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Cleaning of the Ganga

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Abstract: Ganga, the national river of India, is now sadly depleted in flow and utterly polluted due to construction of dams and barrages, discharge of untreated municipal and industrial wastes, floral offerings, cremation of dead bodies on its bank. Kanpur to Trighat is identified as the most polluted section of the river. This critical state of the river has been revealed in the paper based on an analysis of the published accounts and research results by various institutes and individuals. It also sheds light on the strategies and action plans to rejuvenate the Ganga to its pristine quality.

Keywords: Ganga, Yamuna, Thames, Danube, Mission Clean Ganga.

INTRODUCTION

Ganga is considered sacred by people for providing the life- giving and life-sustaining succor for the environment and ecology. In reverence '*Ganga snan'* is considered as holy dip in the river to rid one of his sins committed. It is believed to be the gateway to the heavenly abode for the pious souls, its banks have been places of worship to Gods for soul searching and cleansing. Its emotional, spiritual, socio-cultural, and historical bondage with Indian civilization has given the Ganga its uniqueness.

But today, Ganga has turned into a stinking stream greatly polluted with untreated sewage, industrial effluents and wastes, or agricultural runoffs, intercepted by massive diversion of flows, and encroached upon, leaving a sluggish flow in places in lean months. Dams and barrages constructed for hydropower generation in the upper reaches and canal irrigation, combined with deforestation, mining and civil constructions in the catchments have sapped much of its ability to flow. Global warming, reportedly receding Himalayan glaciers, climate change, overexploitation of aquifers are all threatening to dry up the lean season flows.

Faced with the alarming consequences of the abuse of the river regime, studies have been carried out on revival of the Ganga to its pristine state. The following is an overview of the state of the river and an analysis of the results of the studies brought out in publications, which reveal a grave situation, and the way forward.

GANGA RIVER FLOW

The Ganga has a course of about 2525 km length, winding through the states of Uttarakhand, Uttar Pradesh, Bihar, West Bengal, and draining parts of Himachal Pradesh, Haryana, Punjab, Rajasthan and Madhya Pradesh before debouching in to the Bay of Bengal. It is one of the largest river basins of the world covering 26.3% of the country's total geographical area. It has a number of tributaries, the Yamuna being the largest of all. Its perennial flow is fed by monsoon and partially by the Himalayan glacier melt. Gifted naturally with large freshwater resources and vast fertile lands, the basin has the distinction of being one of the most populated (with a total population of 337,861,976) and intensely cultivated regions in the world, being the food basket of one crore people of the land and the chief source for drinking, irrigation and industrial needs. Therefore, it is but natural that the country is concerned with the health of the river regime, – its flow and purity of water.

If the reports of Union Ministry of Water Resources are to be believed the average annual flow of the river is 5,25,023 MCM, while the live storage capacity of barrages, completed, and under construction totals 63736.84 MCM only, and additional storages of 30617.05 MCM are under consideration, leaving a huge balance in the river flow (Source: Water and Related Statistics, Central Water Commission, 2004).

However, this is hardly a realistic picture of the Ganga and its tributaries. Reliable information regarding the flow and health of the river is practically unavailable. In response to a reference by Himansu Thakkar and others, the Delhi High Court directed the Union Ministry of Water Resources to produce a comprehensive report regarding the impacts

of Hydro Power Projects on the environment and ecology of the Ganga river being a matter of utmost public concern for life, health and well being which the Union Government has, so far, failed to comply with. In this context excerpts from a report in *Time Magazine (In: Holy water, July 19, 2010, p.18)* revealed the ground reality.

> *"Since the dam (Tehri) was completed in 2006 the natural spring that once fed Pipola has dried up. Several times a day Devi …, hoists a 2.5 gal. (10 L) brass vessel atop her head and walks to the nearest hand pump. …spends two or three hours a day, sometimes more, locked in low-intensity combat. ….. (S) several in Pipola had to give up farming for lack of water. Three months ago her (Devi's) husband left the village to work in a hotel bakery outside of New Delhi, hoping to earn enough to feed their five children. …. It's a crisis brought on by India's relentless push to modernize, as water that once sustained small towns and villages is increasingly put in service of big hydroelectric dams, big cities, and big agriculture….."*

Reportedly large hydropower projects in Uttarakhand including Tehri Dam, are critically depleting discharge of the river and its tributaries. The river flow which is already affected by climate change and catchment degradation, is also unable to fill in the dams. At Tehri the used water is recycled to maintain water storage in the dam for power generation, instead of being channelized to the main stream. In the light of this, the 'Run of the River Projects' are but myth. Downstream competitive demands of water are further sapping its flow. A massive diversion of its water by the Upper Ganga Canal Network off the head works at Hardwar reduces the flow to only 15 billion m^3 per annum at Balawali (Das Gupta, 1984). The Lower Ganga Canal is another large irrigation network, which diverts near Aligarh whatever flow is regenerated between Hardwar and Aligarh, thereby causing a critical fall of dry weather flow downstream and, thereby, downgrading its water quality. There is very little dry weather flow in the Ganga at Kannauj and Kanpur where there is a heavy discharge of pollutants in the river. River flow analysis by Central Board of Pollution Control (CPCB 2009) records the discharge of Ganga outside the peak periods of monsoon as meager as 90-386 m^3/s at Kanpur, 279-997 m^3/s at Allahabad, and 278-1160 m^3/s at Varanasi. Upstream of Varanasi Ganga flow virtually disappears at many places. At Varanasi the flow has lost depth to a mere 30m in places. The entire ecology has been degraded with the reduction or gradual disappearance of fishes, and near extinction of dolphins or other aquatic fauna in places along its course. Yamuna, the largest tributary, too, records reduction in the flow due to diversion of large volume of river water into the irrigation canals.

Groundwater

Groundwater in the states of Rajasthan, Haryana, Punjab and NCT Delhi is overexploited, sometimes reaching a stage of more than 250% of its natural recharge. Parts of Uttar Pradesh, and Uttarakhand, too, in its upper catchment are on the verge of overexploitation. This reduces inflows into the Ganga in lean seasons, its flow practically lacking from the upper catchment down to the holy city of Varanasi affecting its capacity for self-purification and aggravating pollution of the river during non-monsoon months.

POLLUTION OF THE GANGA

Charak samhita, the ancient medical treatise, characterizes Ganga water as pure, and sacred. It is the major source of drinking water, as no germ, bacteria or fungi can thrive in it. Hence Ganga water is revered as holy. The properties of the river regime primarily owe to the geology, wind, sun rays, climate and rainfall, trees and vegetation in the drainage basin. The self purifying capacity of the Ganga is derived from its unusually high ability to retain dissolved oxygen (DO) inherited from this environment. Lack of adequate 'dissolved oxygen' leads to septic condition and rise in biochemical oxygen demand (BOD) in the river. According to Markandya and Murty (*'Cleaning up the Ganges'*, Oxford University Press, 2000, p.1) 1.3 billion liters of sewage, 260 million liters of industrial waste, runoff from 6 million tonnes of fertilizers and 9000 tonnes of pesticides used in agriculture, and large quantities of solid wastes, are daily released into the river . The total annual volume of untreated household, and industrial effluents in the Ganga river basin amounts to 328.9 million kiloliters (*Ministry of Environment and Forest, Govt. of India. Statistical Review of Programs under National River Conservation Directorate, Sept. 1996*). The major water polluting industries include chemicals, textiles, pharmaceuticals, cement, electrical and electronic equipment, glass and ceramics, pulp and paper board, leather tanning, food processing, and petroleum refining. But the sewage treatment capacity is 27.8-50.4% in most of the Class I cities, and 13.5% in Class II cities. Reportedly the discharge of sewage/sullage into the Ganga is responsible for 75% of its pollution with nearly 3000 mld (million litres per day) of sewage generated in the towns along the Ganga. This quantity is too large for self-purification by the Ganga. Nearly 50% of waste waters are discharged untreated. In

Table 1. Water quality data of River Ganga and Yamuna (*Source:* Central Pollution Control Board (A-14011/1/2009-MON, dated 14-1-2010)

Location	D.O. (mg/l)			pH			Conductivity (µmhos/cm)			BOD (mg/l)			Fecal Coliform (MPN/100 mL)			Total Coliform (MPN/100 mL)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Ganga at Kanpur	1.6	9.9	5.6	7.4	8.8	8.0	67	860	479	3.8	21.0	8.3	1500	46000	16818	15000	240000	94250
Ganga at Allahabad sangam	6.5	9.7	8.0	8.1	8.4	8.3	270	758	469	3.3	5.4	4.0	1700	11000	5167	3500	17000	8875
Ganga at Varanasi	6.5	7.9	7.3	8.4	8.9	8.6	264	397	353	9.2	12.4	10.5	18000	1100007	4500	94000	220000	144833
Ganga at Dakshineshwar (Kolkata)	4.1	8.2	6.1	7.4	8.2	7.8	201	378	316	1.4	6.0	4.2	35000	850000	283333	55000	1400000	605417
Yamuna at Nizamuddin (Delhi)	0.0	4.4	0.5	7.3	8.0	7.6	410	1590	1153	2.0	55.0	25.7	170000	1990000	1064545	2300000	17900000	8918182

addition, lakhs of devotees take daily holy dips in the Ganga, the number swelling many times more during the festive seasons polluting the river further.

The quality of the Ganga river water is summarized based on crucial indices of FCC, BOD, DO in the following Table 1, vividly revealing the situation in the river from catchment to its confluence with Bay of Bengal.

Monitoring of the river water quality undertaken by CPCB clearly shows that the pure unpolluted river water at Gangotri with BOD 0.0-2.0 mg/L, DO 7.2-10.0 mg/L, 2-340 MPN/100 mL, sharply deteriorates at the pilgrim city of Haridwar with DO 6.0-9.2 mg/L, BOD 2.2-5.4 mg/l, due to disposal of sewage and half burnt dead bodies. At Kanpur, an industrial hub, the water is generally alkaline, but FCC and BOD far exceed permissible limits. Reportedly 45 tanneries, 10 textile mills and several other units discharge 37.15 million gallons per day of waste waters. Further BOD and FCC values up to 12.4 mg/L and 1100007/100 mL respectively have been reported during the period in the river at the holy city of Varanasi, much beyond the permissible limits for drinking and bathing. Pathogenic organisms in river water pose a veritable threat to the residents of the city. Downstream the Ganga turns black and septic, and ripples are foamy at many places, emitting methane bubbles, with floating unclaimed bodies of the dead, corpses of animals, half cremated remains of the babies thrown to the river to attain eternal peace, floral offerings, garlands and garbage. Even toxic metals like Hg (65-520 ppb), Pb(<10-800 ppm), Cr(<10-200 ppm) and Ni (<10-130 ppm) have been detected in the river sediments at Varanasi (Mehrotra, 1991). Markandya and Murty (2000) estimated high toxic metal levels in waste waters discharged into the Ganga at Kanpur and Varanasi as *Cd 0.05 and 0.16; Cr 6.45 and 8.12; Cu 0.88 and 0.16; Fe 8.80 and 3.32; Mn 0.55 and 0.47; Ni 0.22 and 0.14; Pb 0.19 and 0.15; Zn 1.82 and 1.58 mg/L* respectively.

At Buxar (Unnao) further downstream values of BOD, COD, and H_2S rise beyond tolerance limits. Concentrations of toxic metals like Cu, Zn, Ni and Co are high in the river sediments at Patna too. According to the study of Indian Toxicological Institute, Lucknow during 1986-1992, Hg detected in river water, sediments, benthic fauna, fish, soil and vegetables at Rishikesh, Allahabad and Kolkata (Dakshineswar), finds way to food and water (Priyadarshi, 2009). At Kolkata FCC and BOD are precariously high, while DO levels decrease. CPCB in its latest report (2009) has observed that the ambient water quality (Class 'D') between Kannauj and Trighat (border of Uttar Pradesh and Bihar) as also between Kolkata and Diamond Harbour is suitable for only wild life and fisheries, and unfit for human use. Though dissolved oxygen is sufficient, it shows a clear down trend all along the river course.

According to a World Bank Sponsored Study (State of Environment Report- U.P.) (In: Mallikarjun, 2003), pollution levels in the Ganga are contributing 9-12% of total disease burden in Uttar Pradesh (U.P.). The coliform bacteria levels are in excess of 2 lakh MPN as against the national water quality standard of 5000 (Mallikarjun, 2003). The report estimated total health damage on account of water pollution in UP to be around 6.4 million DALYS (Disability Adjusted Life Year).

Yamuna also is equally polluted, According to a report of CPCB, monitoring of the Yamuna at Nizamuddin (Delhi) showed that the lowest level of faecal coliform was 1.7 lakh per 100 ml as measured in January 2010, owing to the discharge of untreated sewage and industrial wastes through drains (Table 1).

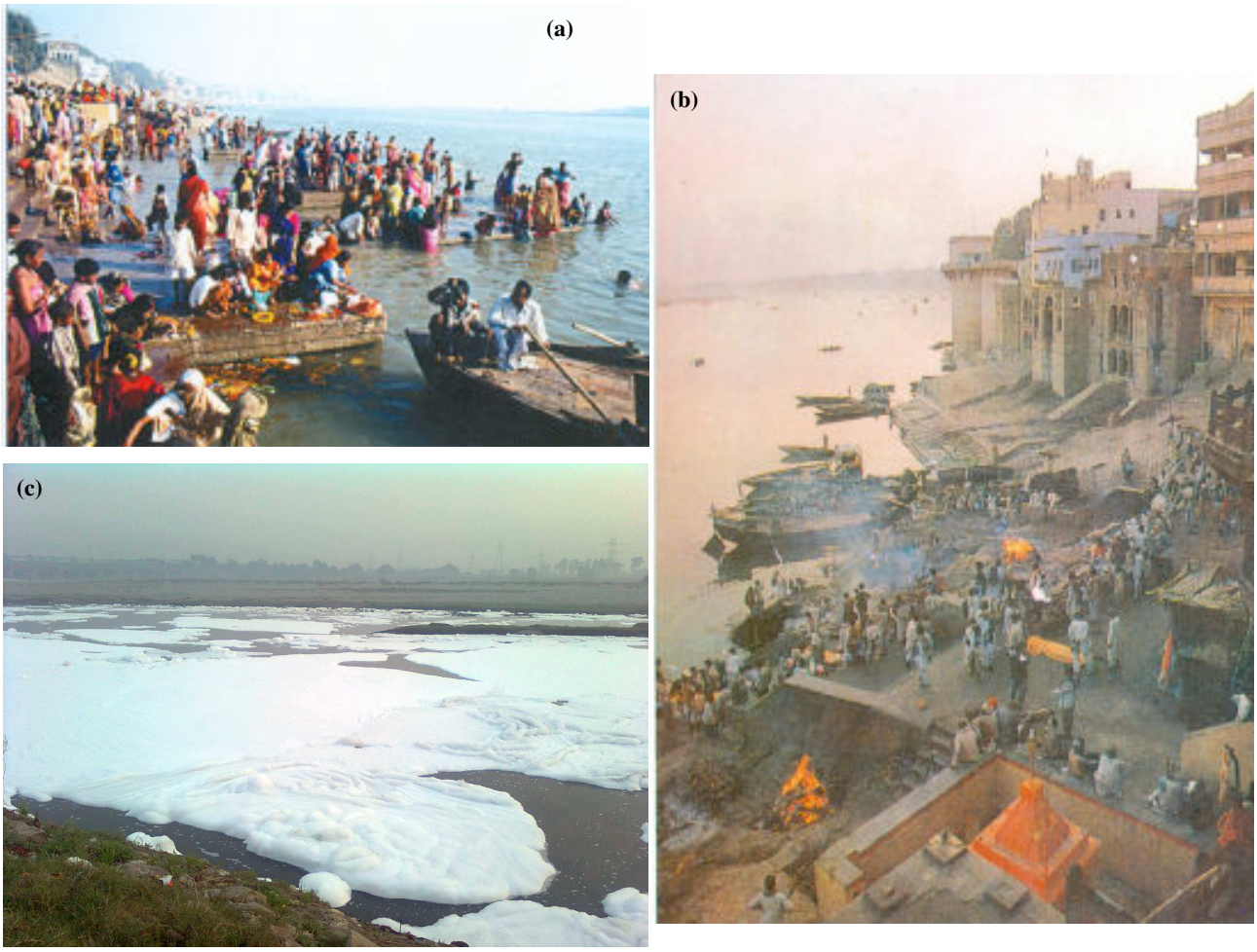


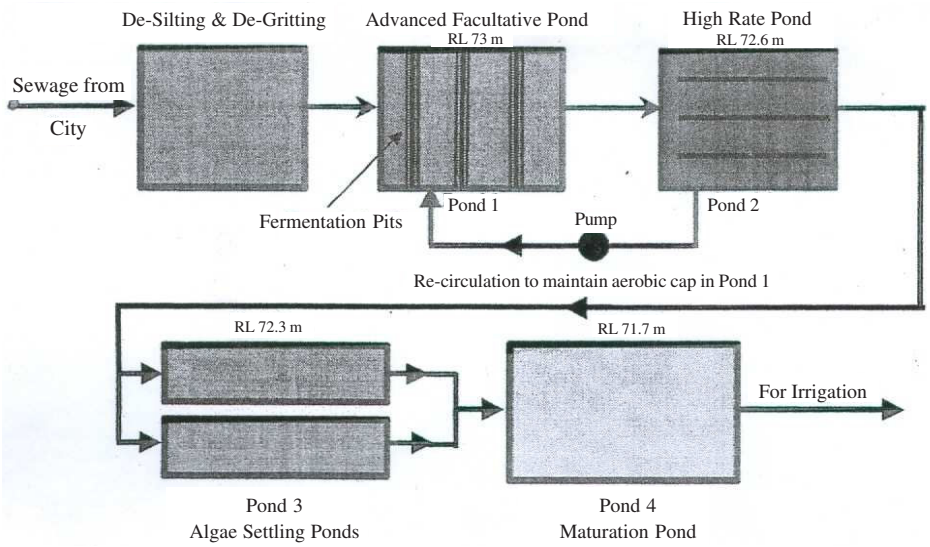
Fig.1.(a) People worshiping after ritual bathing in the river Ganga at Varanasi. **(b)** Cremation of the dead on the bank of the river Ganga at Varanasi (Manikarnika Ghat). **(c)** Yamuna river at Noida, Uttar Pradesh – Polluted and foamy (*source:* S.V. Srikantia).

INTERNATIONAL EXPERIENCE OF CLEANING RIVERS

A river's ecology and environment depends on volume of flow in different seasons, as also source, nature and quantity of pollutant load, and other related factors. Hence any plan for conservation of river needs a multilateral approach,- virtually a trade-off between harnessing its economic potential and protecting its environment (Time, July 19, 2010). In this context the clean-up program of the Thames is internationally treated as a model (Markandya and Murty 2000). Its "setting of location-specific environmental quality objectives (like minimum % of air saturation with dissolved oxygen, water to be non-toxic to fishes and other marine organisms) based on detailed scientific monitoring and modeling under the jurisdiction of one authority has become the foundation of modern aquatic pollution control"(Markandya and Murty, 2000). The river was cleaned up in 20 years time with an investment of Rs.5000 million from 1950 to 1980. The Danube, another international river, has great self purification potential like the Ganga, but is facing problems of nitrate pollution, eutrophication, microbial contamination and contamination from hazardous substances. Its on-going cleaning program starts with locating hot spots, setting water quality objectives for the tributaries and the main river Danube, wetland conservation and management programs, and selecting the programs on cost benefit basis.

CLEANING THE GANGA RIVER

In 1982 the citizens of Banaras and teachers of Banaras Hindu University started Swachha (Pure) Ganga campaign, supported by the Sankat Mochan Temple establishment with a vow to clean the Ganga, to start with at Varanasi. Sankat Mochan Foundation was a tiny organization, which vowed "to act as a catalytic agent to work with the people,



Pond	Cumulative Pollution Removal
Pond-1	BOD - 80% FCC - 1 Log Total methane fermentation of organic matter leaving no sludge
Pond-2	BOD - 85% FCC - 2 Log Nutrients & inorganic matter is assimilated by micro algae
Pond-3	BOD - 90% FCC - 3 Log
Pond-4	BOD - 95 to 99% FCC - 4 to 5 Log

Fig.2. Schematic representation of AIWPS facility process (*source:* Current Science, v.80, No.5, September 2005, p.762).

to spread the message of 'clean Ganga' and the need for everybody's participation and assistance to achieve the objective" (Mishra, 2005). The campaign proved to be very effective.

Ganga Action Plans and their Aftermath

Rajeev Gandhi's Ganga Action Plan in the eighties was an outcome of this intense desire to cleanse the Ganga, initially launched in Varanasi and some other cities. It was aimed at stoppage of sewage disposal in to the river by renovation of sewage pumping and treatment plants, and existing sewerage system, as also installation of new sewage treatment plants (STP), extending the existing sewerage systems to the unsewered systems in parts of the cities, prevention of throwing dead bodies into the river, and regulated use of pesticides and insecticides for agriculture. Trunk sewers parallel to the river were already laid for interception of sewage, leading it to the sewage treatment plants. The effluents from the sewage treatment plants could be treated as rich source of energy (say biogas) and manorial matter.

But sadly, Ganga Action Plan Phases I and II met with only partial success due to various factors, the failure on part of the government to involve people being cited as a major one. The sewage pumps did not work in the flood season and during power failures, often for prolonged' periods, resulting in total sewage of the city draining into the river. The treated effluents from STP caused health hazards, ruined crops and polluted groundwater.

Following this, various alternatives were proposed from several quarters, but the one from Sankat Mochan Foundation accepted by Varanasi Nagar Nigam (Mishra, 2005) which provides for people's participation in the operation, interception and diversion of sewage flowing into the Ganga without using electricity and pumps, treatment plants using minimum electrical power and a technology eliminating faecal coliform and harmful bacteria, using existing facilities. The cleaning operation involves Advanced Integrated Wastewater Oxidation Pond System AIWPS) which allows fermentation in anaerobic condition leaving no residue, release of maximum free molecular oxygen in dissolved state, algal removal, which have fertilizing value, and also disinfection of the residues. Figure 2 presents a flow chart of AIWPS.

It has now been realized that decentralized system is cheap, efficient and self regulating. Domestic waters contain biodegradable elements. Separation of black water (faecal matter) and grey water (remaining waste water) is possible by using two-pipe system. Primary treatment is feasible at plot-holding level. Treated and semi-treated waters may be recycled and reused. Existing STPs can provide additional treatment to water outflows. Use of chemicals and energy is minimal. STPs can provide secondary and tertiary treatment for the water to be recycled. Citizens and NGOs share responsibility.

GANGA – OUR NATIONAL RIVER

In recognition of this problem as of national dimension, the river Ganga was declared as National River by the Prime Minister in 2008 with the constitution of Ganga River Basin Regulatory Authority. It is a solemn pledge to ensure its perennial flow in all its natural quality, quantity and natural piety. It introduces a code of conduct and self discipline for

the citizens towards this national symbol. It aspires for maximum involvement and participation of the people or stake holders, and innovative strategies for its restoration. This has been enshrined in the profile of actions as envisaged in the Government Notification (February 2009) including a river basin approach for conservation, guaranteeing minimum ecological flows, practice of water conservation and constitution of state river conservation authorities, social auditing of river basin management plans.

The Ganga River Basin Authority has launched an ambitious project '*Mission Clean Ganga'* with proposal for a massive investment of 15,000 Crores of rupees for its revival and purification including installation of Purification Plants, by the targeted year of 2020 (*The Hindu*, October 6, 2009). In 10 years no municipal waste water will be discharged into the Ganga. No new project that endanger the ecosystem will be approved by his Ministry.

EPILOGUE

A river belongs to an entire ecosystem, which needs to be protected for the humanity. The Government and the civil society have specific roles in the management of the river. Development and environmental protection cannot be done without combining faith, spiritual approach and science. Decentralisation of the functioning of the river basin authority is a primary step. To meet this end the regulatory authority should include representatives of scientists, local residents, environmentalists, saints, priests, pilgrims, in addition to government. Premier scientific, academic and technical bodies or institutes like Geological Society of India, Geological Survey of India, Central Water Commission, Central Ground Water Board, Departments of Environment and Forest, Pollution Control Board, National Law School, Medical Council of India, Banaras Hindu University, Indian Institute of Technology (Roorkee) should be suitably associated with the authority. A civil society has to keep in mind the long term interest of the mankind, the purity of water and soil, the health of the rivers and water bodies, and survival of its biodiversity. Rivers are repositories of our common future.

Globalisation is leading to private profit making interests taking over river and its management. The people or the stake holders, should now come together to raise the voice of conscience, infuse life to the dying regime and mother earth. Thus the much needed course of actions involves a multilateral approach which needs constitution of an autonomous central authority, established by law and armed with executive and financial powers, which will be responsible to execute the following policies to control Environmental Problems.

1. Monitoring and control, assisted by research and analysis on protection and conservation of river.
2. Preparing and executing river basin management plan.

To achieve these avowed objectives, the following strategic action programs should be initiated drawing from the lessons of cleaning Thames and Danube.

1. Collecting data. Establishing national and regional data bases and information systems. Identification of 'hot spots' of pollution.
2. Based on monitoring data and water quality modeling, pollution budget may be drawn to estimate the maximum pollutant load compatible with quality objectives to be achieved in these identified sections.
3. Drawing up restoration programs in the form of action modules. Conducting feasibility studies.
4. Implementation of the plans through State River Conservation Authorities under its direct control.
5. Providing technical assistance to participating states in implementation of restoration programs. Training cum capacity building of States and NGO's.

Action plans should be phased as short term and long term to achieve the following goals:

1. Phased enhancement of municipal waste water treatment capacity. Construction of waste treatment plants.
2. Reduction in effluent discharges from industries and agriculture.
3. Wetland inventory. Conservation, restoration and management of wetland, and flood plain areas through integrated water management'.
4. Adoption of sustainable agricultural practices, using organic fertilizers only..
5. Adoption and implementation of water quality objectives set for different sections of rivers.
6. Prohibition of discharge of untreated sewage and defecation in the river, throwing dead bodies and cremation articles into the river, and use of plastic bags.
7. Practice of a new set of rituals and Ganga worship without excessive use of flowers, leaves, harmful to the aquatic life;
8. All real estate activities or construction or other related developmental activities around Ganga must have permission from the Authority to accord maximum protection against damage and pollution to the riverine regime.

The Authority should have a Management Board drawing

a number of Members from stake holders, including the public representatives and priests, NGOs, all related scientific and technical institutions or organizations, both government and non government, engaged in management and research on conservation and protection of river regime. It should draw state wise plans in consultation with the members. It will operate through State River Conservation Authorities, which will come under its complete control. It will also introduce a system of social auditing and ensure transparent actions.

The story of the Ganga is no different from most other rivers and water bodies of the country. Time has come for the United Nations to declare all water bodies as our priceless heritage and make them out of bounds from the greedy polluters and exploiters. An example is Lake Ural of erstwhile USSR, tapped to irrigate the parched northern plains, and lost to humanity for good.

The society should strive to unite man's consciousness with the River to reinstate Ganga in its pristine natural glory. Declaration of Ganga as National River was a defining moment in nation's history, - our tryst with destiny.

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