



**RESEARCH ARTICLE**

**Assessment of pollution river Yamuna at Agra with reference to religious importance**

**Rajeev Sharma and K.K. Gaur**

Department of Zoology, R.B.S. College, Agra

Email: [rajeev.rbscollege@gmail.com](mailto:rajeev.rbscollege@gmail.com)

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**ABSTRACT**

*The Day by day quality restoration of any river, especially of the Yamuna at Agra, a religious and historical center in India, is a very complex and interdisciplinary endeavor. River pollution cannot be minimized merely by diverting the routes of drains carrying wastewaters and/or establishing sewage treatment plants. The required strategy for pollution control should not only be a multi-line approach but also be fool proof. The various sources of pollution in the Yamuna River and possible strategies to restore this ailing river to its pristine status are presented in this article.*

**INTRODUCTION**

The Yamuna River at Agra and the surrounding region has high religious importance. It is seriously unhealthy, and calling for a right cure. The pollution in the river Yamuna originates from domestic, industrial and agricultural activities apart from a totally mismanaged solid waste collection and disposal. Mass bathing in the river, open defecation and disposal of dead animals also add to the problem. The management for the collection and disposal of the city's waste is neither effective nor scientific. The public is equally responsible, for mainly because of ignorance, indiscipline and an unhygienic culture. The various strategies for the control of Yamuna river pollution are grouped into defensive and proactive approaches. Apart from adopting the various control strategies outlined in this paper, there is a sincere need to punish the polluters and defaulters through a system of fines with adequate bonus to the fine collectors to keep them duty bound and honest. Creation of public awareness on the suggested lines and keeping away from persons not qualified in environmental technology will also expedite the Yamuna River cleaning.

The river with its total flow length of 1376 km travels through a number of historical, religious and large cities, viz. Delhi, Fariadabad, Vrindaban, Mathura, Agra, and Allahabad where it merges into the Ganga. The river Yamuna has been acclaimed as a holy river (next to Ganga) in Indian mythology. The Yamuna originates from the Yamnотri glacier in the Lower Himalaya at an elevation of about 6380 m above sea level. Yamuna's water quality in the Himalayan segment and in the segment after confluence with the Chambal river is relatively good (Bhargava, 1983b, 1985c). 189 km downstream of Delhi, the historic city Taj Mahal, each year attracts a large number of devotees/pilgrims for taking a holy bath in the Yamuna at Brij Pradesh (Agra) during different festivals and religious occasions. River water quality at Agra stretch is therefore very important but, unfortunately, is characterized by offensive odour and unattractive look. At some points, the river water is jet black, with a thick layer of waste scum on the surface (HT, 2004d), flooding of the city's main market to a depth of about one metre, with stinking sewage, floating dead animals, high load of organic and inorganic material, significant oxygen depletion, excessive presence of pathogens and periodic mass killing of fish and other aquatic life. A religious organization in Agra, for their many demands related to the Yamuna pollution says that although crores of rupees aid from Japan, nothing has improved (HT, 2004b). A UNESCO report (HT, 2004f) by experts has sounded the alarm for the clean up of the Yamuna River as it also forms an integral part of the great monument, the Taj, which attracts millions of people to Agra. Apart from the numerous law suits under

the Water (Prevention and Control of Pollution) Act 1974, the State Pollution Control Board keeps sending warnings to the polluters but has no courage to proceed against them (HT, 2004d).

#### **WATER QUALITY STATUS AT YAMUNA AT AGRA**

Many Indian rivers (including the Yamuna) have been surveyed comprehensively, analysed and reported on for their water quality and suitability for various beneficial uses [Bhargava (1983a, 1994), CPCB (2000, 2002) and HT (2004a, d, g)]. The Yamuna at Agra presents the most unaesthetic scene apart its poor quality as summarized in from Delhi to Agra [Bhargava (1985c), Kumar (2004) and CPCB (2008)]. The water quality as expressed by Bhargava's.

#### **VISUAL OBSERVATIONS OF THE YAMUNA RIVER**

Kailash Ghat is one of the most important ghat for a holy dip and out door bathing at right bank of river Agra is less than 1 km downstream of the major sewer outfall. Yamuna and A minor sewage drain outfalls into the river directly at this ghat. The downstream of river at this ghat of high religious significance is infested with solids of all kinds. Large amounts of solids get deposited on the river banks. The river having dark grey has a transparency of only about 0.2 m. The colonies near the river banks are infested with a serious mosquito problem. Hathi ghat and are seen on the river's bank which is also used as a bathing ghat. Balkeshwar ghat (Right bank of Yamuna river) An outdoor bathing ghat where the river contains large amounts of floating matter from the municipal wastes along with huge quantities of the poly bags and the river looks blackish imparted with objectionable odor in the day time in particular.

Regular dumping of holy materials in the river apart from heaped solid wastes on the right bank of the river. Several drains out fall into the river resulting in periodic mass killing of fish due to higher pollution of river. water quality index (WQI), a number (ranging from 0 for highly/extremely polluted to 100 for absolutely unpolluted water) representing the integrated effect of the pollutional parameters relevant to a particular beneficial use, is also presented in The WQI includes the effect of weight of each variable (pollution parameter) in the sensitivity function values of the various pollution variables relevant to a particular use (Bhargava, 1985a,c). The sensitivity function of all variables for a given use would thus have equal weight. The simplified model (Bhargava, 1983c).

The WQI for bathing, swimming, etc. comes down from a low value of 35 to extremely low values touching around 6 as the river flows along the various ghats of Agra. The biochemical oxygen demand (BOD) values rise to as high values as 13 to 17 mg/L at the ghats from a 8 mg/L value when the river enters Agra. The dissolved oxygen is maintained only at about 3 to 4 mg/L at the various ghats of Agra. The water quality at Agra has been varying over the years due to some action plans which were not, however, be effective for various reasons (Bhargava, 1992, 2000). Despite expenditures running into crores of rupees, the Yamuna water quality at Agra could not manifest any improvement (HT, 2004a, b, d, e, f, g). Considering the significance of Agra as a religious and historical center for the humans, it is high time that serious efforts be undertaken towards restoring the quality of the Yamuna. Large amounts of untreated/partially treated domestic wastewater, solid waste, industrial waste, enter into the Yamuna River between Delhi and Agra. This quality degradation is further aggravated by the low flow conditions of the Yamuna. A major drain carrying the city's wastewater outfalls in the Yamuna just upstream of the series of bathing ghats (the main bathing ghat, the Hathi ghat, is only about 2 km downstream of this major drain). Apart from harmful chemicals, the ammonia concentration reaches as high as 30 times the permissible level (HT, 2004d). It had only been a remote expectation to see their Yamuna River ever meeting the basic requirements of mass bathing. As per the water quality criteria of the Central Pollution Control Board (CPCB, 2002), the water quality of the Yamuna at Agra is of class-D level (some times, even class-E). As per the biomapping water quality criteria, it belongs to class-C level (river in eutrophication stage). The dissolved oxygen (DO) level at

Agra (downstream) comes down to very low values, resulting in periodic mass killing of fish and other aquatic life. Dead floating fish were observed at least three times in Agra (HT, 2004e). The water quality of the Yamuna River in regard to total and faecal coliform is alarming in its Agra stretch. The polluted suspended materials (organic, inorganic and toxic) tend to settle (forming sludge) in the river /drain bed during the dry season. The dissolved materials, like heavy metals and pesticides, are adsorbed on the surface of these suspended materials settling in the river bed. The settled materials redistribute themselves in the river during the flood season, and these toxic substances get de-adsorbed to harm the aquatic life.

#### **SOURCES OF POLLUTION OF THE YAMUNA RIVER:**

Pollution (pollution in Latin means defilement) manifests too much of any contaminant which may render the receiving environment (air, water or land) unsuitable for its desired use (s). For a biologist, it is a change that often brings about a reduction in the diversity of species and imbalance in diversity and abundance. For a chemist, it is the presence of non-permissible or objectionable substances (solids, liquids or gasses). The environmental engineer/technologist regards it as the presence of any foreign substance which tends to degrade the environmental quality, such that a hazard is constituted or the usefulness of the environment is impaired. Therefore, when it comes to water, all pollutants are not detrimental to all uses. For example, dissolved oxygen (DO) is a parameter of highest significance for the fish culturist but not so for an agriculturist. Likewise, temperature of water has great relevance for industrial cooling but not for many other uses. The dissolved salts are treated as pollutants for agricultural uses and coliform bacteria are most undesirable for drinking water. Invariably, one must specify the use when talking of pollution. At Agra along the Yamuna River, natural sources of water pollution are almost absent; the man made sources include the following. 1. Domestic waste water Agra city [population: over 8lac (0.8million)] is spread mostly along the river, and the city's natural slope is towards the river. Hardly 50% of the city area is sewered. Total wastewater generation in Agra city is about 92 mld (million litres a day). Seventeen drains (Kumar, 2004) collect a high portion of this wastewater and discharge it into the Yamuna. But despite these drains having been tapped (under the "Yamuna action plan") for pumping the sewage through 8 pumping stations to the sewage treatment plants of a total capacity of 98 mld (oxidation pond type).

#### **INDUSTRIAL WASTES**

A number of small and big industries such as leather die printing, metallic works (brass, copper and silver mouldings) located between upstream to downstream release harmful and nonbiodegradable toxic chemicals, dyes, detergents, etc. into the Yamuna with or without prior treatment. Some residents carry on mini industrial activities such as electroplating in their private homes. As a result, toxic wastes flow into the open drains towards the river while polluting the groundwater as well through sewage.

#### **1. POLLUTANTS FROM AGRICULTURAL ACTIVITIES**

In the Agra region, the left side catchment areas of the river are mainly used for agricultural purposes. Ignorant and/or greedy farmers use excessive quantities of chemical fertilizers, pesticides, etc. in the hope of a greater yield and of better quality. Large quantity of commercial fertilizers and pesticides applied for agriculture is thus washed down into the river.

#### **2. SOLID WASTES**

In Agra, the problem of solid waste disposal (both domestic and industrial) has become very acute because of insufficient disposal facilities. Solid waste is heaped up everywhere in the city, which also prevents the flow of wastewaters into the drains. The drains, therefore, overflow and the overflowing wastewaters join the river directly instead of going to the

treatment plants. Solid waste is also often dumped on the river banks and even on the bathing ghats. This uncontrolled dumping of solid waste creates ugly, unaesthetic scenes, and the stormwater takes along all the solid wastes into the river. The per capita generation of solid waste in the region ranges from 0.15 kg/day to 0.35 kg/day (Chatterjee, 1987), and about 0.225 kg/day (72 tons/day approximately) for Agra city. The indiscriminate use and disposal of polythenes not only choke the drainage system to cause flooding of streets but also manifest ugly sites.

### **3. DUMPING OF HOLY MATERIALS**

The Yamuna at Agra is well known for its holy status. Poly bags filled with different kinds of holy material viz. defiled photos, flowers, puja (worship) samagree (material) etc. is immersed into the river by the devotees thus increasing the suspended and floating materials (organic, inorganic and toxic) to add to the ugliness. Mass bathing by devotees Mass bathing at Agra (on the Yamuna's right bank) at the time of different festivals and other religious occasions is very common all through the year. Unfortunately, the needed sanitary facilities are not available along the banks of the river. Therefore, a major part of the floating population utilizes river catchment areas for open defecation. Thus, contributed pathogenic and organic contaminants in the river catchments are regularly washed down into the river through the overflow of drains, sudden releases of water from upstream side or rains.

### **4. OTHER SOURCES**

Direct disposal of half-burnt and/or un-burnt dead bodies of humans and animals which are mauled and scattered all over by stray dogs and birds cause more aesthetic problems, continuous unabated problems of siltation and bank erosion, pollution load from upper segment which is highly polluted; over-exploitation of fresh water from the river and thus non availability of proper dilution.

## **STRATEGIES FOR RESTORING RIVER QUALITY OF THE YAMUNA**

The water quality of the Yamuna River has been continuously degraded all along its Agra stretch. The strategies that could restore the Yamuna water quality to its pristine status in the Agra reach of the river, include the defensive approach (reducing the concentration of the pollutants) and the pro-active approach (augmenting the river's ability to assimilate higher amounts of the pollutants at higher rates), as are detailed in the following.

## **IMPROVING THE SEWERAGE SYSTEM**

The entire area of Agra, particularly the one which slopes towards the Yamuna river, should invariably be sewered. The wastewaters thus collected should be sent (through pumps if necessary) to a distance of about 3-5 km downstream of the city for treatment and disposal. This would ensure that the wastewater of the city would not enter into the river. 2. Wastewater treatment and management. The entire wastewater generated and collected in Agra should be subjected to conventional (i.e. primary as well as secondary) sewage treatment before its final disposal on land and/or in the Yamuna river at some 3 to 5 km downstream. For efficient wastewater management, the strategies should include the following aspects. a. Upgrading the two existing sewage treatment plants Agra's wastewaters of 43 mld is collected (Kumar, 2004) through 19 major drains and a part pumped for treatment in two sewage treatment plants (oxidation pond type)] of 28.1 mld total capacity. The existing waste water treatment facilities are incomplete in respect of both, the capacity for treatment of the entire wastewater collected and the degree of treatment because the oxidation pond type of treatment is neither complete nor efficient. Therefore, not only the augmentation of the total treatment capacity of the two plants is necessary, but the treatment should be made complete.

**PROPER DISPOSAL OF (PARTIALLY) TREATED SEWAGE**

The sewage in excess of the existing capacity of the four treatment plants finds direct entry into the river without undergoing any treatment. Therefore, in such situations alternative drainage systems should be made so that the entire wastewater is disposed off on the river's downstream side in such a manner as not to create low dissolved oxygen (DO) conditions in the river. This can be effected through disposal of the wastewater on the downstream river side through outfalls properly designed in respect of their flow rates and spacings with due regard to the river's selfpurifying coefficients and abilities (Bhargava, 1985b).

**WORK PLAN FOR SEWAGE PUMPING STATION**

In view of the frequent power breakdowns, arrangements must be made for alternative power sources. Further, the collection of wastewater for pumping should be carried out from more than one location. Shows the various zones (from a consideration of topography, pumping distances and uniformity of wastewater volumes) within and outside of Agra city. The outside city (newly developed through merger of small villages) is growing faster than the inside city zone. The partially treated sewage can also be tried for ground water recharge in areas where the water table is low and sinking.

**INDUSTRIAL WASTE WATER MANAGEMENT**

The most haphazardly scattered small and big industrial growth of Agra city has closely followed the rise in population. Therefore, the planning, land use regulations and consents for treated effluent discharges should strictly be enforced within industries and the various in-plant practices aimed at reducing the quantity and severeness of the pollutants should invariably be adopted. Such practices include:

1. modifications in the use of raw materials
2. application of latest process technologies
3. alterations in the waste generation process
4. reducing wastewater (after generation) through material recovery system, effluent reuse, wastewater treatment, etc.
5. wastewater load equalization to reduce peak flows
6. neutralization of the wastewater before its release

**IMPROVING AGRICULTURE PRACTICE**

After the 'green revolution' (evolved to increase the crop yield through the use of chemical fertilizers, insecticides, pesticides, etc.) in India, farmers started the use of various fertilizers, insecticides, pesticides, etc. A greed for greater yield and better quality compelled the illiterate farmers to use much larger amounts of these chemicals than their required prescribed doses, and the green revolution became a curse. As a result, the excess amounts of these chemicals entered the ground and surface water sources to pollute them significantly during the flood periods. The lakes/ponds thus manifested eutrophication. This kind of situation should be controlled through an efficient (and scientific) use of the stated chemicals erosion control for preventing the movement of the sand particles (coated with these chemicals) into the various surface water sources ; making use of the agricultural land for disposal of sewage, etc.

**ENVIRONMENTAL CONTROL**

Looking at what floats on the surface of the city stretch of a river indicates whether the city is a clean or dirty one. This reflects on the general environmental and sanitary management systems prevailing in the city, such as for street cleaning, solid waste collection and disposal, public utilities, etc. As for Agra, the major control aspects include the following:



**SOLID WASTE MANAGEMENT**

Mis-management of solid waste in Agra city causes heavy pollution in the Yamuna River. The solid waste of Agra (Kumar, 2004), mainly of garbage is about 102 tons per day. Although reduction in waste generation is important, industry, business as well as the general public all has a role to play in recycling, reusing and reducing their respective wastes. A major portion of Agra's biodegradable waste (cow dung and other dairy wastes, vegetables and fruits wastes; vendors selling eatables; bio-packing waste; food waste; etc.) can conveniently be collected from some identified major generation points listed in Table 5. Door to door collection and segregation of solid wastes in three bags/bins (one for biodegradable waste, the second for recyclable waste and the third for mixed waste) can also be practiced. Some non-governmental organizations may select various dirty littered markets/roads in Agra and engage labour to segregate solid wastes into four bins respectively for iron-glass pieces, waste paper, fruit skins and organic matter to be sold to agents for recycling (iron, glass, paper, etc.), cattle feed (fruit skins, etc.) and pig feed (organic matter). The money thus earned would be utilized for labour wages and other expenses. This self supporting sustainable system (4 'S') strategy would generate some employment, avoid pig and cattle menace in the streets and improve the business, tourism and aestheticity of Agra or any other Indian town. Vermiculture biotechnology (earthworms are used to convert organic solid waste into a valuable byproduct, vermicomposting, a rich manure of use is agriculture and horticulture) can be applied. Fuel pellet (small cubes or cylinders made out of garbage whose calorific value is quite close to coal) can replace petroleum products for domestic and industrial use. Pyrolysis (a high-temperature thermal process and a possible alternative to incineration) of solid wastes refers (Kumar, 2004) to the thermal decomposition of the wastes in an inert atmosphere. The main advantage is lesser air pollution problems (when compared to incineration) resulting from a reduced volume of waste gases. Pyrolysis can also be used for the processing of discarded rubber tires; rubber tires can also be shredded and added to asphalt paving material for road construction. The slogging operation provides 97% volume reduction and non-putrescible residue.

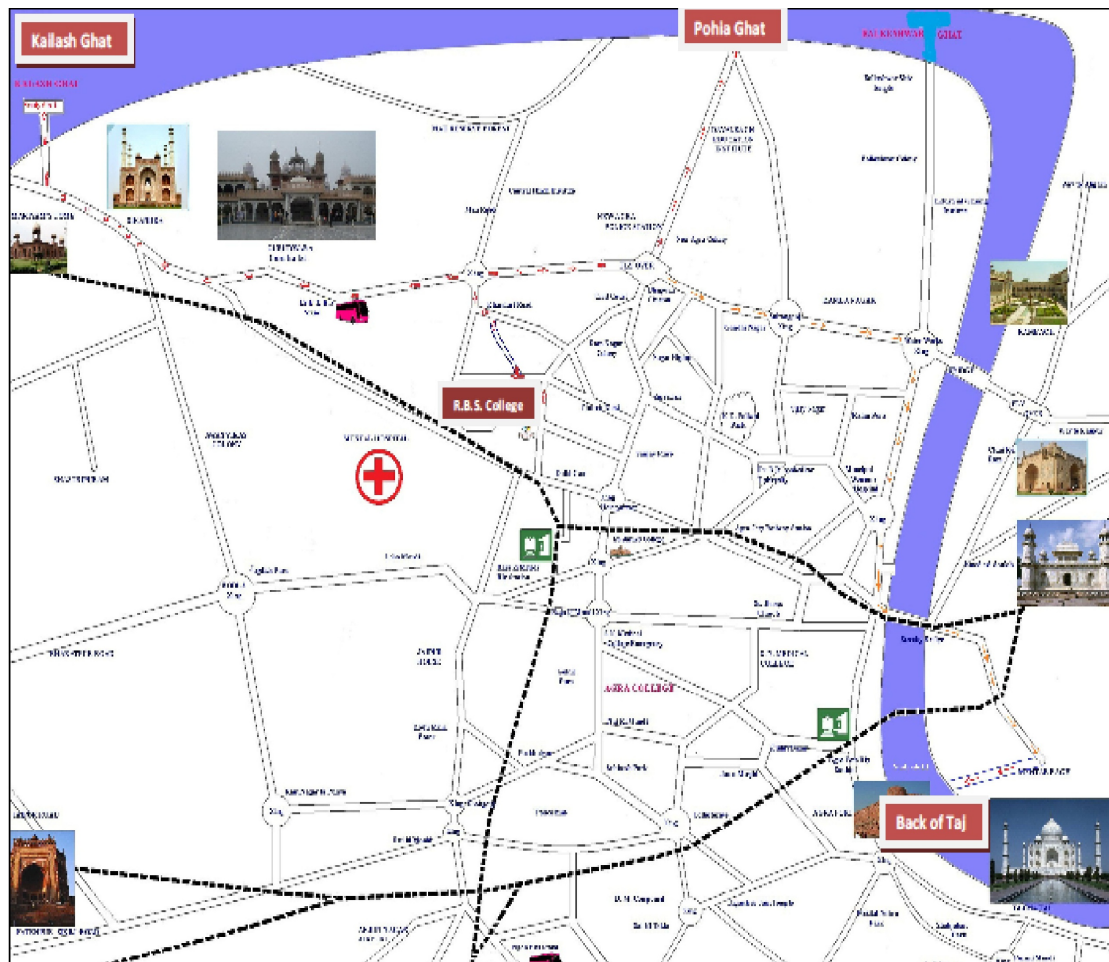
**CONCLUSION**

The Yamuna River at Agra and the surrounding region has most historical and high religious importance. It is (river water) seriously unhealthy, and calling for a right cure. The pollution in the Yamuna River originates from domestic, industrial and agricultural activities apart from a totally mismanaged solid waste collection and disposal. Mass bathing in the river, open defecation and disposal of dead animals also add to the problem. The management for the collection and disposal of the city's waste is neither effective nor scientific. The various efforts of the government have not remedied the situation for numerous reasons and technical faults. The public is equally responsible, for mainly because of ignorance, indiscipline and an unhygienic culture. The various strategies for the control of Yamuna River's pollution are grouped into defensive and proactive approaches. The defensive strategies include scientific collection, treatment and disposal of all the wastewaters originating in Agra, industrial wastewater's management within the industrial campuses, improvement in the existing agricultural practices through controlled use of chemical fertilizers, insecticides and pesticides, better solid waste management strategies, construction of public conveniences at major ghats including alternatives for disposal of holy materials, and development of recreation parks and embankments, or retaining walls (serving as barrier between the town and the river) along the river banks as part of the foolproof pollution control strategy to prevent the flow of wastewater into the Yamuna river, legislative measures including the adoption of scientifically evolved effluent standards, and corruption free management of funds and a sincerely strict qualified supervision of constructional works. The pro-active strategies include creation of awareness and duty amongst the Indian masses and unconcerned public, maintaining enough flow in Yamuna specially during the lean periods, enforcement of the Yamuna river's self-purifying abilities

through artificial and in-stream aeration, scientific exploitation of the river's waste assimilative capacity and creation of an artificial lake for storing the flood waters and later its release into the Yamuna river during the dry flow periods. Apart from adopting the various control strategies outlined in this paper, there is a sincere need to punish the polluters and defaulters through a system of fines with adequate bonus to the fine collectors to keep them duty bound and honest. Creation of public awareness on the suggested lines and keeping away from persons not qualified in environmental technology will also expedite the Yamuna River cleaning.

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### REFERENCES

1. Bhargava D.S. (1983a): A light- penetration model for the rivers Ganga and Yamuna. *International Journal for Development Technology (England)*, 1(3): 199–205.
2. Bhargava D.S. (1983b): Most rapid BOD assimilation in Ganga and Yamuna rivers. *Journal of Environmental Engineering, American Society of Civil Engineers*, 109(1), Proc. No. 17674: 174–188.
3. Bhargava D.S. (1983c): 'Use of water quality index for river classification and zoning of Ganga river,' *Environmental Pollution, Series B (England)* 6(1): 51–67.
4. Bhargava D.S. (1985a): 'Expression for drinking water supply standards,' *Journal of Environmental Engineering American Society of Civil Engineers*, 111(3): 304–316.
5. Bhargava D.S. (1985b): 'Technology of rationally setting effluent standards for water pollution administration,' *Journal of Environmental Engineering Division, Institution of Engineers (India)*, 66(1): 12–15.

6. Bhargava D.S. (1985c): 'Water quality variations and control technology of Yamuna River,' Environmental Pollution, Series A (England),37(4): 355-376.
7. Bhargava D.S. (1992): 'Why the Ganga (Ganges) could not be cleaned,' Environmental Conservation, Switzerland, 19 (2): 170-172.
8. Bhargava D.S. (1994): 'RiverBODprediction under non-point discharge conditions,' Indian Journal of Engineering and Material Sciences, 1(1): 35-40.
9. Bhargava D.S. (1998): 'Foolproof pollution control of Indian rivers,' Indian Journal of Engineering and Material Sciences. 5(4): 162-166.
10. Bhargava D.S. (2000): 'Can Indian rivers be made pollution free?,' Environmental Protection Information, Indian Journal of Environmental Protection., 20(6): 476-480.
11. Chatterjee A.K. (1987): 'Water supply and sanitary engineering,' Khanna Publishers, Delhi, 3rd ed., 487.
12. CPCB (2002): 'Water quality criteria and goals,' Central Pollution Control Board, New Delhi, series MINARS/7/2001-2002.
13. CPCB (2008): 'Water quality status of Yamuna river,' Central Pollution Control Board, New Delhi, series ADSORBS/32/1999-2000. April 2008.
14. HT (2004a): 'Yamuna water too polluted for religious rites,' Hindustan Times, New Delhi., 27-3-2004, p 3.
15. HT (2004b): 'Fast, dharna against Yamuna river pollution,' Hindustan Times, New Delhi., 29-3-2004, p 3.
16. HT (2004c): 'Agra's ghats losing sheen,' Hindustan Times,New Delhi., 27-6-2004, p 3.
17. HT (2004d): 'Pollution in Yamuna river cause of alarm,' Hindustan Times, New Delhi., 14-11-2004, p 3.
18. HT (2004e): 'Fishes found dead in Yamuna,' Hindustan Times,New Delhi., 20-11-2004, p 3.
19. HT (2004f): 'Experts ring Taj alarm bells : clean Yamuna, remove corridor remnants, says UNESCO report,' Hindustan Times, New Delhi., 26-11-2004, p 13.
20. HT (2004g): 'Agra water unfit for drinking,' Hindustan Times, New Delhi., 22-11-2004, p 3.
21. HT (2011): "Taj-Mahal ke Peejhe sabse maily ha Yamuna" 2011 27-08-2011 p 03.
22. Kumar Y. (2004): 'Strategy for Pollution Control of Yamuna river at Agra,' Master's Thesis, IET, Lucknow, 2004.
23. Singh D.K. and Srivastava B. (1999): 'Removal of basic dyes from aqueous solution by chemically treated Psidium Guyava leaves,' Indian Journal of Environmental Health, 41(4): 333-345.