Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-4 Issue-1 || February 2025 || PP. 118-123

https://doi.org/10.55544/jrasb.4.1.14

Assessment of Water Quality in the Varuna River, Varanasi: A Comprehensive Study

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www.jrasb.com || Vol. 4 No. 1 (2025): February Issue

Received: 06-02-2025	**Revised:** 16-02-2025	**Accepted:** 19-02-2025

ABSTRACT

Water is a finite and irreplaceable resource that is fundamental to human well-being. It is only renewable if well managed. It is well managed. It is vital reducing the global burden of disease and improving the health, welfare and productivity of population. Most of the factor directly responsible for the quality of water sources. Keeping this in view, water samples from Varuna River were collected to analyze with the purpose of mutual comparison of water sources with special reference to physiochemical levels. Varuna is the Hindu God of water and the celestial ocean, as well as law of underwater world. It runs though the city of Varanasi from west to east the cross- section of city towards east convergence in to Ganga.

This article helps to know the quality of river water. Some parameters have been analyzed on the spot during the sampling time at each sampling location like ambient temperature, pH, water temperature, dissolved oxygen and other parameters like total suspended solids, BOD, COD, alkalinity, hardness, DO were analyzed in laboratory. Biological parameters like Phytoplanktons, zooplanktons, fishes were observed during study. The water quality of river Varuna is moderately polluted because of sewage, industrial wastes, using of excessive fertilizers and so on. Permeability index indicates that the groundwater samples are suitable for irrigation purpose. Although the general quality of ground water of lower Varuna basin is suitable for irrigation purpose but need to treatment of sewage which pour in river.

Keywords- Physico-chemical characteristic, water quality, Varuna river, Varanasi.

I. INTRODUCTION

Varuna is the Hindu God of Water and the celestial oceans, as well as a god of law of the underwater world. It is a minor tributary of the Ganges River in Uttar Pradesh, India. It originates at Phulpur in the Prayagraj district and merges into Ganges near Sarai Mohana in the Varanasi district. The 6 kilometers stretch between Sarai Moahana and Sadar, Varanasi. The total study area of lower Varuna basin is around 23.05sq.km. Based on major ion chemistry of ground water samples from dug wells and few from hand pumps near Varuna river in Varanasi city, an attempt has been made to understand the spatial distribution of hydro-geochemical constituents and also interprets chemical variation in ground water under various and anthropogenic influences.

Water is one of the vital natural resources on our planet, which is necessary for various commercial purposes like forestry, fishery, agricultural, industry, hydropower generation, residential and other creative undertakings. All organisms depends on water for their survival (Das and Acharya, 2003). Due to rapid increase in the population of our country and need to meet the increasing demands of irrigation, human and industrial consumption the available water resources in many parts of country are getting depleted and water quality has deteriorated (Ramakrishnaiah et al., 2009). Rivers are polluted due to the discharge of untreated sewage and industrial effluents (Aggarwal et al., 2000). The water quality of the Indian rivers is deteriorating continuously due to discharge of industrial wastes and domestic sewage (Krishnan et al., 2007; Duran and Suicmez, 2007). The growing problem of degradation of our river

Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-4 Issue-1 || February 2025 || PP. 118-123

https://doi.org/10.55544/jrasb.4.1.14

ecosystem has necessitated the monitoring of water quality of various rivers all over the country to evaluate their production capacity, utility potential and to plan restorative measures. Water contaminated by effluents from various sources is associated with heavy disease burden (Okah et al., 2007). The objective of the present research was to provide important information on the physico-chemical characteristics of river Varuna at Varanasi as the river water is deteriorating day by day due to industrial effluents, agricultural runoffs, chemicals from battery workshops, dyes from saree printing houses and automobile servicing stations.

I. MATERIAL AND METHODS

2.1 Study area

Varuna is the Hindu God of water and celestial ocean, as well as a god of law of underwater world. It originates from $25^0$27`N $82^0$18`E/25.450^{0}N 82.300^{0}E on the borders of Jaunpur, Prayagraj, Pratapgarh into the Inoojh taal of Malhan Lake $25^0$19`46``N$83^0$02`40``E/25.32944^0 N83.04444^{0}E. This river travels 202km. and merges into Ganges at Varanasi`s Sarai Mohana situated at Aadikeshav Ghat.

The network of sampling stations in the river course was finalized considering the locations of discharges of industrial effluents sewage. It is being utilized enormously for irrigation and fish culture and various other purposes. The figure of sampling site shown in fig.1. and 2 and table 1.

Fig- 1 Nadesar Varuna Bridge

Fig-2 Rameshwar Varuna Bridge

Table 1: Characteristics of the research sites of Varuna River

CHARACTERS	FIRST STRETCH	SECOND STRETCH
Location	Rameshwar bridge	Nadesar bridge
Important source of Pollution	Agricultural run off	Small scale battery industry, Automobile service station, Small scale saree dyeing industries
Sewer line pouring into The river	Razabazar sewer, sewer opposite to Kashiram Aawas	Baghwa sewer, Chaukaghat sewer

2.2 Collection of samples

After a vigourous survey of the river Varuna, 2 sampling sites were selected along the stretch of the river for the assessment of water quality. These samples were collected in a humid – rainy season of the year 2024 to monitor changes caused by Agricultural runoff, Urban discharge, Heap of municipal solid wastes, Industrial effluent as well as Natural resources. Samples were qualitatively analyzed for different physiochemical and microbiological parameters. Sampling locations are shown in fig. 1 and 2.

The qualitative and quantitative status of water in any area, much more depends up on the topographical geological, seasonal and socio-economical conditions of the area. Most of these factors are directly responsible for the quality of water sources. Keeping this in view, water samples from various sources with special reference to physio-chemical and microbiological levels. Much care should be taken, so that bubbling should not be observed during sampling, which avoids influence of the dissolved oxygen. The water of this reservoir is used for agriculture and supports fish culture. The surrounding area of river is rural and agricultural. The need to define quality of water has development with the increasing demand of water, which is suitable for specific uses and confirms to desired quality.

For qualitative and quantitative assessment of pollution level, sampling sites of Varanasi city were selected on the basis of following criteria :

- Location of the water source
- Level of pollution
- Availability and supply of water in society

The temperature , electrical conductivity, total dissolved solids, salinity and dissolved oxygen were determined immediately at the collection sites by the multi-parameter. The objective of the study is to investigate the pytoplanktons present in the water of Varuna river in Varanasi. A study conducted on small water plants throughout the year revealed that different plant species emerge and wither at different times of year.

2.3 Methods

2.3.1 Physio-chemical parameters:

The collected water samples were analyzed for BOD, COD, DO, alkalinity, free CO2 chloride, nitrate and phosphate following the standard protocols of APHA (2005). Whereas, temperature was recorded with the help of Mercury Thermometer, Transparency by the Secchi Disc and pH by pH meter. Depth of reservoir water at various sampling stations was measured with the help of a weight-tied string. Electrolytic conductivity

ISSN: 2583-4053

Volume-4 Issue-1 || February 2025 || PP. 118-123

https://doi.org/10.55544/jrasb.4.1.14

estimated by a systolic conductivity meter having a conductivity cell containing platinum coated electrodes. Conductivity is the numerical expression of water ability to conduct on electric current. Total dissolved solids were determined with the help of a digital TDS meters. All the water samples were analyzed 5 times. Results obtained were expressed as mean± SD

2.3.2 Biological Parameters:

During the course of zooplankton collection, care was taken to keep water body undisturbed and not to allow spilling of water from phytoplankton net. The sample was preserved by adding few drops of the 5%formalin and glycerine. The zooplanktons forms were identified at generic as well as species levels **EDMONDSON (1959).**

Phytoplanktons samples were collected from different stations in polyethylene bottle of 500 ml capacity.one drop of concentrated sample was transferred on a slide and the sample was observed under microscope.

The fishes were collected during evening time by individual local fish market and fishermen. After the collection the fishes were preserved in 10% formalin solution. Preserved fish samples were brought to the laboratory for their identification up to species. The fishes were identified systematically with the help of identification keys given by **JHINGRAN (1975).**

II. RESULT AND DISCUSSION

Understanding the quality of ground water is important because it is the main factor which decides it's suitability for domestic and agricultural purposes. Samples collected from river Varuna and tested are clearly indicative of the deteriorating condition of river water quality and impact of untreated effluents, recklessly being discharged through drains. These variations were mainly due to degree of discharge of untreated domestic and industrial effluent, agricultural runoff and activities of neighbouring population like bathing, washing of clothes, dumping of wastes on the bank of river Varuna. It is found that overexploitation of groundwater has detrimentally affected ground water in terms of quality and quantity. Most ground water samples were suitable for irrigation purpose except one sample. Although the general quality of ground water of the lower Varuna River basin is suitable for irrigation purpose. Application of N- fertilizers on agricultural land as crop nutrients along the Varuna River course is responsible for nitrate pollution in the ground water due to leaching applied irrigation water. The other potential source of high nitrate concentration in extreme northern, southern and south west parts of study area are poor sewage and drainage facilities, leakage of human excreta from very old septic tanks and sanitary landfills. Reverse osmosis, ion exchange and distillation are some of the useful methods of nitrate removal of safe drinking water.

Water temperature is an important water quality parameter, which regulates the biogeochemical activities in the aquatic environment and relatively easy to measure in water bodies which naturally show change in temperature seasonally. The temperature of river Varuna varies ranges from 16 to 30.5^{0}C. The minimum temp recorded in the month of Jan (16^{0}C) and the maximum in the month of June (30.5^{0}C). pH of a water body is very important in determination of water quality since if affects other chemical reactions such as solubility and metal toxicity. pH was positively correlated with electrical conductance and total alkalinity (Gupta, 2009) The pH value recorded ranges between 8 to 8.8. Washing station, discharge of industrial and domestic waste and leachate from heap of municipal solid waste along the river bank may be a significant cause of change in river water pH.

Electrical Conductivity is the measure of water capability to transmit electric current and also it is a tool to assess the purity of water. Electrical conductivity recorded in river Varuna ranges between 200 mho/cm to 350 mho/cm Navneet Kumar et al., (2010) observed that underground drinking water quality of study area can be chaked effectively by controlling electrical conductivity of water .A number of ions enter into the river through point and non-point sources in the form of dissolved salts and in-organic materials such as alkalis, chloride, sulfides and carbonate compound may be a significant cause in changing EC of the river water (APHA,2017 and Khadri and pandey, 2022).

Turbidity of water is the expression of optical property in which the light is scattered by the particles present in water. (Verma et al,2012). High turbidity shows presence of large amount of suspended solids. Turbidity is the condition resulting from suspended solids in the water, including silts, clays, industrial wastes, sewage and plankton.

Water with a high TDS indicates more ionic concentration, which is of inferior palatability and induce an un-favourable physio-chemical reaction in the consumers. Kataria et al. (2006) reported that increase in the value of TDS indicate pollution by extra-neous sources. The amount of TDS recorded in the water of river Varuna ranges between 500ppm to 650ppm. A number of dissociate electrolyte as well as dissolved organic matter enter into the river water through a number of point and non-point sources may also be the cause of increased TDS in the river water.

The amount of acidity recorded in river Varuna ranges between 5.4 mg/l to 7.7 mg/l. Human-induced air pollution, acid-rain and industrial discharge may be a significant cause in fluctuation in acidity of river water.

Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium. (Gopal Krishna H.2011). The amount of alkalinity recorded in the water of river Varuna ranges between 220mg/l to400 mg/l.

Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-4 Issue-1 || February 2025 || PP. 118-123

https://doi.org/10.55544/jrasb.4.1.14

Disposal of dead bodies of animals, clothe washing station and urban discharge through open drains in water bodies may be considered as a significant cause for increasing the value of phenolphthalein alkalinity. Nitrates are contributed to freshwater discharge of sewage and industrial wastes and runoff from agricultural fields (Verma et al.2012). The amount of nitrate recorded in the water of river Varuna ranges between 0.2mg/l to 1.0mg/l. Increasing trend of nitrate in river water bodies may be due to increasing loadings of organic waste disposal from point and nonpoint sources.

Hardness is the parameter of water quality used to describe the effect of dissolved minerals (mostly Ca and Mg), determining suitability of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates., sulphate, chlorides and nitrates of calcium and magnesium (Taylor, E.W.1949). The amount of hardness recorded in the water of river Varuna ranges between 220 mg/l to 400mg/l. Agricultural runoff, urban discharge, industrial effluent and clothe washing station through open drains in water bodies may be significant cause for increasing the value of hardness in river water bodies.

BOD determination is still the best available single test for assessing organic pollution (Verma *A.K and D.N Saxena*, 2010). BOD of water samples value was indication foe entry of organic waste in the river Ganga at Varanasi and showed that high value is indication of organic pollution. The amount of BOD recorded in the water of river Varuna ranges between 30mg/l to 190mg/l. Depletion DO, increasing the TDS, high quantum discharge and lake of adequate water flow may a significant cause to increasing BOD in river water bodies. Permissible limit of BOD for aquatic system is 6mg/l. (table-2 and 3)

Table 2: Showing the physio-chemical characteristics of Varuna River in site 1

Parameters	Month wise study (Site-1)					
	January	**February**	**March**	**April**	**May**	**June**
Water temperature	16±1.0	19.5±0.3	23.9±0.8	27.1±1.0	28.1±0.8	29.9±0.9
pH	8.4±0.5	8.0±0.2	8.7±0.1	8.5±0.05	8.6±0.5	8.7±0.1
Electrical conductivity	246.3±.25	250±1	233±-66	277.6±1	229±0.9	233±0-9
Total dissolved solids	521±1.0	525±0.2	520±1	520.6±0.5	531±1	540±1
Acidity	6.03±0.05	6.2±0.1	6.16±0.6	5.9±0.6	5.4±0.2	6.4±0.4
Alkalinity	223±0.24	329±1.0	310-6±1.2	270.6±0.66	298±1	301±0.9
Nitrate	0.75±0.02	0.99±0.01	0.55±0.03	0.44±0.22	0.29±0-05	0.55±0.03
Hardness of water	291±1.0	296±002	287±1	284.5±0.05	289±0.05	387±-1
Sulphate	33±1.0	34±1.0	29±1	28.33±0.5	29.33±0-5	39±1
BOD	66±0.2	75±0.9	37.33±1.2	32.63±.46	34.46±0-5	56±0.3
COD	56.16±0.1	61.3±0.5	56.56±-9	52.63±.28	158-6±0-4	162.3±.0.5
TSS	43.1±0.5	45.96±1	38±1	33.53±0.5	334.5±1	46-33±0.5
Chloride	27.6±0.57	30.96±0.05	3.6±.6	46.66±0.6	43.66±0-5	48±1
DO	5.8±0.26	7.5±1	3.5±0.3	3.13±0.5	3.4±1	3.16±0.15

Table 3: Showing the physic-chemical characteristics of Varuna River in site 2

Parameters	Month wise study (Site-1)					
	January	**February**	**March**	**April**	**May**	**June**
Water temperature	18-5±0.5	17±0.1	23-9±0.8	27.1±1.0	28.0±0.6	30.5±0.5
pH	8.8±0.05	8.5±0.3	8.7±0.1	8.5±0.05	8.6±0.5	8.7±0.1
Electrical conductivity	346.3±1	300±0.8	233±-0-64	237.±1	249±0.9	247±.1
Total dissolved solids	620±1.0	624±1	619±1	618±0.5	578±0-9	576±0.02
Acidity	7-1±0.1	7.7±0.1	7-4±0.4	7-2±0.3	7-4±0.2	6.2±0.2
Alkalinity	334±0.9	360±0-9	301-6±1.5	370±0.6	355±1	337±0.9
Nitrate	0.58±0.02	0.5±0.1	0.55±0.03	0.5±0.01	0.83±0-03	0.6±0.01
Hardness of water	391±1.0	304±1	387±1	384.5±0.5	364±0.4	362±-1
Sulphate	43±1.0	40±1.0	39±1	38.33±0.5	33.5±0-5	41.33±0.5
BOD	166±0.8	182±0.9	156±0.9	145±1	134±0-6	134±0.3
COD	156±0.6	241±1	162.5±-0.5	255.6±0.8	258±0-4	261±.15
TSS	47.86±0.8	50±1	46.3±0.57	43.3±0.5	53.4±1	35.8±0.8
Chloride	25.66±0.5	22.6±0.5	48.0±.1	49.5±0.5	47.6±0-6	45.9±0.8
DO	8.5±0.4	9.3±1	3.16±0.1	4.1±0.1	4.6±0-3	3.3±0.1

Chemical Oxygen Demand test is quite useful in assessment of pollution strength of industrial waste and domestic sewage. COD as is the amount of oxygen required for a sample to oxidize as its organic and inorganic matter. The amount of COD recorded in the water of river Varuna ranges between 50mg/l to 250

ISSN: 2583-4053

Volume-4 Issue-1 || February 2025 || PP. 118-123

https://doi.org/10.55544/jrasb.4.1.14

mg/l. The increase in COD concentration was found in the bottom water where organic matter is more **(Prasad and Qayyum1976).** Discharge of industries located at bank of river Varuna and leachate from the heap of municipal solid waste disposed along the bank can be considered as sizeable contributor to inorganic and organic carbon to raise COD.

Planktons In Water: Plankton are the microscopic organism of aquatic ecosystems. Phytoplankton are the producers of aquatic ecosystems as they store sun energy and supply the energy to higher tropic levels. They make their food by the process of photosynthesis. They provide food to zooplankton, fishes and other higher organisms in aquatic ecosystems. Phytoplankton and zooplankton constitute natural food for fish fry and adults and an adequate supply of these items are essential for the proper growth of fishes.

Phytoplankton Diversity: Chlorophyceae which is green algae and accounted for the major share of phytoplankton diversity. In the Varuna River there are some phytoplankton present which name is Hydrilla, Cyanobacteria (also known as blue green algae) certain diatoms, hyacinth, and colored flagellates (particularly chrysophyta and euglenophyta). Certain algae flourished in water polluted with organic wastes play an important part in self -purification of water bodies. Nostoc and Occilatoria which grow rapidly in polluted water due to the presence of nutrients.

Zooplanktons Diversity: Zooplankton played a connecting role in the material cycle of water body (Chen, G 2012,2020) Zooplankton makes a significant link in the food web operating in an aquatic reservoir and other aquatic ecosystems. It's regulated the energy and material cycle, which was closely related to water quality. Zooplanktons depend on phytoplankton and provide food to higher organisms in aquatic ecosystems. Protozoans, larval crustaceans, some fishes are found in river. Cyclops was also identified during the study. Rotifers, comman zooplankton in water body have short life cycle, could respond to the change of environment more quickly and good indicator also. Some protozoans, daphnia and other zooplankton also observe in varuna river in present study.

Analysis of fishes: Various type of fishes were found in the river water during study. Some river fish have two behavioural phase one migratory and one static. Fishes are used for various purposes like use for food, some fishes use for laboratories and experimental purposes. Varuna river supports a large number of commercially important fish species, including the major and minor carps. Some fishes are as follows.

III. CONCLUSION

River water pollution is not only an aesthetic problem, but a serious economic and public health problem as well. Agricultural, obstaction of water for irrigation and drinking, washing clothe and utensils. Discharging of sewage waste, send dredging and religious ritual activities along the stretch were generating serious threat to biota by altering the physio-chemical and biological concentration of river system. There is neither protected area nor any hindrance exist in the whole waterway. Information gathered from local populace that, the availability of maximum water is only during monsoon season. Both banks of Varuna River is very much fertile.

Moreover, this analysis will help in future water control management program as it has outlined the parameters contributing to pollution for every site. It is therefore needful, to develop a comprehensive river water quality monitoring program all over the world.

Nitrate and fluoride contamination of groundwater is a serious problem for its domestic use. River water though has some self purification capacity, but in most instances the level and quality of wastes and effluent discharged are far beyond the purifying capacity. There is urgent need for making the policy for the conservation of river and tributaries and monitoring of the river water quality. Water quality can be improved by creating awareness in the local public about the degrading status of river, by making farmers understand about proper use of fertilizers and pesticides in forms and also formulating action plan to save the river from drastic pollution.

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