Status of Tannery Effluent in Ganga River basin

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Abstract

The holy river Ganga passing through five states, is one of the most polluted rivers. Over exploitation and abstraction of water for various purposes coupled with direct discharge of untreated wastewater has completely deteriorated the quality of water. In comparison to other pollutants, industrial effluents are the most dangerous threat to the natural ecosystem of the Holy river. The paper focuses on Tannery industry which is categorized as red-category industry.These tanneries no longer use environment-friendly vegetable dyes for tanning leather they instead use highly toxic chromium which is discharged directly into the river untreated. The paper has also tried to explain the effects of the pollutants on the environment and the natural ecosystem of the river and suggested to adopt some innovative measures like generation of biogas from the waste, adopting phyto-remediation technology and development of integrated plan for waste water disposal and treatment.

Key words: River Ganga, Abstraction, pollution, tannery, industrial effluents, chromium, biogas, phyto-remediation, integrated plan,

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Introduction

River Ganga has been declared as one of the most polluted River in the world in 'Bonn Declaration on Global Water Security', during an international meeting on water issues held at Bonn. It is stated that each year it carries 16,000 tons of ash from cremated bodies along with a mixture of sewage and toxic chemicals (Basu,2014) . 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.

In the Ganga basin states of Uttar Pradesh, Uttarakhand and West Bengal the major categories industries operating are:

- Chemicals: which mainly include fertilizer, petro-chemical, pesticides and pharmaceuticals
- Distillery
- Dairy, Food & Beverage
- Pulp and Paper
- Sugar
- Tannery
- Textile, Bleaching & Dyeing
- Others (Cement, Slaughter house, Ordinance, Packaging & printing, Paint, Electronics& Electrical, Thermal, Kattha –kachh, Electroplating, Metallurgical, automobile etc.

It is observed from the figure-1 that out of the total number of industries, the tanneries are dominant industries (58%) followed by sugar, pulp & paper, food and beverages (9% each), textile dyeing and bleach (8%). Chemical industries are the least to follow. The tanneries shown in the above figure are mostly located in the state of Uttar Pradesh. Figure 2 clearly reflects that the maximum number of the industries is housed in the state of Uttar Pradesh out of which tanneries are leading amounting to some 442 units.

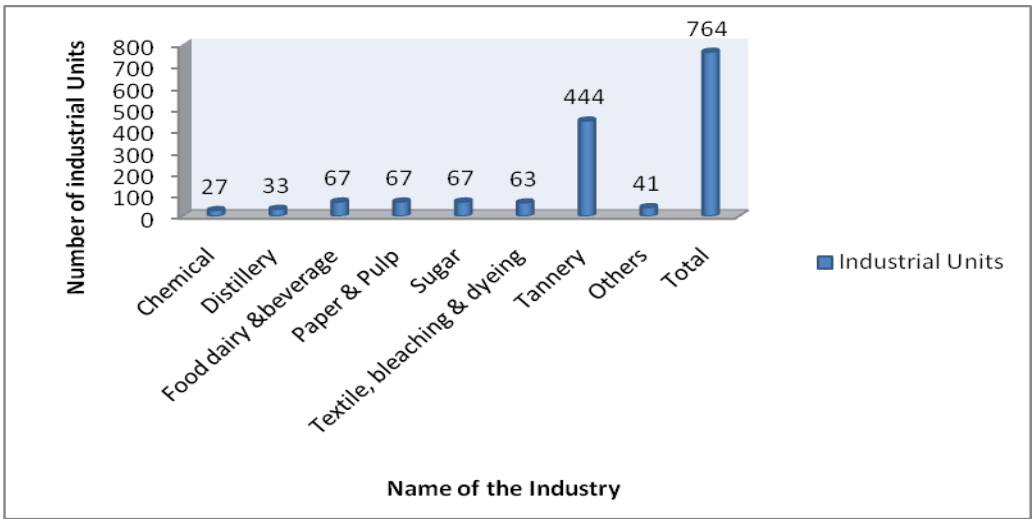

Figure 1: Sector wise distribution of industrial units in the Ganga basin states of Uttarakhand, U.P, West Bengal and Bihar

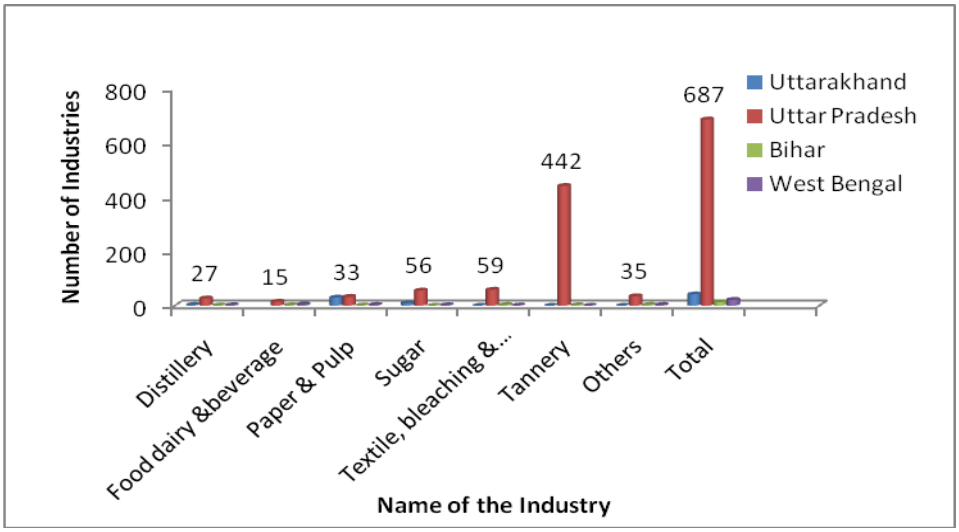

Figure 2: Number of industries located in the Ganga basin states of Uttarakhand, Uttar Pradesh, Bihar and West Bengal

Scenario of Water consumption Vs Waste water generation by the industries located along the Ganga basin states

In 1985 , CPCB had identified 68 grossly polluting industries (GPIs) located on the banks of Ganga and responsible for about 80% of the total industrial pollution but now the scenario has changed completely as per the latest report of CPCB (2013) there are 764 grossly polluting industries discharging wastewater

to main stem of River Ganga (either directly or through drains) and its two important tributaries Kali-east and Ramganga. This trend is reflected in Figure 3

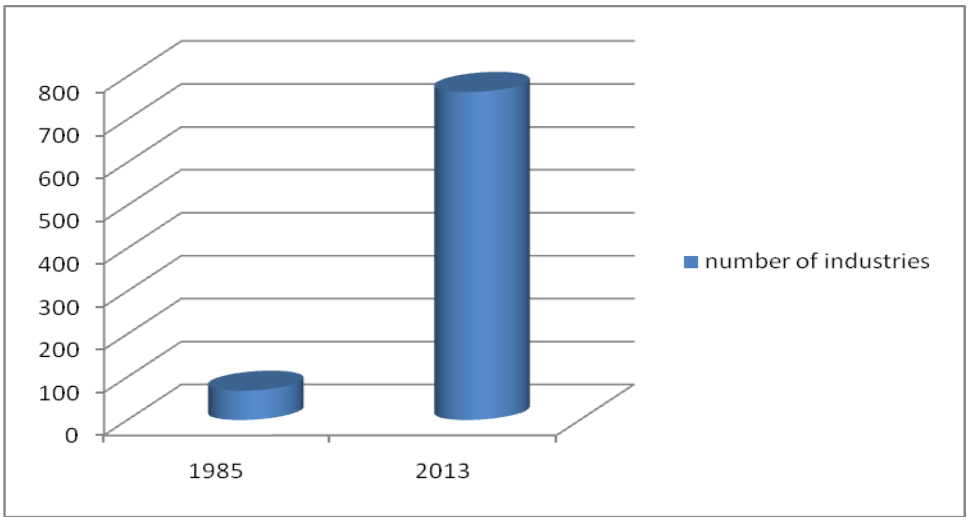

Figure 3: Trend of the establishment of industries along the Ganga river Banks

It was observed that water consumed by grossly polluting industries is 1123 MLD out of which 501 MLD waste water is generated. Table 1 show details of the waste water consumed and generated by these industries. The Table 1 clearly reflects the fact that the maximum waste water is consumed and generated by the Paper and Pulp industry, albeit tanneries are the highest in number but the wastewater generation is comparatively less. Though less in quanta the problem resides with concentrated stretches with no dilution and assimilative capacity leading to high toxicity, caused due to high chemical load (CPCB, 2013).

Table 1: Status of sector specific industrial waste consumption and waste water generation

Name of the industry	**Industrial Units**	**Water Consumption (MLD)**	**Waste water generation (MLD)**	**% of waste water Consumed by waste water Generated**
Chemical	27	210.9 (19%)	97.8(20%)	46.4
Distillery	33	78.8 (7%)	37(7%)	47
Food dairy &beverage	67	11.2 (1%)	6.5((1%)	58
Paper & Pulp	67	306.3 (27%)	201.4(40%)	65.8
Sugar	67	304.8 (27%)	96(19%)	31.5
Textile, bleaching & dyeing	63	14.1 (1%)	11.4(2%)	80.9
Tannery	444	28.7 (3%)	22.1 (5%)	77
Others	41	168.3(15%)	28.6(6%)	17
Total	764	1123	501	45

Source : CPCB, 2013

The state wise scenario waste water generated by the Grossly Polluted Industries (GPI) as reflected in Table 2 clearly shows that Uttar Pradesh is the state which dominates with respect to water consumption being 62 % of total water consumed and surmounting to a 54% of total wastewater generated, this is then followed by Uttarakhand. It is also observed that GPI in Bihar generate minimum wastewater (19%) in terms of water consumed whereas GPI in West Bengal generate maximum wastewater 75.5% in terms of water consumed this is followed by Uttarakhand (56.7%) and Uttar Pradesh (39%). In the riverine system Ramganga carries maximum industrial wastewater followed by main stream of river Ganga and Kali-East (CPCB,2013).

Table 2: State-wise water consumption and generation (MLDs)

State	Number of Industry	Water consumption (MLD)	Waste water generation (MLD)	% of waste water Consumed by waste water Generated
Uttarakhand	42	224 (20%)	127 (25.35%)	56.70
Uttar Pradesh	687	693 (62%)	269 (54%)	38.82
Bihar	13	91 (8.1%)	17 (3.4%)	18.68
West Bengal	22	116 (10.3 %)	87 (17.37%)	75.00
TOTAL	764	1123	501	44.61

***Data for the state of Jharkhand is not available**

Source : CPCB, 2013

As per the CPCB report 2013 waste water generation by the grossly polluting industries is approximately 45% of the water consumed by these industries. The tanneries generate about 77% of the water with respect to the level of consumption. The maximum percentage of waste water is generated by the textile and bleaching industries in comparison the water consumed which is clearly shown in Figure 4

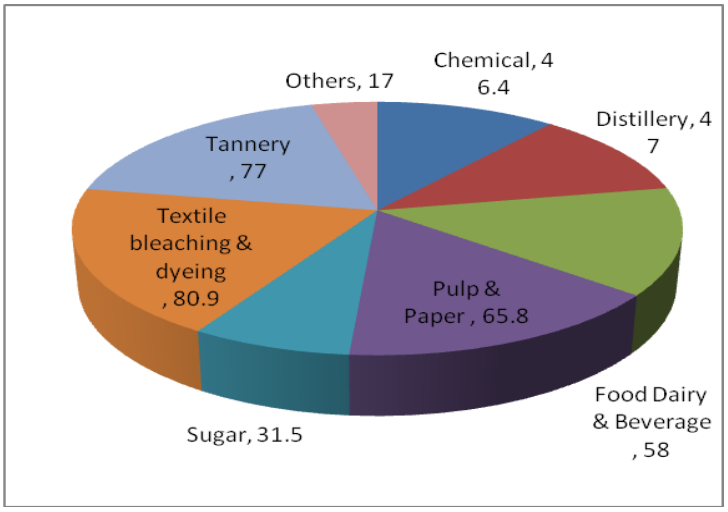

Figure 4: Percentage of sector specific waste water generation w.r.t consumption in the five Ganga basin states.

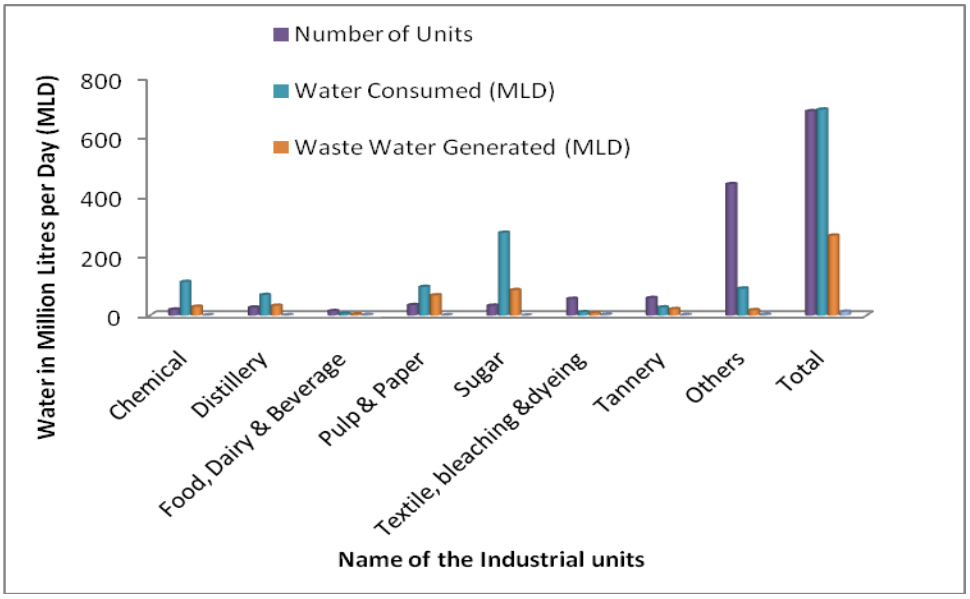

Figure 5: Scenario of water consumed and generated in the state of Uttar Pradesh

In Uttar Pradesh there are 687 grossly polluting industries that pollute the Ganga out of which 442 are tanneries which contribute 8 per cent of the wastewater as reflected in Figure 5 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 (CSE, 2014). The rest were non-compliant in terms of the laws of the country.

Tanneries of Uttar Pradesh

The tannery industry mushrooming in North India has converted the Ganga River into a dumping ground. The tanning industry discharges different types of waste into the environment, primarily in the form of liquid effluents containing organic matters chromium, sulphide ammonium and other salts. As per an estimate, about 80-90% of the tanneries use chromium as a tanning agent. Of this, the hides take up only 50-70%, while the rest is discharged as effluent. Pollution becomes acute when tanneries are concentrated in clusters in small area like Kanpur (Beg and Ali, 2008). The major cluster of tanneries at Kanpur is located at Jajmau. Adjoining to Kanpur the town of Unnao also has some tanneries. Jajmau is an industrial area in the southern part of Kanpur (Khwaja et al.,2001).

Under the GAP phase I which was implemented in Kanpur in 1985 a conveyance system was built in which Intermediate Pumping Stations (IPS) were used to collect and carry tannery effluent to the CETP. Despite of four intermediate pumping stations established along the Ganga for intercepting and diverting the waste to the main pumping station, over 60 per cent of Kanpur's 360 million litres per day (MLD) sewage and 9 MLD effluents were dumped into the river. Problems like lack of electricity, lack of proper controls, insufficient fund transfer to CETP have made the infrastructure set up under GAPs first phase dysfunctional which has resulted in discharge of sewage and effluents rich in hexavalent chromium, a known carcinogen, directly into the river without being treated (Gupta et al. 2007).

Effects of the waste generated through the Tanneries

Tannery generate a lot of waste during the process of fleshing, chrome shaving, chrome splits and buffing dust, skin and hair trimming. It is estimated that 1000kg of hide generates approximately 850 kg solid waste (Dandira and Madanhire, 2013). It has been reported that only about 20% of the large number of chemicals used in the tanning process is absorbed by leather and the rest is released as waste. The maximum concentration of these waste material absorbed by bioaccumulation process is in cultivated crops irrigated by tannery effluent (UNIDO, 2005; Sahu et.al, 2008). Tannery effluents are one of the most hazardous pollutants of industries.

A study of India's tanning industry, carried out on behalf of the Union ministry of science and technology; found that the chemical consumption in Indian tanneries is about 25 to 30 per cent higher than international norms. So a tannery that needs only 100 tonnes of colour ends up using 130 tonnes (Down to Earth, 2005). The extra 30 tonnes goes out as waste and contaminates the soil and the water around the tannery. The inherent nature of the tanning process is such, that large quantities of water are consumed. Attributed to this factor this industry is chiefly located near river banks of UP, Bihar and West Bengal. The tanning industry wastes have been extensively examined for their environmental impact, consequently they are branded as one of the worst anthropogenic polluters (Eye and Lawrence, 1971). Davis et al.(1994) have shown that the reducing environment created due to these wastes can result in the precipitation of amorphous iron sulphide leading to an increased Cr (III) mobility in the atmosphere.

The major threats caused by effluent discharged by the tanneries are summarized below:

Threat to the aquatic flora and fauna

The wastewater generated through the tanneries is a serious threat to the environment since tanneries are disposing of their wastewater into drains, which finally find its way into natural water(Chandak, 1999). A study conducted by Dandira and Madanhire has revealed that pH of directly discharged tannery effluent varies between 3.5 to 13.5. Water with a low pH is corrosive to water-carrying systems and can lead to metal dissolving in the water whereas high pH water can cause scaling in the sewers; this large fluctuation in the pH value is detrimental for the survival of some aquatic species. Besides the large quantities of proteins and their degrading products discharged through the wastewater can increase the Biochemical Oxygen Demand (BOD) from 10-190 times which in extreme cases can kill natural life in the affected area. The study conducted by Dandira and Madanhirein 2013 has also revealed that the Chemical Oxygen Demand (COD) value in wastewater discharged through the tanneries are in the range of 1000-43000 mg/liter which is 25-275 times more than the standard. Suspended solids discharged in the wastewater forms a layer on the bottom of watercourse and covers natural fauna on which aquatic life depends which can lead to localized depletion of oxygen supplies in the bottom waters. Suspended solids also reduce light penetration and thus photosynthesis in the water is reduced (Dandira and Madanhire, 2013).

The salt and hydrogen sulphate present in tannery effluent may adversely affect stream quality and cause bad taste and odour. The effluent from vegetable tannery is highly colored and when discharged into stream, the colour may persist for a very long period, whereas chrome tannery effluents are highly toxic to fish and other aquatic life (Tripathi et al.1998).

Effect in the food chain

Poultry feed manufacturers collect suspended solids of the tanneries containing sulphate and natural salts from tanneries and use it as poultry feed. These wastes contain chrome in the range of 14-26 gm/kg. Though the chromium in the waste is in trivalent form which is less toxic than hexavalent form but during feed preparation the transition of trivalent chromium to hexavalent chromium takes place which poses a serious threat to human health (Dandira and Madanhire, 2013).

Discharge of Chromium

One of the major emerging environmental problems in the tanning industry is the disposal of chromium contaminated sludge produced as a by-product of wastewater treatment(Khwaja,1999).Though chromium and other chemicals are recovered but technically and economically it is not possible to recover all the chromium or other heavy metals present in the effluent as a result of which some amount of chromium remains and becomes responsible for possible adverse impacts on the environment(Ingle et al. 2011).

Existing measures to combat pollution through Tanneries

The Indian government under the Ganga Action Plan (GAP) has implemented several schemes for the abatement of pollution of Ganga by tanneries but there are violations of the pollution control measures, and tannery effluents are still found in the river. Government of India has numerous laws in place that affect the leather industry. Tanneries in India are required to comply with the regulations of the Central Pollution Control Board and concerned State Pollution Control Boards. In 1996, the Supreme Court of India ordered the closure of all tanneries that had not set up pollution control systems. Using government subsidies, the tanneries have built numerous Common Effluent Treatment Plants (CETPs) and Effluent Treatment Plants (ETPs) to treat the toxic wastewater from tanneries. Despite this initiative, many of the pollution problems are still unresolved (Beg and Ali, 2008).

Adopting innovative Technology to combat Tannery pollution

Several innovative technologies have been adopted globally to combat pollution generated through the tanneries some of them can readily be adopted for reducing the tannery pollution

Generating Biogas from Tannery Wastes

Anaerobic digestion (or biomethanation) systems are mature and proven processes that have the potential to convert tannery wastes into odourless, pollution free biogas along with stabilized residue for use as low grade fertilizer. This method degrades a substantial part of the organic matter contained in the sludge and tannery solid wastes, generating valuable biogas. The digested solid waste is biologically stabilized and can be reused in agriculture. The Biogas produced in anaerobic digesters consists of methane (50%–80%), carbon dioxide (20%–50%), and trace levels of other gases such as hydrogen, carbon monoxide, nitrogen, oxygen, and hydrogen sulfide. This Biogas can be used for producing electricity and heat, as a natural gas substitute and also a transportation fuel. This technology has been successfully used by ECCO's tannery in Netherlands (Zafar, 2015).

Use of phyto`-remediation technology for treating tannery waste

Studies conducted by various scientists have recognized the capability of microorganisms in the removal of heavy metals from industrial effluent. Nouri et al. in 2005 studied and recognized the capability of algae, fungi, and bacteria in the removal of heavy metals from industrial effluent. Fungi like *Aspergillus oryzae* was used by him for bio removal of Chromium from tannery effluent. Sen et. al in 2010 isolated fungus from soil and used it for the removal of Cr(VI) from aqueous solution using biological sources as biosorbent . These techniques are advantageous over the existing conventional physico-chemical techniques for the treatment of metal contaminated wastes and should be adopted for developing a cost effective phyto-remediation technology for treating tannery waste**.**

Re-conceptualizing treatment plants

The passage of waste must be re-conceptualized and strictly implemented at the time of planning treatment plants. Measures should be taken to treat the industrial effluents before being discharged into the Ganga river or its tributaries.

Management of the drains constructed

The drains carrying the industrial effluents of the tanneries should be controlled, monitored and mapped; the discharge of treated effluent should be carefully reconsidered and designed. The treated effluent should not be 'mixed' with the untreated waste in drains. Instead, all treated effluent should either be designed for reuse. The drain discharging water into the Ganga river and its tributaries should be properly planned and engineered. The drains carrying high load of pollution should be identified and demarcated and a separate action plan needs to be prepared for their management and monitoring. A drain-wise plan should be developed and plan for interception and pumping to sewage treatment plant should be properly designed (CSE, 2014).

Developing a separate Plan for the effluents

There should be a separate plan for the treated effluents. The wastewater should not be mixed into open drain, where it is again mixed with untreated waste. An effluent treatment plan should be prepared deliberately for utilization or disposal of treated effluent. Plan the reuse and recycling of treated effluent, either for city water use or agricultural use. Either intercept drain before discharge to treatment plant or build treatment plant on the bank of the river for the remaining waste. No untreated waste should be disposed into river.

Tighten enforcement of industrial pollution norms.

Provisions are laid in Water (Prevention and Control) Act, to punish those industries polluting the water bodies with sizable fines and jail imprisonment for 5-7 years but most of the laws, rules and regulations are being violated and unenforced. It should be made mandatory for industries 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 (CSE,2014), defaulters should be penalized strictly and licenses of such industries should be cancelled. There should be periodical monitoring and evaluation mechanism for the checking the functioning of the CETPs and ETPs . Each tanner should be charged for the cleaning on the basis of how much effluent the tannery emits. This would be possible by establishing a measuring unit at the end of each tanner‟s pipe, measuring the amount of effluent it creates before it goes in to the common conveyance system. This

would force the tanners to be more careful about their water consumption, and reduced water use could reduce the quantity of chemicals used (Gupta et al. 2007).

Conclusion

Industrial pollution into the main Ganga has been an issue of attention and focus in most of the Plans and Schemes implemented for cleaning the holy river but without much success. Though the Indian environmental regulations for the tanning industry have been implemented but the pollution load coming from the tanneries is still heavy, and it is a problem both for the people living nearby, and for the river and ground water.

There is a wide gap between the environmental regulations for the tanning industry and the environmental performance among the tanneries.

More emphasis on developing and implementing new ways for combating toxic pollution in the river needs to be given.

Pollution control and abatement technologies have to be techno-economically viable with attractive financial returns for adoption in the traditional leather sector.

The main reason for failure of the Ganga Action Plan was restriction to augmentation of wastewater treatment facilities only no efforts on water resource management, conservation or its judicious use were emphasized.

There is a need to implement an integrated water resources management plan in the entire Ganga Basin in order to achieve water quality targets, and ecological flows in the Ganga and its tributaries.

There is need for adopting more stringent measures against point-source pollution from industries like tanneries discharging toxic waste.

A strategy needs to be formulated for tanneries for better environmental performance, clear cut provisions for pollution prevention, control and mitigation should be developed.

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