e-ISSN: 2347-7830

Research and Reviews: Journal of Ecology and Environmental Sciences

Assessment of Water Quality in River Yamuna during Idol immersion

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Review Article

Received: 10/08/2016
Accepted: 20/08/2016
Published: 07/09/2016

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Keywords: Water Pollution, Industrial effluents, Ecosystems, Water quality, Idol immersion

ABSTRACT

Water Pollution, a major concern in India has been thriving since the past few decades. The introduction of contaminating and hazardous pollutants into the natural water leads to adverse changes leading to unavailability of fresh water for drinking and daily use. The river Yamuna, a sacred river originating from Yamunotri in the Himalayas and is a life-line of Delhi. Yamuna, the most polluted river in the country and the causative factors contributing to pollution of the Yamuna are untreated sewage, industrial effluents, pollution due to in stream uses of water, dumping of garbage and dead bodies and immersion of idols. During festive season, immersion of idols has become a cause for concern because of the use of chrome based paints and cheap lead while making the idols. Along with the idols, puja articles such as flowers, food offerings, metal polish, plastic sheets, cosmetic items, polythene bags are also submerged into the water. This on degradation decreases the dissolved oxygen concentration in the river causing the death of the organisms living in the water body. To analyse the water quality following parameters are to be checked for: Dissolved oxygen, Biological oxygen Demand, Chemical oxygen Demand, Total Solids, and pH.

INTRODUCTION

Water is the most essential part of life of humans and the health of the environment. Water is also one of the most exploited natural resources [1-3]. Water has two closely linked dimensions: quality and quantity. Water quality is important not only to protect the public health, water provides ecosystems habitats, is used for farming, fishing and mining, and contributes to recreation and tourism. The environment will be greatly suffered if the quality of water is not maintained. Water quality is closely linked to the land use and surrounding environment. Water is not pure other than in its vapour form [4-7]. The water quality is affected by the human use such as recreation, urban and industrial use and agriculture.

The water quality of the rivers is best at their place of origin and degrades as they pass through the cities because of the wastes such as waste from household, industrial effluents, agricultural wastes being dumped into the river directly without any prior treatment. Thus, the river gets polluted while its course of run across the land. The river accumulates more of the waste during non-monsoon period due to the low level of water in the river. The water quality of the river varies from region to region [8-10].

The water quality of the river during Idol immersion is affected and degrades the water quality to such an extent that it cannot be utilized for any recreational and irrigational purposes. The presence of heavy metals and other primary and secondary metabolites makes the water unfit for use. The immersion of Idols and other puja materials has organic material that requires large amount of oxygen to decompose [11-12]. Thus, the biological oxygen demand level in the water rises and dissolved oxygen level reaches below the critical level causing the death of the microorganisms living in the water body [13].

Water quality assessment during idol immersion

India is known for its cultural and traditional background because of the presence of many cultures and religions. Every festival has its own relevance and importance and celebrated uniquely according to the beliefs, rituals and significant history behind [14-17]. The Hindu festivals alone are many and these festivals fall almost every month. With many festivals involving the immersion of idols into the water bodies after the festivals. The rivers are considered as pious and holy and are worshipped by a person throughout his lifetime with each ritual and ceremony being associated with these rivers. The immersion of idols of Devi Durga during Navratri festival (Figure 1) and Lord Ganesh during Ganesh Chaturthi are considered as a major source of contamination, pollution and sedimentation caused to the water bodies [18-20].

Figure 1. Idol immersion in the river Yamuna after Durga Puja in Delhi.

The toxic chemicals being used in the preparation of idols cause serious problems of water pollution and also tend to pose a serious threat to ecological system thriving underwater [21-24]. When these idols are immersed, these chemicals and colors dissolve slowly causing a significant change in the water quality. The idol immersion is a religious activity that is responsible for adding excess amount of pollution load in the river [25-28].

To assess the quality of water in the river following parameters are being checked: Biological Oxygen Demand, Dissolved Oxygen, pH, Chemical Oxygen Demand, Total suspended solids, Ammonia, Total Kjeldahl's Nitrogen, Total Coliform, Faecal Coliform, and temperature rise [29-34].

The immersion of idols into the water bodies leads to the accumulation of organic material. The organic material requires large amount of dissolved oxygen for its degradation. The decomposers present in the water uses the dissolved oxygen to degrade the organic materials present making the water body deficit of oxygen. The biological oxygen demand thus increases. Biological oxygen demand represents the amount of oxygen utilized or consumed by the decomposers or microorganisms for the decomposition of organic materials by aerobic processes [35-38]. The BOD thus provides information on the amount of organic content degraded of a sample of water. By this, the amount of oxygen utilized for the degradation of organic content can easily be distinguished. Chemical Oxygen Demand (COD) is commonly employed to indirectly measure the amount of organic compounds in water. COD helps to determine the amount of organic pollutants in the water body and is considered an important parameter in determining the water quality. The value of COD along with BOD helps determine the presence of organic substances that are biologically resistant [39,40].

Effect of water quality on human health

Water is a precious resource without which life on earth would not have sustained. Human beings can survive without eating food for several days, but without drinking water they cannot survive. Water is used not only for drinking, but is also used for washing, cooking, bathing and other purposes. At present, around 1.1 billion people do not have access to an improved and pure form of water resources and over three million people of which mostly are the children die from water-related diseases every year (UNICEF, 2008) [41-44]. Developed countries consumes large amount of clean water than the developing countries that lacks the latest technologies are always left stranded when it comes to clean drinking water (Figure 2). Water quality refers to the characteristics of water such as dissolved minerals, free from soluble primary or secondary metabolites, colour and odour that determine the water being fit for human uses. It is perfectly clear from this that water quality has tremendous effects on not only in short term but in long term to the human [45-78].

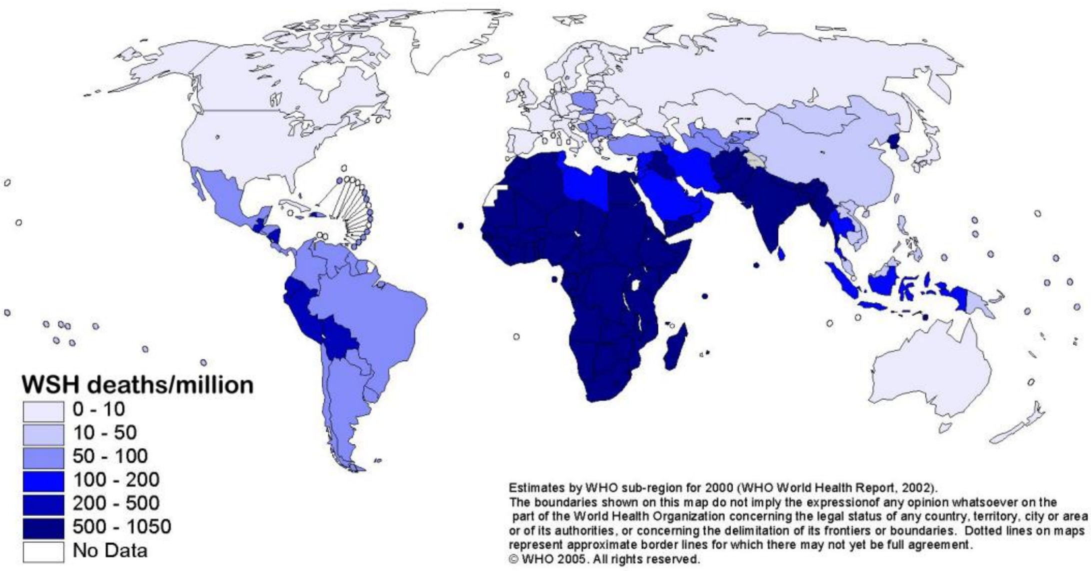

Figure 2. The World map showing the death rate (in numbers) from unsafe water, sanitation and hygiene.

Sudden or in-day consequences of consuming and drinking water determine the short-term impacts of water quality. Unsanitary water or untreated water contains a number of viruses and harmful germs that can be detrimental to human health [48-52]. Drinking contaminated water may result in the occurrence of water-related diseases including bacterial dysentery, cholera, diarrhoea, typhoid and many other contagious illnesses. Diarrhoea causes the loss of water from the body of the patient leading to dehydration because of which a patient dies. One of the diseases majorly confined to African country that causes deaths of hundreds of children in days, or in hours if the treatment is not provided in time is Cholera, a watery disease [53-57]. The presence of harmful substances in the water bodies such as rivers, lakes, or open wells causes more threat to human life. These water bodies with harmful substances and dissolved heavy metals poses a threat to not only human skin but can cause various diseases such as Minamata disease, Lead poisoning, Anaemia, Cholera, Typhoid, Methaemoglobinemia, and others. These diseases can cause skin problems and in the long run, can turn cancerous and because of which person's life can be put to danger [58].

Presence of chlorine, bacteria-disinfecting substance can cause the irritation in the eyes and nose. The poor quality of water no doubt poses a threat to human life but on the other hand, potable water seems to be beneficial. Better the quality of water means better the lifestyle be and quality of life [59-62]. Clean water can help decrease the occurrence or risk of kidney stones as the presence of pure water helps to remove wastes and toxins from the body. The quality of water can greatly affect the health of a person. Thus, drinking at least 2 litres of water daily is beneficial to improving the health of an individual [63,64].

Effect of heavy metals on human health

Heavy metals concentrate into the body through the intake of contaminated food and water. These heavy metals pose a serious health issue [65]. Lead (Pb), a heavy metal that is used in batteries, paints and the oxide employed in the production of crystal glass. A higher level of Lead (Pb) leads to cognitive impairment in children to peripheral neuropathy in adults. Copper (Cu) also a heavy metal, is employed in the electroplating industries. At low concentrations, Cu causes vomiting, headache, nausea and diarrhoea, and at higher levels of deposition, it leads to the malfunctioning of liver and kidneys. Zinc (Zn) is mainly used to paint the idol sculptures and also is discharged from the electroplating industries in the river. Zinc toxicity causes icterus, diarrhoea, vomiting, liver and kidney damage. Nickel (Ni), a neurotoxic, genotoxic and carcinogenic substance or agent that causes health problems such as nickel dermatitis, etc. is discharged from the stainless steel industries directly into the rivers or water bodies [66-68]. Cadmium (Cd), a heavy metal used in various industrial processes for example, as control rods and shields within nuclear reactors, preparation of Cd-Ni batteries, protective coatings for metals like iron and television phosphors. Cd when consumed along with food and water for a longer period of time results in the bioaccumulation in the kidney and liver causing severe damage to these systems [69,70]. Chromium (Cr) present in the River Yamuna is because of the industries that are located near the banks of the river that flush the waste containing chromium into the river without any prior treatment (Figure 3). Intake of Cr in large amounts has severe detrimental health effects like renal, hepatic and gastrointestinal damage [71-85]. The heavy metals concentrate into higher level organisms through the food chain and thereby causing much damage to the higher organisms such as human beings and animals and the process is known as bioaccumulation or bio-magnification of heavy metals [72-76]. Hence, the steps need to be taken to reduce the amount of dissolved heavy metals from the water bodies.

Element	**Acute exposure** *usually a day or less*	**Chronic exposure** *months or years*
Lead	Encephalopathy (brain dysfunction) Nausea Vomiting	Anemia Encephalopathy Foot drop/wrist drop (palsy) Nephropathy (kidney disease)
Cadmium	Pneumonitis (lung inflammation)	Lung cancer Osteomalacia (softening of bones) Proteinuria (excess protein in urine; possible kidney damage)
Mercury	Diarrhea Fever Vomiting	Stomatitis (inflammation of gums) Nausea, tremor Nephrotic syndrome (kidney disorder) Neurasthenia (neurotic disorder) Parageusia (metallic taste) Pink Disease (pain and pink discoloration of hands and feet)
Arsenic	Nausea, vomiting, diarrhea Encephalopathy Multi-organ effects Arrhythmia Painful neuropathy	Diabetes Hypopigmentation/Hyperkeratosis Cancer

Figure 3. Health problems arising due to the dissolved heavy metals in the rivers.

Strategies for restoring the water quality of river Yamuna

Restoration refers to bringing back an ecosystem to an original or earlier condition in terms of biophysical state and its ecological processes [77-79,86]. Restoration is a holistic process that is not achieved through the isolated manipulation of individual element (U.S. National Research Council). Restoration therefore requires addressing the root causes of degradation which may have also changed in their nature and magnitude over time. However, the question of what conditions and functions to restore and how far back in time has to be examined with respect to several other factors concerning a specific ecosystem. These include feasibility, potential for sustainability, and social, cultural and economic considerations [87-90]. Restoration of a river requires interventions to improve channel morphology (such as depth, bed characteristics and meandering), flow regime, water quality, biological diversity, and the riparian and floodplain habitats in a manner that ensures their interactions. Flow regime of a river is the master variable that controls all other components and in turns the river's characteristics. Improvement of flow regime and water quality is critical to the restoration of a river and necessarily requires a catchment wide action [91-93]. Continued discharge of wastewaters without adequate treatment and the absence of adequate flows will negate all efforts to improve the channel, biodiversity and floodplain habitats. Wastewater discharges need to be effectively controlled and the treated effluent quality entering the river has to be strictly regulated. The channel habitat restoration in an alluvial river such as Yamuna requires dredging out of accumulated sediments and sludge, and some re-meandering [94-97]. The riparian areas need protection against erosion and frequent shifting of the channels. Non-structural approaches such as plantation of appropriate vegetation should be preferred. Riparian / floodplain zones link the stream with its terrestrial catchment, and can modify, incorporate, dilute, or concentrate pollutants before they enter a river [98]. The floodplain habitats with appropriate wetland vegetation help improve the water quality further, and depending upon the extent of floodplain areas and the amount and quality of wastewaters, the river water quality can be restored to a fairly high level [99,100]. Floodplain restoration involves creation of habitats on low lying land by reconfiguration to promote and enhance interaction between river and adjacent area through hydrological linkages.

CONCLUSION

The idol immersion activity during festive season has revealed that this has negative impact on the water quality of river Yamuna. The physical-chemical characteristic of the river is affected to a great extent causing alterations in the chemical, physical and biological composition of water in the river. The water quality is degrading day by day and cannot be utilized for any purpose due to high level of chemicals in it. Immersing idols in the holy rivers such as Ganga and Yamuna has been a tradition since ages which now poses an extreme threat to water bodies. During the Hindu festive season, hundreds of idols of God and Goddess are immersed in the rivers polluting its eco-system. The main reason behind such an environmental pollution is the lack of awareness among people and also the lack of monitoring by the governing bodies. Organizing campaigns with the help of communication media such as newspapers, news channels, social networking media, and others can help spread the news locally and globally to stand for the awareness of not polluting the water bodies and save water bodies from getting more polluted.

Central Pollution Control Board has formulated a comprehensive set of guidelines on the practice of idol immersion in seas, oceans, rivers and lakes. These guidelines delineate and specify the role of the state pollution control boards in conducting water quality assessments of water bodies and classifying them on the basis of certain physio-chemical parameters. These guidelines if followed and acted upon can help in bringing tremendous change in the water quality of river post idol immersion. Some alternatives that can prevent the further deterioration of the river during immersion period:

- The water and debris flowing through this marked area can be collected and treated with technical measures.
- This filtered water can be allowed to flow back into the river.
- A ban on synthetic paints used for colouring the idols can be made regulatory and the Pollution due to immersion can be reduced due to great extent.
- An alternate model for the idols can be developed and it should be free from pollution or contamination of water.
- Educating the public about using smaller idols and the manufacturers of idols about using eco-friendly material.
- Lastly, human intervention is very important to tackle this alarming issue and certain regulations should be formulated with the consensus of religious and welfare organizations as they can reach out to masses more powerfully.

REFERENCES

1. Manohar S, et al. Water Quality and Plant Species Composition of Selected Sites within Chemususudam, Baringo County, Kenya. J Environ Anal Toxicol. 2016;6:390.
2. Sarfraz MD, et al. Investigation of Portable Groundwater Quality and Health Risk Assessment of Selected Trace Metals in Flood Affected Areas of District Rajanpur, Pakistan. J Environ Anal Chem. 2016;3:183.
3. Rusnam and Efrizal. The Ability of Water Plants to Reduce the Level of Mercury Pollution in Water Quality in Irrigation. Int J Waste Resour. 2016.
4. Rusnam, et al. The Phytoremediation Technology in The Recovery of Mercury Pollution By Using Water Hyacinth Plant (Eichhornia Crassipes) for Water Quality of irrigation. ICP 2016.
5. Gopal Krishan, et al. Water Quality Assessment in Terms of Water Quality Index (WQI) Using GIS in Ballia District, Uttar Pradesh, India. J Environ Anal Toxicol. 2016;6:366.
6. Jamila H, et al. Assessment of the Water Quality of Bizerte Lagoon of Tunisia by Use of Statistical Analyses. Hydrol Current Res. 2016;7:237.
7. Bingqi Zhu. Natural Water Quality and Its Suitability for Drinking and Irrigation Purposes In the Jungar Basin, Central Asia. J Civil Environ Eng. 2016;6: 232.
8. Bhat NA, et al. Assessment of Drinking and Irrigation Water Quality of Surface Water Resources of South-West Kashmir, India. J Civil Environ Eng. 2016;6: 222.
9. Gopal Krishan, et al. Assessment of Water Quality Index (WQI) of Groundwater in Rajkot District, Gujarat, India. J Earth Sci Clim Change. 2016;7: 341.
10. Nag SK and Suchetana B. Groundwater Quality and its Suitability for Irrigation and Domestic Purposes: A Study in Rajnagar Block, Birbhum District, West Bengal, India. J Earth Sci Clim Change. 2016;7:337.
11. Gopal Krishan, et al. Assessment of Groundwater Quality for Drinking Purpose by Using Water Quality Index (WQI) in Muzaffarnagar and Shamli Districts, Uttar Pradesh, India. Hydrol Current Res. 2015;7:227.
12. Reda AH. Physico-Chemical Analysis of Drinking Water Quality of Arbaminch Town. J Environ Anal Toxicol. 2016;6:356.
13. Sunil Garg, et al. Evaluation of Ground Water Quality Using Contamination Index In Ludhiana, Punjab (India). ICP 2015.
14. Xie L, et al. Water Quality and Plankton in Central Arkansas Commercial Golden Shiner Ponds. J Fisheries Livest Prod. 2016;4:165.
15. Ibironke OO, et al. Development of Water Quality Map for Ogbomoso Metropolis. J Civil Environ Eng. 2016;6:205.

16. Lin X and Peter P. Cool Water Off-flavor Algae and Water Quality in Four Arkansas Commercial Catfish Farms. J Fisheries Livest Prod. 2016;4:158.
17. Touliabah HE, et al. Plankton and Some Environmental Variables as a Water Quality Indicator for Saline Pools at the Western Red Sea (Saudi Arabia). J Coast Zone Manag. 2016.
18. Fenta AD and Kidanemariam AA. Assessment of Cyanobactrial Blooms Associated with Water Quality Status of Lake Chamo, South Ethiopia. J Environ Anal Toxicol. 2016;6:343.
19. Oluwafemi OK, et al. Water Quality Assessment of River Elemi and Ureje in Ado Ekiti, Nigeria. J Civil Environ Eng. 2015;5:199.
20. Jian Zhao, et al. Water Quality Assessment and Apportionment of Pollution Sources of Selected Pollutants in the Min Jiang, a Headwater Tributary of the Yangtze River. Hydrol Current Res. 2015; 6:211.
21. S Sasikala, et al. Water Quality Analysis of Surface Water Sources near Tindivanam Taluk. Ind Chem. 2015;1:106.
22. Inga Badasyan. Water Quality and Macroinvertebrate Communities Monitoring of Catchment Basin of Debed River in Armenia in Spring in 2015. JEES 2015.
23. Elegbede Isa Olalekan, et al. Effect of Water Quality Characteristics on Fish Population of the Lake Volta, Ghana. J Environ Anal Toxicol. 2015;5:317.
24. Gorthi KV and Babu M. Groundwater Studies with Special Emphasis on Seasonal Variation of Groundwater Quality in a Coastal Aquifer. J Geol Geophys. 2015;4:210.
25. Bhat NA, et al. Variability in Water Quality and Phytoplankton Community during Dry and Wet Periods in the Tropical Wetland, Bhopal, India. J Ecosys Ecograph. 2015;5:160.
26. Tecle A and Neary D. Water Quality Impacts of Forest Fires. J Pollut Eff Cont. 2015;3:140.
27. Kaur S, et al. Effect of Fertilization and Organic Manure on Water Quality Dynamics a Proximate Composition of Cyprinus carpio. J Fisheries Livest Prod. 2015;3:133.
28. Gang Xiao, et al. A Delaunay Triangle Network Based Model of Fish Shoaling Behavior for Water Quality Monitor. J Environ Anal Toxicol. 2015;S7-001.
29. Qureshimatva UM, et al. Determination of Physico-Chemical Parameters and Water Quality Index (Wqi) of Chandlodia Lake, Ahmedabad, Gujarat, India. J Environ Anal Toxicol. 2014;5:288.
30. Ravikumar P, et al. Interpretation of Groundwater Quality and Radon Estimation in the Selected Region of Bangalore North Taluk, Karnataka, India. JEES 2015.
31. Jagadeshan G, et al. Groundwater Quality of Kosasthalaiyar River Basin, Thiruvallur District, Tamil Nadu, India. IJIRSET 2015.
32. Talabi AO, et al. Assessment of Impacts of Artisanal and Small-Scale Mining Activities on Groundwater Quality of Ijero-Ekiti, South- Western Nigeria. IJIRSET 2015.
33. Mukherjee S. Climate Change Induces Variation in Groundwater Quality. J Earth Sci Clim Change. 2015;S3-005.
34. Dolma K, et al. Baseline Study of Drinking Water Quality? A Case of Leh Town, Ladakh (J&K), India. Hydrol Current Res. 2015;6:198.
35. Shivashankar P, et al. Seasonal Fluctuations of Water Quality Parameters in Selected Points of Bhadra River, Karnataka, India. IJIRSET 2015.
36. Agarwal M and Agarwal A. Linear Regression And Correlation Analysis Of Water Quality Parameters: A Case STudy Of River Kosi at District Rampur, India. IJIRSET 2013.
37. Kumar M, et al. CCME Water Quality Index and Assessment of Physico-Chemical Parameters of Chikkakere, Periyapatna, Mysore District, Karnataka State, India. IJIRSET 2014.
38. Khare HN and Shukla SK. Water quality status of benisagar dam chhatarpur district (M.P.), India. IJIRSET 2013.
39. Thirumala S. Groundwater Quality Analysis in Davangere city of Karnataka, India. IJIRSET 2014.

40. Gupta MK, et al. Bio-chemical, Physical & Statistical Analysis of Hand Pump's Water Quality in Banda, Uttar Pradesh. IJIRSET 2014.
41. Patil C, et al. Assessment of Groundwater Quality Around Solid Waste Landfill Area - A Case Study. IJIRSET 2013.
42. Udayashankara TH, et al. Study of water quality and dynamic analysis of phytoplanktons in four freshwater lakes of mysore, India. IJIRSET 2013.
43. Ramamurthy V and Rajakumar R. a study of avifaunal diversity and influences of water quality in the udhayamarthandapuram bird sanctuary, tiruvarur district, Tamil Nadu, India. IJIRSET 2014.
44. Barabde RB and Patil YS. To study water quality of shegaon town of buldana district in maharashtra, India. ICP 2013.
45. Anandakrishnan B, et al. Assessment of post-biomethanated distillery effluent movement on ground water quality using piezometers. ICP 2007.
46. Hariharan AVNSH. Some studies on the water quality parameters of vuda (Mithilapuri) Colony Visakhapatnam. ICP 2007.
47. Priya KL, et al. Ground water quality in the singanallur sub-basin of coimbatore city. ICP 2011.
48. Naik DP, et al. Ground Water Quality Evaluation in Stone Quarry area. ICP 2007.
49. Saxena N and Kaur H. Evaluation of ground water quality of bareilly city. ICP 2003.
50. Khadsan RE and Kadu MV. Drinking Water Quality Analysis of Some Bore-Wells Water of Chikhli Town, Maharashtra. ICP 2004.
51. DEY K, et al. Assessment of water quality parameters of the river brahmani at rourkela. ICP 2005.
52. Senthilraja K and Jothimani P. Effect of Brewery Wastewater Discharge on Surface and Groundwater Quality. ICP 2014.
53. Kowsalya R, et al. assessment of water quality and pollution of porur double lake (erettai eri), chennai. ICP 2010.
54. Geetha A, et al. Evaluation of ground water quality in and around ariyalur district, Tamil Nadu - a statistical approach. ICP 2009.
55. Harinath S. Water quality studies on bommanahalli lake. ICP 2009.
56. Panda RB, et al. Water quality of the brahmani river- an analytical study upstream, mid stream and down stream at effluent discharge point of talcher industrial complex, Orissa, India. ICP 2009.
57. Sunkad BN. Water quality of malaprabha river with reference to physicochemical factors near khanapur town of belgaum district. IJIRSET 2013.
58. Saxena P, et al. Seasonal variation and assessment of wqi of raw water quality in water treatment plants at Delhi, India. IJPAES 2014.
59. Khwakaram AI, et al. Application of water quality index (wqi) as a possible indicator for agriculture purpose and assessing the ability of selfpurification process by qalyasan stream in sulaimani city/iraqi kurdistan region (ikr). IJPAES 2015.
60. Bhadula S and Josh BD. Impact of religio-touristic activities on the water quality of ganga river and solid waste generation within Haridwar city, India. IJPAES 2014.
61. Seyedsalehi M, et al. The effects of active carbon on the increase of water quality. IJPAES 2014.
62. Bala Chennaiah J, et al. Assessment of ground water quality in ghatkesar and bibinagar areas of andhra pradesh, India. IJPAES 2013.
63. Azareh A, et al. Assessment of the groundwater quality feasibility zones for irrigational purposes (case study; southwest part of kerman province, iran). IJPAES 2014.
64. Karim AA, et al. Estimation of water quality status of kalinga nagar industrial complex in the district of jajpur of Odisha, India. IJPAES 2013.
65. Bhadja P and Vaghel A. Assessment of physico-chemicalparameters and water quality index of reservoir water. IJPAES 2013.

66. Karim TH, et al. Rate of soil aggregates disintegration as affected by type and rate of manure application and water quality. IJPAES 2013.
67. Dalal P. Drinking water quality of ujjain district. IJPAES 2013.
68. Singh S, et al. Status of the drinking water quality in school of datia town (M.P.). IJPAES 2013.
69. Shah R, et al. Evaluation of drinking water quality in rainy season near tekanpur area, Gwalior, India. IJPAES 2013.
70. Khwakaram AI, et al. Determination of water quality index (wqi) for qalyasan stream in sulaimani city/ kurdistan region of Iraq. IJPAES 2012.
71. Bhargava and Devendra Swaroop. "Water quality variations and control technology of Yamuna River." *Environ Pollu Ser A: Ecol Biol* 37.4:1985;355-376.
72. Pandey, et al. Biomarkers of oxidative stress: a comparative study of river Yamuna fish Wallago attu (Bl. & Schn.). Sci Total Environ 1:2003;105-115.
73. Dhote S, et al. Impact of idol immersion on water quality of twin lakes of Bhopal. Indian J Environ Protect 2001;21:9981005.
74. Gupta A, et al. Impact of religious Activities on The Water Characteristics Of Prominent Ponds at Varanasi (U.P.), India. Plant Arch, 2011;11:297-300.
75. Paliwal R, et al. Water quality modeling of the river Yamuna (India) using QUAL2E- UNCAS. J Environ Manag 2007;83:131 144.
76. Kumar A, et al. Physical, chemical and bacteriological study of water from rivers of Uttarakhand. J Human Ecol 2010;169-173.
77. Paliwal R, et al. Water quality modelling of the river Yamuna (India) using QUAL2E-UNCAS. J Environ Manag 2007;131-144.
78. Anju A, et al. Water pollution with special reference to pesticide contamination in India. J Water Res Protect 2010;432.
79. Atiqur R. A GIS based DRASTIC model for assessing groundwater vulnerability in shallow aquifer in Aligarh, India. Appl Geog 2008;32-53.
80. Mehra A, et al. A study of eichhornia crassipes growing in the overbank and floodplain soils of the River Yamuna in Delhi, India. Environ Monitor Assess 2000;25-45.
81. Janardhana RN, et al. Groundwater quality in the lower Varuna river basin, Varanasi district, Uttar Pradesh. J Geol Soc India 2009;178-192.
82. Cude C. Oregon Water Quality Index: a tool for evaluating jwater quality management effectiveness. J Am Water Res Assoc 2001;125–137.
83. Kaushik A, et al. Heavy metal contamination of river Yamuna, Haryana, India: assessment by metal enrichment factor of the sediments. J Hazard Mater 2009;265-270.
84. Melching, et al. Key sources of uncertainty in QUAL2E model of Passaic River. J Water Resour Plann Manag 1996;105-113.
85. Zafar M and Alappat BJ. Landfill surface runoff and its effect on water quality on river Yamuna. J Environ Sci Health *Part A* 2004;375-384.
86. Kumar R. Water quality of the River Yamuna in the Delhi Stretch: Key determinants and management issues. Clean–Soil, Air, Water 2008;306-314.
87. Suthar, et al. Assessment of metals in water and sediments of Hindon River, India: Impact of industrial and urban discharges. J Hazard Mater 2009;1088-1095.
88. Indrajit S, et al. Study for determination of heavy metals in fish species of the river Yamuna (Delhi) by inductively coupled plasma-optical emission spectroscopy (ICP-OES). Adv Appl Sci Res 2011;161-166.
89. Aradhna G, et al. Analysis of some heavy metals in the riverine water, sediments and fish from river Ganges at Allahabad. Environ Monitor Asses 2009;449-458.

90. Mohammad A, et al. Distribution of heavy metals in plants and fish of the Yamuna River (India). Environ Monitor Asses 1985;361-367.
91. Kaushik A, et al. Heavy metal pollution of river Yamuna in the industrially developing state of Haryana. Indian J Environ Health 2001;164-168.
92. Suresh G, et al. Influence of mineralogical and heavy metal composition on natural radionuclide concentrations in the river sediments. Appl Rad Isotopes 2011;1466-1474.
93. Sundaray SK, et al. Geochemical speciation and risk assessment of heavy metals in the river estuarine sediments—a case study: Mahanadi basin, India. J Hazard Mat 2011;1837-1846.
94. Devendra BS. Revival of Mathura's ailing Yamuna river. Environ 2006;111-122.
95. Misra AK. A river about to Die: Yamuna. J Water Resour Protect 2010.
96. Ramachandra TV. Restoration and management strategies of wetlands in developing countries. Elect Green J 2001.
97. Brij G and Sah M. Conservation and management of rivers in India: case-study of the river Yamuna. Environ Conservat 1993;243-254.
98. Ramakrishna N and Paravasthu R. Economic value of conserving river water quality: results from a contingent valuation survey in Yamuna river basin, India. Water Policy 2010;260-271.
99. François M, et al. River basin closure: Processes, implications and responses. Agricultural Water Manag 2010;569-577.
100. Jhingran AG and Ghosh KK. The fisheries of the Ganga river system in the context of Indian aquaculture. Aquaculture 1978;141-162.