from the treated waste waters.

There are some anomalies and flaws detected in the project formulation. Under GAP–I, the sewage estimates were based on population and water supply rate, with the sewage generation taken as 80% of water supplied. The NRCD found the criterion to be flawed which led to an overestimation of sewage in several cases. Also, the sewage estimation of 70 mld in Noida in UP, for example, was found to be underestimated as it did not include the sewage of Shahdara drain, which discharges 404 mld sewage in the Yamuna at Okhla barrage. Similarly, the estimate of 200 mld sewage in Varanasi did not include 50 mld sewage bypassed into the river Varuna, which finally meets the river Ganga.

A report by the Comptroller and Auditor General (CAG) identified many reasons for the GAP failure—including bad planning, poor execution, extensive corruption, absence of coordination between central and state organisations as well as among the states themselves, leading to delay in the completion of schemes and resultant cost escalation in three states—UP, Bihar and West Bengal—underperformance of completed STPs, inadequate treatment of effluents, especially in tackling

the problem of bacterial load, ineffective monitoring leading to unauthorised use and diversion of funds by the implementing agencies; deficient public awareness and participation. The CAG report concluded that the GAP, launched in 1985, with the objective of bringing water quality of the Ganga and its tributaries to bathing levels was not able to achieve its objective, despite a total expenditure of ₹901.71 crore over a period of 15 years, up to March 2000.

Some instances of faulty planning are conspicuous: for example, in Kanpur, the pumping station at Sheesamau remained idle because bad alignment rendered gravity sewers incapable to carry water to it. Most of the STPs installed along the river under the GAP are not linked to the drainage system; as a result, the waste water gets dumped into the river unchecked. Continuous electricity is essential for their proper functioning; this is mostly lacking in many places. The municipal STP near Jajmau, an industrial suburb of Kanpur, had untreated water discharged into the Ganga because of power cuts. The generator installed there was found to be inadequate to operate the sewage treatment plant.

Many of the industries that discharge noxious chemical pollutants into the river are small scale, which find technologies for treatment to be unaffordable. Small-scale industrial units have little capacity to pre-treat waste water prior to discharge into the common effluent treatment plants. According to the CPCB, 2013 observations, 764 industries in the mainstream of Ganga (and its two tributaries, Kali and Ramganga) consumed 1,123 mld of water, but discharged only 500 mld of effluent, the bulk of pollution emanating from pulp and paper sector.

Ineptitude and Neglect

There appears no accountability established; no credible attempt made to unravel why the river cleaning schemes initiated in 1974, 1985, 1993, 1996 or 2008–09 have been monumental failures. What does this sad commentary signify? With the country beset with countless instances of deplorable governance, GAP showed up several infirmities, including those owing to pressure from groups like land developers succeeding in circumventing the system for their vested interests. A Varanasi land developer, it is said, obstructed the Assi drain which was intended to be a main carrier of the city's sewage.

Like in countless myriad spheres in the country, ever fattening bureaucracy does not deliver; numerous institutions and individuals, *netas* and *dadas* sprout to siphon off funds, with impunity. No heads roll at time-overruns and cost-overruns of projects; main issues get lost in specious technicalities and ingenious subterfuges. Plans remain mired in ineffectual implementation, lack of coordination between the centre and the states as much as among diverse implementing agencies. Reports abound, of unauthorised use and diversion of funds. In most of the major urban settlements on the banks of the Ganga, trunk-sewers have been laid along the riverside to intercept the drains/sewers coming from the inhabited areas, often though the pumping plants installed for this purpose are not properly operated and maintained; sewage thus overflows from the sewers and finds its way to the river.

At many places, the plants lie out of commission for years. In some cases, the sewer networks connecting the treatment plant may be incomplete, and in some others, connections are not adequate. In yet some cities, the power bills for these pumping stations are not paid for years; power supply agencies are compelled to disconnect the power connection. The Ministry of Environment, Forest and Climate Change itself holds that, after creation of assets like the sewage treatment plants under the River Action Plans, the state governments do not adequately provide for the O&M of these assets.

It is imperative that no sewage or effluent must get into the river without treatment; open defecation along riverbanks and adjacent areas be stopped; so also throwing of dead bodies, wood-based cremation, immersion of idols, throwing of flowers and plants, and any solid waste dumping along the riverbanks. Common effluent treatment plants, if commissioned for clusters of small-scale industrial units—tanneries, textile units, dyes and dye intermediate manufactures, and hotels, would help. The crux of the matter is effective implementation of policies and unwavering enforcement of laws and rules. For this, it is imperative that the State Pollution Control Boards function in close coordination with the CPCB, especially to stringently enforce Section 5 of the Environment (Protection) Act 1986. No tangible notice seems to have been taken of the CPCB's memos to the offending industrial units along the Kannauj–Varanasi stretch for flouting the provisions of the act.

Minimum Flow: Essential for Its Ecosystem

Rivers have a self-cleansing ability, which allows for assimilation and treatment of biological waste, using sunlight and oxygen. During winter and peak summer months, only sewage flows between the Ganga banks. About 43% of the country's total irrigated area is located in the Gangetic basin. Practically the entire dry-weather flow is diverted to the Upper Ganga Canal at Haridwar; whatever flow is regenerated between Haridwar and Aligarh is again diverted to the Lower Ganga Canal near Aligarh. As a result, there is little dry-weather flow in the Ganga at Kannuaj and Kanpur, where a heavy inflow of pollutants occurs in the river.

At least 30–35% of the total volume of the waters of the Ganga is needed to maintain a minimum flow, according to the consortium of Indian Institutes of Technology responsible for drawing up the new action plan. "But today the Ganga hardly has any water in it," said Rakesh Jaiswal of EcoFriends. "Over 90% of water is diverted for agriculture before the river reaches Kanpur...". As the river reaches the plains, the water withdrawal is maximum for irrigation and drinking. The stretch from Rishikesh to Allahabad finds itself almost devoid of water during winter and summer months. The river receives only waste, and turns into a sewer.

This is only a part of the story. The minimum flow is the very life-blood to sustain riverine ecosystems. Damming a river or diverting its water through canals retards its flow and adds to its pollution. Unrestricted withdrawal of Ganga waters through hydel projects, irrigation projects, and industrial activities has been endemic, rendering the river to be just a small

stream along several of its stretches. The three large barrages at Haridwar, Bijnor and Narora divert the river flow. The Alaknanda basin plans pose a threat to all the five Prayags; the Vishnuprayag, for example, is already a victim of the 400 MW eponymous projects. It is feared that scores of hydropower projects planned on the Alaknanda and Bhagirathi river systems in Uttarakhand would seriously affect the unique Himalayan ecology and the Ganga flow.

The central electricity authority and the Uttarakhand state power department have estimated Ganga's hydroelectric potential at some 9,000 MW and planned around 70 projects on its tributaries, which would entail modification of its key tributaries to the extent of 80% of the Bhagirathi and 65% of the Alaknanda, besides 90% of the other smaller tributaries. Glaciologist Syed Iqbal Hasnain has warned that, at this rate, the Ganga will disappear by about 2030–40. Water withdrawal for hydropower plants jeopardises the river health. The faecal coliform levels have been increasing even in the upper reaches such as Rudraprayag and Devprayag owing to inadequate flow for dilution.

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% 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, commissioned to look at ecosystem and fish biodiversity needs, has suggested 20–30% e-flow in different seasons. The Centre for Science and Environment 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% e-flow scenario, there was substantial impact on the amount of energy generated, and therefore, on the tariff. The projects actually did not generate much energy in the lean season. The plant load factor showed that even in the unrestricted scenario (e-flow of 10% or less) there was no water to make energy in the lean season.

Ancillary Benefits and Gains

A Markandya and Murthy maintain that the various schemes under the GAP improved the physico-chemical quality of the river and had positive effects on its biota. The GAP did not have an ecological restoration component; nevertheless, the improvement in water quality probably resulted in the return of biota. GAP has facilitated the collection of information on species and their habitat, which may contribute to their conservation.

An integral part of the earlier planning of the sewage treatment works had been self-sufficiency from resource recovery by the sale of treated effluent as irrigation water for agriculture, sale of dried sludge as manure, and generation of electricity from biogas production in the plant. The generation of bioelectricity was expected to be sufficient to offset much of the cost of the energy inputs required. It was realised in due course that these assumptions were only partly true. Each sewage treatment plant was presumed to function as a resource recycling unit producing energy, manure, and poultry feed fish and irrigant. An improved physico-chemical quality of the river could also enable increased yields for farmers, fishermen and labourers.

The agricultural benefits of GAP are noticed to come in three forms: (i) benefits arising from the partially treated water released to farms in the area; (ii) benefit accruing from the fertiliser value of the irrigation water; and (iii) benefits of the use of sludge from STPs. The sludge generated in the process of treating wastewater in STPs has been found to have fertiliser potential. The cleaning-up of the Ganga also provides multiple benefits, user benefits, in the form of recreation and health, escalation in land value and economic activities triggered by a general upliftment of the environment consequent upon cleaning of the river. A well-planned river front can be an important amenity for the residents, while increased land values could generate opportunities for investment in mixed use development that attracts more investments.

A cleaner Ganga provides benefits to the rich as well as the poor. The increased fish supply from clean Ganga can increase the income of fishermen. Beneficiaries like farmers, fishermen, most residents close to the river, and skilled and unskilled labourers belonging to lower income groups share a significant part of incremental incomes arising out of GAP. Besides aquatic mega fauna, there are many wild plants and animals along its banks which have economic value and commercial use. It has even been suggested that the cost of cleaning-up of the Ganga be borne by the households and industries in the Gangetic basin in terms of the polluter pays principle. Pollution taxes on households and industries can raise revenue for financing the GAP projects. A number of different mechanisms are suggested: a polluter pays principle; a user pays principle, in addition to funding under the general tax system.

International Experience

Examples of important rivers such as Potomac, Thames, Seine, Rhine, Danube, St Lawrence show how the riverfront development can be a catalyst for tourism, sports, cruises, and entertainment. Experts cite some of the somewhat comparable programmes worldwide, matching the scale of the challenge to clean-up the Ganga—especially the Thames, the Rhine and the Danube.

The Thames provides a sink for approximately one-third of the sewage of Great Britain. The first "crisis" over the quality of water in the Thames arose as the result of its impact on human health through an increase in cholera outbreaks. During the period 1815–50, the quantity of raw sewage entering the river continued to grow in volume, especially resulting from the growing popularity of water closets, the installation of which was made mandatory for all new houses after 1850.

As late as the 1950s, the Thames flowing through London was an open sewer. The polluted state of the river reached its peak in 1858, the Year of the Great Stink, when the House of Commons was forced to abandon its sittings, to escape its malodorous presence; disinfectant-soaked sheets were hung in the windows of the Houses of Parliament to reduce the smell. By mid-1970s, the river was restored to its pristine glory, after the clean-up campaign that began in 1964. Many of the lessons

learnt from the Thames have been applied to the Ganga problem through direct involvement of Thames Water International. Of course, the Ganga project is far bigger in terms of scope and complexity.

The River Rhine runs 1,320 km from its headwaters in the Swiss Alps, through Lake Constance, the Black Forest, and through Germany, France, and the Netherlands before discharging into the North Sea. The catchment area of the river covers almost 2,00,000 sq km and has a population of over 50 million people, including most of Switzerland, the south-western provinces of Germany, the north-eastern corner of France, all of Luxembourg, and most of the Netherlands. The major programmes for its clean-up started in 1950. In 1987, the Rhine Action Programme was initiated with targets to be met by 2000. On 1 November 1986, a fire at the Sandoz chemical factory at Schweizerhalle, near Basel, resulted in the release of extremely toxic pesticides and mercury compounds into the river, killing thousands of fish and freshwater invertebrates. The public outcry which led to renewed international activity culminated into the Rhine Action Programme.

The Danube is also an international river, 2,857 km long (longer than the Ganga), and serving 11 countries. With a floodplain that covers 17,737 sq km and a total drainage area of about 8,17,000 sq km (79% of the total area of central Europe), the Danube basin is home to 86 million people, 12% of all Europeans. Pollution from the river was a cause of serious problems with fisheries in the Black Sea. Concerted action to control pollution in the Danube basin was started in 1985; progress was limited until recent years.

All these purification projects have a long history. The Thames investments amounted to over £100 million, in the period 1950–80; the Rhine programme was even larger; for a river 1,320 km long, the expenditure was around DM 100 billion between 1965 and 1989.

River clean-up requires sustained investments over a long time. The clean-up of the Rhine required investments of more than €40 billion for the construction of municipal and industrial waste water treatment plants alone during the years 1970–90. The Singapore river clean-up, though in no way comparable to the Ganga project, holds a lesson in cleaning a river with extensive economic activities along the riverfront. The ex prime minister of Singapore, Lee Kuan Yew, gave the Public Utilities Board 10 years to complete the project and demanded monthly progress reports that were carefully reviewed. The project was completed within time, and well within budget.

New Approach Required

As an important sociocultural-economic project, cleaning up the rivers requires to be freed from the familiar ineptitude of bureaucracy, and instead, executed innovatively as a public–private partnership (PPP) entrepreneurial activity, also enlisting enthusiastic participation of civil society—youth, women and children, educational institutions and religious/cultural groups. Instead of following a top-down approach as hitherto, an attempt must be made to elicit the beneficiary enthusiasm and aspirations, encouraging participatory processes with stakeholder engagement in the planning and implementation of the schemes.

Acknowledging that the Ganga clean-up is, in fact, a herculean task, Maitreyee Mukherjee and Asit Biswas (2014) emphasise a major share of investments envisaged in the waste water sector. While government provided for an amount of ₹2,037 crore for the Ganga project in its interim budget 2014–15, an outlay of ₹20,000 crore (including ₹8,000 crore for sewage treatment infrastructure, ₹1,000 crore on industrial pollution, ₹500 crore for R&D, ₹400 crore for Ganga Task Force, ₹250 crore for riverfront management, ₹150 crore on biodiversity conservation, ₹128 crore on awareness creation, ₹100 crore on Aviral Ganga, ₹50 crore on solid waste management) was approved by the union cabinet in May 2015 for the Namami Gange Project.

Smaller units such as tanneries in Kanpur would be assisted with soft loans to set up their common effluent treatment plants. These units have little capacity to pretreat waste water prior to discharge into the common effluent treatment plants. Many of the industries that discharge noxious chemical pollutants into the river are small scale, which find technologies for treatment to be unaffordable.

For cleaning of the ghats and surface pollution, it is proposed to deploy hi-tech systems such as trash skimmer machines, aerators, river surface cleaning boats and arresting booms in eight towns, to begin with, namely, Allahabad, Haridwar, Kanpur, Mathura–Vrindavan, Nabadwip, Patna, Sahibganj and Varanasi. An India-specific geographic information system tool, backed by the Indian Space Research Organisation, has been envisaged for ensuring real-time public monitoring of ground situations.

Not an Impossible Task

The Maha Kumbh in Allahabad draws over 100 million people to the city of the confluence of the Ganga and Yamuna over a two-month period. At the 2013 Kumbh, the central and state governments acted in concert; their efforts to combat pollution had an impact:

(i) More water was allowed to flow in the river. The UP government mandated the irrigation department to release 2,500 ft^3 per second (cusec) or 71 m^3 per second (cumec) during January–February to ensure adequate depth and dilution of expected pollution loads at the bathing site. Additionally, the state irrigation department released 11.3 cumec, over and above the minimum stipulated flow, two days prior and one day after each of the six *shahi snan* days.

(ii) Allahabad broke convention in intercepting sewage from open drains to convey to treatment plants. The city tried experimenting with innovative ways of treating sewage—by using bioremediation technique.

(iii) 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 Kanpur, which failed to meet the discharge norms, to shut down. During the Kumbh, a complete closure of all tanneries in the city was ordered.

Akin to Swachh Bharat Abhiyan, Ganga-cleaning must perforce be a people's movement. Ex-prime minister Rajiv Gandhi clearly realised that Ganga cannot be cleaned "by the government alone"; he hoped, "the entire public of India will take part" and the programme "will become like a revolution for the masses…" Strangely, the mainstream national political parties have hitherto been purblind to its immense potential for political dividend. If any party were to adopt clean-Ganga as a firm commitment with a credible road map and unwavering implementation, its victory at the hustings would well be assured.

The project nirmal, aviral Ganga must be a national programme of action. A blitzkrieg through media and curriculum should generate awareness among the people. The $1 billion World Bank-financed project is expected to support India in the development of the NGRBA programme over eight years through a specific investment loan (SIL), blending $180 million of IDA and $820 million of IBRD resources. This constitutes 64% of the total project cost of $1,556 million, with a counterpart funding, including $437 million from the state governments and $119 million from the central government. The project will have two components relating to institutional development and priority infrastructure investments, a sub-component financing a dedicated communications and public outreach programme undertaken in partnership with different stakeholders, including affected communities, elected representatives, school and college student groups, and the media.

The ₹20,000 crore outlay for the Namami Gange project includes an integral element specially focused on "strengthening public participation" and improved centre–state coordination. The Ganga Volunteer Corps will be a part of it for channellising public volunteer services for cleaning of ghats and generating awareness. The Nirmal Ganga Bhagidari project will steer non-governmental organisations (NGOs) involved in Ganga cleaning.

The special space the Ganga occupies in the cultural and religious psyche of people in India provides a great opportunity for tapping this reverence and harnessing it into a people's movement. The wide range of stakeholder views, concerns and sensitivities, if duly taken into account, will immensely help—such as those of religious opinion leaders, state governments and government officials, local industry, environment-focused NGOs and community-based organisations, academics and research scholars, the media, youth, local communities that depend on the river, and millions living elsewhere in India for whom the river is an iconic religious and cultural symbol. Why should not the ruling party at the centre galvanise vociferous elements such as Vishva Hindu Parishad to take up the river cleansing as a mission, besides generally improving sanitation in and around temples across the country? A senior journalist advocates the empowerment of religious groups to help cleanse the Ganga.

In a way "outsourced" to enterprising industrial houses, the project would in all likelihood assume a credible implementation road map. India Inc may individually launch ingenuous schemes not only around important locations, including for the development and management of ghats, commercial, cultural and healthy entertainment and tourist interest activities, of course, also with appropriate caution to preserve the sanctity and dignity of the river as well as the city like Varanasi and other towns such as Haridwar. Specific stretches all along the

length of the river may be assigned to a few selected among the India Inc for cleaning the Ganga and its maintenance. The waterfront developments, for example, of the ghats at Varanasi, if similarly made the responsibility of the designated corporate on commercial terms, besides what they undertake as their corporate social responsibility, the burden on the exchequer for cleaning the river would also be reduced.

Clear Accountability

It is axiomatic that there should be no ambiguity or ambivalence in regard to leadership, autonomy, accountability and professional management of the project. The ultimate onus for sustained management of the facilities and maintenance of assets such as sewerage treatment plants, solid waste management systems, riverfront development infrastructure, etc, created in terms of the project will lie with the respective cities and towns.

As long as states do not have the responsibility to build sewage treatment systems or to maintain them, they have no incentive to plan for affordable solutions or even to implement projects. There needs to be a 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 with payment for capital and operation of infrastructure.

India has facilities to treat only 18% of the 33,200 million litre of sewage generated daily in its cities, while, in fact, it treats only 13%, due to shortages of power, water and technical expertise in the sewage plants. In reality, the figures may underestimate the problem inherent in measuring the output of 700 million Indians who have no access to a toilet.

The main problems that need to be addressed in order to rid Ganga of pollution would essentially include: (i) inadequate flow of water in the river, (ii) growing quantum of untreated sewage discharged from cities along the river, and (iii) lack of enforcement against point-source pollution from industries, which discharge waste into the river. Domestic sewage is the major cause of contamination in the river. According to a 2013 CPCB report, generation is 2,723.30 mld of sewage from 50 cities located along the river, which adds up to over 85% of the river's pollution load. Again, there is a wide chasm between the generation of domestic sewage and treatment capacity along the main stretch of the river; the treatment capacity lags behind, at 1,208.80 mld.

Over half the sewage goes untreated into the river or other waterbodies. The poor performance of sewage treatment capacity is ascribed to 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 revealed that, for 51 of the 64 STPs, less than 60% of the installed capacity was utilised, and that 30% of the plants did not even commence operation.

Sewage generation is underestimated; the planned treatment capacity is much lower than needed. The estimation of sewage generation is based on the assumption that 80% of the water supplied is returned as waste water. Some recent data compiled by CPCB show that actual measured discharge of waste water into Ganga is 6,087 mld, 123% higher than the estimated discharge of waste water, implying that the real gap between treated and untreated waste is not 55%, but 80%.

Most cities along the Ganga do not have any sewage conveyance infrastructure. In case of Kanpur, Allahabad and Varanasi, for example, 70–85% of the concerned city has no working underground drainage system, as a result of which, drains are not connected to STPs. Instead, what exist are open drains, which make their way into the river.

The pollution of the Ganga is linked in large measure to the challenges of providing adequate sanitation and waste management at the local government level. "The Case Study—The Ganga, India"—compiled by Richard Helmer and Ivanildo Hespanhol reveals that 75% of the pollution load was from untreated municipal sewage. Currently, the responsibilities for provision of these services overlap considerably across the state government and local agencies. The ULBs also suffer from inadequate technical and management capacity required for effective service delivery.

Cities will ultimately be the custodians of the assets being created: sewerage networks, treatment plants, riverfront development schemes and solid waste management systems. They need to be strengthened. Cities along the Ganga are all expanding rapidly where impoverished municipal bodies are unable to set up any civic infrastructure. The Kanpur Nagar Mahapalika had to suspend all work temporarily, for lack of funds. The JNNURM supports 15 cities in the Ganga basin, for which the Government of India has allocated more than $10 billion for investment, policy reform, and capacity-building.

The centre has asked the concerned states to launch a special drive to provide for individual household toilets and community sanitation complexes in villages along the riverbanks. There are 25.82 lakh households, 8,042 schools and 10,588 anganwadis along the Ganga stretch. Of these, more than 15 lakh households, in addition to over 600 schools and 6,000 anganwadis along the banks of the Ganga in Uttarakhand, UP, Bihar and West Bengal neither have toilet facility, nor any community sanitary complex. A recent government circular enjoins upon the 1,657 gram panchayats in 253 blocks across 53 districts in the five states on the Ganga basin to make open defecation off-limits on priority. UP hosts 959 of these gram panchayats, Bihar 309, and West Bengal 224.

The country's leading institutions—Indian Institutes of Technology and Indian Institutes of Management—have in a way been involved in the Ganga project. There is already a cacophony of announcements and resolutions, not unoften incoherent; the most recent has been a "Ganga *manthan*," a national dialogue organised on 7 July 2014 by National Mission for Clean Ganga, a society under the aegis of Ministry of Environment, Forest and Climate Change and an implementation arm of the National Ganga River Basin Authority, supported by state-level Project Management Groups of the five basin states.

While some measures have been initiated towards administrative glitches to be overcome, a huge lot of work beckons the government, to get down to serious business, particularly to ruthlessly enforce notifications, rules and laws.

- To avoid diversion of funds by state governments, it has now been decided to make releases of money directly to the implementing agencies.
- To minimise slippage on account of delays in land acquisition, the state governments have been asked to process the schemes of land acquisition first before the schemes of sewage treatment plants, etc, are approved.
- The matter of continuous supply of electricity for operation of assets has also been taken up. The State Pollution Control Boards issued showcause notices to local bodies responsible for non-operation of assets in Bihar and UP under the Water (Prevention and Control of Pollution) Act, 1974. CPCB also issued notices to such local bodies under the Environment (Protection) Act 1986.

Conclusions

The successful completion of the clean-Ganga project within five years will raise country's bar world over and provide the countrymen great pride of performance. The project has a wonderful opportunity to raise popular enthusiasm and zeal. There should be public contribution solicited through reputed and reliable institutions. Indians look upon the river as *Ganga maata*. The Clean Ganga project can leverage the Swachh Bharat campaign, as the Prime Minister has envisaged, generating a new awakening across the country. But this calls for an earnest, concerted agenda of concrete action, not just platitudes.

There is a need to plan for drains that discharge into the Ganga, not as much to plan STPs; there is need to prioritise action based on drains with high pollution load, so that impact is immediate. A plan for in situ drain treatment is required as it will bring down pollution levels of discharge that is not intercepted, the open drain used for treatment of waste. There needs to be a plan for treated effluents: not to treat and put back treated waste water into open drain, where it is again mixed with untreated waste.

Similarly, there should be an emphasis on the reuse and recycling of treated effluent, for city water or agricultural use. A plan to treat waste water before it discharges into the river will help, either by intercepting the drain before discharge into treatment plant or building treatment plant on the bank of the river for the remaining waste.

Industries must be able to meet discharge standards that have been legally prescribed. In UP, records show that almost all industries inspected by the CPCB in 2013 were in breach of the standards.

There have been judicial indictments of both GAP and Yamuna Action Plan in regard to ineffectiveness of the schemes, delays in their execution, and lapses in the project formulations as well as implementation thereof. Most of it boils down to failure of governance. The Parliamentary Standing Committee on Environment and Forests advised that the Yamuna cleansing process had to "go beyond the cosmetic measures like removal of slums along the banks and greening the banks." The ministry submitted, "Pollution abatement is not a one-time effort; the demands of river cleaning keep increasing with the increase in the population and expansion of townships….."

The Varanasi city today has acquired a great importance, and has a unique opportunity for a transformational change. The Ganga at Varanasi can only be cleaned if the city is cleaned. As the case study referred to by Richard Helmer and Ivanildo Hespanhol maintains, the official 233 mld of city's sewage generation is underestimated; 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; that is, only 25% of the waste generated can be treated and 75% is discharged without treatment into the river. The quantum of discharge from the drains is still much higher and will probably increase over the period as population grows.

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